A STUDY OF VISUAL INTELLIGENCE AND THE INFLUENCE OF A VISUAL ENRICHMENT PROGRAM ON MEASURES OF IQ AND CREATIVITY ON 10 AND 11 YEAR-OLD STUDENTS NOMINATED AS GIFTED

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A Study of Visual Intelligence and the Influence of a Visual Enrichment Program on Measures of IQ and Creativity on Students Nominated as Gifted

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ABSTRACT

This thesis is a study of general intelligence, creativity, advanced intelligence and visual thinking. The study uses narrative, creative design, literature review and empirical testing. The wide scope of the literature review was considered necessary to this multi-faceted study of intelligence, giftedness, creativity and visual thinking.

The study initially tested 305 subjects at the Year 5 level, across 15 South Australian Government primary schools, to assess their measured general intelligence, creativity and visual skills. The following tests were used: a figural test of IQ, the Raven's Progressive Matrices (RPM, Standard Form); the Torrance Test of Creative Thinking (TTCT Figural Form A) and the *Figures of Sound* instrument (FoS), which the author designed to identify markers of visual thinking ability.

Following the period of testing, the author designed and taught a 30 hour visual enrichment program, entitled the *Turning World,* in 10 consecutive weekly sessions at the University of Adelaide to a class of 20 students who were nominated by their teachers as students with high intellectual potential.

A year after the initial testing, the original cohort which was available for testing (n=193), including the subjects who had completed the *Turning World* program, were re-tested with the RPM as well as the parallel form of the TTCT (Figural Form B).

The author designed the FoS instrument around the principles of visual form which Wassily Kandinsky designated as point, line, plane and colour. The FoS is not presented as a final product or a standardised instrument but an original idea in progress.

This thesis presents the author's design of the *Turning World* program based on the principles of a differentiated curriculum. This visual enrichment program resulted in changed measures of intelligence and creativity for the students who completed it.

This thesis examines:

1) whether visual thinking is a factor in advanced intelligence and whether it can be measured with appropriate instruments and enhanced by teaching interventions

2) current theories of intelligence, creativity, and giftedness

3) the inclusion of visual thinking in higher-order thinking programs and outlines a grammar of universal form

4) the design and execution of an enrichment program on visual thinking for students nominated as gifted by their teachers

5) current measures of creative thinking

6) measures on the RPM, the TTCT and the FoS and their correlates

7) results of the research and presents proposals for future areas of investigation.

DECLARATION

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

I give my consent to this copy of my thesis, when deposited in the University Library, being available for loan and photocopying.

Signed:

Dated: June 30, 2003

DEDICATION

I dedicate this work with love to my Father

Hugh McCann

(1920 – 1983)

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Chapter 1: Visual Intelligence and the IQ/Creativity Interface: A Statement of the Problem, Research Questions and Hypotheses

Clear and precise seeing becomes as one with clear and precise thinking
(Tufte, 1997: 53).

[The purpose of this chapter is to provide the background to the study and a statement of the problem; outline the basic questions which prompted the research; provide a definition of visual intelligence; and provide the rationale for a study which updates the latest research on the relationships between intelligence, creativity, giftedness and visual thinking ability; central hypotheses are stated]

1.0. Background to the study

The earliest studies on intelligence were prompted by observations of individuals who evidenced difficulties with intellectual processing and who consequently displayed poor adaptive or general functioning skills. The first tests designed to measure intellectual functioning were intended primarily to help meet the special needs of these individuals who in general are labelled as having some degree or kind of intellectual disability. Depending on their positioning on the lower side of the Normal Curve of intellectual ability, such individuals require special support if they are to reach their natural intellectual potential. Only in recent years have some studies focussed on the needs of the equal number of individuals on the upper side of the Normal Curve. These individuals do not identify themselves so readily as requiring special identification or support, and consequently research on their characteristics and the most appropriate methods of catering for them is relatively recent and relatively sparse.

Although there are varying *degrees* and *kinds* of their advanced intellectual abilities, such individuals are commonly labelled as 'gifted'. Most policy and curriculum documents in Australia and other Western countries refer to "Gifted and Talented" children and the implications of this wider term will be discussed in this thesis. It has been a difficult task in Australia to convey the message to educators, researchers and politicians that "Gifted and talented children exist across all socioeconomic and ethnic groups within Australian society (and that) they have a right to be given appropriate educational opportunities to realise their gifted potential" (Kronborg in Vialle & Geake, 2002: vi). While individuals with an intellectual disability have, during the last century, gained the sympathy and support of the community in general, their history previous to this era was one of suspicion, contempt and rejection. Before the causes of and appropriate support for individuals with intellectual disability were researched and better understood, such individuals were alienated by society, often 'locked away'

with individuals with mental illnesses and physical disabilities and denied access to an education appropriate to their abilities in the regular, 'neighbourhood school'. Interestingly, there has been a documented history of antagonism to meeting the needs of gifted children. Less than twenty years ago one Australian State teachers' union had officially 'black-banned' any specialised provision for gifted students, claiming such intervention was elitist. The statement issued to justify a rejection of provision for gifted students stated:
"While there is one disabled child in this State, there will not be specialised provision for gifted children"(in Start, 1983).

Very senior educational leaders and advisors in Australia have been cited with obvious deep-seated, negative attitudes to gifted students as this public comment from a Chief Executive of Education in the State of Victoria indicated:

> *I don't have a view about what you do for 1% of the population. We think all kids should have opportunities, not just those who are defined by some probably suspect IQ test as having special abilities*
>
> *(Morrow in Boag, 1990: 48).*

The fact that 'one percent' was the identified population and the means of defining it 'suspect' reveals a great deal about these deep-seated and basically ignorant observations. Yet even in the 1990's this ignorance of the nature of giftedness and its incidence in the general population fuelled many to adhere to the belief that "helping the gifted overlooks and devalues the excellence that is inherent in everyone" (Turner in Boag, 1990: 49). In an attempt to counter this antagonism, the Australian Senate Enquiry into Gifted Students, released in October 2001, has highlighted as Recommendations 2 and 3 (from 20 recommendations in total), that the Commonwealth:

> *should commission research into the reasons for negative attitudes to high intellectual ability ... (and that) ... peak education policy documents ... where they refer to special needs or individual differences, should make it clear that 'special needs' includes giftedness*
>
> *(Senate Employment, Workplace Relations, Small Business and Education References Committee, 2001: xiv).*

The release of this Senate Enquiry has fuelled hopes that, with the increases in training in gifted education which will flow from it, attitudes of suspicion and negativity that have beset appropriate provision for gifted students will eventually disappear.

The need for increased teacher education was identified by Strom in his keynote presentation to the very first National Seminar on the Education of Gifted and

Talented Children in Australia in 1981, when he stated, "Whether teachers favour the gifted, reject them for behaving in non-conforming ways, or fail to notice their talent, better training is implicated.' (Strom, 1981: 11)

It is a basic tenet of this study that gifted individuals, as human beings, are no better than individuals who do not have advanced intellectual potentials, however they are *different* in some ways, and this difference needs to be identified, understood and accommodated, particularly in Education. That all human beings differ in intellectual potentials and functioning has been known for a long time, yet giftedness has suffered from the incorrect notion that it only encompasses the genius, even the 'freak of nature' who constitutes a fraction of the population. With knowledge comes insight and the attendant political and wider community support, as Vialle & Geake have stated: "It is this reconceptualisation of giftedness as an ordinary difference that promises to capture a wider base of political support"(2002: xxvii). While the Australian attitudes to gifted individuals are changing to recognition and support, studies on giftedness are still few. It is a new field of educational research and practice.

This thesis provides an examination of the advances in studies into the nature of intelligence, creativity, and giftedness, and the unique role that visual thinking ability plays in the determination of these characteristics.

This study reaches conclusions and recommendations, but not closure. It is a unique glimpse, through assessments, creative design and teaching practice, at the interplay of factors which describe thinking in general, advanced thinking specifically, and how these abilities are determined by visual intelligence and creative production.

Early markers of intellectual development in children invariably stress verbal ability: early language skills, reading, and early writing ability feature on observational checklists and standardised testing procedures especially those that yield an Intelligence Quotient or IQ. Visual ability, perhaps as evidenced in drawing productions or appreciation of visual form, has only recently been suggested as a possible insight into intellectual development but does not feature in most measures of intelligence. Creative abilities, such as unusual thought processes, original or fluent productions, flexible or different responses, also have not been traditional, standardised markers of intelligence.

The focus on visual thinking has been prompted from the research, particularly in cognitive neuroscience, on the early development of visual intelligence in the brain, the significant portion that the brain allocates to visual intelligence, and the links between visual intelligence and higher-order, original problem solving. Of all the senses, it is vision which is developed in the most active and complex way at birth, as Hoffman (1998: 12) states:

> *Among the most amazing facts about vision is that kids are accomplished geniuses at vision before they can walk. Before age one, they can construct a visual world in three dimensions, navigate through it quite purposefully on all fours, organise it into objects, and grasp, bite, and recognise those objects …*

This thesis presents the design and implementation of a visual enrichment program, the *Turning World*, designed for students nominated as exhibiting high intellectual potential. The study also outlines the author's original pilot instrument called the *Figures of Sound (FoS)*, designed to explore visual thinking and compares responses to it with results on the Torrance Tests of Creative Thinking (TTCT) Figural Forms A and B. In addition, scores on the standardized IQ test, the Raven's Standard Progressive Matrices (RPM), provide this study with new data on the creativity-intelligence interface referred to in some studies on advanced intelligence.

An exploration of the links between intelligence, creativity, giftedness and visual thinking is at the heart of this study.

It is argued that creative and visual acuity are central factors in the configuration and measurement of general intelligence and that their failure to feature in some definitions of intelligence and many measurements of giftedness is a result of difficulty with identification and assessment procedures, and the pluralistic nature of intelligence in general and giftedness specifically.

1.1. Statement of the problem

The initial prompt for the design of this study was twofold. First, the author wanted to clarify the documented relationship between the measurement of intelligence and the measurement of creativity and possibly explain the lack of correlation between the two concepts which some researchers have identified at the upper levels of IQ measurement. Second, the author wanted to identify the key markers of visual intelligence and examine the possible links with advanced intelligence and creativity.

It has been the observation by the author over twenty-seven years of teaching experience in schools and universities, that education in general and schools specifically, do not utilise the visual mode of learning to the same degree that they utilise the visual/linguistic mode. It is an assumption of this thesis that if schools do not value visual learning ability, then they will not develop the means to help identify students who may have specific talent in visual thinking ability, nor will they value programs to train and enrich visual thinking ability. It is further proposed that students who are intellectually gifted are also advanced in their creative and visual thinking skills and that the experience of school can have a negative influence on the development of these special abilities. It is also proposed that exposure to an enriched learning environment which features visual thinking skills will increase these skills. While acknowledging that exposure to enriched learning environments would no doubt increase such skills in children of *all* intellectual abilities, this thesis argues that for intellectual gifted students, their difference in this respect (i.e. visual intelligence), justifies a differentiated curriculum.

1.2. Defining visual intelligence

Before the central research questions are posed, it is important to define the nature of visual intelligence and identify how it differs from verbal intelligence.
The following definition of visual intelligence is proposed by the author and will be followed by an appropriate rationale:

> *Visual intelligence is an active and holistic ability which occupies the highest level of the sensory and perceptual hierarchy and relies upon the excitation of both recent and long-term memory for sense-making and problem-solving. Visual intelligence engages with motor co-ordination and verbal language and is essential to the determination of advanced reasoning ability. Visual artistic intelligence has its own universal grammar, relying on the principles of point, line and colour within a basic plane to communicate.*

The key elements underpinning this definition are elaborated in Chapter 3 of this thesis. In summary however, these elements are:

Visual intelligence is **active**. While verbal intelligence has been studied in both its expressive (active) and receptive (passive) modes, visual intelligence appears to have no corollary in the passive mode of thinking and learning.

Visual intelligence is **holistic**. Verbal intelligence relies on 'piece-by-piece' or linear thinking skills whereas visual reasoning can only occur when a 'whole' is understood, even if it develops from an appreciation of the sum of the parts. Because visual thinking is non-linear it is also chaotic in the positive sense of being able to continually develop. There is no visual equivalent of written language's use of the full-stop.

Visual intelligence occupies a **higher perceptual hierarchy** than verbal ability. The use of words, particularly in the engagement of advanced reasoning and problem-solving, is not as important as the utilisation of images.

Visual intelligence engages **all of the senses** and specifically connects with spoken language and motor co-ordination.

Visual intelligence is essential to **advanced reasoning**, relying on the excitation of recent memory for meaning and sense-making, and long-term memory for problem-solving.

Visual intelligence has a **universal grammar** which pre-dates the development of written/verbal communication. The reason why most school systems do not rely on visual form for communication is that most students and teachers have not learned the grammar of universal form.

1.3. Visual intelligence is different from verbal intelligence

thoughts die the moment they are embodied by words

(Schopenhauer in Penrose, 1989: 424)

Pictures preceded written words as a form of human communication and expression. Hence it could be argued that pictures or other visual forms including colour, are more primitive than nonpictographic language or conventional writing. Conversely, it could be argued that visual representation and communication is a more advanced form of expression than the alphanumeric precisely because it pre-dates the verbal and gestural forms and helped to dictate the development of the written form. It needs to be remembered that alphanumeric communication is a relatively recent phenomenon and that "prior to this century the visual image was often considered to be the crucial element of thought and it is still viewed as central to some types of thinking" (Arnheim, 1969 in Chase, 1973: 35).

Today, with the extent of the visual media's influence on our lives and the reliance on visual representations in the forms of computers, CD roms, PowerPoint displays and the massive assault of the visual media on communication and decision making, it is curious that visual intelligence is not actively trained in schools. As Barry (1997:3) stated:

> *As the enormous impact of images on the quality of individual lives becomes clearer, the necessity to educate people to the implications of an image-driven society becomes more critical.*

The focus on written and spoken language in schools today, with the relegation of visual studies (e.g. Art Education, Visual Media Studies) to 'elective' components of the curricula, suggest that the latter has a reduced importance. Although mathematical and linguistic forms of reading, writing, listening and speaking are regarded as essential to basic education, this thesis will argue that because the alphanumeric forms of expression evolved from pictographic language, "we should not infer that words and numbers are necessarily more recent or advanced" (McKim, 1980: 142). Indeed, the research indicates that,

> *In developmental experience, words not only come later than images, but they are also often inadequate in communicating it, precisely because they are removed from experience and therefore lack the immediacy and power of the real world's change and relativity*
>
> *(Barry, 1997: 74).*

The 'real world' of regular school curricula is focussed on reading, writing and mathematical skills which are viewed as *basic* and not necessarily connected with visual intelligence. Part of the problem with promoting visual arts training is the on-going emphasis by governments on school efficiency in meeting these 'basics' and in Australia the Government's introduction of 'Basic Skills Testing' (BST) in many States and Territories is further evidence of this. It is interesting that the BST does not measure visual thinking or visual artistic ability and perhaps Sylwester's (1998: 31) observation provides the reason:

> *good arts programs are not* **efficient**. *They're difficult to evaluate in an era concerned with measurable standards. Educators have therefore had to continually justify arts programs, but not algebra or spelling.*

The fact that visual arts training is undervalued in schools is not surprising if we consider the wider environment (and this is no doubt true of most Western countries) where, "... it is generally perfectly alright to be artistically incompetent in our culture" (Benjafield, 1992: 307). That this dominant cultural view is reflected in the education system is no surprise but it is the author's opinion that change is needed if students are to be exposed to an education which reflects and enhances this aspect of their intelligence. As Sless (1978: 1) has observed:

> *Our education system is dominated by two areas: literacy and numeracy. It is time a third area of skills was introduced into schools – that of Visual Thinking.*

This thesis argues that both linguistic (including the language of mathematics) and visual intelligence are essential to good thinking but that education values one over the other.

The inclusion of both terms, 'visual thinking' and 'visual intelligence', is important to a central argument of this thesis, which is that intelligence which relies on vision is a general feature whilst visual thinking is a more specific process. Both visual thinking and visual intelligence can be measured, but with much greater difficulty than their verbal intellectual counterparts. Education in general has not progressed very far in an examination of the importance of visual representation to general intelligence, nor have the links between visual intelligence, creativity, and giftedness been adequately explored.

Twenty years ago Howard Gardner proposed his theory of Multiple Intelligences (MI). He was not the first to identify visual/spatial ability as a marker of intelligence but he was the first embody it as a discrete ability within a theory of intelligence (Gardner, 1983; 1997). On the complex relationship between general intelligence and visual thinking, he has posed a series of questions which are relevant to this thesis:

> *How do various visual impressions and images relate to thinking? Are they thoughts in themselves, do they provide the vehicles of thought, do they represent the manipulation of symbolic entities, or are they but epiphenomena, vestiges that do not materially contribute to our ability to know, to learn, or to understand?*
>
> *(Gardner, 1993: 111).*

Despite some advances in research on visual intelligence, it is this author's belief that, at the beginning of the 21st Century, visual representation in the field of Education is still regarded as the 'vestige' of an idea, rather than the idea itself; the illustration of a problem rather than the exploration of the problem or the solving of it. In schools this translates into common classroom practice where students solve problems with written or spoken language, either in words or numerals and if they have the time, they illustrate their work with shape, colour or some other visual form. Such standard classroom practice is the legacy of the limited research on visual thinking and its links with intelligence in general. While the author concedes that "we have emerged from a period in which almost all emphasis in theories of thought has been on verbal or linguistic processes" (Posner in Chase, 1973: 67), more research is needed on visual thinking.

Human beings have many words to describe a state of understanding or belief but few corresponding visual prompts or markers that are easily understood by all. The image of a light bulb flashing is the trite caricature of what Martin Gardner (1992) calls the *Aha*! of thinking; that sudden, illuminating insight into a problem. It is interesting to note that those great thinkers, for whom the *Aha*! has changed the course of history, science, art, mathematics, or whatever field they contributed to, have often cited visual thinking or visual imaging as being at the heart of such awakenings or discoveries.

McKim (1980) points out that much of the language at such times of discovery is actually of a visual kind: I *see* it now! He reminds us that the word 'idea' comes from the Greek *Idein*, which means to *see*, and that "many words link vision with thinking, such as Insight, foresight, hindsight, and oversight ..." (McKim, 1980: 1).

The few studies within the field of Gifted Education, which have focused on children who have displayed visual artistic abilities, have often marginalized such abilities, referring to them as 'talent' and in some instances suggesting that they are not necessarily even related to intelligence. One example here is the studies on savants, which is raised in Chapter 3. It is only within the last few years that some convincing research studies have gone beyond identifying the simplistic markers of visual talent, such as early, fluent and precocious drawing ability, to a deeper analysis of the visual intelligence underpinning such ability. It seems that the artworks of artistic savants, (those individuals with apparent intellectual or adaptive impairment but precocious drawing ability), display an "impaired capacity for abstraction" (Morelock & Feldman in Heller et al, 2000: 228) which the earlier research by O'Connor & Hermelin (1987) highlighted. It seems that the 'pocket' of outstanding ability evidenced by savants is still impaired by this feature, along with very limited creativity in general:

> *Savants appear to be incapable of producing totally original work ... even the prodigious savant does not achieve a higher order of creativity – the invention of new ideas and new ways of seeing things*
>
> *(Morelock & Feldman in Heller et al, 2000: 230).*

The research suggests however, that children who are very advanced in their visual intelligence think and perform in a qualitatively different way from other children and that correct or precise reproductions of form (which savants are capable of) are not indicative of higher-order thinking abilities.
As the work of Winner & Martino (in Heller et al, 2000: 95). suggests:

> *Children who may be labelled 'gifted' in drawing are not just more advanced than typical children in drawing milestones. Rather, they draw in a qualitatively different way ... Using the terminology of Piaget, Milbrath (1998) ... argues that artistically gifted children are guided by 'figurative' rather than 'operational' processes ... according to Milbrath, these children actually see the world differently.*

This difference in *seeing* (and presumably thinking) is described by Milbrath (1998) as characteristic of children who:
(1) *encode* visual information more accurately, and see the world less in terms of concepts and more in terms of shapes and visual surface features
(2) have superior visual *memories*

(3) attend more to the act of drawing itself: they can *see* when something looks wrong, and this leads to discoveries about how to represent the world on paper.
In Milbrath's terms, these children are "better at seeing, remembering and doing" (Winner & Martino in Heller et al, 2000: 96).

Despite the lack of research into possible links between visual intelligence and problem solving ability, it is relevant to note that acute visual memory has often been cited as attending a cognitive breakthrough or a problem solved, even when the problem was not necessarily of a visual nature. Charles Darwin's heightened visual memory and acuity is recorded as he made a breakthrough in his theory of evolution: "I can remember the very spot in the road, whilst in my carriage, when to my joy the solution occurred to me" (*The life and letters of Charles Darwin*, 1887 in Edwards, 1986: 3).

Many great scientists, musicians and artists have showed a propensity for visual intelligence from an early age. Gertrude Stein observed of Picasso, that he " … wrote painting as other children wrote their *a b c* … drawing always was his only way of talking" (in Gardner, 1993: 140). Interestingly, Picasso also treated numbers as if they were visual patterns rather than symbols for quantities "for example seeing a pigeon as an arrangement of 0s, wings as 2s, and the baseline as the sum of the figures … he anthropomorphised the numerals and was distracted by his own fantastic perceptual abilities" (in Gardner, 1993: 141).

Although many examples of visual thinking and advanced intelligence can be noted, such as that of Picasso, it should be remembered that visual thinking is not the exclusive (or even reclusive!) reserve of visual artists. Visual thinking is regarded as essential thinking in many diverse fields as McKim (1980: 7) has noted:

> *Surgeons think visually to perform an operation; chemists to construct molecular models; mathematicians to consider abstract space-time relationships; engineers to design circuits, structures, and mechanisms; administrators to organise and schedule work; architects to coordinate function with beauty; carpenters and mechanics to translate plans into things.*

It has traditionally been assumed that visual thinking is not within the realm of mathematical, scientific, or other 'quantitative' explorations, unless it fulfils some illustrative purpose. However, more recent research has confirmed the necessity of visual explanations and the visual display of quantitative data to clear thinking and problem solving. Indeed in the modern world the visual reasoning about data is almost a daily activity. For this reason it is difficult to explain why visual reasoning and visual expression skills are given a lower priority in education than verbal or written skills. As Tufte (1997: 53) has stated:

> *Visual representations of evidence should be governed by principles of reasoning about quantitative evidence. For information displays, design reasoning must correspond to scientific reasoning. Clear and precise seeing becomes as one with clear and precise thinking.*

It would seem from the limited research that at the highest levels of thinking, visualization dominates over verbalisation. For example, the famous mathematician Roger Penrose claims that visual thinking has dominated the thinking processes of the most gifted of the mathematicians known to humankind. Penrose himself claims that his own mathematical thinking is of a non-verbal kind, and that "almost all my mathematical thinking is done visually and in terms of non-verbal concepts, although the thoughts are quite often accompanied by inane and almost useless verbal commentary, such as *that thing goes with that thing and that thing goes with that …*" (1989: 424).

In addition he cites the words of other gifted mathematicians and their own observations are worthy of consideration here:

Albert Einstein:

> *The words or the language, as they are written or spoken, do not seem to play any role in my mechanism of thought. The physical entities which seem to serve as elements of thought are certain signs and more or less clear images which can be 'voluntarily' reproduced and combined … the above mentioned elements are, in my case, of visual and some muscular type. Conventional words or other signs have to be sought for laboriously only in a second stage, when the mentioned associative play is sufficiently established and can be reproduced at will …*

Francis Galton:

> *It is a serious drawback to me in writing, and still more in explaining myself, that I do not think as easily in words as otherwise. It often happens that after being hard at work, and having arrived at results that are perfectly clear and satisfactory to myself, when I try to express them in language I feel that I must begin by putting myself upon quite another intellectual plane. I have to translate my thoughts into a language that does not run very evenly with them …*

Hadamard:

> *I insist that words are totally absent from my mind when I really think and I shall completely align myself with Galton's in the sense that even after reading or hearing a question, every word disappears the very moment that I am beginning to think it over; and I fully agree with Schopenhauer when he writes, 'thoughts die the moment they are embodied by words'*
>
> *(in Penrose, 1989: 425).*

Given such insights, it is curious that spatial intelligence and advanced mathematical functioning have only recently been linked in the research (Geake, 2000b; Geake & O'Boyle, 2000) and that developmentally, visual intelligence has not been regarded as important to overall intellectual development as, for example, verbal intelligence is.

Other scientists, mathematicians and artists (Penrose, 1989; Rucker, 1989; Hertjer, 1986; Perkins, 1992; Cowie, 1992) have referred to the phenomenon of visual thinking as the key to understanding creative intelligence.
Comparisons relating to the power of creative visual thinking, have been made between the two famous and gifted mathematicians, Henri Poincaré and Albert Einstein. While both were born into relatively privileged families for the time, Poincaré excelled early in academic pursuits while Einstein struggled through a school and university career which he desperately described as a "comedy" (Miller, 1998: 51). As Miller further records:

> *No two early lives of highly creative scientists could have differed more than those of Poincaré's and Einstein's. Dramatic contrasts emerge between their school careers, personal lives and early reception of their research efforts ... in 1905 they both possessed the same data and mathematical formalism to formulate a theory of relativity. Yet only Einstein succeeded. Einstein's visual mode of thinking, in contrast to Poincaré's nonvisual mode, made the difference here (Miller, 1998: 51).*

Einstein claimed that visual and motor images, not words or language, served as the elements of his creative thought. That these images were not only visual, but engaged with notions of proportion, order and beauty, is further evidenced in the words of his son, who once said of his father,

> *... he had a character more like that of an artist than of a scientist as we usually think of them. For instance, the highest praise for a good theory or a good piece of work was not that it was correct nor that it was exact but that it was beautiful*
>
> *(Hans Albert Einstein in Edwards, 1986: 230).*

Einstein could *see* the beauty in mathematics, not just understand it.

From the time a child is born, a significant period of time is devoted to training his or her speaking and listening language skills. Ability to communicate verbally and in writing is considered essential to normal human development. However, as the famous linguist Hayakawa has pointed out, learning the verbal means of communication within a culture can be as limiting to good thinking as being trained from an early age to paint red flowers on a green stem can be limiting to visual art ability. Hayakawa (in Kepes, 1969: 8) claims that how we are 'taught to see' in either words or images can extend or limit our thinking skills:

> *Whatever may be the language one happens to inherit, it is at once a tool and a trap. It is a tool because with it we order our experience, matching the data abstracted from the flux about us with linguistic units: words, phrases, sentences. What is true of verbal languages is also true of visual 'languages': we match the data from the flux of visual experience with image-clichés, with stereotypes of one kind or another, according to the way we have been taught to see.*

Kepes (1969) used the term, the 'Language of Vision' to describe the principles of clear communication through visual form. Kepes argued that visual form itself is a language, albeit one that most human beings do not understand.

The Russian artist, Wassily Kandinsky (1866 - 1944), believed passionately in the power of visual language to communicate and express emotions. Kandinsky claimed that this process relied on the two major principles of colour and form, but he stressed that "form can stand alone…"(Kandinsky, 1926 in 1979: 28). It is a central argument in this thesis that knowledge of, and appreciation of form is linked with intelligence and specifically helps to explain giftedness.

1.4. The purpose of this study and key research questions

The purpose of this study is to research the links between visual thinking ability, creativity, general intelligence and giftedness; to determine the stability of standardised and non-standardised measures of such abilities over the period of one year; and to propose guidelines for alternative assessments of such abilities as well as provide guidelines for differentiated curricula in visual thinking skills.

Both qualitative and quantitative methodologies underpin this study.
The qualitative aspects of the study update the links between general intelligence, creativity, giftedness, and visual thinking and present the design of an original instrument *(FoS)* to explore visual thinking as well as the design of a visual enrichment program (the *Turning World*). This qualitative exploration is made through narrative, literature review, and creative design.

The quantitative aspects of this study present research findings comparing the performance of children at the year 5/6 level of schooling on a measure of figural intelligence (the RPM), and measures of visual creativity (the TTCT Figural forms A and B). In addition, the study presents the design of the FoS, an instrument to identify visual thinking ability and compares results on this instrument with results on the standardised tests of visual creativity and visual IQ. This thesis also reports on the effects of the visual enrichment program on measures of intelligence and creativity.

The thesis examines the stability of IQ and creativity testing over a period of one year. In addition it sheds new light on the little known asymptotic relationship between standardised tests of IQ and creativity. It proposes that visual thinking ability has its own grammar or universal language in the same way that verbal ability has.

Key questions addressed in this thesis are:
(1) what is the nature of intelligence, creativity, and giftedness?

(2) what is the nature of visual intelligence and what are its links with general intelligence, creativity and giftedness?

(3) how have our conceptions of, and measurements of intelligence and creativity changed over the past century?

(4) how can we design and teach visual enrichment programs, suitably differentiated for gifted students?

(5) how can we measure creativity with the kind of accuracy normally afforded the measurement of IQ and can we measure visual intelligence?

(6) what are the correlates of intelligence, creativity and visual thinking and are there gender or environmental influences which need to be considered?

(7) how stable are standardised scores of IQ and creativity over the period of one year and how reliable is teacher nomination in comparison with such scores?

(8) what are the new directions in the measurement of and enrichment of visual thinking, creativity and differentiated programs for gifted students?

The central hypotheses posed from these questions are:
1. visual intelligence is a central component of advanced creativity and intellectual giftedness

2. the RPM and TTCT are stable measures of figural IQ and figural creativity

3. the RPM and TTCT will correlate asymptotically, i.e. at the low to above average IQ/Creativity interface but not at the highest levels of performance

4. teacher nomination is a sound indicator of giftedness as measured by IQ scores but not necessarily as measured by creativity or visual thinking tests

5. training in visual thinking can enhance visual intelligence

6. a universal language or grammar of visual intelligence exists and can be identified and measured.

This chapter has provided the background to the study and posed the central research questions.

The Literature Review in the next chapter of this thesis explores the parameters of intelligence, creativity and the varying definitions of giftedness or advanced intellectual potentials. Some definitions of giftedness include the concepts of creativity as well as psychometric intelligence (Getzels & Jackson, 1962; Wallace & Wing, 1965; Guilford, 1967, 1988; Renzulli, 1974, 1986; Torrance, 1989; Sternberg, 1988, 1990; Sternberg & Lubart, 1991). Other definitions separate advanced intelligence into giftedness (assuming an innate ability) and talent (assuming some evident, specific skill or performance) and conclude that creativity may be just one domain of ability (Gagné, 1985; 1998).

The debate on the IQ-creativity interface is relevant to this research because the studies which have examined the correlations of creativity measures with psychometric measures of intelligence have generally found only a moderate to low correlation (MacKinnon, 1978; Reis and Renzulli, 1982; Davis and Rimm, 1989; Phillipson, 1999; Cropley, 2001; Heller et al, 2000). Conversely, whilst advanced measures of psychometric intelligence do not guarantee advanced creativity measures, low creativity scores generally attend low IQ scores (McNemar, 1964 in Khatena, 1992). The research consistently raises deficiencies in both IQ testing and creativity testing, in particular identifying problems with content validity and standardisation.

Torrance (1962, 1970, 1989) has defended creativity testing, claiming that the Torrance Tests of Creative Thinking (TTCT) identify the gifted population more reliably than IQ tests. Although the TTCT are generally recognised as the best available tests of creativity, and the most often cited in Gifted Education research (Colangelo & Davis, 2003; Cropley, 2001; Heller et al, 2000), the shortfalls of the TTCT and other tests of creativity have been noted (Wallace and Kogan, 1965; Wallace, 1970; Simonton, 1988; Lubart, 1990; Urban & Jellen, 1993; Baer, 1994; Heller et al, 2000; Cropley, 2001) and are outlined in this thesis. In particular, the fact that creativity measurements fail to identify subjects at the highest levels of IQ (Khatena, 1992) is explored.

This study proposes to clarify the concept of visual intelligence and visual creativity and to offer an assessment of such abilities within a context which has greater usefulness and ease of scoring for teachers than any previous designs. The active, practical dimension to this study is presented in the design and implementation of the university-based enrichment program for students nominated by their teachers as gifted. This thesis was designed as a qualitative study, providing an exploration of the links between intelligence, creativity and visual thinking but it also provides the quantitative data on these links. Currently there are not the instruments accurate enough to definitively and quantitatively measure this interface. In this study, empirical measures have been obtained from the whole initial group (n=305), including the measurements of IQ, creativity and visual thinking which were taken while the subjects were in Year 5. The group was then re-tested on IQ and creativity one year later when they were in Year 6.

The enrichment program was not designed to 'change' IQ, creativity, or visual thinking abilities in the students who participated in it. However, the results, as detailed in Chapter 7, do suggest that there were changes in the measurements of IQ and creativity following the enrichment program.
The Literature Review which follows in Chapter 2 provides much of the rationale for this study and highlights the research and the lack of research underpinning the key questions and the hypotheses raised in this chapter.
As T.S. Eliot has so aptly put it,

To make an end is to make a beginning ...the end is where we begin ...

and like any rigorous academic work, the completion of this study raises as many new questions as it addresses.

Chapter 2: Literature Review: Intelligence, Creativity and Giftedness

... the path to the future lies through the corpus callosum ...
(Carl Sagan in Clark, 1997: 392)

[The purpose of this chapter is to provide a detailed literature review of current conceptions of intelligence in general, creativity, and giftedness]

Section A: Intelligence

2.1. General Intelligence

The 17th Century philosophical and mathematical viewpoint of *dualism* espoused by Réné Déscartes asserts, "there are two separate kinds of substance: *mind-stuff* and *ordinary matter*" (Penrose,1989: 21). Since Spearman's (1927) proposal that intelligence consists of a general ability, labelled *g*, and specific, non-generalisable abilities, researchers have sought to discover the nature of this *g*, the 'mind-stuff', and to find a method of accurately measuring and enriching it. A century ago, the pioneering work of the French psychologist Alfred Binet, supported by Théophile Simon, resulted in the first measures of what was considered to constitute intelligence, and the birth of the Intelligence Quotient, or IQ, ushered in the studies aimed at measuring this hitherto elusive concept of human behaviour. Binet's work (1905), in collaboration with Stanford University's Lewis Terman, resulted in the Stanford-Binet IQ Test and the famous Terman study from 1916 which was the first significant, empirical study of individuals who scored highly on an IQ measure.

The Terman study provided a great insight into the nature of giftedness and the measurement of such ability, yet questions remain regarding the nature of intelligence itself and whether conceptions of intelligence change as researchers' views on what it is to be an intelligent person change. The questions which this chapter addresses are complex and underpin this multi-faceted study: can the complex phenomenon of human intelligence ever be explained, as Jensen (1927) asserted, simply by a number, a score achieved after a detailed question and answer interview lasting approximately one hour with a stranger? What was the popular notion of intelligence a century ago and is it the same today? Is the measurement of intelligence a reliable science, or an ongoing debate? Can intelligence be increased by environmental enrichment or genetic endowment? Do the reported increases in IQ (Flynn, 1987a; Stough, Nettelbeck & Cooper, 1993) suggest that human beings, even from one generation to the next, are becoming more intelligent?

Flynn (1987b: 3) argued that "IQ tests measure something close to the primitive concept of intelligence and attempt to match test scores with popular assessments of intelligence and popular expectations about intelligent behaviour".
These 'popular assessments' of how human intelligent behaviour should be defined, are largely driven by social and cultural mores. Sternberg (1999b) has argued that, in the same way that beauty is regarded as 'in the eye of the beholder', intelligence, in a cultural context is also a relative phenomenon. Yet when it comes to standardised methods of measuring intelligence, a strict set of culturally and universally 'good' or desirable behaviours (such as speed of mental processing) are put forward for examination.

'Intelligence' is a commonly used term yet research on what constitutes it is a relatively recent phenomenon, with the majority of research projects taking place during the last fifty years. The studies have yielded conflicting results and varying points of view. Intelligence has been variously regarded as, on the one hand, a fixed, biologically determined function of the brain, and on the other, a malleable, complex set of characteristics, incorporating emotional and social skills, and relying for development on environmental enrichment as well as genetic endowment. It is clear that at the end of the 20th Century, no universally accepted theory of what constitutes intelligence, nor how to measure it, existed.

Any theory of knowledge should be based on a sound understanding of its component parts and its origins. The Iroquois Indians of Native North America held the theory that the world rested on the back of a giant turtle. The vexing question asked ever since is, what is the giant turtle standing on? Another turtle, *ad infinitum*? Is the basis of the origin of the world, as Hinton has suggested, *Turtles all the way down?* (in Rucker, 1985: 200). Jonathan Swift described an infinite regress of fleas in a poem, which the mathematician Augustus de Morgan rewrote in *A Budget of Paradoxes:*

> *Great fleas have little fleas upon their backs to bite 'em*
> *And little fleas have lesser fleas and so* ad infinitum.

Is there a regressive component to the theory of intelligence indicating that some abilities underpin others? And what of this 'mind stuff'? How much of what we 'think' with is even conscious and how much is subconscious?

It is interesting that an IQ measure reflects conscious responses to problems, yet most of our thinking and learning is subconscious. As we continue to debate the origin and nature of our intellect, perhaps Prospero's claim that *we are such stuff as dreams are made on* (Shakespeare, *The Tempest*) makes as much sense as many of the more scientific theories which abound. Plato believed that the source of our thinking abilities resides within our hearts. As the heart is traditionally linked with our emotions, it is interesting that some of the most recent additions to theories of intelligence have stressed the essential inclusion of feelings and beliefs, including advanced spiritual awareness, in any configuration of intelligence (Silverman, 1993; Goleman, 1996; Sisk & Torrance, 2001; Sisk, 2002).

Many theories have been put forward to explain the origin and nature of intelligence, but which ones can best instruct us in our research? What does intelligence rest on or rely upon for bedrock foundation and development? Is intelligence a *neck-up* concept, primarily the result of genetically acquired neural functioning? Is intelligence the same as cognition? Does creative ability form the basis of intelligence or is it a lucky by-product if the environment has been conducive? Is intelligence illuminated by emotional acuity and sensitivity, or muddied by it? Is intelligence primarily linguistic, conceptual, kinesthetic or visual, or a complex interaction of these and other variables? Is it primarily a *neck-down* concept, assuming that only by our actions, or by what we produce or how we perform, may we be judged as 'intelligent' or not?

There has been a well-documented lack of agreement, even among the experts, about what constitutes intelligence. In 1921 the editor of the *Journal of Educational Psychology* asked several specialists in the fields of education and psychology what they thought intelligence was. All gave different answers with very little overlap. Two examples of what the specialists thought constituted intelligence were the 'ability to carry on abstract thinking' and the 'capacity to acquire capacity'. It would not take training in cognitive processes to appreciate that these are two vastly differing abilities. Sixty-five years later, Sternberg & Detterman (1986 in Howard, 1991: 27) repeated the exercise with twenty-four 'experts', defined as such because they were engaged in professions which required them to research or teach about the intellect at a tertiary level. There were twenty-four different replies, and the four examples below reveal the disparate nature of the definitions put forward. Intelligence was regarded as a:

- differential ability to solve problems
- proficiency in cognitive performance
- repertoire of knowledge and skills available at a single time
- set of independent abilities operating as a complex system.

With such a diversity of definitions and opinions relating to intelligence, is it possible to propose any one theory relating to its origin and development?

Eysenck (in Cropley et al, 1986: 96) points out that intelligence is not one 'thing' but "it is a concept; it is just an idea in scientists' heads". He likens intelligence to gravity, energy, time, and heat. Gravity in particular is an interesting analogy as it can be both a scientifically observed phenomenon and a behaviour (Jewell, 2000). Eysenck reminds us that in physics there is still no unified theory of gravity, after three hundred years with the most brilliant minds devoted to its solution. In comparison, the study of intelligence has a much shorter history. Eysenck stressed that intelligence, as a *concept*, could take at least three different forms:

Intelligence A - the biological basis of intelligence: that which is genetically given, which underlies all cognitive processes, and all differences in cognitive processes

Intelligence B - social intelligence: the application of intelligence to social problems, educational problems or general survival problems, and

Intelligence C - simply a number, or the IQ measurement of intelligence: the figure generated through psychometric testing which can vary a great deal from one individual to another (Eysenck in Cropley et al, 1986: 97).

That intelligence can be defined as quite different constructs is not a new phenomenon. Earlier work by Hebb (1949 in Biggs, 1993: 154) had proposed that intelligence is made up of:

Intelligence A: a biological or innate capacity that is never measured directly,
Intelligence B: the capacity for *acting* intelligently, a function of A, and *learning*.

Vernon (1969) agreed with Hebb's theory but twenty years later added
Intelligence C: the figure generated by psychometric testing or what intelligence tests measure.

It is clear that the researchers in this new field of study need to state their particular convictions about the nature of intelligence at the outset, as each could be talking about quite different concepts or abilities without this clarification.

2.2. Intelligence as brain function

Intelligence has been recognised as a physical state of being or a condition for many centuries, and we know that the ancient Greek and Roman philosophers discussed it at length. Prior to these records, it can only be assumed that human beings noticed differences amongst each other in certain processing and behavioural characteristics. Observations of the fact that human beings do exhibit differences in *kinds* and *levels* of abilities led to the very first explorations into intelligence. Some of the earliest studies linked intelligence with head shape and size, skin sensitivities, height, and even length of nose, (the *good* news being, "Madam, you must be *very* bright"...). The majority of these early studies progressed to a focus on the size of the brain, regarded at the time as the surest indicator of intellectual functioning. The work of these early phrenologists "mapped the functions and capacities of the brain by observing and measuring the bumps on the human cranium" (Baldwin & Vialle, 1999: xii). The early 'macro' measurements of brain size were replaced by more scientific and precise studies which researched the *EQ* or 'encephalization quotient' (Jerison in Dawkins & Ridley, 1985) which is calculated "taking logarithms of brain weight and body weight, and standardising them against the average figures for a major group such as the mammals as a whole" (Dawkins, 1988: 189).

The term *EQ* should not be confused with the other EQ or 'emotional quotient' (Goleman, 1996) which will be referred to later in this chapter. At this stage however it is a reasonable assumption that the early studies on brain size and make-up, and possible correlates with IQ, have significantly contributed to the current focus in education on mind/brain learning (Diamond & Hopson, 1998; Jensen, 1998a, 1998b; Sousa, 1995; Geake, 2000, 2002). Indeed research into the biological basis of intelligence, including the size of brains, is a very active field of investigation in Educational Psychology today. Such studies exploring the anatomical structures of the brain, with their documented gender differences, are proposing some very controversial findings, as the following indicates:

> *On an anatomical level, a more efficient information processing is thought to be associated with an increased cortical surface area in the brain ... and the relationship between brain size (adjusted for weight and height) and intelligence, revealed that IQ scores correlated with increased brain size*
>
> *(Willerman, Schultz, Rutledge & Bigler, 1991 in Phillipson, 2000: 43).*

We could dismiss studies of brain size as primitive or low-level, ignoring other more sophisticated or higher-order variables, however species-wise, research supporting the theory that links between brain size and intelligent behaviour as measured by IQ tests, is reasonably well-documented. As Dawkins (1988: 190) has succinctly proposed, "whatever the reason, it seems to be fact".

Early studies on the brain were limited in what they could tell us about the 'black box' or the 'engine room' which seemingly determines everything we know and do. The intricate wonders of the brain, "an apparatus with which we think that we think"

(Bierce, 1968: 76), are becoming clearer to us through the scientific advances of neuroscience. That the brain, this most amazing of all aspects of our bodies and consciousness, should resemble "nothing so much as a bowl of cold porridge" (Turing in Penrose, 1989: 374) has been pointed out by researchers who have been privileged enough to study it at first hand.

The terms 'brain' and 'mind' are often used interchangeably. Jensen elegantly points out that the former is the physical or steady-state embodiment of the latter, stating that, "Our brain is what we have; the mind is what it does. In other words, the 'mind' is not a thing; it's a process" (Jensen,1998a: 15).
In a similar way, Eisner views the brain as basically fixed by genetic endowment as opposed to the mind when he states:

> *Brains, in contrast to minds, are biological – they are given by nature ... Minds are cultural – they are the result of experience ... Minds, then, in a curious and profound way are made*
>
> *(Eisner, 1997: 350).*

The physical properties of the brain have been the cause of much debate, particularly with the advent of neuroscience. An analogy with a computer was a common conception of the brain, based on its facility for speed of information processing and storage. However, what is now known about the brain places it far ahead of the computer in higher-order functioning. In particular it appears to be in the field of visual functioning (as opposed to the verbal/linguistic) where the brain is elevated to the higher status, as:

> *Computers cannot see or dream nor can they create.*
> *They are language bound.*
> *Thinkers who cannot escape the structure of language are often utilising only that small part of their brain which is indeed like a computer ...*
> *Verbal and mathematical thinking tends to be "piece by piece".*
> *Visual thinking is holistic and spatial.*
>
> *(McKim, 1980: 27).*

The quest to measure the capabilities of the brain has fascinated yet largely eluded researchers for centuries. Studies in more recent years have moved from a focus on IQ measures of intelligence (although these are still widely used) to results from Encephalograms (EEG) and brain imaging techniques such as Evoked Potentials involving Inspection Time (IT), Averaged Evoked Potentials (AEP) and Event Related Potentials (ERP) and other techniques like Positron Emission Tomography (PET) and functional Magnetic Resonance Imaging (fMRI).

Most of these studies have taken place within the field of psychology and cognitive neuroscience. However, the neurologist Zeki used PET and fMRI techniques to examine the functions of the brain and links with visual art.
Although conceding that *all* of the senses contribute to our ability, "to be able to acquire knowledge about this world", which is Zeki's (1999: 4) definition of intelligence, "vision just happens to be the most efficient mechanism for acquiring knowledge and it extends our capacity to do so almost infinitely."
Zeki's view of intelligence, as it is illuminated by brain studies, is a new field of research which "unites neurology and art and finds a common thread linking the workings of the brain to visual art, which is itself one of the products of the brain" (Zeki, 1999: 5).

The importance of understanding the biological makeup and functions of the brain itself has also been raised by Hoffman (1998: xi), who also regarded visual thinking as of a higher order than other forms such as linguistic, noting that "behind the swift ease of vision is an intelligence so great that it occupies nearly half of the brain's cortex". Neuroscientific studies which have been conducted over the last twenty years have confirmed Hoffman's observations.

Chapter 3 further examines the links between vision and visual intelligence as the highest form of thinking.
Studies on the EEG have explored correlations with IQ. These studies in general are called 'Evoked Potentials' or 'Averaged Evoked Potentials' (AEP) and have focussed on the speed of mental processing as measured by Inspection Time (IT) and Reaction Time (RT) experiments. These studies, which are often called 'string length' studies, showed clear correlations between EEG and IQ measures. One example is reproduced below in Figure 2.1.

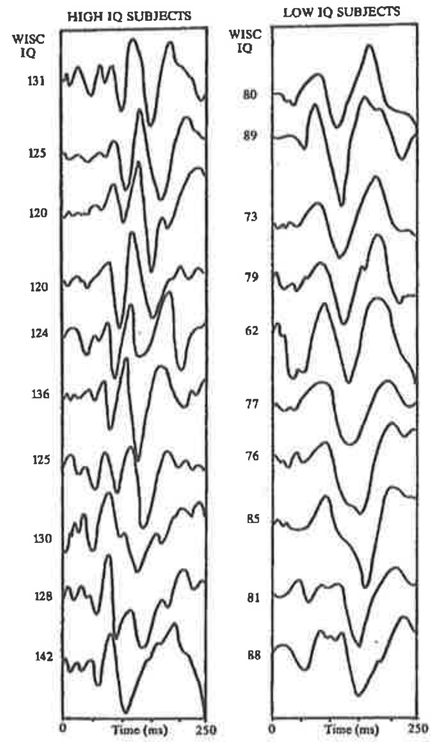


Figure 2.1: AEP/IQ (Eysenck in Cropley, 1986)

Eysenck (1986: 112) called such studies "a revolution in our conception of intelligence".

Speed of processing has been the focus of many studies which have proposed it as a key marker of intellectual processing (Vernon, 1987; Neubauer & Bucik, 1996; Nettelbeck & Young, 1989; McCann & Stough, 1991; Deary & Stough, 1996). Anderson (1992: 51) concluded that, "the most obvious parameter of neuronal functioning that might be related to intelligence is speed of conductivity".
Evoked Potential studies have been in use for more than twenty years but the most recent forms have changed the nature of measurement, and predictions are that they will continue to instruct us in the specific workings of the brain, in particular the pivotal functions of speed and visual information processing.

Theorists who adhere to a fixed, biological basis of intelligence have argued that 'general ability' or *g* is, in its simplest form, a measure of the basic efficiency of neural transmission, and that neural efficiency is usually synonymous with speed (Bates & Stough, 1997, 1998).

Inspection Time is the minimum time required to make a single inspection from sensory input. Studies have concluded that IQ and IT have a significant negative correlation - the higher the IQ the shorter the IT: " … the Inspection Time approach is thought to represent the greatest potential for understanding the basis of individual differences in cognitive ability related to intelligence" (Deary & Stough, 1997 in Phillipson, 2000: 39).

Deary & Stough (1996: 599) reiterate the substantial problems with IQ testing and predict that IT type of experiments may be more accurate, as "Differential psychologists are now searching for the underlying causes of differences in intelligence. As a result, reductionism is in vogue". The term 'reductionism' suggests a reducing or percolating down to the essence of understanding differences in human intellectual abilities, although they caution that "the search for the 'true' single information-processing function underlying intelligence is as likely to be as successful as the search for the Holy Grail" (Hunt, 1980 in Deary & Stough, 1996: 599).
Studies on IT represent what has been called the next 'wave' of research. In particular the practical aspects of IT experiments are evident:

> *Inspection Time may prove to be an important parameter to monitor in child development and in old age … (it) may also find application in specific disorders where visual or more general information processing has been mooted as a key deficit, such as dyslexia … in addition, Inspection Time is more obviously culturally fair than other forms of cognitive testing (Deary & Stough, 1996: 606).*

Most studies agree that IQ and IT develop with age and peak in mid to late adolescence. Other researchers have been critical of the 'compartmentalisation' of intellectual markers such as *speed*. While Anderson uses the term 'module' to describe an essential marker of intelligence within the brain, Pinker (1997: 30) is critical of such terminology:

> *... the word 'module' brings to mind detachable, snap-in components, and that is misleading. Mental modules are not likely to be visible to the naked eye as circumscribed territories on the surface of the brain, like the rump roast on the supermarket display. A mental module probably looks more like road kill, sprawling messily over the bulges and crevasses of the brain ...*
>
> *(Pinker, 1997:30).*

Approaches such as Anderson's have led to a debate on intelligence and cognition as possibly discrete properties. Anderson's (1990: 27) study defends the psychometric concept of *g* but proposes that this *g* is a property of a low-level information processing mechanism: in short, "the day of the intelligent synapse is upon us". Anderson argues that while this basic processing mechanism is fixed and does not develop with age or other factors, cognitive abilities, in their myriad forms (verbal, spatial, mathematical, reasoning, memory) reveal a "clear developmental pattern" (Anderson, 1990: 5).

Despite the range of viewpoints regarding the nature of cognition and psychometric intelligence, "most research studies relying on stringent laboratory experiments, conclude that subject response times for elementary cognitive tasks (ECTs) are significantly correlated to g-factor scores obtained from conventional psychometric tests" (Bjorklund,1989: 219). There is a greater degree of variance attributable to g in higher ability and lower ability groups (Anderson, 1990). At all ability levels, the asymptotic development of psychometric intelligence with age is well established. These studies are now challenging traditional insights into the nature of g and the attendant role of cognitive strategies and *non-intellective* properties.

Speed of functioning (such as reaction time, inspection time, storage and recall) has emerged as a fundamental consideration to the assessment of g and the relative ease of assessing such functioning has reinforced the viewpoint of many psychometricians that IQ results, based on strictly timed, standardised tests, are a reliable indicator of intelligence.

The role of the environment, while of limited significance to neuroscientists in the past, has become central to the brain-based view of intelligence.
According to Jensen (1998a: 4) neuroscientists have discovered that,

> *students with more challenging and demanding school lives had more dendritic branching than those who didn't. In other words their brains had physically changed and were more enriched and complex.*

Researchers in Australia are proposing that understanding the brain should have direct relevance to our teaching programs. Many studies are yielding up data confirming "different neural wiring" as differentiating between different intellectual functioning, as Geake (2000: 2) states:

> *...cognitive neuroscience, should be of professional interest to principals, teachers and education academics because cognitive neuroscience involves studies of learning, memory, language, literacy, numeracy - especially in young children - areas in which education has always claimed experiential and conceptual supremacy. Interestingly, many of the findings of cognitive neuroscience underscore what has long been regarded as best teaching practice.*

The biological basis of intelligence, including genetic studies and brain studies, are new fields of research and interpretations of the data need to avoid simplistic conclusions. The bridge between the researcher and the interpreter of such scholarship is sometimes rather flimsy. Bruer (1997) cautions that the connection between education and neuroscience is a "bridge too far". He argues that because this is such a new field of science, superficial educational interpretations of brain research should be avoided.

Amidst the research suggesting strong links between brain science and educational practice, Bruer's is a strong cautionary voice (1997: 7) with his claim that the research to date in this youngest of fields means that we:

> *cannot look to neuroscience as a guide to improve educational practice and policy ... The development of vision, tactile discrimination, movement, and working memory are developmentally significant. However, these are not abilities and skills children learn in school or go to preschool to acquire ... we have no idea, certainly no idea based on neuroscientific research, how the emergence of those capacities relates to later school learning or to the acquisition of culturally transmitted knowledge and skills.*

Bruer cites the term "complex environments" as more appropriate than "enriched" environments, and argues very convincingly that there is a "chasm" between neuroscience and education, and that current teachers' resource materials based on brain research attempt to bridge this chasm,

> *by drawing educationally relevant conclusions from correlations between gross, unanalysed behaviours - learning to read, learning math, learning languages - and poorly understood changes in brain structure at the synaptic level. This is the bridge too far*
>
> *(Bruer, 1997: 10).*

In addition, further caution has been raised in linking findings of neuroscience and advanced intellectual potentials. Van Tassel-Baska (1999: 63) has argued that "applications of brain-based research to gifted education are premature, given that research on complex operations of the brain is not yet clear enough to establish sound educational inferences".

Others have argued that brain studies are essential to the revolution in education which is needed to keep pace with the knowledge explosion which has come with increased technological advances. As the most recent OECD publication has observed, "The more we learn about the human brain, especially in the early years, the less comfortable we find ourselves with the traditional classroom model and imposed curriculum of formal education" (OECD, 2002: 14).

One of the simplest interpretations of cognitive neuroscience which has entered the realm of teaching has been cerebral hemisphericity or left-brain versus right-brain research. It is well documented that the brain has two separate yet connected hemispheres. The conduit between the two hemispheres is the corpus callosum. According to Shlain, (1998: 17):

> *The human brain lobes, while appearing symmetrical, are functionally different. This specialisation is called hemispheric lateralisation. A bridge of neuronal fibres called the corpus callosum connects and integrates the two cortical lobes so that each side knows what the other is thinking.*

This interpretation of hemispheric specific abilities and the role of the corpus callosum is rather simplistic however, as Sperry's (1965) original work did confirm that even when the corpus callosum is severed, the hemispheres manage to communicate.

It is clear that there are functions which are relatively specific to each hemisphere, yet it is now believed that the brain is also incredibly flexible and malleable in crossing over hemispheres or compensating when one or both spheres is damaged. Battro (1997) reported on a young boy who had his right hemisphere surgically removed, yet detailed developmental tracking of his progress proved that the left hemisphere was clearly fulfilling functions traditionally reserved for the right. Battro's presentation of his research at the 7th International Conference on Thinking included a video coverage of the boy who, at the age of nine, was functioning very well academically and socially. A slight 'spasticity' on the left side of his body was the only physical sign of any trauma. The title of Battro's paper, 'Half a brain is enough', served as a discomforting prod to all teachers and parents, who at some stage in their careers or parenting have accused students or progeny of only fifty percent usage.

Sousa's (1995) text details the common understanding about left/right hemispheres. Cognitive neuroscience has documented well that the left hemisphere is predominantly responsible for speech, analysis, time and sequence, all of which allow people to recognise words, letters and numbers. The right side is responsible for creativity, patterns, spatial response and context, which allow people to recognise faces, places and objects (Sousa, 1995: 87).

Teachers need to understand the specific sites of language on the left and spatial response on the right, however, trite educational interpretations of hemispheric lateralisation may lead to equally naive classroom practice, as Geake (2000: 3) has stated:

> *To divide a curriculum between so-called left-brain and right-brain activities is a complete nonsense, and a gross over-simplification and misunderstanding of what has been learned about cerebral modular organisation and its hemispheric distribution.*

Another area where 'gross oversimplifications and misunderstandings' may be occurring in brain research is that of gender implications.

Woody Allen once commented, *"My brain? It's my second favourite organ"* (in OECD, 2002: 27). However, today the brain is likened more to a gland than to an organ. A gland is receptive and responsive to differing chemical, hormonal and other influences whereas an organ is more stable and fixed in its functions. It should follow therefore, that gender differences are to be expected in brain functioning, just as gender-based hormonal differences are well documented. One of the particularly interesting findings appears to be in the corpus callosum in which gender differences have been identified, as Shlain (1998: 23) reports:

> *... women have between 10 – 33% more neuronal fibres in the forward part of their corpus callosum than do men. The higher the number of connecting neurons, the greater the integration between the two sides. The extra connecting neurons in women seem to enhance the communication of emotions and increase global awareness, field perception, and understanding the moods of offspring. Generally, women can perform multiple tasks simultaneously better than men.*

While this research is too young to provide universally-accepted theories, it does help explain the well-documented earlier development of language in females. Conversely, studies on males and mathematical development (Alexander, O'Boyle & Benbow, 1996; Geake, 1997; Geake & O'Boyle, 2000) suggest gender differences:

> *... Haier and Benbow (1995) have tested the notion that mathematically talented children think differently from others by comparing the Positron Emission Tomography (PET) profiles of mathematically gifted 13 year-olds with those of ability-matched college students (members of both groups scoring 1100 or more out of 1400 on the Scholastic Aptitude Test – Math (SAT-M). The researchers found that the extremely mathematically gifted 13- year olds had similar PET profiles to 20-year-old math-major college students despite their marked differences in age and experience.*
>
> *(Geake, 2000b: 2).*

These differences were also reflected in the PET scans of mathematically talented boys as compared to girls. Haier and Benbow (1995: 412) speculate that *"boys who have high SAT-M scores have a different way of mathematical reasoning from everyone else"*. The notion of sex differences in mathematics ability, while controversial in some circles, might be expected given the hormonal make-up of the two groups. In particular, it now seems that differential prenatal testosterone exposure may influence underlying brain organisation (O'Boyle, Benbow & Alexander, 1995) specifically by enhancing the development of the non-dominant (usually the right) cerebral hemisphere (Geschwind & Galaburda, 1987) while concomitantly slowing the maturation of the dominant (usually the left) cerebral hemisphere. Because males and females differ in testosterone levels, it may follow that male and female brains differ in terms of a predisposed affinity for mathematics. Such theorising stems from the idea that it is the right cerebral hemisphere that plays a major role in mediating successful high-level mathematics performance (Springer & Deutsch, 1998).

Gender differences in intelligence and the links with cerebral hemisphericity could be, as Bruer argued, the bridge too far, yet many texts are now evident in classroom planning and curriculum differentiation which advocate separate left and right brain activities.

Jensen's (1998) research is worth presenting as one which could cause concern on the issue of gender differences and intelligence as depicted in current research. According to Jensen, the gender differences in brain make-up are, in summary:

Female brains:

- *left hemisphere develops earlier than the right*
- *has a larger corpus callosum (3 - 10% more fibres) than the male*
- *has monthly fluctuations in hormones, progesterone and oestrogen which cause shifting scores on spatial, math, verbal, and fine motor skills tests*
- *has 20 - 30 percent more serotonin which is linked to fearfulness, shyness, low self-confidence, obsessive-compulsive behaviour, and unduly dampened aggression*
- *spread thinking function over a wider area of the brain which translates to fewer learning disabilities*
- *hypothalamus uses positive internal feedback which maximises hormonal fluctuations*

Male brains:

- *right hemisphere develops earlier than in females which impacts classroom discipline and preferences in sport*
- *moderate testosterone level aids skill in abstract manipulation, spatial, science, math, sport, business, computers*
- *is more compartmentalised in usage than in females due to narrower corpus callosum*
- *has 20 - 30 percent less serotonin. This level is linked to impulsive aggression, suicide, alcoholism, depression, impulsive aggression, and explosive rage*
- *hypothalamus uses negative internal feedback which minimises hormonal fluctuations*
- *testosterone linked to aggression and competitiveness*

(Jensen, 1998: 29-30).

Is there some cause for concern in this rather alarming set of gender-based characteristics, set out as the 'factual basis' upon which teachers design curriculum? If Jensen's interpretations of data on brain research is to be accepted, then it would seem that education is returning to gender stereotypes which for both males and females it has worked hard to escape. Paraphrasing Jensen's list above, girls are verbal, thoughtful, co-operative, not good at maths, good at languages, shy, low in self-confidence, able to do many things at once and, although it is unclear what "unduly dampened aggression" is, it seems to indicate low levels of competitiveness. Boys, on the other hand, are destined by their brains to be mathematical and spatial, sporty, aggressive, impulsive, narrow in their fields of interests and alcoholic depressives who are likely to suicide.

This 'hard-wired', gender-based stereotype of behaviour, personality and cognitive correlates, has been lampooned by the Australian comedian, Andrew Denton, who took part in an ABC debate (2000), on the topic that "Males are not as sensitive as Females". At a pivotal stage in the debate, Denton slammed the podium with his fist, proclaiming, in defence of all males that "I, and most of the men I know, *do* actually experience the *full* range of human emotions: *fear, lust* and *anger!"*

More research in the exciting field of neuroscience needs to be encouraged, but we also need to avoid hasty and shallow interpretations of the findings. This field must not replace the other fields of research which have confirmed the importance of equitable access to and challenge in all academic areas for males and females.
Left and right hemispheres, along with their documented differences, contribute to whole brain functioning. As Carl Sagan's prophetic words (in Clark, 1997: 392) indicate, "The path to the future lies **through** the corpus callosum."
Educators need to avoid the packaged notions of what each hemisphere can or cannot do. The power of the integrated brain, along with the focus on the positive characteristics emerging from brain science (rather than a litany of fixed and doomed behaviours) must surely be the path to the future.

One of the other gender-based views of differing brain make-up is evidenced in the often-cited co-operation versus competition debate. According to Wertheim (1997) the consequences of such perceived gender differences have been profound for human evolution:

> *One of the most important changes women have wrought in the biological sciences is that across the spectrum, from the level of cells to the biosphere as a whole, women scientists have focused on cooperation rather than competition between organisms. World-renowned cell biologist Lynn Margulis believes it has been the major factor driving evolution . . . the very cells of which animal bodies are composed are an evolutionary adaptation of several primitive kinds of cells working together symbiotically (Wertheim, 1997: 243).*

All of the research on the makeup of the human brain suggests that humans might be closer to replicating these processes in more sophisticated forms of Artificial Intelligence. Our knowledge of hemispheres of the brain suggest that if verbal and mathematical thinking is learnt "piece by piece" as a language then it will mimic left brain functioning. Visual thinking is holistic and spatial which is closer to right brain functioning. When mathematics is taught as a language, such as algebraic notation rather than as a spatial or relational concept, it will be a predominantly 'left-brain' process.

Penrose (1989) claims that all forms of Artificial Intelligence are "language bound" and as such will always be limited in output compared to human brain potential. McKim (1980: 27) has also confirmed the holistic, visual nature of the brain's workings as opposed to the limitations of the computer, when he said that, "Computers cannot see or dream, nor can they create. They are language bound."
The mystery of the 'dreaming' which seems to be at the centre of human intellectual 'creation' has fascinated those who have mapped the singular and multiple tracks leading to a definition of intelligence.

2.3. Intelligence as a unitary or multiple concept

In Spearman's (1927) determination of what constitutes intelligence, the most critical factor was viewed as the general one, or *g*, which influences performance on all intellectual tasks. The other kinds of factors were called *specific*, and they were not regarded as generalisable. As such these highly specific abilities, sometimes called 'talents', have traditionally been of little interest to psychologists trying to construct theories to explain individual differences among people (Eysenck 1986, 1998; Jensen 1927, 1987; Anderson 1992; Gottfredson, 1997a).

From Spearman's point of view, general intelligence or *g* is viewed as existing on a single dimension and not as being some multi-faceted phenomenon. This *g* is supposed to be generalisable, in other words, people who behave intelligently in one situation should behave intelligently in other situations.
Despite the diversity of theories, most psychometricians and other researchers into the nature of intelligence agree that a general factor of intelligence, *g*, does exist, but that there are also 'lower-level' factors, reflective of more specific skills. These skills may be defined as specific *talents* in culturally acknowledged fields such as dance or visual art or in other areas not traditionally recognised by society as evidence of intellectual performance, for example, the skills exhibited in the games halls by the 'the pin-ball wizards'. Although pin-ball wizardry may rely upon advanced hand-eye co-ordination and speed of reaction time, unless it is recognised as a culturally relevant and useful skill it is unlikely to be identified as a marker of intellectual performance.

The *g* factor has been referred to in terms of a central or Basic Processing Mechanism (BPM) (Anderson, 1992; Detterman, 1987). Anderson's theory of intelligence and development is a provocative one, purporting that "intelligence does not develop"(1992: 1) but is a fixed entity. Drawing primarily on Fodor's (1983) research, Anderson proposes that the part of our processing that *does* or *can* develop, our cognition, is made up of three distinct processing mechanisms. The first is the Basic Processing Mechanism (BPM) and the other two are the Specific Processors and the Modules. Anderson's is very much a 'systems theory' approach to explaining intelligence and speed of processing in particular. Anderson (1992) based his theory of intelligence around the concept of three Modules, each one drawing on the research on ecological visual perception (Marr, 1982), language (Chomsky, 1986), and aspects of speech perception (Fodor, 1983).

It is interesting that both Marr's 'visual perception' and Chomsky's 'language universals' are included in Anderson's theory as they both feature in this thesis, with one of this author's central hypotheses that visual intelligence has its own universal grammar.
Anderson suggests a fixed concept of *g*, unaffected by age, whilst acknowledging that cognition does develop in accordance with age and a supportive environment.

A central, unitary view of *g* has not always been assumed. Multiple notions of intelligence, as opposed to *g*, have generated the most debate.

The last twenty years have witnessed enhanced and heated debate on the nature of intelligence since Gardner published his controversial theory of Multiple Intelligences (MI) (1983), initially arguing that there are seven specific abilities underpinning what we call intelligence. The original seven intelligences, or *Frames of Mind*, proposed at the heart of the MI theory were:

1. Linguistic
2. Logical-mathematical
3. Spatial
4. Musical
5. Bodily-kinesthetic
6. Interpersonal
7. Intrapersonal

Gardner himself admitted that only the first two, "fall comfortably within the usual definitions of intelligence" (Gardner, 1998: 113). In addition, educators have agreed that "schools focus significantly on but two frames: logico-mathematical and linguistic" (Biggs, 1993: 150).
Gardner more recently (1998) added an eighth intelligence to the MI Theory, which is the *naturalist* intelligence, epitomised by Charles Darwin in Gardner's view. Gardner has argued that this intelligence is evidenced by an individual who,

> *demonstrates expertise in the recognition and classification of the numerous species - the flora and fauna - of her or his environment. Every culture places a premium on those individuals*

> *who can recognise members of a species that are especially valuable or notably dangerous and who can appropriately categorise new or unfamiliar organisms*
>
> (Gardner, 1998: 115).

A ninth intelligence, the spiritual or *existential* intelligence, has also been proposed (in Colangelo & Davis, 2003) but Gardner has formally declined to ratify this as part of the MI theory until further research is completed. Others (Sisk & Torrance, 2001) have argued that the ninth intelligence does exist and that it, "integrates all of the others" (Sisk, 2002).

How did Gardner arrive at this theory which has caused such controversy and debate over the past twenty years? Gardner established his criteria for the multiplicity of abilities which constitutes intelligence as: having:

> *identifiable core operation(s);*
> *evolutionary history and evolutionary plausibility;*
> *recognisable end-state and distinctive developmental trajectory;*
> *existence of savants, prodigies, and other individuals distinguished by the presence or absence of specific abilities;*
> *potential isolation by brain damage;*
> *support from experimental psychological tasks;*
> *support from psychometric findings; and*
> *susceptibility to encoding in a symbol system*
>
> (Gardner, 1993).

Gardner's theory is contentious, not only because it is based on a multiplicity of abilities, most of which cannot be measured in an IQ test, but also because it is one of the first to recognise social and cultural constructs within a view of intelligence. The MI theory is usually presented in the literature as in direct opposition to the views of researchers who believe that intelligence is a biological, genetic inheritance. Gardner himself does not reject the biological basis of intelligence, or the essential *g*, but he:

> *questions only the explanatory power of* g *and does not believe that his theory is incompatible with the concept. Instead, Gardner believes in the usefulness of* g *to explain certain theoretical ideas, but he rejects outright the notion that all of intelligence can be explained by* g*; it is simply too broad a concept*
>
> (Phillipson, 2000: 21).

The MI theory has been criticised as lacking in empirical basis (Anderson, 1992; Gottfredson, 1997b; Stough, Nettelbeck & Cooper, 1993) and merely relying on case studies or detailed observations of eminent human behaviours which have been judged as representative of specific intelligences. Critics of the MI Theory have argued that not only does it lack an empirical research basis but also that it relies on *descriptions* of intelligent behaviours rather than *explanations* of intelligent behaviours (Anderson, 1992; Deary, McCrimmon & Bradshaw, 1997; Gottfredson, 1997a; Plucker et al, 1996; Klein, 1997; Phillipson, 2000). This is an important distinction and has established a demarcation in research and debate between educators and psychologists. In addition, criticism of the MI theory has indicated that "attempts to measure these intelligences in order to predict future achievement have not achieved consensus" (Phillipson, 2000: 36).

With such a dichotomy evident, it is reasonable to ask where this research is leading. If human intellectual ability is fixed and biologically determined, should we be engaged in research aimed at discovering and isolating the '*g spot*' of intelligence (Menz, 1997) or, if MI theory is correct, should we be identifying a myriad of complex and interacting factors? The implications for education are massive. For instance, if the *g spot* is fixed and determined solely by genetic inheritance then what is the role of enriched or enhanced learning environments? If, on the other hand, intelligence is primarily developmental and trainable then educators and psychologists need to at least agree on what constitutes it, how it can be measured and how it is best developed.

Although Gardner's (1983; 1987; 1998) theory of Multiple Intelligences is most often cited in more recent studies, Thurstone had proposed, as early as 1938, a theory of multiple intelligences comprising what he believed to be the seven primary mental abilities:

1. *Verbal Comprehension*: including vocabulary and reading comprehension
2. *Verbal Fluency*: as measured by tests that require rapid production of words
3. *Number Ability*: as reflected by arithmetic word problems
4. *Spatial Visualisation*: as measured by the mental manipulation of symbols
5. *Memory*: evaluated by tests of recall for lists of words or the ability to associate names with pictures of people
6. *Reasoning*: as exemplified in verbal analogies, and
7. *Perceptual Speed*: involving the rapid recognition of symbols, such as crossing out all the 3s that are embedded in a string of numbers.

It is pertinent to note that all of these factors except number 4 require language, including mathematical language. Near the end of his career, Thurstone conceded that his seven primary mental abilities typically correlate with each other, thus suggesting a *general* factor of intelligence, or a basic *g*.

Doppelt (1950) agreed with the concept of Spearman's *g* but contended that the *g* factor is actually made up of various competencies which include: Reasoning ability, Speed, Memory, Perception, and Rote skills (in Tannenbaum, 1983: 97). Doppelt also researched the importance of an age factor in these competencies, arguing that as a person matures, some specific competencies, such as rote skills and memory, seem to detach themselves from the general mass and may be identified as distinct abilities or factors.

Theories such as Doppelt's, which supported the concept of a *primary* ability, responsible for individual differences amongst people, yet with *specific competencies*, set the scene for the plethora of research studies which followed. Most notable as an extension of Doppelt's theory was Cattell's (1963) theory which argued that the *g* factor, while existing as the key determiner of intelligence, is actually represented by two kinds of ability, *Fluid* ability and *Crystallised* ability

2.4. Intelligence as a developmental concept

Cattell's Fluid ability is defined as the inherited ability which a person has and is relatively fixed in its potential for development. Fluid ability predominantly takes the form of inductive problem solving, figural thinking, and general reasoning. It accounts for success in adapting to new situations in which previously learned skills are of no advantage. Crystallised ability by comparison, is described as the breadth of knowledge which a human being can acquire, the level of sophistication, the intelligence of experience, and the appropriation of the norms of the culture within which one exists (Bjorklund, 1989).

Cattell's theory, along with the length-of-nose theory, is like the 'good news/bad news' view of intelligence. The good news is that Crystallised intelligence continues to grow with experience, especially if it is challenged and enriched throughout life. The more it is used, the richer it develops. The bad news is that Fluid intelligence declines gradually, and according to some studies, this decline starts before adulthood. In terms of speed of mental processing, for example, which is regarded as a key marker of fluid intelligence, human beings appear to reach peak performance at mid to late adolescence. By comparison, the crystallised ability to learn new skills may continue well into old age. Picasso would be a prime example of crystallised intelligence as he formulated new ideas, new genres and 'turned corners' in his thinking well into old age. If Cattell's theory is correct, however, Picasso did not get any faster in his thinking skills, and probably experienced less accuracy of thought, such as diminished storage and retention, or memory, which is typical of the ageing process and its proposed basis in Fluid intelligence.

Cropley (2001: 78) has cautioned against a simplistic interpretation of Cattell's theory, indicating that:

> *the relationship between age and intellectual performance is complex. The level of intellectual performance at any age results from a compromise between two age-related aspects of cognition: the 'mechanics' on the one hand, the 'pragmatics' on the other.*

Cropley's notion of mechanics stems from the 'biologically-based' Fluid intelligence, while the pragmatics are the "skills acquired as a result of experience with a particular environment" and related closely to the Crystallised intelligence (Cropley, 2001: 79). While the studies since the 1980s have variously denounced and supported the theory that biological aspects of intelligence decline with age, the more recent research in cognitive neuroscience, has supported the significance of enriched learning environments to brain development.

J.P. Guilford (1980) was critical of the concepts of Fluid and Crystallised intelligence, arguing that they lacked any theoretical or empirical basis and represented only a vague, limited approach to intellectual functioning. Guilford's (1967) Structure of the Intellect model (SOI) comprised 180 unique cognitive factors which varied as a function of the type of mental operation, the type of content, and the product that results from applying a given operation to a particular content (Guilford, 1988 in Bjorklund, 1989: 202). Within the Operations factors, Guilford included both *Convergent* production and *Divergent* production, the latter embodying the fundamental principles of what was then thought to be creative thinking skills. It is interesting to note that the other five mental operations - evaluation, convergent production, memory retention, memory recording, and cognition - can all be measured with the use of an IQ test. Guilford regarded the Crystallised intelligence as basic forms of specific talent and the Fluid intelligence as separate intellectual and specifically cognitive functions.

It is proposed that it is in these early studies, which proposed unitary or multiple, Fluid and Crystallised intelligence, that we find the origin of the terms *gifted* and *talented*. Gifted ability traditionally reflects the concept of Fluid or fixed intelligence, while talented ability represents the Crystallised intelligence, reliant on environmental chance and enrichment for growth. Through the latter part of the 20th Century, the terms *gifted* and *talented* have been commonly used, assuming that those children labelled as *gifted* are bright 'from the neck up'. Such children typically exhibit classic high *g* with its attendant levels of advanced speed, memory, coding or language skills. If tested, they would no doubt perform well on a standardised IQ test, such as the Weschler Intelligence Scales or the Raven's Progressive Matrices, which identify such abilities well in populations for whom the tests are appropriate. *Talented* children, on the other hand, are those with specific areas of abilities, usually in visual arts, dance or other traditionally viewed or culturally recognised creative pursuits. The traditional view was that one could be *talented* but not necessarily *gifted*, as giftedness demanded a high IQ and people with specific talents do not always score highly on IQ tests. A recent interpretation of this dichotomy (Gagné in Colangelo & Davis, 2003) is discussed in the final section of this chapter, which focusses on giftedness.

2.5. Intelligence as a factor of heredity or environment

Fluid and Crystallised intelligence have been debated as Explicit and Implicit theories of intelligence respectively.

Explicit or 'low-level' theorists regard intelligence as a biological, genetically determined attribute of our nervous system. Explicit theorists initially relied on IQ tests but now often use brain scan and brain imaging techniques as a possible culture-free way of estimating intelligence. Standardised psychometric measures such as IQ tests are still favoured. Advances in brain studies have become a focus of study for Explicit theorists.

A classic 1920's view of intelligence, as an example of the explicit theorists' view is reproduced below:

> *The chief determiner of human conduct is a unitary mental process which we call intelligence: this process is conditioned by a nervous mechanism which is inborn: the degree of efficiency to be attained by that nervous mechanism and the consequent grade of intellectual or mental level for each individual is determined by the kind of chromosomes that come together with the union of the germ cells: that it is but little affected by any later influences except such serious accidents as may destroy part of the mechanism*
>
> *(in Perkins, 1995:13).*

In comparison, Implicit or 'high-level' theorists regard intelligence as culturally determined and experientially driven. IQ tests are criticised by Implicit theorists as being very narrow in the range of abilities they measure and culturally determined in favour of white, high socio-economic groups (Anderson, 1992).

From the pioneering work of researchers like Spearman and Cattell, the author acknowledges the importance of understanding *g* in the essential makeup of intelligence but rejects the fixed concept of its importance as set out in the 1920's view above. The core of the debate between educators and psychologists is this: can intelligence be increased, or is intellectual potential hardwired from birth? The studies have argued that on the one hand intelligence is genetically acquired and developed, relatively unaltered by the environment and essentially fixed in our brains. On the other hand, studies have argued that intelligence is a multiplicity of varying characteristics which result from a complex interaction between an individual and his or her environment. The argument which is inclusive of both debates is exemplified by studies which maintain an inherited 'coding' for potentials which may or may not be realised depending on cultural and environmental factors.

Since Guilford's SOI model, research introduced more 'creative constructs' and Sternberg and Gardner's research introduced more 'social constructs' into the determination of intelligence. The creative constructs of intelligence are a major focus of this thesis and Section B of this chapter is devoted to a review of the importance of understanding the role of creativity in the determination of intelligence. The issue of social constructs, along with the more recent notion of 'intrapersonal' or emotional constructs of intelligence will be addressed next.

2.6. Intelligence as a factor of Social Constructs

While many early theorists of intelligence recognised social skills as contributing to overall intelligence, the majority tended to view such skills as personality correlates rather than an intrinsic part of intelligence. In the early 1980's the research of Sternberg and others advanced the study of intelligence by initially proposing that intelligence itself is far more of a social construct than ever thought before.

The term *non-intellective* functioning has been used to describe characteristics such as social/emotional and personality characteristics which must be considered in the determination of intelligence. The issue of these so-called non-intellective functions as a determining factor in intelligence has been debated (Tannenbaum, 1983; Piechowski, 1979; Renzulli, 1986;) with factors such as motivation or task commitment (Renzulli, 1978) and personality variables (Eysenck, 1986) included in profiles of general intelligence.

Sternberg, Conway, Ketron and Bernstein (1981 in Bjorklund, 1989: 200) proposed that intelligence involves three main sets of skills:

1. Practical problem-solving ability: *these skills include getting to the heart of a problem, seeing all aspects of a problem, and reasoning logically*
2. Verbal ability: *these skills involve speaking and writing clearly and accurately, dealing effectively with people, having detailed knowledge about a particular field, reading widely and with good comprehension, and having a good vocabulary*
3. Social competence: *these skills include displaying curiosity, being sensitive to the needs and desires of others, being on time for appointments, having a social conscience, and making carefully considered and fair judgements*

Sternberg's (1982, 1985a, 1988b, 1990) research supports multiple *strategies* rather than *abilities*, and his *Triarchic Theory of Intelligence* (1985b) emerged as a cornerstone theory of intelligence, and one of the few, following Gardner's (1983) *Frames of Mind*, to include social and emotional constructs. These theorists were the first to formally propose that environmental or cultural factors need to be considered in the determination of intelligence. The Triarchic Theory included the *components* of intelligence, levels of *experience* and the *context*.

It is clear from the work of Guilford's SOI Model, Sternberg's Triarchic Model and Gardner's MI Theory that previous, fixed views of intelligence, and the primary role of *g*, have been significantly challenged. Despite the obvious differences between these pluralistic theories, they all support the views that intelligence:

> *is not a single or fixed trait*
> *is 'teachable'*
> *is culture-dependant*
> *involves both internal and external factors.*
> *(In other words, the individual's inherited intellectual potential is activated, enhanced, or hindered by their interaction with the environment).*
>
> *(Baldwin & Vialle, 1999: xiv).*

One of the theories which perhaps best reflects a *blend* of unitary and multiple intelligences is that of Perkins (1995). Perkins' inclusion of 'meta' components, or what he calls *Reflective* intelligence, blends the theory of *g* with social determinants. Perkins claims that there are three broad views of intelligence:

Neural intelligence: the contribution of the efficiency and precision of the nervous system to intelligent behaviour

Experiential intelligence: the contribution of intuitively applied prior experience to intellectual functioning and

Reflective intelligence: the contribution of mindful self-management and strategic deployment of one's intellectual resources to intelligent behaviour. The relationship and differences between the three are summarised by Perkins (1995: 13):

> *Neural theorists argue that in large part intelligence is inborn and unchanging. Advocates of experiential intelligence note that intelligent behaviour grows with learning. Champions of reflective intelligence not only hold that we can learn to behave more intelligently but hold out for the possibility of general improvement through strategies and attitudes that cut across many different areas of experience.*

If intelligence can be studied as a social construct then identifying it and being able to measure it is a complex exercise.

2.7. Testing for Intelligence and the use of the IQ measure

> *"The history of intelligence 'testing' is replete with gross misrepresentations of the data, shady scientific practice, and, frankly, frightening and spurious political analysis"*
>
> *(Anderson, 1992: 12).*

Jensen (1927) and others have claimed that an IQ score is a reliable measure of intelligence. Gardner, while critical of the measurement of intelligence which most standardised tests provide, has offered no viable options, although he has provided a description of the general form of a test for each intelligence comprising the MI theory (Chen & Gardner, 1997). Gardner has argued that actual testing for MI abilities is often not possible and that,

> *by definition, pencil and paper tests for most of these intelligences are inappropriate, and bodily-kinesthetic intelligence, for example, should be assessed in a way that reflects the nature of the intelligence*
>
> *(in Phillipson, 2000: 22).*

Sternberg is equally critical of the standardised tests for IQ currently in use, claiming that "the tests used today are little better than tests used three decades ago and are, in many cases, the same tests ... the weakness of these tests is not the kind of items they contain, but rather their lack of a viable theory base" (in Clark, 1992 :204). Sternberg questions 'information' items from the Weschler Intelligence Test for Children (WISC) for example, as completely lacking in theoretical basis or real-world validity. Anderson (1992: 211), while acknowledging the predictive and comparative value of IQ testing, recognises its limitations but suggests that its main strength lies in testing the efficiency of a "knowledge-acquisition mechanism". Anderson views knowledge acquisition as the core ability within the basic processing mechanism which defines intelligence, and as such he supports the use of the mainstream IQ tests such as the Raven's Progressive Matrices, the WISC and the Stanford-Binet.

A key argument against the use of the IQ measure as a marker of intelligence in general is the fact that, although most of the tests (particularly the WISC and the Stanford-Binet) rely on a language base, much of this base is 'knowledge-poor' (Sternberg, 1990b). For example, the sub-tests on 'Information' and 'Language' are culture specific and become dated very quickly. Criticism has been levelled against the Raven's Progressive Matrices as measuring an ability which has nothing to do with the context (according to Sternberg's Triarchic Theory for example) within which any intelligent human being is required to function. Anderson defends this aspect of the IQ measure, arguing that:

> *... psychometric intelligence is not synonymous with knowledge. Intelligence tests work, by and large, by measuring variations in the quality and quantity of the knowledge base. However, the primary cause of these differences is the speed of the basic processing mechanism. This is why 'intelligence' is general, but knowledge itself is domain-specific. It also explains why 'intelligence' can be measured by relatively* knowledge-free *information-processing tasks*
>
> *(Anderson, 1992: 109).*

Cattell (1963 in Flynn, 1987b: 8) identified two different forms of IQ tests : those that test fluid intelligence well and those that favour crystallised intelligence. Fluid tests were those that "have little informational content but demand the ability to see relationships between relatively simple elements ... while tests of crystallised intelligence emphasise already acquired knowledge, such as vocabulary, general information, and arithmetic."

Despite the range of criticisms of the IQ test, and claims that it discriminates against children from impoverished, disabled and isolated groupings as well as those in cultural minority groups, the IQ test has served research into intelligence very well and is a sound measure of the cognitive abilities it purports to measure, within the populations for which it is appropriate. What we now understand to be the full range of intelligence in human beings however, is not able to be measured by the IQ test alone. Many observable behaviours have emerged which correlate with IQ.

Sternberg's (1999b) research compared results on IQ tests and tests of "high creative and high practical" ability. He found that the bright group from "white, upper-middle-class and well-regarded high schools" performed best on the high-analytic, IQ measures while students from "minority groups, diverse socio-economic-class backgrounds and less well-regarded high schools" performed better on the high creative, practical measures (Sternberg, 1999b: 151). Although Sternberg claims that his own measurement, the Sternberg Triarchic Abilities Test (STAT) is a better measure of intelligence than other standardised tests, he admits it is still not culture-free, observing that: "*no* test is or can be culture fair ... intelligence is always embedded in a cultural context" (Sternberg,1999b, 150). Because of this, Sternberg suggests that "rather than analyse and reanalyse the conventional tests, the time has come to create new tests to supplement the conventional ones" (Sternberg, 1999b: 157).
The Sternberg Triarchic Abilities Test (STAT) involves 12 tasks:

1. *Analytical-Verbal* (artificial words). Students see a novel word embedded in a paragraph, and have to infer its meaning from the context.
2. *Analytical-Qualitative* (number series). Students have to say what number should come next in a series of numbers.
3. *Analytical-Figural* (Matrices). Students see a figural matrix with the lower right entry missing and have to say which of the options fits into the missing space.
4. *Practical-Verbal* (everyday reasoning). Students have to solve a set of everyday problems in the life of an adolescent (eg. what to do about a friend who seems to have a substance-abuse problem).

5. *Practical-Quantitative* (everyday math). Students have to solve math problems based on scenarios requiring the use of math in everyday life (eg. buying tickets for a ballgame or making chocolate chip cookies).
6. *Practical-Figural* (route planning). Students are presented with a map of an area (eg. an entertainment park), and have to answer questions about navigating effectively through the area depicted by the map.
7. *Creative-Verbal* (novel analogies). Students are presented with verbal analogies preceded by counterfactual premises (eg. money falls off trees), and must solve the analogies as though the counterfactual premises were true.
8. *Creative-Quantitative* (novel number operations). Students are presented with rules for novel number operations (eg. *flix*, for which numerical manipulations differ depending upon whether the first of two operands is greater than, equal to, or less than the second). Students have to use the novel number operations to solve presented math problems.
9. *Creative-Figural* (novel series completions). Students are first presented with a figural series that involves one or more transformations; then they must apply the rule of the original series to a new figure with a different appearance, to complete a new series.

There were also three essay items, one each stressing analytical, creative and practical thinking (examples here are from the high school level):

10. *Analytical Essay.* Students have to analyse the advantages and disadvantages of having police or security guards in a school building.
11. *Creative Essay.* Students have to describe how they would reform their school to create an ideal school.
12. *Practical Essay.* Students have to specify a problem in their life, and to state three practical solutions for solving it.

(Sternberg, 1999b: 149 - 150).

Significantly, the STAT relies on scores for: componential information processing (analytical ability), coping with novelty (synthetic ability) and automatization and practical-intellectual skills.

The IQ is regarded as a sound measure of *g*, yet it would be true to say that the majority of studies since the 1920's, including those which support a centralised notion of *g*, include 'other' abilities as necessary in any determination of intelligence:

> *High IQ is generally a pre-requisite for high achievement in mathematics, science, and other areas dependent on academic learning, but it is not a sufficient condition. Aside from the obvious need for non-intellectual traits such as motivation, persistence, good health, there is*

> *clearly a special talent for things like mathematics and music, a creative imagination that IQ tests cannot identify*
>
> (*Flynn, 1987b: 3*).

It is significant to note here that IQ, as a measure, appears to be increasing on a global scale. Flynn's research highlighted the fact that, across the fourteen countries which comprised his study, IQ gains ranging from between 5 to 25 points were found in a single generation. Flynn concludes that "IQ tests do not measure intelligence but rather a correlate with a weak link to intelligence" (Flynn, 1987a: 171).

One of the recommendations from Flynn's study was that researchers should favour 'culturally reduced tests' such as the Raven's Progressive Matrices. Kline (1991: 137) has also argued that the "Raven's Matrices and other culture fair tests are good tests of fluid ability".

Anderson summarises the debate saying that:

> *A theory of intelligence is a theory of thinking. Although intelligence tests are the best measures of human thinking that we have, this does not commit us to believing that current intelligence tests are good measures of the theoretical construct 'intelligence'. Intelligence tests are imperfect instruments*
>
> (*Anderson, 1992: 16*).

In 1996, at the 6th Australian National Conference in Adelaide, Abraham Tannenbaum suggested that researchers impose a moratorium on the IQ as a means of measuring and defining intelligence. This suggestion was in the midst of the provocative debates surrounding the publication of Herrnstein and Murray's (1994) book, *The Bell Curve*, with its claim that society is directing its support to the sectors of society which are least likely to provide a return. In addition it was argued in this text that the most intellectually advanced children were actively discriminated against and locked into schools with 'dumbed-down' curricula within which 'everyone succeeds'. Not since Jensen's provocative racial interpretation of the IQ measure had there been such controversy.

Tannenbaum's argument in 1996 was strongly influenced by the sociological/cultural debate at the time. However other researchers have been critical of the use of the IQ measure for reasons of validity and reliability, particularly at the upper levels of IQ. Spearman himself had noted that the correlations among the differing cognitive abilities measured by the IQ test were lower for the higher ability groups. Many subsequent studies (LeGree, Pifer & Grafton, 1996; Deary et al, 1996) have confirmed this "differentiation hypothesis". As Detterman (in Deary et al, 1996: 121) explains:

> *... the differences in correlation across IQ levels are consistent with the systems theory of intelligence ... in this theory, lower IQ's result from deficits in important cognitive processes. Because these processes are part of a system, they affect the functioning of other parts of the system. If these important processes are deficient, the parts dependent upon them will also be impaired. Essentially, a deficit in an important process will put an upper ceiling or limit on the efficiency of the operation of other parts of the system. This means that all parts of the system will be more similar if there is a deficiency in an important process. This forced similarity in abilities is what causes a higher correlation among IQ subtests for low IQ subjects.*

Given the belief in the "durability" of *g* by the proponents of the biological theories of intelligence, the differentiation hypothesis "would in part explain why the testing of single IQ and g factors has often seemed an unduly limited way of assessing intellectual abilities of people of above average IQ" (Deary et al, 1996: 106).

So, is the IQ test redundant for current studies on intelligence? The author would argue that it is not. While researchers believe other more reliable methods are being sought and found, the IQ remains a correlational benchmark in many of these studies on individual differences. However it is reasonable to postulate at this stage in the assessment of intelligence that the field has rejected a *predominantly* IQ-based definition of what constitutes intellectual abilities. Science has progressed past the design of IQ tests and alternative methods are now available which may help to identify a much wider range of intellectual functioning, more reliably and well beyond the verbal and performance-bound measures of IQ. The Raven's Progressive Matrices test was used in this study primarily because it is spatial/figural rather than verbal in design.

2.8. The Raven's Progressive Matrices

The Raven's Progressive Matrices (RPM) test is available in three different forms. The first, the *Coloured* Matrices, is suitable for testing very young children or older people with an intellectual disability. The most popular form is designed for regular populations and is called the Standard Progressive Matrices. The third form, the Advanced Progressive Matrices, is specifically designed for advanced groups. The Standard Progressive Matrices was the instrument used in this study as a basic measure of *g*. This test deviates from other measures of IQ, such as the WISC and the Stanford-Binet test because it is totally visual in content. There is no language involved except the simple directions which are read out by the person administering the test. As the name of the test suggests, the subjects are given a series of matrices with a pattern and the subject has to determine which piece of the matrix is missing. Figure 2.1 below is an example of one of the items:

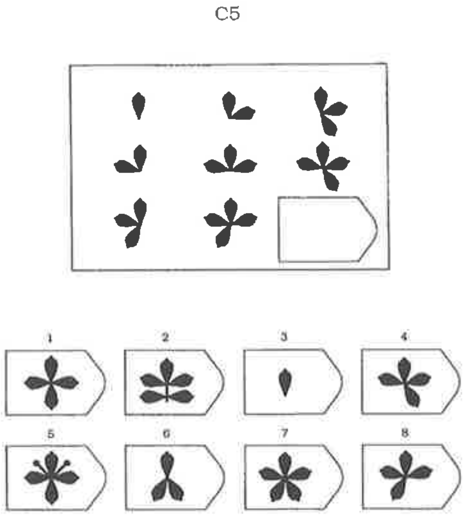


Figure 2.2: Example of test item from the Raven's Progressive Matrices (Standard Form)

The Raven's Progressive Matrices (RPM) is generally regarded as a sound measure of basic *g*. Indeed, many studies have reported that the RPM is a more reliable measure of *g* than any other psychometric test (Snow, Kyllonen & Marshalek, 1984; Roberts & Stevenson, 1996). Because it is nonverbal and free of domain knowledge, it has been argued that the RPM is possibly the only reliable measure of *g*, or fluid intelligence that is available for research.

The components of the MI Theory which are measured by the RPM are the logical/mathematical intelligence which involves" recognising and exploring patterns, categories or relationships using objects or symbols", and spatial intelligence, defined as "the ability to perceive and manipulate three-dimensional objects or visual materials in the head" (Vialle & Perry, 2002: 12).

As Sternberg has previously stated, *no test is culture free*, however one could argue that the RPM is possibly the closest current measurement of a basic, general intellectual ability, which is not influenced by cultural knowledge or language:

> *... performance at the test primarily depends upon domain-free reasoning processes, i.e., cognitive processes which function in the same way irrespective of the actual meaning of the material that is being processed.*
>
> *(Roberts & Stevenson, 1996: 519).*

The RPM was selected for this study because of its ease in delivery, particularly to whole groups at the one time, and because many studies have confirmed its reliability and validity as probably "the best or only measure of intelligence in current research," and that it "is consensually accepted as the quintessential test of inductive reasoning" (Alderton & Larson, 1990: 887). Many studies have reported the RPM, involving inductive reasoning and "abstract" figural content as having "the highest *g-loading* and thus to be the *purest* measures of intelligence … and that scores on various similar tests suggest that Raven-type tests lie near the 'centre of gravity' of intelligence" (in Richardson, 1991: 129).

The RPM has consistently shown significant correlations with other markers of general intelligence, specifically those elementary cognitive tasks (ECTs) which can be measured under laboratory conditions (Stough, Nettelbeck & Cooper, 1993). Confirming status of the RPM as a measure of Fluid ability, Bors and Stokes (1998: 382) have argued:

> *Not only are such tests considered to be measures of specific forms of higher cognitive abilities, but these tests are also considered to be among the best single indexes of general intelligence … of such tests, Raven's Progressive Matrices tests have been among the most popular.*

Some studies have argued that the RPM measures a multiplicity of abilities however the majority have concluded that it is an essential measure of *g* or unitary ability:

> *What we do want to argue is that underlying this medley of diverse and unique items is a singular ability construct, along which individuals can be rank-ordered, and this rank-ordering can predict who is most likely to succeed at solving any particular item. This ability construct, whether it is called* g, *education or correlates and relations, or fluid intelligence, or whether it is attributed to mental energy limits or working memory capacity, it is fundamentally singular*
>
> *(Alderton & Larson, 1990: 899).*

In addition, Arthur and Woehr (1993) researched the dimensionality of the Advanced Progressive Matrices, and confirmed a unidimensional measure of the APM rather than a multidimensional one and they concluded that their results were consistent with the development and use of the APM as a unidimensional measure (Arthur & Woehr 1993, 476). Other studies focussing on the APM have confirmed the stability of it as a measure of g, even when shortened versions of the test are given (Bors & Stokes, 1998). In addition, significant correlations have been reported with both the full version and the shortened version with measures of Inspection Time (IT) "although, as expected, the correlations between the short form APM and IT was weaker than that with between the full-length APM and IT, it remained moderately strong and statistically significant" (Bors & Stokes, 1998: 395).

In summary, the majority of researchers argue that because of its avoidance of a language base it has a 'centrality' within testing for IQ as Carpenter, Just & Shell, (1990: 405) indicate:

> *The centrality of the Raven tests indicates not only that it is a good measure of intelligence, but also that a theory of the processing in the Raven test should account for a good deal of the reasoning in the other tests.*

While this 'centrality' is regarded as the greatest strength of the RPM by most, it is regarded by others as its essential weakness. The fact that it is based on patterns arranged in a figural matrix renders it 'knowledge or domain poor'. Richardson (1991) argued that there is no such thing as domain-free reasoning processes and experimented with the form of the RPM by substituting meaningful content for the standard matrix boxes. He called his items, *Socio-Cognitive* items and an example of one is reproduced below:

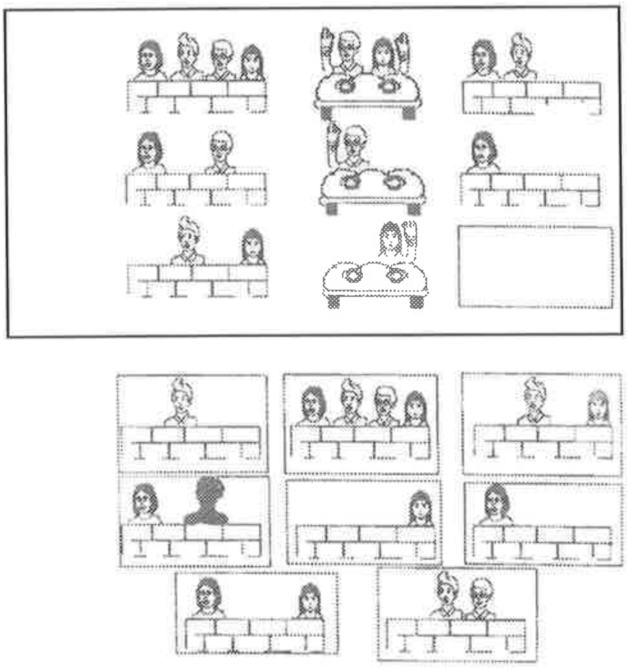


Figure 2.3: Socio-Cognitive variation on the RPM (Roberts & Stevenson, 1996: 520)

Richardson found that "performance was considerably better for the Socio-Cognitive items than the Standard items, and that there was no correlation in performance between them" (Roberts & Stevenson, 1996: 521).
Richardson's basic argument is that psychometric tests in general, even the RPM which is specifically regarded as culture-fair, are not able to predict success in real-life reasoning or problem solving and therefore should not be used. Without 'reasoning schemas' that have some real world validity, Richardson argued that IQ tests, including the RPM, are not reliable indicators of *g*.

In later research (Richardson & Webster, 1996) the concept of *schemas* was replaced with the term, *knowledge*, as an explanation for reasoning performance. These studies claim that IQ tests in general, including the RPM, cannot test intelligence in a knowledge-poor environment. Other studies have cautioned against any measure of *g* that is *embedded in context* as this automatically corrupts the validity of the measure according to the amount of cultural commentary or cultural knowledge which must, of necessity, accompany such a test.

There have been convincing criticisms of Richardson's (1991, 1996) attempts to infuse context and meaning into tests such as the RPM. Roberts and Stevenson (1996) and Roberts (1996: 539) have argued that Richardson:

> *has not supplied evidence that disproves the existence of domain-free reasoning processes ... reasoning depends on both context-specific knowledge and domain-free reasoning processes depending on the problem ... knowledge will never be available for every task and so domain-free processes will sometimes be required.*

In general the weight of research in favour of the RPM as a sound measure of *g* (e.g. Jensen, Saccuzzo & Larson, 1988; Alderton & Larson, 1990; Arthur & Woehr, 1993; Roberts & Stevenson, 1996; Bors & Stokes, 1998; Heller et al, 2000; Colangelo & Davis 2003) is more convincing than Richardson's research.

The increases in IQ found by Flynn (1987a) focussed mainly on the Standard version of the RPM. Stough, Nettelbeck & Cooper, (1993) have researched any possible increases in IQ as evidenced in the Advanced RPM. Citing the data from Yates and Forbes (1967), based on Australian University students Stough, Nettelbeck and Cooper found the mean score of 23.17 found on the APM in 1967 had only increased to a mean score of 24.4. They concluded (1993: 104) that, "at least in university samples, the mean IQ measured by the APM has not increased greatly over the last 25 years". The stability of APM scores across the two samples may reflect that the APM is not prone to the same large increases reported by Flynn for the RPM (Standard) test.

The RPM has a robust record for use with populations who are minority groupings or other traditionally under-represented groups. Being able to identify intellectual abilities in culturally and linguistically diverse students, many of whom may not be performing well in the school system, has been regarded as a problem ever since IQ tests were designed. It is well documented that Terman's (1921) subjects came predominantly from the middle to upper white sections of society, which is precisely the group most likely to score well on the Stanford-Binet IQ test. Torrance was one of the first to recognise that economically disadvantaged students as well as those in cultural minority groups are less often identified as gifted and placed into advanced level programs. As he noted, "there is a great deal of giftedness among the culturally different, and the waste or underuse of these resources is tragic" (Torrance, 1981a). Torrance himself designed a checklist of "Creative positives for the culturally different" as a means of helping to train teachers to identify abilities which may not be evident using more traditional measures. It is recognised that if the traditional tests are biased against certain groups then such tests should be abandoned. Mills and Tissot (1995: 209) researched the value of the RPM in under-represented populations, comparing scores on it with scores on the traditional measures of academic aptitude (The School and College Ability test). They found that,

> *a significantly higher proportion of minority children scored at a high level on the RPM than on the traditional measure ... and that in addition ... the RPM does appear to be a useful instrument for identifying academic potential in students with limited English proficiency.*

This section has presented an overview of intelligence in general and attempts to measure it. The following section will focus on the notion of creativity and the role it plays in any configuration of intelligence.

Section B: Creativity

2.9. Creativity

"I have the trick of it now ... all it needs is belief"
(David Malouf, An Imaginary Life)

In Malouf's novel, 'An Imaginary Life' the poet Ovid is banished to a foreign country where neither the landscape nor the language is familiar to him. He is socially and emotionally destitute, as a poet without words is like an artist without form or colour. At a pivotal point in the novel the poet sights a single poppy, waving and bouncing in a desolate and flat landscape, a red poppy, and suddenly the gift of language is restored to him, as words, represented by a profusion of flowers,

> *...burst into bud, they click open, they spread their fragrance in my mind, opening out of the secret syllables as I place them like seeds upon my tongue. I am Flora. I am Persephone. I have the trick of it now. All it needs is belief ...*

Ovid is represented in this novel as the archetypal 'creator', the poet who is dislocated from society and seemingly incapable of forming and maintaining normal human relationships. Yet this character, with the creative muse restored, is also capable of the extremes of emotion, not only of depression, but also of exultation, as the closing lines of the novel witness:

> *It is summer. It is spring. I am immeasurably, unbearably happy. I am three years old. I am sixty. I am six. I am there.*

Belief in the positive power of the creative intellect is a relatively recent phenomenon. Traditionally, creativity has been viewed with suspicion, with profiles of creative individuals from the time of Aristotle assuming "an association with madness and frenzied inspiration" (Albert & Runco in Sternberg, 1999a: 18). Even the 20th Century has linked creativity with mysticism (Sternberg & Lubart, 1991), madness (Jamison, 1995; Neihart, 1999), self-abuse, isolation (Silverman, 1993; Greenspon, 2000) and depression (Piirto, 1999; Jackson, 1998).

Although the 21st Century has ushered in a veneration of the artistic or creative producer, the traditional caricature of a highly creative person still prevails as someone so taken up in the hiatus of invention that everyday details, like wearing shoes or eating, are forgotten. The term 'creativity' conjures up images of behaviour which may be unconventional, unusual, 'feet-off-the-ground' thinking and 'hanging loose' to open up new ideas. Yet the Latin root of the word is *creatus* which means:

> *to make or produce', or literally, 'to grow'... creativity as a word has its roots in the earth. Other similar derived words are cereal, crescent, creature, concrete, crescendo, decrease, increase, and recruit*
>
> (Piirto, 1992:7).

Despite this origin of the term as 'rooted' in practical outcomes, creativity has traditionally been viewed as outside the realm of everyday thinking and the prerogative of just a few, possibly unstable, individuals.

The necessity for creative thinking is "becoming a common purpose throughout the world" (Strom, 2002: 183) and countries with traditionally disparate views on education have highlighted the need for education for creative thinking. Strom's (2002) research has indicated that Japan's National Commission on Educational Reform criticised universities (Chan, 2000) for not fostering nor educating for creativity. Similarly, in China, Kuo's (2000) research concluded, "the Education Ministry for the Republic of China wants reforms that enable colleges to educate students more broadly and reward creativity instead of rote memory (in Strom, 2002: 183). Research from the business sector in the United States of America has made similar recommendations (Senge, Cambron-McCabe, Lucas, Smith, Dutton, & Kleiner, 2000).

Research on creativity is more recent than research on intelligence in general and arrives at as many differing conclusions, if not more.
According to Cropley (1999) the "modern era of creativity research" only began in 1950 when Guilford addressed the American Psychological Association with his proposal that creativity, or 'Divergent Production,' must be taken into account in any determination of intelligence.

Since the middle of the 20th Century, vague notions of creative ability had been linked with intellectual functioning, however Guilford was the first to formalise the inclusion of 'divergent' thinking skills into a map, or structure of the intellect (SOI). It is only since the SOI model that the terms 'creativity' and 'intelligence' became, not synonymous, but linked.

Finke, Ward & Smith (1992) used the term *creative cognition* to argue that the capacity for creative thought is "the rule rather than the exception in human cognitive functioning" (in Sternberg, 1999a: 189). A generative view of creativity has been proposed by their Genplore model, which is based on a fusion of the *generative* and *exploratory* processes. They viewed creativity as a cognitive construct and hence within reach of all thinking beings.

Just as the 1980s ushered in the age of *Cognitive Science*, so too the same era gave birth to the first cognitively based explorations of creativity. The research, as opposed to simple observations and collations of creative behaviours, began in earnest, although it has rarely focussed on Information Processing (IP) or laboratory based studies on creativity as Phillipson (2002: 83) has observed:

> *... in one of the most comprehensive treatises of creativity (Sternberg, 1999), information processing models of human creativity appear not to have been extensively explored.*

This could be explained by the diversity of theories, including implicit and explicit views, about what constitutes creativity. Creativity has never been envisaged as a single characteristic, although the studies have in general isolated the common element of 'novelty' or originality (Morgan, 1953; Cropley, 1999) as central to most theories. The majority of theorists have attributed multiple components, generally from four to six core characteristics, to creative ability (Guilford, 1967; Torrance, 1966; Clark, 1989; Nickerson, Perkins & Smith, 1985; Sternberg, 1988a; Sternberg & Lubart, 1991; Khatena, 1992; Piirto, 1999). These components usually stem from external factors as well as intrinsic abilities and, as Sternberg (1990a) has indicated, are formulated as explicit as well as implicit theories. The implicit and explicit theories of creativity, which probably account for the measurement of creativity by both tests and rating scales respectively, have been described by Plucker & Runco (1998: 2) as:

> *Perhaps the most exciting development in recent years ... in contrast to traditional studies that rely on experts' definitions and theories of creativity (i.e. explicit theories), these researchers assess individuals' personal definitions of creativity (i.e. implicit theories). From a practical viewpoint, when people engage in creative activity, they do not have explicit theories in mind. Their thoughts and actions are guided by personal definitions of creativity and beliefs about how to foster and evaluate creativity that may be different from the theories developed by the experts.*

However exciting these developments are, research on creativity is still not an exact science and the explorations have been fraught with difficulty. Rothenberg (in Austin, 1977: 97) summed up the problems regarding researching creativity, arguing that it is "beset with mysticism, confused definitions, value judgements, psychoanalytic admonitions, and the crushing weight of philosophical speculation dating from ancient times."

It is the author's view that creativity, with youth on its side in terms of research, is still the 'wild child' of intelligence and the 'poor relation' of giftedness, in both schools and research settings.

Why is creativity a *wild* child? There is not one accepted definition of creativity and it has been argued that creativity is a form of human behaviour which has been postulated in such a variety of ways that "it nearly defies definition" (Clark, 1997: 65).

This lack of agreement is evidenced in "the number and variety of definitions and tests for creativity and their weak real-world predictive validities" (Sternberg, 1984 in Albert, 1990: 15). The only consensus among researchers of creativity is that it is a highly complex concept which is central to intelligence, but which is difficult to define, to observe and to measure.

It follows that research on creativity has been thwarted by the inability of the researchers to agree on a precise definition of it. Just as the early canvassing of definitions of intelligence by Sternberg and Detterman (1986) yielded such differing views, so too creativity, as a term or as a concept, has never been established or verified. Gardner (1993: 19) observed that:

> *...Like* intelligence, *the term* creativity *has been applied over the years as an honorific label to a wide range of individuals, situations, and products. Such lay use of the terms* creative, creativity, *or* creating, *may have sufficed on the streets; but as happened with the term* intelligence, *the variant forms of* creativity *have seemed in need of more precise formulation.*

These 'variant forms' of creativity have engendered a range of definitions. Mednick (1962) defined creativity as a bringing together of events that are remotely associated with each other. Mednick championed the 'Associative Theories' view of creativity and designed the *Remote Associates Test* which has its basis in the ability to form associations between similar and dissimilar items. Baer (1993: 18) noted that Mednick's work relied on the assumption of a "general, domain-transcending theory that would account equally well for creativity no matter what the task domain".

Rogers (1976: 301) defined creativity as an open-ended, game-like ability, "the ability to play spontaneously with ideas, colours, shapes, relationships – to juggle elements into impossible juxtapositions". This view has persisted and is raised in Chapter 5 of this thesis which reports that some formalised tests of creativity request a 'fun, game-like' atmosphere for the testing process.

Nickerson, Perkins & Smith (1985: 88) define creativity in accordance with the need to create a product, indicating that, "creativity is that collection of abilities and dispositions that lead to a person frequently producing creative products."

Sternberg (1991) also stressed the need for a practical outcome in the form of a product. Sternberg has indicated that his 'Investment' theory focuses on creative performance rather than creative potential and that "given a substantive product, such as an artist's painting, the evaluation of creativity can proceed" (Sternberg & Lubart, 1991: 3). This idea of the necessity for a *product* has been referred to in many theories of creativity which rely on a cognitive, associative basis of creativity as opposed to theories which place the origin for creative behaviour in the unconsciousness.

The views of social psychologists also reflected the need for a product. Simonton (1988a: 394) observed that "the offered creative product must succeed in the domain of interpersonal influence; that is, it must be accepted by others with an active involvement in the same area of creative endeavour."

Definitions relying on the notion of a product may sound almost trite in their perceptions of creativity, e.g., "creative persons make creative products", yet this contextual view of creativity is more popular in the current research than the other views of creativity which regard it in more cognitive, low level terms (e.g. Guilford, 1950; Finke et al, 1992; Phillipson, 2000).

Cohen-Shalev (1993: 106) affirmed the "complex and ambiguous" nature of creativity yet proposed one necessary condition for it which is currently accepted: "that it be publicly acknowledged to have made a meaningful contribution in its field". Interestingly, this notion places the definition of creativity within an adult sphere only, as "children, for all their ingenuity and inventiveness have rarely, if ever, produced outstanding contributions in any field."

Cohen-Shalev's overview of literary or verbal creativity highlights the necessity for "conflict or enduring dilemma" as central to the notion of creativity and this is explored in more detail in Chapter 4 of this thesis.

The necessity for creative intelligence to be judged as 'useful' in some way is at the heart of Gardner's (1993: 35) definition of a creative individual:

> *... a person who regularly solves problems, fashions products, or defines new questions in a domain in a way that is initially considered novel but that ultimately becomes accepted in a particular cultural setting.*

The necessity for novelty or originality is also essential to this definition but, as Cropley (1999: 253) reminds us:

> *....Merely novel structures display surprisingness and incongruity, to be sure, but they must also be meaningful and practicable to be effective.*

Debate on the need for a creative product is similar to the Gagné (1998) model of giftedness and talent, the latter dependant on the necessity to produce the evidence of the assumed underlying abilities (or gifts). This model is reproduced in the next section and has been criticised as requiring a definition of talent which requires, for recognition, some product or some 'return' to the society that fostered it.

Cropley (2001: 6) has argued that there is a "common core" to what constitutes creativity and this core has three elements. The first is the classic marker of *novelty*: "a creative product, course of action or idea which departs from the familiar". The second is *effectiveness*: in other words "it works, in the sense that it achieves some end," and the third is *ethicality* which interprets creativity in the true generative nature of the word as, "not selfish or destructive behaviour, crimes, warmongering and the like."

All of the known attempts to define creativity have included some central notion of *novelty* or uniqueness, a feature which has no doubt often set creativity itself apart as *different* from other intellectual, cultural or personality traits. Different as it may be, creativity is also inherently linked to intelligence, cognitive style, personality and culture. As Sternberg (1988a: 126) observed,

> *... creativity is unlikely to be understood merely as an adjunct of some other cognitive or personality phenomenon. Creativity overlaps with other psychological phenomena, such as intelligence, cognitive style, and personality, but it is not identical with any of them.*

The themes of creativity as an altruistic characteristic of providing value or giving back to the society is a feature of some of the more recent definitions.
The inclusion of community or cultural notions of creativity is evident in Csikszentmihalyi & Wolfe's definition (2000: 81):

> *"Creativity can be defined as an idea or product that is original, valued, and implemented ... whatever individual mental process is involved in creativity, it must be one that takes place in a context of previous cultural and social achievements, and is inseparable from them".*

The influence of Sternberg's Triarchic Theory of Intelligence, comprising *components* of intelligence, levels of *experience* and *context*, are evident in this definition.

Definitions of creativity which have been influenced by differing theoretical views of creative intelligence tend to fall into three major categories:

Divergent Thinking theories, Associative and Connectionist theories and Cognitive/Cultural theories, although all of these overlap to some degree.

Guilford's divergent production and Torrance's divergent thinking theories have been most influential in the first category, Mednick's associative theories in the second, and Gardner, Sternberg, Sternberg & Lubart's theories have largely instructed the third. Guilford was responsible for the divergent thinking theories of creativity, based as they are on his original notion of divergent production. The work of Torrance, who built upon Guilford's model to develop, "the most influential divergent-thinking theory of creativity" (Baer, 1993:15), also adheres to the divergent thinking theory.

Guilford's original (1967) Structure of the Intellect Model (SOI) specified 180 unique cognitive factors identified under three types of function: mental operations, contents, and products. Divergent thinking is identified as one of the six mental operations. It is interesting to note that the remaining five mental operations: evaluation, convergent production, memory retention, memory recording and cognition can all be measured with the use of an IQ test.

Brown's research (1989, in Glover et al, 1989: 3) states that the divergent thinking approach to the study of the creative process is the most reliable channel of exploration as it, "has the most explicitly developed theoretical base, underlies most creativity tests, and has generated the most research."

At a time when, despite the publication of Guilford's SOI, there was no presumed acceptance of divergent thinking principles into the profile of intelligence, researchers such as Torrance (1962) put forward his theory that the posits of creativity were essential to any determination of general intelligence. Torrance has emerged, since the early 1960's as one of the foremost researchers on creativity. He based much of his work on the proposal of four major categories of creative thinking ability, originally identified within Guilford's divergent-production. The factors are:

> *Fluency* - Related to the generating of a quantity of ideas, on the premise that the more ideas generated, the greater the likelihood of originality.
> *Flexibility* - Examining a problem from different perspectives: seeking variety in responses.
> *Originality* - Coming up with new or unique solutions to given problems or questions; putting two known ideas together to make a third original one.
> *Elaboration* - Adding to what is already apparent to make an idea more interesting or exciting, seeing relationships to the given idea.

Torrance (1962; 1966) and later Williams (1970) merged Guilford's concept of creativity into a dual process: firstly the teachable cognitive strategies of fluency, flexibility, originality and elaboration, and secondly the personality or affective strategies of risk-taking, curiosity, imagination, complexity, independence, humour and strong self-concept. They believed that both processes were central to any determination of intelligence.

In an era when intelligence was defined by an IQ test, Torrance was very critical of the limitations of such standardised testing, claiming that testing for creative behaviours is a more reliable measure of intelligence and particularly giftedness. Torrance's Tests of Creative Thinking (TTCT) which were used for this study, are possibly the most often used tests in research projects and the "most widely validated test of creative thinking"(McCabe, 1991: 116).

Associative theories of creativity are probably best epitomised in the early research of Mednick (1962) and in particular with the design of the Remote Associates Test which has its basis in the ability to form associations between similar and dissimilar items. Mednick's work relied on the assumption of a "general, domain-transcending theory that would account equally well for creativity no matter what the task domain" (Baer, 1993: 18).

Connectionist theories have features similar to the associative theories but with essential differences. In its simplest form, connectionism relies upon the fact that "information can be broken into *elements*, and that there are *connections* between those elements ... connectionist models allow for parallel processing (many connections can be active at once), rather than just serial processing (only one connection can operate at a time). In addition, there are hidden units that mediate between input and output" (McClelland & Rumelhart, 1988 in Benjafield, 1992: 38).

The Cognitive/Cultural theories maintain a cognitive base to the development of creativity but indicate that this must always be viewed as within a cultural context or a domain. This theory probably became most well established with the publication of Sternberg & Lubart's (1991) *Investment* Theory which reinforced the message that society will only invest in creative ability if it values such ability. The six major components of this theory of creativity are:

- intellectual processes
- knowledge
- intellectual style

- personality
- motivation
- environmental context

Sternberg & Lubart (1991) found that the component with the strongest link to creativity was the "intellectual processes" one, which further strengthened the view that intelligence and creativity are essentially linked.

It is relevant to note here that the divergent, associative, and cognitive/cultural theories of creativity have all instructed the design of the differentiated curriculum for the *Turning World* program outlined in Chapter 4.

It is argued that a fourth theory is the 'purely' cognitive or 'low-level' approach to defining and conceptualising creativity (Finke et al, 1992; Phillipson, 2000). This approach has not dominated the research, as Cropley (1999: 253) has explained:

> *The cognitive approach takes little account of personality, the social environment or motivation, but it provides a practical definition of some aspects of creativity, and some insights into what promotes it.*

Although this thesis does not have its focus on this aspect of creativity, it is clear from the dearth of research that more work needs to be done in this important field.

2.10. Creative intelligence and links with social and emotional development

The strong influence of MI theory since 1983 has focussed much research on identifying the many and varied characteristics of creativity, arguing that it is central to understanding the make-up of intelligence and essential to any definition of higher intelligence.

Many studies on creativity have concentrated on its "noncognitive" (Cropley, 1999) aspects such as motivation (Amabile, 1983), personality (Helson, 1996), creative attitude (Schank, 1988) and the social environment (Csikszentmihalyi, 1990a). These studies have focussed on the case studies, especially with a focus on personality, of people who have proved through their products that they are creative and have tended to reveal the following characteristics:

> *self-aware regarding their own creativity; independent; risk-taking; energetic; curious; sense of humour; perceptive; artistic; original/imaginative; need for privacy/alone time; open-minded; and attracted to complexity and novelty*
>
> *(Davis in Colangelo & Davis, 2003: 313).*

Dellas & Gaier (1970) reviewed creativity research within the cognitive and personological investigative orientations of five parameters of creativity as they affect the individual. They identified the following five parameters necessary to understanding creative intelligence:
1. intellectual factors and cognitive styles associated with creativity
2. creativity as related/unrelated to intelligence
3. personality aspects of creativity
4. potential creativity
5. motivational aspects associated with creativity
This study set the framework for the later development of theories of creative intelligence.

Davis (in Colangelo & Davis, 2003) summarised the characteristics of creative intelligence which he claimed can be seen as paradoxes:
1. Individuals can be creative in any part - or all parts - of their personal, educational, and adult professional lives
2. Cognitive and non-cognitive traits must combine to orient students toward creativity thinking
3. Some persons are high in self-actualised creativity whilst others show special-talent creativity and may not even be mentally healthy
4. Some have small-scale creative insights : others large-scale
5. Creativity can be forced for some but it also happens suddenly and unpredictably
6. Creative innovation may stem from hard work and planning; it may also be sudden inspiration and insight
7. Creativity involves logical thinking and analysis as well as irrational and unrestrained fantasy
8. Creative talent will remain repressed and hidden without a psychologically safe social and cultural environment that supplies opportunities and reinforcement for creativity.

Davis also identified the last paradox which is that:
9. Problem *finding* is a hallmark of creative accomplishment.
The highest level of this problem finding is "true creativity" which leads to "open problem finding and open solutions".

Cropley (1997) also used the framework of *paradoxes* underpinning creativity to explore creative intelligence. As an example, two of Cropley's twelve paradoxes are:

> *... creative production requires deep knowledge but, simultaneously, freedom from the constraints imposed by such knowledge ...(8)*

> *... creativity implies bringing something new into existence, but creativity can be studied without reference to products at all ...(10).*

Cropley's seminal publication on creativity as *"a bundle of paradoxes"* summarises the various paradoxes as cognitive, serendipitous (relying on chance factors), product, personality, motivation and social factors. His twelfth paradox takes a 'macro' view of creativity, claiming it:

> *... may have more to do with characteristics of the society than with the psychological processes and personality characteristics (1997: 12).*

The term, 'divergent thinking' is often used interchangeably with the term 'lateral thinking' and indeed both have a basis in the creative thinking principles. Guilford's original conception of *divergent production* relied on the generation of a multiplicity of ideas. The term *Lateral thinking* which has perhaps best been described by de Bono, is viewed as the opposite of *vertical thinking* where "one moves forward by sequential steps ... to prove or develop concept patterns ... Lateral thinking however is not necessarily sequential but may jump from relevant to irrelevant ideas and is concerned with restructuring concept patterns ... and provoking new ones" (de Bono, 1970: 11).

Vertical thinking is epitomised by the learner who can 'follow a good path' in thinking, who can pick up leads and clues towards finding a solution. Lateral thinking is epitomised by learners who 'turn corners' in their thinking, to find a new path, or a new way to the solution. Artificial intelligence, because it is 'language bound' is very good at vertical thinking but is limited in lateral thinking which relies on novelty or originality of ideas. It would be a mistake to view vertical and lateral thinking as separate functions, just as the previous section cautioned against trite left brain/right brain thinking. Similarly divergent and convergent abilities are best conceptualised as working together and in the field of gifted education for example, it has generally been assumed that,

> *divergent thinking (production of variability) and convergent thinking (production of singularity) are separate, more or less competing, or even mutually exclusive aspects of giftedness ... however, in studies of achievement at school or university level, it has been shown that the most gifted students produce both singular and varied information*
>
> *(Cropley 1992 in Cropley 1999: 255).*

Brown (1989, in Glover et al, 1989: 4) has indicated that most theorists study creativity as both an *intervening variable,* used to explain relations between stimuli and responses, and a *trait*. Creativity itself, according to Brown, consists of at least four components:

(1) the creative *process*,
(2) the creative *product*,
(3) the creative *person*, and
(4) the creative *situation*.

Although Cropley (1997) has hypothesised that the situation, or society, might be the defining factor in the development of creativity, the nature of the creative *person*, has dominated much of the research. The focus on what is perceived as the 'social and emotional' aspects of creative intelligence has developed in a similar way to the interpersonal and intrapersonal intelligences proposed by Gardner (1983) and others. Once again the issue of degrees of intellectual ability have been highlighted in the literature as critical to understanding the relation between intelligence, creativity and social/emotional maturities:

> *Using the notion of IQ as a threshold variable, researchers have concluded that among high-IQ persons, personality characteristics are more highly related to creativity than IQ*
> *(Roe, 1963 in Weinstein & Bobko, 1980: 162).*

The profile has already been raised of the wild child of intelligence and seems to be most evident in studies which have highlighted these social and emotional characteristics. As Kurtzman (1967:162) observed:

> *More creative individuals tend to be more adventurous and have a greater tolerance for ambiguity than less creative individuals ...more creative individuals tend to be more extroverted than their less creative counterparts.*

However, as Daniels argues, it is precisely these social and emotional constructs which determine creative intelligence, as,

> *Particularly creative people are recognised most often by their creative accomplishments within a particular field or domain, but creative individuals do not just create external things. They also live creatively and in many ways create their own selves. The creative personality purposefully seeks out experiences and ideas which promote psychological growth and expansion (1998: 154).*

Personalities of creative people, according to Tardif & Sternberg (1988 in Piirto, 1994: 155) have been summarised as comprising a generally high intelligence, the ability to be original, advanced verbal ability and the ability to *imagine*. The latter characteristic is explored in detail in the following chapter of this thesis as it is argued that it is possibly the most powerful yet least understood aspect of the creative intellect.

Piirto's (1994: 156) more detailed outline of some of the most often cited personality characteristics of creative people reveal characteristics such as:

- can encounter antagonism and take mental risks
- tenacity
- propensity for questioning and interest
- openness and naiveté
- drive and absorption
- concentration and dedication to creative work
- high intrinsic motivation
- focus on tasks
- free-spirited rejection of outside limits
- ability to set personal rules rather than follow others' rules
- sometimes introverted, taciturn, contemplative and bemused
- effect on people around them
- acceptance of ambiguity
- respect for originality and creativity
- unorthodox in behaviour
- experience intense emotions
- intuitiveness
- look for fascinating situations
- often experience conflict: both self-critical and self-confident; both socially withdrawn and socially acceptable, depending on peer group.

It is argued that such characteristics may not contribute to a positive experience of schooling and may in part explain the research which indicates that teachers in general dislike students who score highly on tests of creativity (Getzels & Jackson in Csikszentmihalyi & Wolfe, 2000).

Colangelo & Davis (2003: 313) viewed the positive traits of high creativity as: having original ideas; being aware of their creativeness; independent; risk-taking; motivated; curious; sense of humour; attracted to complexity; artistic; open-minded; needing time alone; and intuitive. It is argued that each one of these characteristics could be viewed as negative traits within certain educational settings. Their profile of the aspects of high creativity which the research indicates can lead to negative profiles of highly creative individuals are summarised as:

> *overactive physically and mentally; temperamental; indifferent to conventions and courtesies; challenges rules and authority; resists domination; rebellious, uncooperative; capricious, careless, disorderly; absentminded, forgetful; argumentative, cynical, sarcastic; and sloppy with details and unimportant matters.*

Gender differences have been observed in the social and emotional maturity of creative individuals suggesting that:

> *"highly creative boys are more self confident and mature than less creative boys, but there is no difference between more and less creative girls on these two personality characteristics ... and more creative boys tend to receive greater acceptance from peers than less creative boys but more creative girls are less accepted by their classmates"*
>
> *(Kurtzman, 1967:162).*

Bern (1974) study of highly creative individuals coined the term 'androgynous' to refer to those individuals whose characteristics 'crossed over' stereotypical profiles of male/female characteristics. The inability to access both profiles may lead to individuals who "suppress their opposite sex traits and interests and may stifle their creativity" (Hall, 1979 in Weinstein & Bobko, 1980: 163).
It is Bern's belief that "society has traditionally not encouraged the development of these positive masculine and feminine traits within the same individual" (in Weinstein & Bobko, 1980: 162).

The consensus from the few studies in this field suggest that "highly creative males appear to be more feminine/sensitive than other males while highly creative females appear to be more masculine/independent than other females" (in Weinstein & Bobko, 1980: 163). It is interesting that in this study, feminine/sensitive criteria applied opposite masculine/independent rather then masculine/insensitive or feminine/dependent. Torrance (1962: 111) had earlier observed that "creativity, by its very nature, requires both sensitivity and independence".

Clark proposed that creative intelligence, including its affective aspects, is a higher order set of abilities than the more observable characteristics embodied in notions of cognitive intelligence. Clark (1997: 64) presents her model, in figure 2.11.1 below, of creativity as "the highest expression of giftedness". This model shows the integration of the four areas of thinking (being rational or reasoning), feeling, intuition and sensing as necessary for creative intelligence to develop:

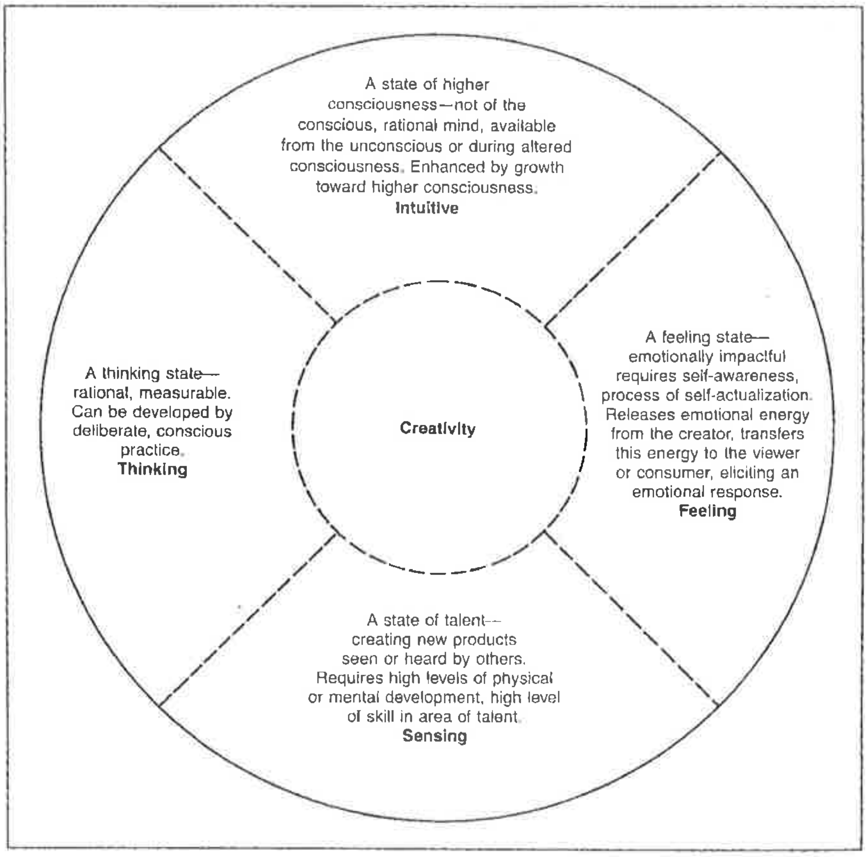


Figure 2.4: Clark's Creativity Circle

It is pertinent to this section to note that three quarters of her construct of creativity is devoted to intuition, sensing and feeling, further stressing an essentially affective view of creativity.

2.11. Creativity and identified links with intelligence

"Because it denotes rare and valued human accomplishment, creativity should be considered interchangeable with giftedness"

(Tannenbaum, 1983).

The previous section of this chapter highlighted the differing notions of intelligence in general as a relatively fixed, general capacity as opposed to a dynamic, multiple set of talents. In a similar way, the research on creativity has also presented a bi-focal view, with researchers on the one hand claiming it is a general capacity "that influences an individual's performance across many domains … and on the other hand … a widely diverse collection of skills and knowledge, each contributing to creative performance in only a single domain" (Bamberger, 1990 in Baer, 1993: 1).

Eysenck (1995: 222) has argued that "creativity is not identical with *g*," which is in keeping with the earlier research of Weinstein & Bobko (1980), Wallach & Kogan

(1965), and Getzels and Jackson (1963) who all claimed that creativity is independent of standard notions of intelligence as measured by IQ tests.
In general an asymptotic relationship between measured intelligence and measured creativity is supported by the research. In essence this means that intelligence and creativity correlate with each other, up until a point, usually IQ 120, beyond which there is no observable relationship. As Phillipson (2002: 98) has indicated, "a threshold effect appeared where the low correlation between creativity and intelligence seemed to disappear entirely when the IQ score reached 120".

The early researchers of creativity, Getzels and Jackson (1962) and Torrance (1962, 1972), found creative skills to be different from intelligence and that on the basis of IQ and creativity tests, "these researchers claimed that above a certain minimum level of intelligence, being more intelligent does not guarantee a corresponding increase in creativity" (McCabe, 1991: 11).

Other researchers (in Kurtzman, 1967: 162) argued a direct link between creativity and intelligence, maintaining that the *degree* of advanced intelligence is not a deciding factor:

> *The more intelligent a person, the more creative he is likely to be. This holds true even when dealing with a select sample of individuals who are in the top 15 percent of the population in terms of intelligence.*

If creativity is a general ability then training in the techniques of creative thinking is surely justified. However Baer, (1994) provides convincing arguments to challenge the existence of any general creative-thinking skill, claiming that creativity is entirely 'task-specific', and that "creative performance on one task is not predictive of creative performance on other tasks, including those that might be considered to fall into the same domain such as writing poetry and writing short stories" (Baer, 1994: 81).

When testing for intelligence, creativity measures are rarely utilised.
The role of creativity in determining general intelligence has traditionally been of secondary consideration to the observable and quantifiable primary cognitive traits which are more easily identified in psychometric intelligence testing. In general, the earlier studies concluded that intelligence rather than creativity contributed to successful academic achievement. High scores on intelligence tests were claimed to be surer predictors of school success than high scores on creativity tests (Edwards & Tyler, 1965 in McCabe, 1991). Countering these findings, Torrance's research (1989) concluded that high scores on his tests of creativity were a surer indicator of academic achievement than high scores on an IQ test.

Even at the highest levels of intellectual functioning, creativity has not necessarily been identified as necessary to the configuration as Gallagher & Courtright observed, "One of the strangest results of the current educational definition of 'giftedness' is the separation of the concept of creativity from intellectual superiority" (in Sternberg & Davidson, 1986: 103). Although most researchers agree that the 'lack of fit' between creativity and intelligence lies in the instruments used to measure them, others believe that "giftedness and creativity are different capacities" (Winner, 1997 :18).

Any attempt to measure creativity has depended on percolating its myriad definitions and characteristics down to an essence or core ability.

Just as *g* has featured in research on intelligence, so too a 'monolithic' view of creativity has been favoured by researchers who wish to be able to construct a neat, general theory in order to explain creative thought processes, predict creative behaviour and "demonstrate an underlying unity among diverse creative activities and productions" (Baer, 1993: 1).

Phillipson (2000: 51) also argues that if any neat, general theories or definitions of creativity are to be posited then a separate view of intelligence and creativity is likely to be the most useful:

> *If there is no consensus as to the nature of intelligence, how can there be any agreement as to the nature of creativity especially if creativity is an aspect of intelligence? It would seem fruitful to consider creativity as separate to intelligence and to generate separate testable hypotheses until the precise nature of each can be established*
>
> *(Phillipson, 2000: 51).*

Even at this early stage it is clear that the studies which explore the relationship between intelligence, creativity, and academic performance have produced conflicting results.

The earlier section presented research on knowledge of the brain and specifically the roles of the two hemispheres in mediating intellectual functioning. McKim (1980: 25) has argued that creativity and intelligence could not possibly be separate constructs, as the highest form of creative thinking is "ambidextrous thinking" which engages whole brain activity. He cites the work of Abraham Maslow who identified 'primary' and 'secondary' creativity as essential to this debate:

> *primary creativity emanates from the unconsciousness; it is the result of the ability to fantasise, let loose, be crazy, privately …*
>
> *secondary creativity stands on the shoulders of those who have gone before; is logical and orderly but lost intimate contact with senses, feelings, and inner fantasy life.*

Incorporating Newton's famous line "*If I have seen further than others it is because I have stood on the shoulders of giants*", Maslow argues that the superior intelligence is the primary, creative one and its link with the ability to 'see further' is relevant to this thesis, and is discussed in more detail in the following chapter. McKim (1980: 25) views arguments of left brain versus right brain determinants of thinking as trite, because, "the most creative thinkers are those who have achieved psychological integration."

Educational practice which separates out notions of creativity from general intelligence, or which 'packages' left-brain (logical) and right-brain (fantasy) as the academic and creative aspects of learning respectively, may overlook the needs of the most creative learners.

Section C : Giftedness

"Equal opportunity for the gifted and talented is nothing less than a matter of human rights. It is nothing less than the right of people who, by genetic chance, have skills and gifts to make the most of their precious life ... Unless we are lifted in our spirit, and in our opportunity, then we are stunted as people ... Not only is that bad for us, it is bad for our fellow citizens"

(Kirby, 1991 in Eyre & Geake, 2002:15).

2.12. Giftedness

This thesis has referred to gifted individuals yet not indicated what constitutes giftedness nor how it might be linked to creativity and visual intelligence. The issue of 'rights' referred to by Justice Michael Kirby in the opening quotation for this section, was raised in Chapter 1, with the recommendation from the National Senate Enquiry (2001) that gifted students be included the category of 'special needs'. Similarly, Kirby's explanation of giftedness as 'genetic chance' is at the heart of much debate about the origins and development of giftedness.

It is proposed that if educators, researchers and the wider community understood the nature of giftedness, its incidence within the general population and the best means of enhancing it, then the benefits would flow to individuals of all abilities. Kirby's warning that we are 'stunted as people' if we do not nurture and foster even the most extreme intellectual abilities, is a harsh yet accurate observation.

Nurturing the special abilities of gifted children should be a goal of all societies which value excellence.

Kenneth Clark's credo in *Civilisation* (1969: 346) is a timely reminder in a world of disharmony, that if wisdom is bred of civilised societies then it needs to be nurtured:

... I believe that order is better than chaos, creation better than destruction. I prefer gentleness to violence, forgiveness to vendetta. On the whole I think that knowledge is preferable to ignorance, and I am sure that human sympathy is more valuable than ideology. Above all, I believe in the God-given genius of certain individuals, and I value a society that makes their existence possible.

Whether belief in a divinely bestowed genius or the more biologically-based genetic chance is at the heart of such belief, the fact of a 'given' underpins traditional notions of very advanced intelligence or giftedness.

The term *giftedness* implies that a state of being has been given and that the recipient has not had to work hard to receive it nor to bring it to fruition. If a purely genetic view of giftedness is proposed then the analogy with *a present* or *a gift* is reasonable as genes are passed on, not earned.

This thesis has provided a review of the literature on intelligence in general and creativity specifically. How have these studies instructed our understanding of *giftedness*? There is currently not one accepted definition of either intelligence or creativity and it should come as no surprise that there is not one definition of giftedness. Indeed, the diversity of definitions of giftedness attest to the fact that giftedness is still a very new field of specialised study within Education in general. The singular and multiple theories of intelligence have already been outlined. At the level of giftedness and where the *degree* and *kind* of giftedness are significant to successful outcomes, these theories present as even more complex, as Monks, Heller & Passow (2000: 841) queried:

> *Can a single theory explain the rare Einsteins, Shakespeares, Nijinskys and similar talented individuals as well as the child whose 'giftedness' appears to be achieving unusually well academically as measured by standardised achievement tests?*

Plato believed that giftedness was bestowed by *The Muse* when he claimed: "The great poets, have their genius by *inspiration*, thus they utter all their admirable poems ..." (in McCann et al, 1998).
The belief that genius is inspired and outside the conscious control of the individual is evident in the stereotype of the genius as 'other-worldly' and has no doubt fed the common adage that *there is a fine line between genius and insanity.*
Galton's (1898) hereditary studies concluded that giftedness is essentially a matter of genetic endowment. The contemporaneous research of his equally gifted cousin, Charles Darwin no doubt helped to sustain this theory. Genes replaced the Muse in this era of research into giftedness.

Terman's major research in the 1920's on the largest population of identified gifted subjects ever studied, added the dimension of *measurement*, in the form of a number, to the identification of giftedness. Terman dispelled many of the cruel myths regarding gifted students as bespectacled, unsociable and physically weak individuals who would rather read a book than play sport. Terman's subjects, who became known as the 'Termites', presented, in comparison with the population on the whole, as fitter, more socially confident, and they scored more highly on measures of moral reasoning. The later studies showed they had lower incidence of maladaptive behaviours such as crime and lower frequency of divorce rates and suicide. It needs to be remembered however that because Terman used the Stanford-Binet IQ test to initially select the subjects, groups such as white middle/upper class individuals were over-represented in his sample. This was a selected group, as Gallagher (2003: 13), nearly eighty years later, has stressed when he makes an analogy with his own 'Talent Search Program':

we will not randomly pick from the gifted population; rather, we will pick the very best and most effective of those students. This would tend to make these particular gifted populations look slightly better adjusted than any unselected gifted population.

Terman's study provided an inestimable contribution to the field of gifted education but its one major drawback was that, because it relied on IQ for selection, the research throughout the 20th Century tended to trap researchers into the belief that giftedness is high IQ. The ease of the score, the miraculous number, was seductive for researchers who were seeking to encapsulate the complex nature of human intelligence into an easily defined category. Yet as Piirto (1999: 28) has cautioned, we need to look hard if precious material is to be found, and gifted children:

... can be found in all socio-economic and ethnic groups by those who look hard enough. Standardized testing is a good way to find them but not the only way, especially for disadvantaged groups where observation, portfolio assessment, and other methods should be utilized.

The allure of the IQ score has been supplemented by theories of Gardner (1983, 1997) with a multiple construct of intelligence, Sternberg (1985, 2000) with a social/cultural construct, and Guilford and Torrance with their creative constructs. This research has expanded the view of intelligence and giftedness but not weakened it. Many early views still prevail as Braggett (1997: 16) observed:

While it may not be openly stated, there is usually ... an ... assumption that gifted students were born gifted and that their giftedness is bestowed on them by the divine, by one or both of their parents or by chance.

The mediating role of the environment in determining giftedness is criticised by those who believe solely in the genetic inheritability of basic *g* as Miller (1998: 51) reflects,

It has even been suggested in a post-modernist vein that giftedness is a social construction! In today's society where elitism is frowned upon, downplaying giftedness is perhaps understandable.

The more socially constructed views of intelligence claim that giftedness is not fixed, but developmental and directly affected by environmental influences.
This is in accordance with Braggett's (1997: 16) definition that giftedness is a "developmental concept ... teachers and administrators may positively or negatively influence the expression of a student's giftedness over time."
Monks et al (2000: 851) have further confirmed that the role of the environment is critical in developing or hindering the innate coding for potentials which a gifted child might be born with, arguing that "classroom curriculum and instruction can be boring

and unchallenging or the classroom climate and school environment can influence student behaviour and learning positively or negatively".

2.13. Defining giftedness

"Behind the wall of my backyard you can see two trees: one is a date tree, the other is also a date tree."

(Lu Hsun, 1931: 5)

From a plethora of vastly differing definitions of giftedness, Gina Ginsburg's is a simple yet insightful one. Ginsburg (in Education Department of Victoria, 1981: 4) states that "Gifted children do things a little earlier, a little faster, a little better and a little differently."

Most parents and teachers have some strategies to manage the children who are *earlier*, *faster* and *better* than their chronological peers, if only to accelerate the content of their work. However the child who is '*different*' poses quite another challenge. It is the author's view that this 'difference' is predominantly the outcome of enhanced levels of creative intelligence as well as differences in social and emotional acuity which attend advanced intelligence. Monks et al (2000: 851) have commented on this difference when they observed that "by virtue of their being 'different', the gifted often encounter socio-emotional problems which can become serious".

The South Australian Policy Statement launched in 1996, defines gifted students as follows:

> *A 'gifted' child or student will possess, to an outstanding degree, demonstrated ability or potential in one or more of the following areas:*
> - *general intelligence*
> - *specific academic areas*
> - *visual and performing arts*
> - *psychomotor ability*
> - *leadership*
> - *creative thinking*
> - *interpersonal and intrapersonal skills.*
>
> *Appropriate intervention by the family, community, schools and Children's Services can help a gifted child or student to reach full potential.*
>
> (DECS, 1996)

This definition has its basis in the multiple nature of intelligence, while still retaining the basic *g* and acknowledging the role of the environment.

Renzulli (1978) defined very high intellectual functioning as consisting of an interaction, which he presented as a Venn diagram, between three clusters of human traits: above average general ability or *g*, creativity, and motivation or task commitment. The links between these three traits will be referred to at the conclusion of this chapter when the author proposes that, it is the degree of overlap or interaction between intelligence, creativity and social/emotional constructs which define giftedness. These three characteristics supported the model of enrichment and extension in the design of the *Turning World* program in this study, outlined in Chapter 4.

The notions of high *g* and creativity underpin the main characteristics of academically talented children as outlined by Piirto (1999). Such students:
• learn at a faster rate
• think abstractly about content that is challenging
• think productively, critically, creatively, and analytically
• have the ability to increase constantly and rapidly their store of knowledge, of both facts and processes.

Traditional markers of giftedness, particularly when IQ-driven, tend to be limited to abilities identified by white, middle to upper class cultures. It is also interesting to note that such traditional markers are also dominated by notions of *childhood* and most definitions of giftedness tend to have children in mind. Yet 'lifelong' conceptions of what it is to be gifted have instructed other observations such as, "Giftedness in children is linked to potential, in adults to achievement ..." (Noble, Subotnik & Arnold, 1999 in McCann, 2000b). This is an interesting notion as Gagné has provided the view of giftedness as domains of inherited abilities which are massively influenced by both internal and external factors. The ensuing talents that a successfully functioning gifted individual may evidence are proof of giftedness but if those domains of ability are not developed then an individual's giftedness may never be evidenced as talent. Figure 2.15.1 below details Gagné's Differentiated Model of Giftedness and Talent:

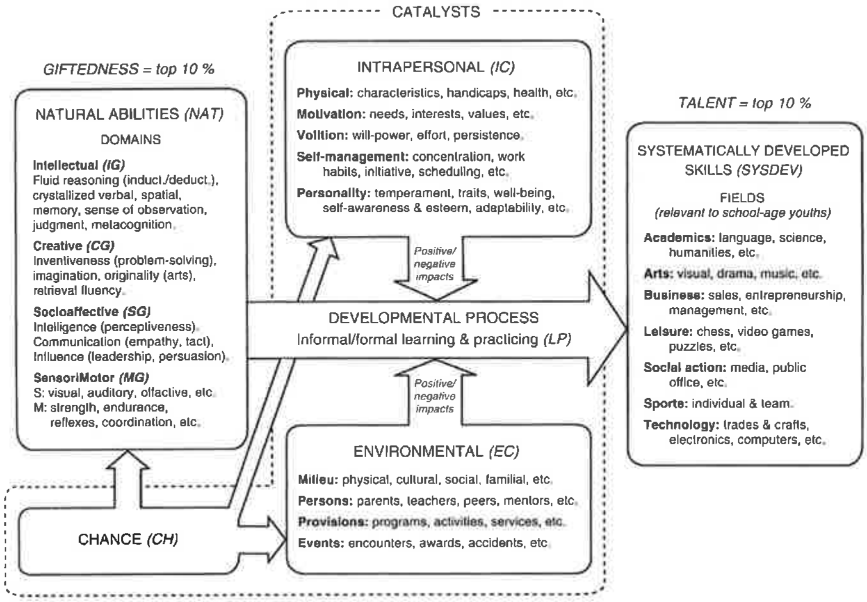


Figure 2.5: Gagné's (2003) Differentiated Model of Giftedness and Talent

Gagné does differentiate between the notions of 'giftedness' and 'talent' with the following definitions:

> *Giftedness designates the possession and use of untrained and spontaneously expressed natural abilities (called aptitudes or gifts), in at least one ability domain, to a degree that places an individual at least among the top 10 percent of age peers.*
> *Talent designates the superior mastery of systematically developed abilities (or skills) and knowledge in at least one field of human activity to a degree that places an individual at least among the top 10 percent of age peers who are or have been active in that field or fields*
> (Gagné in Colangelo & Davis, 2003: 60).

Definitions and models of giftedness which differentiate between abilities and achievements such as Gagné's, have been criticised by researchers such as Grant and Piechowski (1999: 8) who claim that such researchers are:

> *Trapped by the metaphor of 'gifts', they believe that the most important aspect of being gifted is the ability to turn gifts into recognisable and valued accomplishments.*

Gagné's model was criticised by Sternberg (2000:231), who argues that:

> *all abilities represent forms of developing expertise that are the result of interactions between genes and environments. From this latter point of view, it is difficult and usually impossible to separate purely genetic from environmental contributions.*

Rather than follow the 'gifts versus talents' approach to defining giftedness, Sternberg has moved beyond Gardner's theory of *types* of intelligence, to *patterns* of intelligence, based on his Triarchic Theory model. Sternberg's 'patterns of giftedness' assumes that an individual is not purely in one category or another but that there are variations on patterns of abilities which go beyond MI's eight or nine *types*. According to Sternberg (2000: 232) gifted individuals whose contributions have been historically enduring have demonstrated three common attributes:

Analytical: *the ability to analyse and evaluate one's own ideas and those of others*
Creative: *the ability to generate one or more major ideas that are novel and of high quality*
Practical: *the ability to convince people of the value of ideas and to render the ideas, practical.*

It is interesting to reflect upon the findings outlined in Chapter 1 of the socio-cultural links with students who do well on the analytical and those who do well on the creative and practical measures of intelligence.
Sternberg has argued that the differing combinations of these three basic skills lead to the *patterns* of giftedness, which may take nine forms of the:

Analyst
Creator
Practitioner
Analytic Creator
Analytic Practitioner
Creative practitioner
Consummate Balancer

The *Consummate Balancer* is described as having "the good fortune to have developed extremely far in analytical, creative and practical abilities ... and hence is in the best position to make a gifted contribution" (Sternberg, 2000: 233).

With the current diversity of definitions of Giftedness, from *g*-driven to multiple talents within a cultural milieu; from fixed at birth or in childhood to developing possibly into old age; perhaps a new definition and a new word should be found. Any new term would need to reflect the complexity of giftedness, as Monks et al (2000: 843) state:

> *At the beginning of the 21st Century, it would appear that efforts to develop better theories and conceptions of giftedness and talent in order to improve program and practice will continue but the focus will no longer be on devising a single, comprehensive conception or construct of giftedness.*

In addition, defining gifted individuals according to their accomplishments still needs to be addressed in the definitions, as Piirto (1999: 28) so rightly points out:

> *These children have no greater obligation than any other children to be future leaders or world-class geniuses. They should just be given a chance to be themselves ... and to have an education that appreciates and serves these behaviours.*

A chance 'to be themselves' is often difficult for gifted children and this difficulty is compounded when their abilities do not mesh with those defined as 'gifted' by the dominant culture.

2.14. Cultural conceptions of giftedness

Giftedness does not just exist within an individual, it exists within a cultural milieu. Although this thesis argues that universals do exist, there are obvious differences in the determinants of giftedness and the consequent markers for identification across different cultures.

Baldwin and Vialle (1999: xxi), whilst agreeing that giftedness is a 'hard-to-define' quality, stress the role of the environment in nurturing and developing (or conversely hindering) such potential. Their work has focussed on specific sub-groups in society such as those with disabilities or from impoverished cultural minority groupings. They believe that giftedness is the ability to:

> *… process information, acquire skills, and produce products within specific domains at a much higher level than those of the average population. We also believe that these abilities can also be found in all ethnic and racial groups and that environment, social mores, and physical and emotional challenges, as well as political restrictions, can influence the display of this ability.*

This cultural view of giftedness is in keeping with Braggett's and Gagne's 'developmental' one which argues that the environment may or may not facilitate gifted development. The Australian view of 'mateship', with its documented love of 'lopping the tall poppies' (McCann, 1998), has no doubt contributed to the relatively sparse number of Australian studies in this field.

Australian research into giftedness within both urban and traditional Aboriginal communities has expanded the view of giftedness well beyond the fixed concept of *g*. Gibson's research outlines eleven markers of giftedness which her findings suggest are relevant to urban Aboriginal children:

> *Communication: highly expressive and effective use of words, numbers, symbols*
> *Humour: conveys and picks up on humour*
> *Imagination/creativity: produces many ideas; highly original*
> *Inquiry: questions, experiments, explores*
> *Insight: quickly grasps new insights and makes connections; senses deeper meanings*
> *Interests: Intense (sometimes unusual) interests*
> *Memory: large storehouse of information on school or nonschool topics*
> *Motivation: evidence of desire to learn*

Problem-solving ability: effective, often inventive, strategies for recognising and solving problems
Reasoning: logical approaches to figuring out solutions
Intrapersonal/Interpersonal ability: an unusually heightened understanding of self and others
(Gibson, 1995 in Baldwin & Vialle, 1999: 59).

The research of Day (1992) and Haslett (1992) (in McCann & Bailey, 1994) reported similar findings in Australia and it is interesting to note how common such characteristics of giftedness are, as reported within cultural minority groups, not just in the Australasian region but also within American cultural minority groupings. Studies in the USA on the cultural profiles of gifted children in Hawaiian, African American, Hispanic and native American populations identify similar characteristics (Gibson, 1992 in Vialle & Geake, 2002).

The New Zealand Maori compilation of 'gifted characteristics' includes such markers as service to Maoridom, spirituality and ability to cook. The inclusion of 'pakeha knowledge' or knowledge of 'white' skills, which are likely to feature on standardised IQ tests, is rated very low on the scale of gifted Maori characteristics. As Bevan-Brown (1996: 96) points out:

One of the most noticeable differences between the New Zealand Department of Education's definition of special abilities and the Maori concept ... is the great importance the latter places on 'intangible' qualities, mainly in the affective, interpersonal and intrapersonal domains.

The greatest number of studies on cultural notions of giftedness have been done specifically with African Americans. The following characteristics outlined by Boykin (1994 in Colangelo & Davis, 2003: 508) built upon the work of Torrance who identified 'creative positives' in this cultural minority grouping. The characteristics of giftedness in African American cultures is summarised as:

Spirituality
Harmony
Movement
Verve
Affect
Communication
Oral tradition
Expressive individualism
Social time perspective.

Many of the children who were the subjects for the American, New Zealand, and Australian research would not have performed well on standard psychometric tests of intelligence such as the WISC or the Stanford-Binet with their narrow interpretation of what high intelligence entails. Researchers have used such findings to propagate the 'cultural deficit' theory of giftedness, arguing that there is some inherent deficiency in the culture rather than a difference between the abilities measured on the test and those valued by or developed in the minority culture.

In terms of the Australian Aboriginal population, the practice of subordinating the individual's personal achievement goals to group harmony is standard.

For many Aborigines the curricula offered by the education system are irrelevant and have been cited as the reason for the high drop-out rate (Partington, 1996 in French, 1997).

The deficit view argues that the concept of Aboriginal learning styles is inherently a weakness in the culture itself in that:

> *Aboriginal students are always behind the eight-ball in educational situations, always having to make up for some inherent deficiency, that there is some lack in the way they think.*
>
> *(McCann, H., 1995: 45).*

Callahan & McIntry (1994 in Baldwin & Vialle, 1999: 55) urged educators to consider giftedness in cultural minority groupings in terms of "a model of *potential* rather than *deficiency*". Braggett (1985 in Baldwin & Vialle, 1999: 55) described an environment which is conducive to the expression of gifts and talents as one that "is tolerant of difference, accepting of diversity ... free from value judgements about the worth of different cultures ... and promotes self-esteem and pride in excellence regardless of the area of study".

2.15. Social and emotional constructs of giftedness

> *" I was born with a gift ... and it is a very precious thing, it's a kind of incredible permission and my biography is that I was born with this infliction and I hope to get mature and protective and to tune and enlarge it and share it and that's the only purpose of my existence"*
>
> *(Brett Whitely, 1990: Australian artist, died by drug overdose in 1995)*

The 'infliction' that Whitely identifies and which the Australian arts community claims contributed to his early death, is referred to at length in the research into giftedness. The relative social and emotional stability of Terman's subjects is not an observation reported in studies which have now identified giftedness in a wider range of abilities than those measurable by an IQ test.

Shakespeare's 'fine frenzy' has been researched in gifted education particularly where links with visual art intelligence and gifted writers have been identified. Gallagher (2003: 13) has synthesised the research to date by observing that "there is some indication that youngsters who are extremely creative artistically have more vulnerability to mental illness than their academically gifted classmates".

The Polish researcher Dabrowski, working in the mid 1930's, proposed the argument that highly gifted individuals are also highly sensitive in a range of areas. Dabrowski identified the characteristic of 'overexcitability' (OE) which in the original Polish translated as 'superstimulatability', and which he claimed "is an intense visceral reaction to experience that expresses itself in five forms :
psychomotor: a surplus of energy, psychomotor expression of emotional tension
sensual: sensory pleasure, sensual expression of emotional tension, aesthetic pleasures
intellectual: probing questions, problem solving, curiosity, theoretical thinking
imaginational: free play of the imagination, spontaneous imagery as an expression of emotional tension
emotional: intensity of feeling, somatic expressions, strong affective memory, fears and anxieties, feelings of guilt, relationship feelings, feelings towards self."

(in Silverman, 1993: 14).

It needs to be remembered that the characteristics of the 'overexcitabilities' as they have been identified in gifted individuals, may not be a negative or disabling aspect of their intelligence. In the example of visually artistic individuals it seems that some degree of OE may be a contributing factor to their craft:

> *Numerous individuals in the fields of psychology and gifted education have studied the mental health and developmental potential of intellectually, creatively, and artistically gifted individuals (Piechowski, 1997). Aware that highly creative individuals tend to live more intensely, Dabrowski (1967, 1972) viewed this sensitivity and emotional intensity as an integral part of their psychological development. In the intensified feeling, thinking, and imagining of these persons, Dabrowski found great potential for unusually high levels of psychological growth and individual development.*

(Daniels, 1998: 155).

The following chapter in this thesis explores visual intelligence and it is argued that the very active nature of visual thinking is linked with high levels of sensitivities. Clark (1997) has argued that the OEs are a natural part of being gifted:

> *The characteristic most readily identifiable in gifted children, varying both in kind and degree, is sensitivity. Whether the sensitivity is to one or more particular areas of learning, sensitivity to discovering or solving problems, or sensitivity to the feelings of one's fellow man, it is so much a characteristic of giftedness that it can almost be said that the two terms are synonymous*

(Barbe in Clark, 1997: 141).

However, as the literature on visual and literary artists also confirms, there can be a 'down side' to these high levels of sensitivities, as Gross (1998: 169) has observed:

the gifted child is likely to become aware, at an early age, that she is different from the children around her. Contrary to popular myth, however, this awareness rarely leads to feelings of conceit or superiority. Rather, gifted children are likely to blame themselves for the discrepancy between themselves and their age peers.

The 'blaming' for this 'difference' or asynchrony (Silverman, 1993) can lead to low self-concept which has been cited in the literature (DECS, 1996; Delisle, 1991) as the single most evident characteristic which separates a gifted achieving student from a gifted underachiever. Because giftedness creates asynchrony between the individual and others who are not so gifted, it has been argued that 'self-knowledge' or 'self-experience' is more difficult to attain for gifted individuals, as Greenspon (2000: 179) indicates:

The self-experience of the gifted person ... refers to the experienced world of a person who is gifted. This is different from the self-experience of non-gifted people because of what giftedness entails in terms of capabilities and reactions from others. All of the qualities that define giftedness, such as high intelligence, broadness and depth of thought, multi potentiality, divergent thinking, and profound emotional sensitivity contribute to a particular self experience. Others may react to the gifted person's expression of these qualities with pride, acceptance and support, or with jealousy, meanness and rejection. Combinations of these and other related qualities and social reactions contribute to a variety of gifted self experiences. For example, the child who is a talented mathematician will have a strong sense of agency, based on her ability to do math well. If others around her prize and affirm this, her self esteem and sense of self cohesion will be high. If she is instead ridiculed or ignored, the opposite will be true.

For gifted children, the experience of school is not always positive. In particular for highly gifted and creatively gifted students, whose interests and abilities may be manifested in areas not supported by mainstream school programs, their talents may be unrecognised and not catered for by the school. This can lead to a sense of isolation and disengagement with the school system. As Olenchak (1999: 297) observed:

These non-traditionally gifted youth often feel as if they do not belong to any *group, and the school itself is often viewed by such students as foreign, cold, and aloof. Whenever individuals, gifted or not, feel separated from the mainstream of society, they risk development of a wide array of social and emotional problems. Behavioural issues, denial of talent, and even denial of self are but a few of the concerns arising from students whose unusual talents go unnoticed and unserved.*

Educational 'fit' is one of the factors Neihart (1999) identifies as having a strong impact on gifted students' psychological well-being, along with their personal characteristics and the nature (and degree) of their giftedness.

Jackson (1998: 48) identifies what he calls the 'Tripartite Needs System of the Gifted Adolescent' which he summarised as the need:

1. for *Knowledge*: to know and comprehend the nature or meaning of phenomena as opposed to simply inferring or believing

2. for *Communion*: to be able to exchange thoughts and emotions or share something in common involving strong emotional or spiritual exchange, and

3. for *Expression*: to be able to transform into words or manifest an emotion or feeling without words through music or art or some other nonverbal means.

It is relevant to note the links between knowledge, communion and expression and the design of the *Turning World* program with its Types 1, 2 and 3 guidelines and activities as outlined in Chapter 4.

This thesis argues that gifted students do have a 'right' to an education which is appropriate to their advanced intellectual abilities and that the methods of differentiating their curricula need to be clearly articulated.

Piirto (1999: 28) affirmed this right when she stated that:

> *... the 'gifted', for the purposes of the schools, are those individuals who by way of learning characteristics such as superior memory, observational powers, curiosity, creativity, and the ability to learn school-related subject matters rapidly and accurately with a minimum of drill and repetition, have a right to an education that is differentiated according to these characteristics.*

The question arises as to the responsibility of the school to cater for students whose giftedness and interests lie outside the realm of traditional and "school-related subject matter". How can schools become more relevant for these students? How can the curriculum be extended to cater for their different needs and support and affirm their diversity of talents?

The Columbus Group (1991 in Jackson, 1998: 216) acknowledged the need for a differentiated curriculum to support the different needs of the gifted student, defining giftedness as:

> *asynchronous development in which advanced cognitive abilities and heightened intensity combine to create inner experiences that are qualitatively different from the norm.*

These 'inner experiences', especially those of isolation or being different, if kept trapped within, can place the gifted adolescent "at risk for a depressive experience" (Jackson, 1998: 218).

Silverman (1993: 1) expressed it succinctly when she stated that "gifted children not only think differently, they feel differently". The confluence of cultural differences, a sense of isolation and being different from the others, combined with higher sensitivities and insights can mean that:

> *While the physical development of academically talented children is most often similar to those of their age, their cognitive and emotional development often far outstrip their age mates. As a result, these students often experience great stress that can lead to such phenomena as disabling perfectionism, underachievement, acting out behaviour, and depression".*
>
> *(Piirto, 1999: 468*

It is significant to note that gifted visual and literary artists in particular have been identified (Jamison, 1985; Piirto, 1992) as having a higher than normal incidence of depression and introversion. The implications for education are massive if the cognitive, creative and social/emotional abilities of gifted students are to be nurtured.

2.16. Implications for gifted education

The abundance of resource materials based on Gardner's Multiple Intelligences Theory (1983; 1997) is evidence that the field of gifted education has embraced this theory. Despite the fact that "broad theories of giftedness are still largely untested" (Phillipson, 1999: 11) specialised gifted programs continue to proliferate, and "the distinct lack of empirical support for any of the multifaceted models ... has not diminished their substantial influence in directing pedagogy (Hong & Milgram, 1996 in Phillipson, 2000: 12).

Planning curricula around seven or eight "ways of learning and teaching" has become common practice in gifted education. However, many of the MI resources have been a superficial interpretation of the MI theory and not necessarily related to enriching, extending or accelerating gifted students. Proponents of the biological basis of ability have been critical of the success enjoyed by the educational behaviourists (many of whom would prefer to call themselves cognitive scientists) claiming that training behaviours is not necessarily enriching learning as Brand (1996: 322) observed:

> *For the past generation, the English-speaking world has largely abandoned the recognition of lasting and general human differences to which adaptation must be made by educators. Instead, despite the decline of behaviourist ideas in academic psychology, education has been gripped by a philosophical insistence on treating all children as similarly conditionable. Supposedly, all differences in achievement are superficial and ephemeral: they can easily be*

> *reduced by the employment of suitably enlightened behaviourist educators. Yet ..... even Skinner has since argued ...we would double the efficiency of education with one change alone - by letting each student move at his or her own pace.*

Letting each child move at 'his or her own pace' is a simplistic view of the innumerable theories and models of classroom practice which have been fed by the various debates on the nature of giftedness. The practice of teachers altering, adjusting or differentiating a curriculum (usually by enrichment, extension and acceleration) to allow for different abilities has been tempered by postmodernist views which recommend student-centred education and 'constructivist classrooms' (Perkins, 1999) where students have an active participation in their education.

Belief in the 'trainability' of intelligence is evident in the burgeoning programs in Multiple Intelligences, the revised Bloom's Taxonomy, the Question Matrices, Thinkers Hats, Thinkers Keys, CoRT programs and others (e.g. de Bono, 1970, 1992; Ryan, 1990; Pohl, 2000). These programs generally have their focus on enriching and extending gifted students rather than accelerating them.
In addition the evidence from cognitive neuroscience has indicated that the make-up of the gifted brain is different from others and that:

> *the implication for education is clear - due to their different neural wiring, gifted students have different learning needs, and require an appropriately advanced curriculum, delivered with an appropriately higher-order pedagogy*
>
> *(Geake, 2000: 1).*

In particular in the field of mathematics, Geake and O'Boyle (2000) claim that "a differential pedagogy for the mathematically talented, especially males, "is "justifiable" (Geake & O'Boyle, 2000: 4). The contentious nature of these studies, especially with their gender-based implications suggest that the 21st Century is poised to bring new views of intelligence, creativity and giftedness and possibly new pedagogies. Rather than adhere to seven, nine or any number of discrete intelligences, this thesis argues that the multiplicity of human intellectual abilities percolates down to three major categories which encapsulate the essence of both *g* and MI theories.

2.17. Critical, Creative, and Caring: a view of intelligence for the future

At the International Conference on Thinking Skills in Boston in 1994, Gardner confirmed his (then) seven intelligences, and indicated that teachers should test for the seven intelligences in a classroom setting and design their teaching programs according to the MI guidelines. According to Gardner, students who are more spatial or visual in their learning, should be allowed to learn in this mode; students who are more kinesthetic in their abilities should not be forced to sit still and listen. Following

Gardner's presentation, Matthew Lipman, the author of '*Harry Stotelmier's Discovery*' (based on Aristotelian discourse) and other *Philosophy for Children* programs, presented his paper which countered Gardner's by claiming that 'individualising' instruction for each child according to his or her specific intelligences was neither didactically possible nor socially sustainable, as "today, the need for community outweighs the need for individuality" (Lipman, 1994). Such a view could be equally countered by J.S. Mill's famous observation that "In the long run, the worth of the State is the worth of the individual". However the two perspectives, in the author's opinion are not exclusive of each other and both have instructed the view of giftedness which this section proposes.

According to Lipman, too much emphasis in gifted education has been given to the analytic and creative intelligences and not enough to what he called the 'caring intelligences'. Social and emotional thinking is more important to good thinking than any combination of the other two, according to Lipman, who also cited the research outlined in the previous section on the links between advanced intelligence and advanced levels of sensitivities and moral reasoning. Lipman claimed that if gifted students were to have an education differentiated according to their abilities then the social/emotional intelligences must be included. Lipman outlined an 'Inventory of Caring Thinking', suitable as a guideline for differentiated curriculum within gifted education. This Inventory has been used as a guideline for the design of some aspects of the *Turning World* program. It has also been incorporated into popular classroom practice through Pohl's (2000a; 2000b) teacher resource publications.

In summary the Caring Thinking inventory (in Pohl, 2000a) is comprised of:

- **valuational thinking:**

  This involves training children to value or appreciate.

- **affective thinking:**

  This involves training children to understand feelings and emotions more acutely, e.g. *indignation* is the result of realisation that someone innocent is being hurt. It is as much cognitive as any other ability.

- **active thinking:**

  This involves training children to act on their beliefs. Languages, gesture, all are involved in active thinking. There is ambiguity in the terms "need caring for" (affective thinking) and "caring about" (active thinking), and

- **normative thinking:**

  This involves training children to appreciate the ideal, what could be desired, and to link it to what is desired. It is the conjunction of the normative with the actual: what is and what ideally should be.

Lipman claimed that gifted education had focussed on critical thinking and creative thinking skills, yet had given little time to what he claimed was the most powerful of intelligences, the caring thinking skills. Lipman indicated, however, that training in all three are essential to gifted education:

By adding caring thinking to critical and creative thinking we can teach children not just moral rules and cultural empathy, but how to engage in higher-order ethical thinking (Lipman,1994).

The author has identified the following three aspects of Lipman's work and translated them into practical training programs (in McCann, 2000a, 2000b, 2002a, 2002b; McCann et al, 1998) which the *Turning World* utilised:

Critical thinking: the need to train speed, recall, logic
Creative thinking: the need to train original, fluent and flexible thinking and
Caring thinking: the need to train moral reasoning and ethics.

In addition, the author has summarised these three categories as essential to defining intelligence in general and giftedness specifically:

*Gifted individuals have enhanced ability to be **critical** (analytical, evaluative, fast), **creative** (fluent, flexible, original, elaborative), and **caring** (empathetic and sympathetic) in thinking skills. These abilities vary in degree and kind within the gifted population.*

The critical, creative, and caring abilities are universal to human intelligence but different cultures place different values on recognising and developing them. A genetic coding for these abilities is inherited and plays a significant role in their determination. The role of the environment is critical to the fulfilment of inherited potentials.

It is argued that IQ tests, when appropriately used, are useful for identifying the critical abilities and creativity tests may help in identifying the creative abilities. However wider measures such as checklists or rating scales should supplement such measures, particularly to help identify those gifted in the social/emotional, or caring thinking abilities. An example of such a checklist is presented in Figure 2.6 below:

CRITICAL THINKING
Learns quickly
Wide general knowledge
Large vocabulary, fluent language, avid reader/writer
Visual/holistic in problem solving
Advanced in at least one subject area
Advanced analysis of problems or situations
CREATIVE THINKING
Can generate many ideas quickly & easily
Keen sense of humour
Good at novel /original ideas
Advanced curiosity/ questioning
Likes inventing, constructing: can visualise outcomes
Willing to take risks/experiment
CARING THINKING
Shows concern/sensitivity to others
Exhibits personal intensity of feelings
Deep appreciation of aesthetic/artistic pursuits
Strong sense of justice
Is a perfectionist
Shows leadership - good at organising

Figure 2.6: A Checklist of Critical, Creative and Caring Thinking skills (McCann, 2003)

At the conclusion of this chapter it is important to note that the exploration of intelligence, creativity and giftedness is far from complete. This thesis proposes that visual thinking plays a special role in the determination of intelligence yet one which has not been researched at length, as Hoffman (1998: X1) observed:

> *We have long known about IQ and rational intelligence. And, in part because of recent advances in neuroscience and psychology, we have begun to appreciate the importance of emotional intelligence. But we are largely ignorant that there is even such a thing as visual intelligence …*

Chapter 3: Visual Intelligence

The real voyage of discovery consists not in seeking new landscapes
but in having new eyes
(Marcel Proust).

[The purpose of this chapter is to examine the nature of visual intelligence and make the links between visual imagery, perception, depiction and the design of differentiated curriculum. It outlines a grammar of visual thinking and provides examples in the forms of analogue drawings and visual language universals]

3.0. Introduction

Richard Wagner once said of his brilliant operas that people should not worry if they did not understand the libretto because "the music will make everything perfectly clear" (in Zeki, 1999: 2). It would seem that through the language of music Wagner and other great composers are able to communicate feelings and ideas that most of us would find difficult to express in words. In a similar way, visual artists who communicate in non-objective or abstract art works rely on the interplay of form, light and colour to express their beliefs or to convey their messages. The *Figures of Sound* instrument which was designed for this study, is based on the *form* of visual art, as set out by Kandinsky, who claimed that all visual form is essentially the interplay between the use of a point and a line within a basic plane (or frame) to communicate.. While he conceded that colour was an important element in this communication, Kandinsky maintained that form was superior and that it develops as a universal 'language' in the same way that Noam Chomsky postulated that spoken language develops.

A definition of visual intelligence has been proposed in this thesis.
The purpose of this chapter is to clarify the nature of this intelligence and to provide the rationale for the design of the *Figures of Sound* instrument which is presented in Chapter 5. In addition, this chapter details the principles of visual intelligence and higher-order interpretation of visual art and links with visual arts curricula which directed the design of the visual enrichment program, the *Turning World*, which is outlined in Chapter 4.

3.1. Vision as an active, information-processing activity

"Vision is not merely a matter of passive perception, it is an intelligent process of active construction. What you see is, invariably, what your visual intelligence constructs"
(Hoffman, 1998: X11).

In most instances throughout this chapter the word 'visual' could be replaced with the word 'vision', the latter interpreted as providing the receptive or sensory uptake of information through the eyes. Yet vision itself is a very active process, engaging far more than just the vision centres of the brain. The fact that vision is, in terms of the evolution and make-up of the brain, "the last of our senses to evolve and the most sophisticated" (Barry, 1997: 15) has been corroborated by much research. The cited advances in PET and fMRI techniques have confirmed that visual intelligence is "an intelligence so great that it occupies nearly half of the brain's cortex" (Hoffman, 1998: X1). The total engagement of the brain in visual uptake or stimulus is out of proportion to that which is required for the other senses to function.

Although specific areas of receptive and expressive language have been identified and studied in the brain, particularly in the left cerebral hemisphere, the equivalent functions in visual intelligence seemingly engage the entire brain. The mediating role of the corpus callosum is critical in visual thinking. As the diagram reproduced below in Figure 3.1 illustrates, for visual thinking to occur left retinal stimulus crosses through the corpus callosum to the right parietal and occipital lobes to the visual cortex, and the right retinal stimulus crosses over to the left side. Visual uptake literally engages the brain from back to front and left to right:

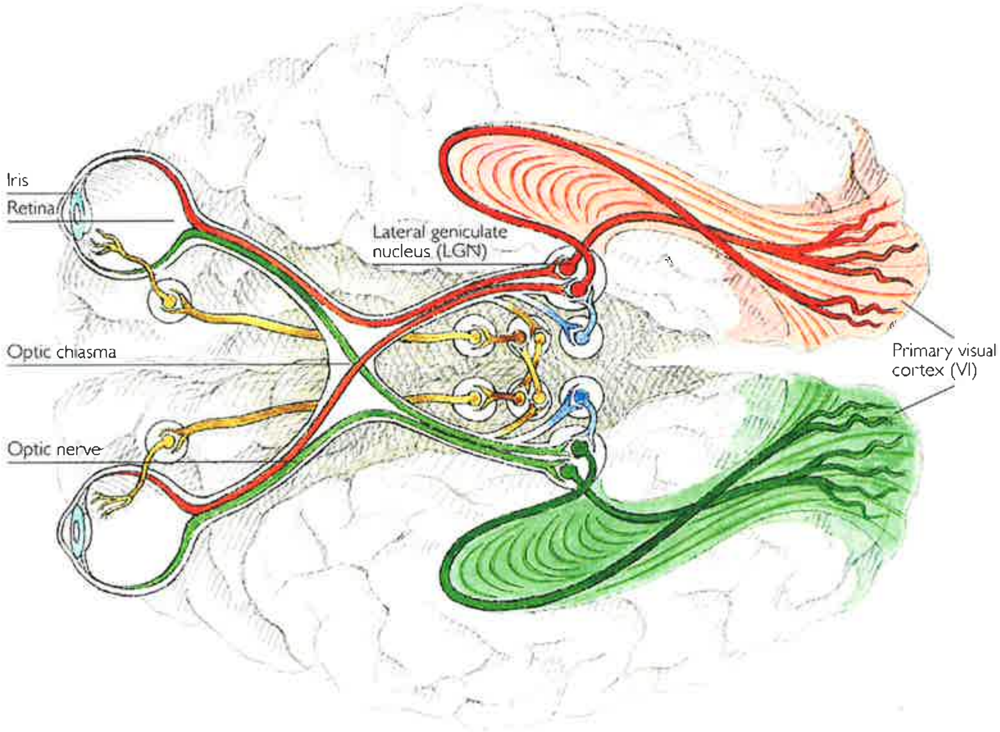


Figure 3.1: Visual Functions of the Brain (Greenfield, 2000: 68)

As Penrose (1989: 374) has explained:

> *In the case of the visual cortex, it is not that the right side is associated with the left side,* but with the left-hand field of vision of both eyes. *Similarly the left visual cortex is associated with the right-hand field of vision of both eyes ... a well-defined map of the left-hand visual*

field is formed on the right visual cortex and another map of the right-hand visual field on the left visual cortex.

It seems fitting that the massive activity that initial retinal stimulus engenders in the brain is matched by the active, information-processing outcome which is visual thinking. Some of the visual processing takes place in the retina itself, "and indeed the retina is actually considered to be part of the brain" (Penrose, 1989: 387).

This initial visual stimulus, or the retinal image, which Hoffman called "the image at the eye", has "countless possible interpretations" and combined with the massive engagement of the brain's cortex, results in an active *kind* and *degree* of visual thinking whereby "we **create** what we see" (Hoffman, 1998: 13).

This active, complex process is what makes vision different from the other senses and as this chapter argues, more closely linked to higher-order creative thinking. Without the role of 'envisioning' solutions to problems or new inventions (including those in words), the *aha*! does not take place.

The sensory uptake of information by the eyes has been compared to the workings of a camera. Yet knowledge about the eye and vision is now precise enough to confirm that analogy with a camera is misleading. A camera, according to the way it is programmed, will faithfully record what it 'sees'. Human beings, however, do not see as a camera does, as Myers (1989: 223) states:

The eye is not an objective, impartial mechanism that observes or records images like a surveillance camera ... the eye does not record discrete images at all. It simply responds to the stimulus provided by waves of light with nerve impulses ... which it transmits along an optic nerve often to different parts of the brain. These transitory bits of sensory data are sorted, restructured, and then modified by memories of past experiences.

In other words, simply to 'see' something involves a slice of past experiences, engaging short and long term memory and the active recall of relevant data to this experience. Although a basic visual acuity is required for the initial uptake of the stimulus, it needs to be stressed that:

vision is ... an information-processing task ... we cannot think of it just as a process. For if we are capable of knowing what is where in the world, our brains must somehow be capable of representing this information – in all its profusion of colour and form, beauty, motion, and detail (Marr, 1982: 3).

Interpretation of the research in this field suggests that rather than being just an 'information *processing* task' vision is an 'information *seeking*' process and the role of the eye is certainly not a passive, receptive one. Terms such as ' in the mind's eye' should serve to remind us that:

the world of images does not simply imprint itself upon a faithful, sensitive organ. Rather, in looking at an object, we reach out for it. With an invisible finger, we move through the space around us, go out to the distant places where things are found, touch them, catch them, scan their surfaces, trace their borders, explore their texture. Perceiving shapes is an eminently active occupation

(Arnheim, 1974: 43).

There have been many models proposed to explain the information-processing which takes place in visual processing. The model by Haber and Hershenson (1973: 160) reproduced below in Figure 3.2, provides a visual explanation of the visual processing paradigm:

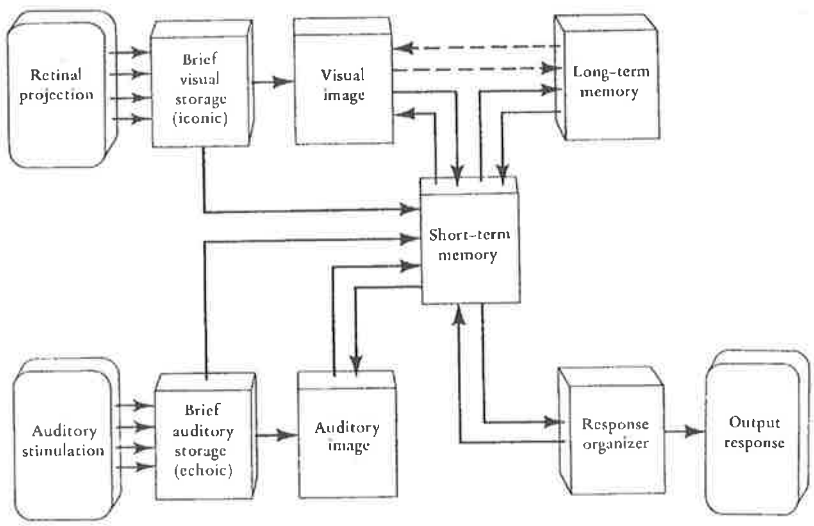


Figure 3.2: The Visual processing paradigm (Haber & Hershenson, 1973: 160)

From this model it is evident that the visual image, unlike the auditory one, can directly access long term memory and is interactive with both long and short term memory in a way that auditory sensory uptake is not. It is relevant to note here that artistically gifted children have been found to have "superior visual memories" (Rosenblatt & Winner 1988 in Colangelo & Davis, 2003: 336).

Because both long term and short term memory, incorporating a significant knowledge base, are involved in making sense of the world visually, the process is an active, information-processing one. It should come as no surprise that this process should engage such a large section of the brain:

Neither the perceiver's visual experience nor his overt responses are immediate results of stimulation. They are consequences of processes, or a sequence of processes, each of which takes a finite amount of time

(Haber & Hershenson, 1973: 158).

The *Turning World* program invested much time in training the students to *see* artworks rather than just *look* at them. As so much memory and past knowledge are involved in the uptake of visual perception and visual imaging, it could be argued that no two people see the same object in exactly the same way, despite the fact that they both might be looking at it, at the same time, and under the same conditions. Examples of this phenomenon have been found in famous experiments such as Wittgenstein's 'rabbit-duck' drawing (McKim, 1980; Hoffman, 1998) which is seen either as a duck going in one direction or a rabbit going in the opposite direction. Other examples provide an image of either an old woman or a young woman and Rubin's famous vase-face, figure-ground illusion, which is seen either as a white vase against a black background or as two silhouetted faces looking at each other (see Figure 3.3 as an example).

Figure 3.3: The vase-face image (McKim, 1980: 65)

Images like these can be disturbing to human beings who perceive an ambiguity of meaning in a single, visual form. It is a normal human condition to look for wholeness and meaning in visual form.

The ambiguity in examples such as the one in Figure 3.3 occurs, "despite the fact that the same pattern of contours, lines, and angles strikes the eye under both interpretations … although the stimulus itself does not change, the interpretation given that pattern does" (Clark, Carpenter & Just in Chase, 1973: 313). In the case of the vase-face pattern, it is almost impossible to perceive both shapes actively at the same time. Visual perception is so strong in its quest for wholeness and meaning that it actively dictates one shape or the other only: "pattern-seeking nature, in its quest for meaning, craves unity in a single figure-ground relationship" (McKim, 1980: 65). Clearly, the active role of prior knowledge and memory dominate the image we are likely to see.

Hoffman's experiments on this phenomenon have shown that by varying the face/goblet illusion, different responses can be observed. For example in Figure 3.4 below, his research showed that subjects are three times more likely to see the face on the right and the goblet on the left:

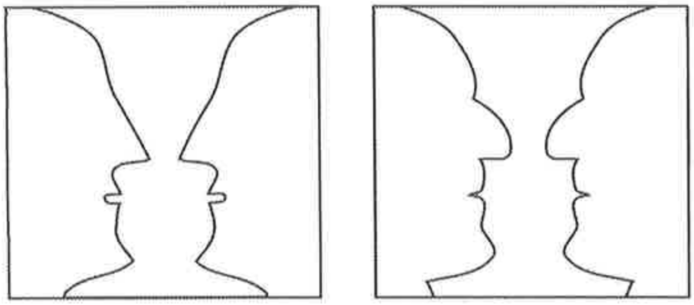


Figure 3.4: The vase-face image (Hoffman, 1998: 99))

This is an example of what Hoffman calls" the fundamental problem of vision", which he sets apart from sensory uptake in other areas claiming that the brain 'intervenes more' with vision and "the image at the eye has countless possible interpretations" (1998: 13). Hoffman viewed this 'problem' in a positive sense, proposing that it allowed for visual intelligence to have almost unlimited development and training potential. This thesis argues that the problem of vision helps to explain the links between visual thinking and higher-order, creative problem-solving.

The 'intervention' of the brain is so powerful that, as the example in Figure 3.5 illustrates, that the 'evidence' of our eyes is called into question. Each image of the men on the station is exactly the same size yet the vast majority of viewers will argue that the man on the left is much smaller than the others and particularly the man on the far right:

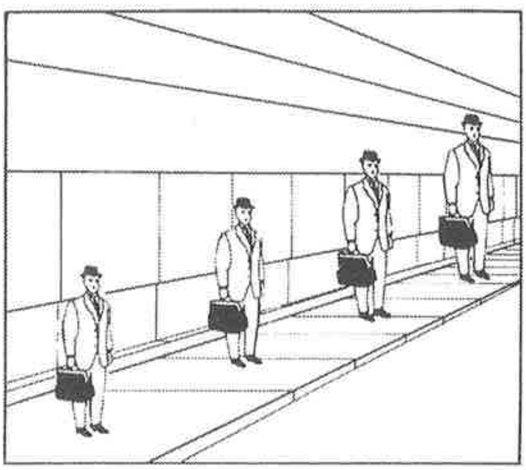


Figure 3.5: The men on the platform (Edwards, 1986: 179)

Try as we might, it is almost impossible to override the brain with the evidence of our eyes, to convince ourselves that each man is, in reality, the same size. Most viewers will only accept this after physically measuring the figures.

The schemas, developed from memory and experience of the world are so powerful in visual thinking that they are hard to escape. As Bouma has lightheartedly put it, human beings in this *positive* respect "suffer from a hardening of the categories" (Bouma in Edwards, 1986: 181).

As knowledge and memory are largely responsible for the determination of what we see, the need to make sense of our visual environment is paramount. We actively look for meaning in everything we see. The image depicted in Figure 3.6 below is disturbing because the viewer is not able to locate visually the source or the origin of the central trouser leg, nor intellectually deal with (i.e. in knowledge or memory) the concept of three-legged trousers: the quest for sense-making and wholeness is so strong.

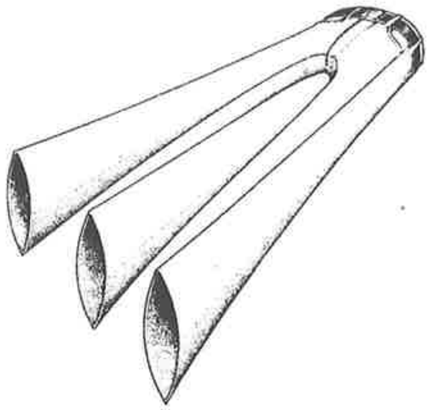


Figure 3.6: Three-legged trouser image (McKim, 1980)

Images such as this one are a further indication of the active nature of our visual intelligence, as Khatena (1992: 335) has noted:

> *An individual perceives the external world through his or her senses and records messages about the world in the brain as images that are later retrieved from storage in the absence of the original stimulus event. These images can be photographic, without the mediation of emotive-motivational processes unique to each individual, but this is unlikely. Images can be expected to differ from one person to the next even when the original stimulus events are the same.*

It is argued in this thesis that this quest for wholeness and 'making sense of the world' is more than just the gestalt phenomenon (which is discussed later in this chapter) but is linked to the principles of a universal grammar of form in much the same way that Chomsky proposed a universal grammar of verbal and linguistic form.

The difference between Chomsky's theory and this theory of visual intelligence however, might be the 'active' aspect of visual uptake of information which does allow us to 'create what we see'. Hoffman (1998) has called the 'minima' rule of visual thinking one which dictates that often minimal cues are needed for active construction of an image. For example, in Figure 3.7 below he presents three sets of images with exactly the same amount of contour deleted from the images on either side of the central drawings:

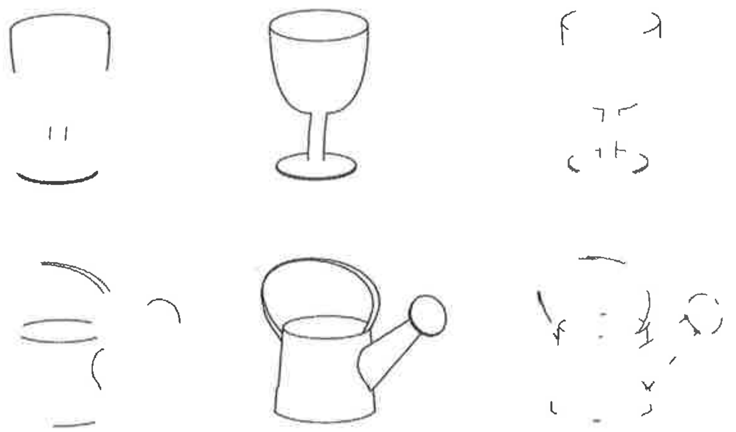


Figure 3.7: Visual Closure (Hoffman, 1998: 97)

Most subjects can identify the images on the right more easily than those on the left. The preservation of boundaries is more important than just preserving lines:

> *You create parts according to the minima rule, but … you do so 'preattentively': you create parts quickly and in parallel all over the visual field, and you can't stop yourself. Evidently parts are important to you. You devote substantial resources to creating them (Hoffman, 1998: 97).*

The need to preserve boundaries rather than just lines is presented as further evidence of 'universals' in visual language and the links between this phenomenon and verbal clozure are made in the next section of this chapter.

Visual 'universals' do not just occur in aspects of *form*, but according to some research, in aspects of light and shading. For example, when it comes to lightness and colour, there is no 'absolute' in terms of how the eye sees but that context, including illumination and surface reflections, are visually processed by what is called, "retinex computation" (Land & McCann, 1971 in Marr, 1982: 255). Marr reports on the research of Land & McCann which:

> *shows the image of a monochromatic Mondrian lit from above … two patches marked with arrows have exactly the same intensity, yet one appears to be darker than the other … the argument is that this is essentially what our visual systems do, and it is called retinex computation (in Marr, 1982: 255).*

As this research indicates, even at the time of sensory input or retinal uptake, it is clear that in form and context the visual process is a complex, active and multi-processing one. Just as Piaget's theory claimed that we establish cognitive 'schemas' through the process of assimilation and accommodation, so too vision and visual intelligence rely on an inner conceptual development of form which also influences how we see light and colour. What we actually *see* depends as much upon the inner stimulus of our visual schema within us as from the outside stimuli of the world:

> *Visual perceptions do not necessarily only come from light patterns reaching the retina from without. The fascinating thing about vision is that the retina and the brain can be induced to generate patterns and visual images by a variety of non-optical stimuli ... we really cannot deny that some of what we see originates from within us rather than from the environment around us*
>
> *(Morris, 1986: 9).*

Warrington (1973 in Marr, 1982:35) was one of the first to note the different functions that vision and verbal language play in making sense of the world and her postulation that vision is possibly the 'stronger' is exemplified in her findings. Her study with patients who had suffered either left or right parietal lesions revealed that a patient with a right lesion could recognise a common object, as long as it was presented in a conventional way. For example, a water bucket seen from the side was clearly a water bucket. However when such subjects were presented with the image of the bucket from above or below, unconventional viewpoints, such subjects would not only "fail to recognise it, but they would vehemently deny that it could be a view of a pail". Subjects with left parietal lesions behaved differently:

> *Often these patients had no language, so they were unable to name the viewed object or state its purpose and semantics. But they could convey that they correctly perceived its geometry – that is its shape – even from the unconventional view*
>
> *(Marr, 1982: 35).*

These studies conclude that even in the absence of conventional spoken words, the language of form can still communicate. Research on visual uptake of information, in particular the measurement of the speed of such uptake (usually measured as Inspection Time or IT experiments) has shown some interesting correlations with basic *g* as reflected in IQ scores. Traditionally, psychometric tests such as the Stanford-Binet and the Weschler Intelligence Scales have concentrated on verbal skills assessment, with even the method of delivery for the Performance sub-tests being predominantly verbal, relying on question-and-answer formats. However, some of the Elementary Cognitive tasks (ECTs) referred to previously in Chapter 2 of this thesis, have suggested very strong correlations between powerful markers of *g*, such as speed of mental processing and visual processing. Deary (1993) (in Phillipson, 2000: 40). found evidence that "Using a test of visual Inspection Time and the WAIS –R, IT correlates more strongly with Performance IQ scores than with Verbal IQ scores" It is argued that the non-verbal or visual aspects of such measures of *g* might be even more reliable indicators of intelligence than the verbal markers.

3.2. Visual Imagery and Perception: Links with Language Development

" … when I eat a tomato then I look at it the way anyone else would.
But when I paint a tomato, then I see it differently … " .
(Picasso talking to Gertrude Stein, in Edwards, 1986)

The theme of the *Turning World* enrichment program was 'Perception' and both visual perception and visual imagery were trained as a part of this program. In this section, it is important to differentiate between visual perception and visual imagery which are terms that are often used interchangeably. Both involve assimilation of the external and the internal stimuli into a visual whole or a schemata, yet perception is literally perceiving what the eye tells, whereas imagery is perceiving what the brain remembers and creates in a new form. One involves the ability to 'see well' and the other the ability to visually 'imagine' as Khatena (1992: 337) has observed:

> *… individuals may paint what they see, like a tree … in this case they rely on perception. Or they may paint by memory rather than by looking at what they see. In the latter case, they resort to imagery …*

Although it would be simplistic to suggest that perception is passive while imagery is active, comparisons with similar processes in language development, specifically reading and writing, (both of which rely on decoding and encoding data) will be relevant at this stage. The simple act of writing out a list of requirements prior to shopping at a supermarket will stimulate the vision centres of the brain. What this study proposes is that visual intelligence is active from such elementary writing experiences through to the very advanced abilities, including advanced writing such as poetry. As Barry (1997: 75) has claimed, "it is images, not words that communicate most deeply". Even a master of words, the poet T.S. Eliot, has claimed that even poets "strain, crack and sometimes break under the burden of communication …" (in Barry, 1997: 75).

In the field of reading there is a great difference between the decoding (or passive/receptive) and encoding (or active/expressive) aspects of language acquisition and that although visual information is passed through the eyes, the process relies on, "information which is already stored inside the reader's head" (Burnes & Page, 1985: 31). The simple act of decoding was earlier reported in Smith's (1978) research which claimed that this is the information which is no longer available to the reader 'if the lights go out'. Even in the dark, however, a proficient reader can encode the information or data previously stored, retrieve it, elaborate upon it, and even predict future directions, such as the ending of a story.

In a similar way, recent studies on vision and visual perception, suggest that visual processors are not just the passive 'receptors' of information but are active in the development of visual schemas. A further example from the research on learning to read will illustrate this.

This chapter documents the need for gestalt, or wholeness and meaning in the determination of visual form. It has been well documented that reading, rather than being a passive, receptive process is also a very active one. In seeking to make meaning from the visual print in front of them, competent readers tend to look for 'wholeness' or meaning rather than individual images such as letters or individual sounds such as phonemes. A good reader's use of visual information has been shown to be very selective and, "this implies that the reader does not need to pay close attention to every piece of information (that is, every letter) on the page" (Burnes & Page, 1985: 31).

Cloze procedure is an example of a reader's ability to make sense of written words even when the text has been visually (or graphically) mutilated as in the following way:

> Two people were killed and two were ----
> By three ex--- in --- city last ---.
> P --- believe the explosions --- caused by faulty g--- mains
> underneath the footpath.

The inherent semantic and syntactic knowledge and memory which a competent reader brings to this exercise enables the sense-making or comprehension of the story.

In a similar way to reading, the writing process (unless it is just copying or recording a dictation) is an active, information-processing activity. Yet vision still dominates the writing process. A good writer has a good 'eye', not just to describe what she or he sees in the external environment, but to also 'see inside' and articulate feelings and emotions. Good writers do not know what they think until they write it down; their writing is an act of trying to come to terms with, of trying to understand, life, and especially their own lives in relationship to the world at large. Writing literally makes the link between what we can see and how we express this.

Writing is often represented in schools as 'evidence' of good thinking, rather than being the 'process' of thinking itself, in much the same way that visual thinking is often portrayed as the illustration of an idea rather than the idea itself. Nickerson et al. (1985: 251) have used the term "frozen speech" to illustrate how education in general views and undervalues writing as an occasion for thinking :

> *'frozen speech' is a natural metaphor for writing ...*
> *However, the activity of writing outdoes the 'frozen speech' metaphor in at least two ways.*
> *First, writing demands much more of the writer than the transcription of spoken words, an activity that is limited to a few special situations such as court stenography.*
> *Second, writing often becomes not merely a way of representing thoughts for purposes of transmission but a means of thinking itself.*
> *Accordingly, writing is relevant to teaching thinking both because, (1) writing demands thinking, and (2) writing is a vehicle for thinking.*

If writing might be a 'vehicle for thinking' and this thesis is arguing that visual thinking is a very advanced 'vehicle for thinking', then what are the links between visual intelligence and the ability to write? The following chapter details the design of the *Turning World* program which engaged the students in writing experiences connected to works of visual art. The ability to 'see' better, to understand the language of visual thinking, was actively trained in this enrichment program. While the writing aspect was intended as a 'vehicle for thinking' throughout the *Turning World*, it was the initial training in visual perception which this thesis argues is the higher form of thinking. This study also claims that the most advanced of proficient writers have higher-order visual intelligence.

Barron (1968, 1972 (in Piirto, 1994 : 363)) noted that creative writers were statistically more likely to engage in "primary process phenomena" in their creative activity. He described these phenomena as highly visual, such as dreams, "especially recurring dreams, prophetic dreams, and dreams of a preternatural vividness and intensity". Other phenomena were "precognitions, telepathy, clairvoyance, the occurrence of unusual coincidences, falling in love, mystical experiences of oneness with the universe. On the negative side, phenomena such as total forlornness" were also experienced by creative writers"

John Gardner characterised creative writers as having strong "verbal sensitivity" and he claimed that "this is different in poets, short story writers and novelists, with poets being more 'pernickety', short story writers having a talent for 'lyrical compression', and novelists having a talent for fitting language to character and situation". He also claimed that an essential feature of all writers was to have "a good eye: the good writer sees things sharply, vividly, accurately, and selectively" (Gardner, 1982 in Piirto, 1994: 364). Gardner summarised of the qualities of a good writer as the following:

- verbal sensitivity
- a good eye
- intelligence.

The specific nature of this 'intelligence', as outlined below, is representative of the kinds of characteristics which teachers in regular classrooms might not value nor encourage. According to Gardner some of the key characteristics that have been identified in outstanding writers are "wit, obstinacy, childishness, a lack of proper respect, mischievousness, powers of eidetic recall or visual memory, shameless playfulness and embarrassing earnestness, criminal streak of cunning, psychological instability, recklessness, impulsiveness, improvidence" (Gardner, 1982 in Piirto, 1994: 364).
It is noteworthy that visual memory is included in this rather alarming profile of students whom teachers would no doubt rather avoid!

The role that verbal language plays in the determination of our thinking abilities has been the object of much debate and research for many decades. A study of young verbally talented children (Colangelo & Kerr, 1990; Benbow 1992) indicated that their long-term memories were more efficient than those of mathematically talented youth.

The famous Piaget/Vygotsky debate on the origins of language and thought, while highlighting the extreme positions, also argued strongly for the power of both processes in the development of cognition. Whether educators believe that "language is a creator of thought", or that "thought is a precursor to language", "there is no doubt that the two processes interact with and complement each other" (Thorn & Braun, 1974: 33). The 'middle ground' between the Piaget/Vygotsky debate is most often recommended as being of use to educators ... in a similar way, language has been evaluated in both its receptive and expressive modes and the necessity of the former to support the latter has been well established.

Vygotsky has argued that language enables an individual to internalise his or her cognitive processes. Speech itself is seen as necessary for making sense of thought : "schematically, we may imagine thought and speech as two intersecting circles. In their overlapping parts, thought and speech coincide to produce what is called verbal thought" (Vygotsky in McKim, 1980: 142). Piaget of course argued that speech itself was not necessary for thought to develop but that cognitive concepts develop first through active interaction with the environment. The fact that the earliest and most complex explorations of the environment appear to be visual is significant to note here. It is argued that the creation of Piaget's schemas, so essential to thinking and the later development of language, has its origins in visual thinking.

This interaction is predominantly visual and active, as Piaget argued that assimilation and accommodation can only occur when the learner is actively engaged with the environment.

In this respect, the visual mode would still seem to be superior to the verbal or written, as Barry (1997: 75) has suggested:

> *This is why images hold a such privileged position not only in poetry but also in relation to our innermost beings. What visual images express can only be approximated by words, but never fully captured by them. Words represent an artificially imposed intellectual system removed from primal feeling; images plunge us into the depths of experience itself.*

It is a fascinating observation by the author that, although it has taken a century of research to identify visual intelligence as critical to understand written and spoken language The Bard himself had identified these links between perception and imagery, well beforehand. His own poetical insight is further proof that visual intelligence drives verbal, and that the *pen* is the slave to the *eye*:

> *The poet's eye in a fine frenzy rolling,*
> *Doth glance from heaven to earth, from earth to heaven;*
> *And as imagination bodies forth*
> *The forms of things unknown, the poet's pen*
> *Turns them to shapes, and gives to airy nothing*
> *A local habitation and a name*

(Theseus, A Midsummer Night's Dream)

Visual Thinking and Cognition: can they be trained?

This study proposes that visual thinking ability is as cognitive in origin as, for example, speed or logic ability, and that it can be trained.

According to Colangelo & Davis (1997) the training of visual thinking can be conducted in three primary modes:

1. *Perception* : the images we see
2. *Imagination* : the images we imagine, recall, invent, combine, and/or transform internally in our "mind's eye" independent of immediate perception
3. *Depiction* : the images we represent externally - those that we draw, sketch, paint, or model.

The *Turning World* program concentrated more on training perception and visual imagination than the actual depiction or drawing of visual images. The *Turning World* was not designed to be an art class but rather a visual thinking class. It focussed on teaching students the language of point and line within the basic frame and to interpret and extrapolate a communication from a work of art, rather than to produce one. Higher-order cognitive thinking exercises underpinned this training.

Prior to undertaking the *Turning World* program the students, along with the entire cohort (n=305), were tested with the Raven's Progressive Matrices, and it is interesting to note that the visual cognitive processes outlined below which Colangelo & Davis (1997) have identified as comprising visual thinking are also processes which subjects needed to employ as they completed the RPM.

In summary, these cognitive processes are identified as:

- *Pattern-seeking* : finding patterns, matching, filling in gaps, categorising, and completing patterns
- *Rotation* : Inverse drawing, mental manipulations, and orthographic imagination (imagining how a solid object looks from several directions)
- *Visual Reasoning* : Spatial analogy and visual induction
- *Comprehension of dynamic structures* : Mental representations of three dimensional motion (paper folding, visualising a knot being tied, the movements of a pulley)
- *Visual Synthesis* : Combining multiple images. In creative synthesis, new entities emerge that are both different from and greater than the sum of their parts.

(Colangelo & Davis, 1997)

All of these are active, visual, cognitive processes and this thesis argues that they can be trained.

Visual thinking does not just rely on 'thinking with the eyes'. More specific analyses of visual spatial tasks suggest that they can be partitioned into "three homogenous groups representing different ability categories ... spatial perception, mental rotation, and spatial visualisation"(Vederhus & Krekling, 1996: 33). The links between visual perception and imagination should help to explain the *Aha*! or creative insight when a new idea is produced. Creative ideas often result from a shift in perception. The direct interplay and deliberate manipulation of perception and transformational imagery (imagination) has led creative scientists and artists to original hypotheses, inventions, and creations. As Kepes (1969: 15) has commented, "To perceive an image is to participate in a forming process; it is a creative act..." and Khatena (1992: 334) has observed, "Imagery is the *language of discovery*".

The presence of perception and imagery, in addition to the 'inner sight' which we all have and the 'ambiguous' nature of what we might see, could all lead to an assumption that visual language is chaotic in some way, and that it lacks the comforting guidelines of syntax, semantics and graphophonic rules that generally underpin spoken and written form. However, research is confirming that there are distinct rules underpinning visual intelligence and a very strong urge, within human beings, to impart order upon visual thinking skills.

This urge for holistic as opposed to linear or 'piece-by-piece' thinking has been proposed as the gestalt of visual intelligence, as Hayakawa (in Kepes, 1969: 10) states:

The re-organisation of our visual habits so that we perceive not isolated 'things' in 'space', but structure, order, and the relatedness of events in space-time, is perhaps the most profound kind of revolution possible – a revolution that is long overdue not only in art, but in all our experience.

3.3. Visual Intelligence and the role of Gestalt and Order

A powerful insight that we have into the presence and the importance of visual processing as holistic thinking is the theory of gestalt organisational law. Gestalt is a term used to:

unite the concept of 'wholeness' with ideas of form, shape, and pattern. Gestalt psychology emphasises the fact that behaviour and experience must be studied as organised wholes and cannot be understood by analysing parts

(Myers, 1989: 22).

Although Wertheimer and Koehler were generally regarded as the founders of Gestalt, it was not until Koehler defined it as the making of "any segregated whole or unit" that the concept of gestalt developed, as "the only theory to deal with visual form in a comprehensive fashion" (in Zusne, 1970: 108). This thesis has already established that visual thinking is an active process and a brief study of gestalt also confirms this as Zusne (1970: 108) has further claimed that "Gestalt theory is more than a theory of form perception. It is a theory of behaviour".

Artists who have performed within a culture as gifted, have presented as those whose inner and external motives have been dominated by the desire for order and wholeness. The links with the gestalt and visual art production can be seen in the necessity for artists to strive for

... unified organic wholes through the dynamic interaction of external physical forces with internal psychological and physiological forces. The basic Gestalt principles of proximity, similarity, continuance, and closure worked to keep attention alive by creating the greatest amount of movement and tension in a picture or image, primarily through color, line, and the use of large and small units to create rhythm and unity.

(Barry, 1997: 125).

The gestaltists proposed a number of laws of organisation which describe perception as the result of the organisational processes of the brain and the relationships among the elements making up the stimulus. More precisely, they argued that the perceived organisation arose from the impact of these elements on the representational processes within the nervous system … the major organisational laws of Gestalt theory include … the laws of proximity, similarity, continuity, common fate, and closure

(*Haber & Herschenson, 1973: 188*).

Myers (1989: 23) has proposed these principles of Gestalt related to the organisation of the visual fields and Figure 3.8 below provides visual examples of proximity (a), similarity (b), continuity (c) and closure (d), with the following explanations:

Proximity – visual elements that are close together unite and are easily seen as a figure
Similarity – visual elements that resemble one another, whether in size, shape or colour, unite, and are seen as a figure
Continuity – organisation tends to flow in one direction. We have no difficulty following any single line or contour through a maze of lines
Closure – visual elements in close proximity that suggest contours of a form, though incomplete or separated by gaps, will visually join to become a closed form.

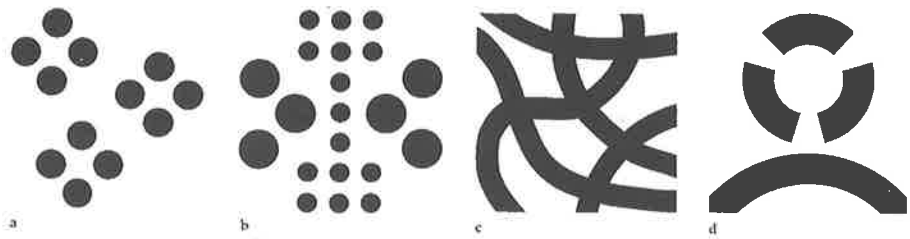


Figure 3.8: Gestalt scan (Myers, 1989: 23)

The notion of equilibrium is seen as essential to the gestalt since every visual field tends towards excellence or precision and completeness just as all physical activity is directed toward attaining physical balance or achieving equity in opposing forces.

The concept of equilibrium, the bringing of balance and order to erstwhile chaotic images or ideas, could be seen as the antithesis of truly creative thinking. Visual creativity as evidenced in visual artists is traditionally associated with 'zany' or 'left-of-field' ideas. Yet in reality, as Myers (1989: 24) has noted "Psychologically, we are very uncomfortable, sometimes frightened, by anything perceived to be out of balance whether or not it is something we are experiencing physically or perceiving visually. It is a condition that we will not tolerate for very long"

According to Barrow (1995: 30) the necessity for order rather than chaos is a 'powerful urge' and has its roots in the evolutionary process:

> *Our sophisticated scientific knowledge might be seen as a by-product of other adaptations for the recognition of order and pattern in the environment. Artistic appreciation is clearly closely connected with this propensity. But a susceptibility for recognizing patterns and ascribing order to the world is a powerful urge. The abundance of myths, legends, and pseudo-explanations for the world witness to a propensity we have for inventing spurious ordering principles to explain the world. We are afraid of the unexplained. Chaos, disorder, and chance were closely linked to a dark side of the universe: the antithesis of the benevolent gods. One reason for this is that the recognition of order has passed from having some reward that is beneficial - recognising food sources, predators, or members of the same species - to becoming an end in itself. There is a satisfaction to be gained from the creation of order, or from the discovery of order. These feelings probably have their origins in an evolutionary past where the ability to make such identifications was adaptive.*

It would seem that the opposite of the visual Gestalt phenomenon is visual creative intelligence which is based on notions of cognitive conflict or even confusion. As it is, the two are very much linked and formed the basis of much of the design of the *Turning World* enrichment program outlined in the next chapter.

3.4. Visual thinking and creativity: ambidextrous thinking and cognitive conflict

The research cited in this study to date has confirmed that the traditional determinants of intelligence and its assessment focus on the acquisition and measurement of language or verbal skills and these can be measured quite accurately. It is well established that IQ tests in particular stress language skills. For the same reason, many determinants of creativity have also focused on verbal skills. Chapter 5 of this thesis provides more detail on the design and the strengths and limitations of creativity tests. When compared with verbal creativity, visual or figural creativity has proved to be more difficult to define, let alone measure, as there does not exist a clearly defined grammar of visual structure and development that exists in the verbal domain. Yet as Chapter 5 confirms, the creativity tests which can avoid a language basis (i.e. which are spatial or figural in content) are more culture-fair and reliable indicators of creativity.

Research on visual creativity has suggested that there are differing visual creative 'types'. It has already been argued in this thesis that creativity is not a single concept but a multiple one and that it can be evidenced as verbal, visual, motoric and other behaviours. These behaviours have been variously identified as differing 'types' of creative intelligence, and it has been proposed that the *visual* creative type is one of the most powerful of the creative intelligences.

The development of two creative types was recorded by Lowenfeld and Brittain (1964: 258) as the 'visual creative type' and the 'haptic creative type'.

The visually creative thinker, "starts from his environment, ... feels as a spectator, and the intermediaries for experience are mainly the eyes. The haptically creative thinker, on the other hand" is primarily concerned with his own body sensations and the subjective experiences in which he feels emotionally involved". The term *haptic* derives from the Greek word *haptikos* and means 'able to lay hold of'.

In some early research (Millar, 1971; Goodnow, 1971 both in Chase, 1973) the addition of visual cues to a haptic task greatly enhanced the performance of four year olds on a matching task. However the addition of haptic cues to the visual task had no effect. The visual mode appeared to be the stronger as Posner (in Chase, 1973: 65) observed that "even with quite young children, who might be thought to be 'motoric' in orientation, one finds that visual cues dominate".

The links between haptic, visual, and creative intelligences and IQ have been debated. The visual mode in creative production has been cited as one that lends itself to what has been called 'ambidextrous' thinking. With the emergence of PET and fMRI scanning techniques, the studies can be more precise in measuring the exact sites of the brain that are engaged.

Ambidextrous thinking crosses over a simplistic interpretation of 'right brain' versus 'left brain' learning, although clear 'hemispheric preferences' develop early with the combination of genetic, educational and cultural influences, "no matter which hand or eye is dominant, or which hemisphere you have learned to prefer, you can learn to move your thinking from one hemisphere to another, at will. In other words, you can train your thinking to be ambidextrous" (McKim, 1980: 25).

Such 'ambidextrous' thinking is linked to high levels of creative thinking and it has been well documented that visual imaging has often led to some of the most creative discoveries or compositions known to humankind. Mozart claimed to have stored mental images of sound in his mind which would only much later be translated into the language of a musical score. The famous chemist, Kekule's visual account of his discovery of the structure of the carbon ring, which he envisaged as a snake taking its tail into its mouth, is often cited as evidence of the power of visualisation to cross over traditional disciplines and link with creative discovery. Even those who have proven to be masters of the spoken or written word such as Wordsworth and Coleridge, have commented on the importance of their visual imaging well before their poetry, in *words*, was reproduced. Wordsworth's claim that the images, "flash upon the inward eye" (*I Wandered Lonely as a Cloud*) is certainly one of the most poetic of the descriptions of visual imagery and its links with creative production.

Ambidextrous visual thinking principles which focus on the development of visual creative thinking skills were incorporated into the design of the *Turning World* program. These visual/creative principles, in summary were:

1. synectic and dialectic thinking, or the science of opposites
2. Janusian thinking, or learning which is based on seeing a range of differing viewpoints
3. analogy and metaphor, assuming a pragmatic, semantic and syntactic similarity
4. core dilemmas and cognitive conflict, or the necessity for some cognitive uncertainty in solving problems.

A foundation study in the art of synectic thinking was first proposed by Gordon (1961) although he based his practical work on previous research studies. Synectics, put simply, is the study of the art or the science of opposites. Taking one concept, for example, and attempting to describe it by selecting one opposing concept, will often lead to a novel or original outcome. Synectics is the opposite of brainstorming which relies on the generation of a stream of ideas. Instead, synectics "is directed toward generating one intriguing idea" (Kawenski, 1991: 264). An example of a synectic image is to describe antibiotics as a 'safe attack' or the ocean as 'imprisoned freedom'. The principles of synectic thinking are embodied in the original work of Edward de Bono (1970) and his principles of *Po*, whereby seemingly disparate objects or ideas are fused to arrive at an original insight.

Synectics is closely linked to the notion of dialectic thinking, which is a thinking process which relies on the power of opposites. The philosopher Hegel (in Jones, 1975) first postulated good thinking as the proposal of a thesis, followed by the consideration of the opposite or antithetical position, then resolving the conflict between thesis and antithesis through a synthesis and solution. The assumption in the thesis/antithesis procedure is that the good problem solver explores the furthest boundaries of a problem before the best solution is found.

Common links with synectics and dialectical thinking can be found in the more modern design of creative teaching strategies such as Ryan's (1990) Thinker's Keys, especially the *Reverse Key*. This key is the opposite of the *Brainstorming Key*. Examples of these activities as they are linked to artworks are outlined in the next chapter. In addition, de Bono's CoRT Thinking strategies such as the *PMI* (Plus, Minus and Interesting) were taught. The PMI trains thinkers to explore the positive, negative and neutral aspects of a problem before arriving at a solution. Practical examples of these are outlined in the detailed description of the *Turning World* program in Chapter 4.

A further insight into the notion of dialectic thinking is janusian thinking. The term, 'janusian thinking' is derived from the Roman god Janus, whose several faces were able to see multiple and opposite views of the world.
Janusian thinking, which relies on sharpened visual perception, has been described by Rothenberg (1983,: 100), as "a type of creative cognition". The main point in training janusian thinking is to force the thinker to view "the active and intentional conception of two or more opposites or antitheses simultaneously in the solution of a problem". This process is based on the principle of complementarity, which "states that two descriptions or sets of concepts, though mutually exclusive, are nevertheless both necessary for an exhaustive description of the situation (Jammer, 1966 in Rothenberg, 1983: 103).

Cohen-Shalev (1993: 106) proposed that the most "creative cognition" emerges when there is a significant "interplay between dialectical opposites". He noted that particularly in the case studies of visual artists and creative writers, the presence of some form of 'core dilemma' leads to the formative stage of a creative person's development, particularly in early adulthood. He proposed (Cohen-Shalev, 1993: 107) that in their work, "the thematic nucleus often appears in the form of conflict or enduring dilemma … a core dilemma … personal documents – and particularly works of art – offer legitimate, indeed indispensable, data for the study of creativity development".

Complementing the synectic science of opposites and differing views, the *Turning World* program also trained students in the techniques of finding similarities or analogies in visual works of art. Analogies basically make unfamiliar matters more comprehensible to students. Particularly at the outset of a problem, analogies are ideal for leading students into the beginnings of understanding in a new domain such as abstract or non-objective art. This chapter outlines the principles of analog drawings which students in the *Turning World* program learnt as part of their higher appreciation of visual art works.

Thagard (1992: 538) proposed that the use of analogies in classroom instruction relied on the necessity of there being a pragmatic, or 'natural correspondence' between the source analog and the target analog – "these correspondences are of two kinds: semantic, involving the two analogs using terms with related meanings, and structural, involving the two analogs using similar configurations of objects". It is significant to note that scientists such as Darwin and Maxwell successfully exploited analogies in developing their important theories. Thagard's (1992: 542) flippant yet insightful analogous statement that "democracy is the worst system of government, except for all the others" is also a timely reminder of the opportunities for humour in analogous learning.

The importance of training analogies and remote associates in the creative process has already been raised (Nickerson, Perkins & Smith, 1985) and formed the basis of some of the earliest tests of creativity which are outlined in Chapter 5.

Making links across seemingly remote associations also was highlighted by Sternberg & Lubart (1991) in their "Investment Theory" of creativity outlined in Chapter 2. Their *selective encoding* principle, most closely linked to brainstorming, incorporates the noticing of potentially relevant information for the solution of a problem from amidst a stream of information. The *selective comparison* involves the perception of an analogy between the old and the new. This linked closely with divergent thinking skills and the ability to make remote associates. Their third principle, that of *selective combination* relies on training students to put disparate pieces of information together in a novel and useful way. This ability is linked to the concept of janusian thinking, or the simultaneous integration of opposite or antithetical thoughts. The final two items of the *Figures of Sound* instrument which is outlined in Chapter 5 are based on these principles.

Wong (1993: 368) promoted *self-generated* analogies and also put forward the principle of 'cognitive uncertainty', which in concept has links with the 'core dilemmas' previously mentioned as a powerful learning tool, when students have to move beyond the boundaries of concrete, memorised facts and into "the conceptual grey area where understanding is tenuous and incomplete ... such an approach ... is an unfamiliar and uncomfortable experience". Wong argues that it is precisely this uncertainty which is necessary for training higher order creativity and advanced thinking skills, particularly in the training of visual thinking which is active and wherein the thinker actively 'creates' what is seen. In addition, the reason why literature such as *The Canterbury Tales* by Geoffrey Chaucer mid 14th Century and *The*

Love Song of J. Alfred Prufrock by T.S. Eliot (1917) were incorporated into the *Turning World* program, was to introduce this notion of 'uncertainty' into the content rather than just content 'novelty' or 'sophistication'.

Adey & Shayer (1992) used the term 'cognitive conflict' to describe what they regarded as a positive condition (as opposed to a negative condition more often associated with conflict) necessary for creative problem solving. The significance of "cognitive conflict" as essential to higher-order thinking skills, particularly in the field of visual thinking, is clearly evident in Einstein's personal accounts of problem solving. Einstein (in Rothenberg, 1979: 39) observed that "the thought that one is dealing here with two fundamentally different cases was, for me, unbearable". This thought, referred to by Einstein as the "happiest" one in his life, has been described by Rothenberg (1979: 39) as an example of janusian thinking as well as cognitive conflict "actively conceiving two or more opposite or antithetical concepts, ideas, or images simultaneously, both as existing side by side and/or as equally true".

It is proposed in this thesis that the phenomena of conflict, janusian thinking, synectic or oppositional thinking, is evident in major art movements, or 'leaps of thought', especially the visual art movement from Realism to Impressionism and then on to Abstract and Non-Objective art.

All of these essential principles of uncertainty and complexity contributed to a new view of visual art, whereby "artists are no longer bound by the dictates of the retina" (Khatena, 1992: 337). Yet it is precisely from the crucible of visual chaos (in the positive sense) and uncertainty that the essential principles of form, order and balance, which separates 'good' art from 'bad' art, emerges. Arnheim (1974: 36) argued that this is intrinsically linked with the visual intelligence when he asks:

> *Why should artists strive for balance? Our answer thus far has been that by stabilising the interrelations between the various forces in the visual system, the artist makes his statement unambiguous. Going a step further, we realise that man strives for equilibrium in all phases of his physical and mental existence, and that this same tendency can be observed not only in all organic life, but also in physical systems.*

The most gifted artists seem to be those who can achieve this 'balance' between the internal dilemmas of 'conflict' and the external physical systems.

3.5. Visual Art Ability and links with Giftedness

Though superior intelligence and superior art abilities are clearly interdependent, not all children with a high IQ possess art talent. All children with a superior art talent, however, do possess a higher than average IQ
(Clark & Zimmerman, 1984:14).

The connections between visual thinking ability, visual art ability, intelligence, and creativity have not been widely researched. Generally they have been regarded as separate but possibly connected talents. The notion of assessing general intelligence outside of the realm of visual art ability is quite acceptable, as evidenced by the absence of such assessments in most teacher/parent/peer checklist or nomination forms for gifted students, and most IQ tests. It is interesting to note the statement from Khatena (1992: 153) that "to identify a student who is gifted in art, some consideration needs to be given to intelligence". Yet the reverse is usually not implied, which is, that to identify an intellectually gifted student, consideration needs to be given to his or her art ability. Khatena does indicate, however, that "students who are highly talented in art are generally quite bright" and he claims that in any assessment of intelligence, "creative thinking abilities, especially as manifested in the visual-figural dimension should be taken into account" (1992: 154).

There is no standardised test of *g*, for example, that attempts to measure visual artistic ability. At best, a talent in this field may be included in an observational checklist or a rating scale.

The fact that visual art ability is generally overlooked in assessments of intelligence is no doubt a Western cultural phenomenon, reflecting the view that "it is generally perfectly alright to be artistically incompetent in our culture" (Benjafield, 1992: 307). This thesis proposes that advanced visual art ability is a sure indicator of giftedness albeit one that most educators are not trained to identify. Age also appears to be a factor in this determination. Burkhardt (1969: 248) states that:

It has been shown that there is a positive relationship between the number of details included in a drawing and the intellectual ability of children. In fact, the relationship between art ability and intellectual ability is both strong and positive up until the age of ten.

Other research findings have confirmed this belief, that, "drawing is generally a valid expression of intelligence and as such correlates well with IQ tests" (Dileo, 1973 in Clark, G., 1989) although more research is required.

Key markers of visual intelligence, such as memory skills, have been the subject of limited but convincing research (Bartlett, 1984; Perkins 1995) and the important role of memory to visual thinking has already been raised in this study as Bartlett (1984: 225) has further confirmed:

> *Art works are things that people remember, they are sometimes about memory, they are often intended to be highly memorable, and they depend upon memory for interpretation, appreciation and analysis …*

In an overview of research which could be seen to counteract the links between art ability and intelligence, Benjafield (1992: 314) suggests that "artistic competence appears to be an example of an intelligence that can exist separately from other forms of intelligence". He cites the research of O'Connor and Hermelin (1987) and their work with idiot savants who exhibited very superior forms of artistic ability, despite evident intellectual disability. This research resulted in the conclusion that it is possible to exhibit "an IQ-independent graphic ability". It is important to note here however that of the four artistic abilities assessed by O'Connor and Hermelin, which were recognition of designs, matching of designs, reproduction of designs, and copying of designs, "reproduction and copying scores were determined by level of artistic ability and not by general intelligence" (in Benjafield, 1992: 315), and it was in the fields of reproduction and copying that the subjects excelled. It could be argued that recognition and matching, which rely on receptive and expressive visual ability, are higher-order or more *g*-driven abilities than reproduction and copying of designs.

So what exactly is visual art ability and in what way could it be linked to advanced intelligence? Key indicators of advanced visual art ability, according to Pendarvis, Howley & Howley (1990: 198) are the following:

- *drawing skill*

  Although most children draw, only some exhibit unusual talents in drawing. Sophistication depends on a number of different elements including the organisation of a drawing, an indication of linear perspective, the use of varied line widths, and the use of shading.

- *cognitive complexity*

  In general, the research does confirm that artistically talented individuals have higher than average levels of intelligence, as Clark and Zimmerman (1984: 14) observed:

  > *Although superior intelligence and superior art abilities are clearly interdependent, not all children with a high IQ possess art talent. All children with a superior art talent, however, do possess a higher than average IQ.*

> The third indicator of advanced visual art ability is reported as:
> • *perseverance*
> Art educators agree that in general, successful achievement in the visual arts is associated with extensive practice and high levels of motivation
> *(Pendarvis et al, 1990:198).*

The inclusion of perseverance may also help explain why the greatest artists have tended to be prolific in their output: one 'brilliant' work of art is rare. Life histories of artists have consistently reported a passion and determination to work tirelessly at their craft. Yet it is interesting that, unlike the traditional fields of humanities and sciences, the notion of working hard and doing well in art does not conjure up the same degree of importance to overall intellectual growth. As Brittain (1979: 200) observed "there seems to be the general attitude that unless one has a talent for the arts there isn't much that a youngster can do, or for that matter the teacher either, to increase the quality of the work produced".

Since Gardner's inclusion of visual/spatial abilities in his MI Theory, a number of researchers have explored the possible links with giftedness. Winner (1996: 74) has focussed her research on gifted students and their performance in visual art, concluding that visual/spatial ability is a discrete intelligence and that it is evident in qualitatively different ways:

> *the core ability of the visually artistic child is a visual-spatial precocity that makes it possible to capture the contour of three-dimensional objects in two-dimensional space ...*
> *Their drawings are like those of older people in these ways:*
> 1. *shapes that are recognisable*
> 2. *lines that are fluid and confident*
> 3. *volume and depth*
> 4. *drawing objects in difficult positions*
> 5. *composition shows dynamic proportion*
> 6. *realism*
> 7. *an ability to master the drawing customs of their own culture*
> 8. *an ability to tell stories in pictures.*

Children talented in the visual arts may or may not have high scores on IQ or achievement tests, but they will often score highly on spatial sections of ability tests. Visual arts talent, as outlined by Piirto (1999: 245) is made up of:

> *visual-figural intelligence in both Guilford's terms and spatial intelligence in Gardner's terms.... Gardner said that spatial intelligence is necessary but not sufficient for visual arts achievement. Spatial intelligences is necessary in the sciences and mathematics as well as in visual arts. The person with spatial intelligences possesses the ability to see imagery... chess ability is the "single area" most illustrative of the need for spatial intelligence.*

This chapter has argued that visual intelligence does have specific links with advanced intelligence and that the visual arts curricula can have an impact on the development of this intelligence. It is pertinent at this stage to note that there is significant research to suggest that age itself is an important factor both in the identification of visual artistic ability and in its development, particularly in gifted children.

It is well documented that children's art does not just 'happen', but follows clearly determined stages (Gardner, 1980; Kellogg,1970; Brittain, 1979; Winner, 1996). There is debate, however over the significance of children's art when compared with adult art, especially the artworks of those adults who have performed at a gifted level in visual form. Successful artists such as Jean Dubuffet and Pablo Picasso studied children's art in detail, concluding that there is a definite excellence of the use of form and colour that is natural to human development but that somehow is corrupted with age. It is an observation of this author that most children who produced artistic masterpieces in kindergarten, confidently and with free play of form and colour, would now regard themselves, as adults, as artistically incompetent. In general, it is assumed that formal schooling and other 'strictures' contribute to this loss. Picasso's journey through realism to cubism and abstraction was influenced by his reverence for child art. At one stage he commented "Once I drew like Raphael, but it has taken me a whole lifetime to learn to draw like a child" (in Gardner, 1980: 8). Other artists such as Paul Klee and Marc Chagall, whose art embodies infantile and primitive form and colour, have claimed that child art is quite different from adult art. Klee studied his own artworks and that of his son, as well as researching child art works in general, and has cautioned:

> *Don't translate my works to those of children ... They are worlds apart ... Never forget the child knows nothing of art ... the artist, on the contrary, is concerned with the formal compositions of his pictures, whose representational meaning comes about with intention, through associations of the unconscious (in Gardner, 1980: 8).*

Winner (1997: 18) has argued in a similar way, that although early markers of visual ability are likely indicators of giftedness, the ability to contribute to a domain such as visual art tends to be the prerogative of adults. Just as no child to date has ever solved a problem or written a poem worthy of a Nobel prize, so too no child has ever produced a Picasso. Winner regards this level of precocity as a stage of creative production which will only evidence itself in gifted adults, and only if the environment has been conducive. Her notion of 'domain creativity' in the visual arts, is characteristic of adults. She discriminates between the following three kinds of creativity in visual thinking, progressing from childhood to adulthood:

1. *Universal* creativity - the creativity that characterises all normal young children
2. *Gifted* creativity - the creativity that characterises children who are particularly gifted in the visual arts
3. *Domain* creativity - the creativity that characterises adults who alter a domain in the visual arts.

Winner has separated the concepts of giftedness and creativity in the visual arts arguing that they should not be equated as they are different capacities. She argues that there is such a difference between early childhood ability and later adult achievement in the visual arts and " the striking difference between childhood giftedness and domain creativity can help us to understand why it is that there is no necessary link between early high ability and adult creative mastery" (Winner, 1997: 18).

An examination of the art produced by children from anywhere in the world will yield universal motifs that are very similar to indigenous and prehistoric art motifs. These ancient motifs could not have been made by children because child musculature could not have possibly made rock carvings or paintings on cliff faces or the ceilings of caves. The presence of such motifs suggests that the abstract and early visual images made by children have some 'universal' link with a visual intelligence which may be common, in varying degrees, to all human beings. Yet the visual art of children has received very little attention in studies on intelligence and, "most scholars have ignored this fact and have sought explanations for ancient and native art without regard to the work of children" (Kellogg, 1970: 208).

It is a common assumption that some students are simply born with visual art ability and that early teaching intervention in visual art must proceed cautiously as this ability is fragile and its creativity may be spoiled by too much pedagogy. The focus on art ability in kindergartens and pre-schools is evidence of the belief that all children can engage in at least some form of art from a very early age. The fact that visual arts training becomes less important as children remain in the education system is well-documented. Edwards (1986: 6) makes an interesting corollary with learning to read:

> *What if we all believed that only those fortunate enough to have an innate, God-given, genetic gift for reading will be able to learn to read? What if teachers believed that the best way to go about the teaching of reading is simply to supply lots of reading materials for children to handle and manipulate and then wait to see what happens?*

One further example of the significance of age with visual art ability is in the area of colour. Young children are often selected to participate in studies on colour because they have not developed the prejudices to colour that develop with age. It has been well documented that young children initially favour bright, primary colours (Myers, 1989; Gardner 1980 ; Brittain, 1979; Kellogg, 1970). Indeed, colour is more important to early visual expression for children, as "they respond to the colour in a visual field before they respond to the shape or form" (Myers 1989: 304). This early 'addiction' to colour to express emotion or to communicate knowledge changes with age until virtually all adults become form-dominant, relying on shape and figural response to communicate rather than colour. It is interesting that the ten percent of adults who maintain colour-dominance "are seen as highly sensitive, individualistic, and somewhat impractical … they tend to score very high in fluid intelligence, a creative, nonverbal kind of thinking involving visualisation rather than step-by-step deduction" (Myers, 1989: 304). The term 'fluid intelligence' is used here in the artistic sense as the equivalent of visual stream-of-consciousness, rather than the psychometric term which was raised in Chapter 2.

An advanced sensitivity to colour in gifted individuals is possibly linked to the higher levels of affective response to the world in general which many studies, cited previously in this thesis, have linked with giftedness. Specifically for visual artists, these characteristics are not always positive as Neihart (1999: 47) has observed: "Disturbances of mood appear to be present in a high percentage of talented visual artists".

It is argued that talented visual thinkers may be developmentally 'at risk' of not achieving their potentials, as the combination of overexcitabilities and personality characteristics may not suit them to a system of education which is language driven. According to the Getzels and Csikszentmihalyi's (1976 in Piirto, 1992: 123) study of the personalities of visual artists, the following profiles emerged:

> *both men and women artists were aloof, reserved, introspective, serious, and nonconforming to contemporary social values - that is, "standards of behaviour and morality have little hold on them". Their personality measures had low scores in what is called "superego strength", or conscience. They were unconventional, subjective, intense, and imaginative. Independent, they preferred to make their own decisions, and their self-sufficiency was high. They were both radical and experimental... the stereotype of the unconventional artist seems to have some basis if the results of this personality assessment are to be believed*

Engagement in the visual arts has been cited even by gifted writers (in Hertjer, 1986) as essential to maintaining emotional balance. C.S. Lewis for example is portrayed in

Hertjer's study as being *doubly gifted* in art and writing. Khatena (1992: 154) has used the term 'visual narrative' to describe how the visual arts allow gifted writers to function:

> *For gifted young people visual narrative is the train engine which pulls with it the freight cars of tension and relief, emotions and feelings, repressions and sublimations, symbolizations and expanding aspects of reality.*

Unfortunately for the majority of gifted individuals, the language of this 'visual narrative' does not feature in their curriculum.

3.6. Visual Arts training and Curriculum Design

> *" there appear to be two modes of thinking, verbal and non-verbal, represented rather separately in left and right hemispheres respectively, and our educational system … tends to neglect the nonverbal form of intellect.*
> *What it comes down to is that modern society discriminates against the right hemisphere"*
> *(Sperry, 1973 in Edwards, 1979: 29).*

This thesis has argued that one of the main reasons why visual art ability is not necessarily linked with general intelligence is that art itself is often not perceived as having the value of other subject areas within a school curriculum.
It is not only the sphere of visual arts but also music that are, according to Seeley (in Feldhusen et al, 1989), given a "short shrift" within the curriculum areas of most schools. They are often taught as separate disciplines and outside of the realm of the real schoolwork. There is a general weak base of arts, music and the humanities in the regular curriculum and it is argued that the curriculum differentiated for gifted students should redress this imbalance in programs that are designed to stretch the brightest students, to extend and expand the core content areas rather than providing more, or more difficult, material.

The arts in general, according to Feldhusen et al. (1989: 230) offer gifted students a unique opportunity to subject to the most rigorous scrutiny the knowledge, experience and values they derive from all their studies and to use these as bases for an individual world view. To achieve this goal, arts education should contain the following elements:

1. learning should be *interpretive* or *integrative* of the students' knowledge and experience,
2. learning should be *normative*; it should move the students toward an understanding of the common culture and the students' own position relative to that culture through the study of art history, aesthetics, and philosophy, and

3. learning should develop *critical thinking* by strengthening the students' ability to question, confront, deliberate, judge and create alternatives.

So why is it that visual thinking and visual art ability, when compared with ability in the mathematics and science fields, have traditionally been regarded as separate? As Morris (1986: 2) states:

> *Science and art have been seen as 'two cultures', distinguished by ideology and by ethic, technology and progress ... science is concerned with the discovery of empirical facts about nature and in developing concepts to bring these facts into an intelligible theory to explain the reality of the natural world. Art, on the other hand, is the personal statement of an attitude towards something that is acknowledged as real. Art is subjective and personal; it may support the reality or deny it; science claims to be the reality.*

Yet as this thesis has already indicated, visual thinking ability occupies the largest section of the brain and actively engages both cerebral hemispheres. It could be postulated that visual art training should be essential to studies such as mathematics and science.

It is still a novel idea that visual thinking skills could form the core of school curricula. Training within visual arts in schools is traditionally aligned with notions of 'expression', or evidence of 'things learnt previously'. It may not be regarded, for example, as a learning process in itself, as Brittain (1979: 184) has commented:

> *Art is primarily considered an expressive medium. The act of drawing or painting is looked upon as an external expression of an inner state, both intellectually and emotionally. It has therefore been assumed that if a child develops cognitively beyond his years, he will express this same development in his art products. Our belief is that art activities do more than just reflect the inner child: they help to form it.*

Perkins (1995)has actively promoted the view that training in the appreciation of artistic form leads to higher-order 'thinking dispositions'. Perkins (1995: 5) summarises the features of art, particularly as it is displayed in an art gallery, which support better thinking dispositions as:

- sensory anchoring
- instant access
- personal engagement
- dispositional atmosphere
- wide-spectrum cognition
- multiconnectedness

Perkins's notions of 'sensory anchoring' and 'dispositional atmosphere' are what make an art gallery a unique learning environment, and his guidelines for viewing artworks were used as a guide for the implementation of the *Turning World* program, which was taught primarily in the Art Gallery of South Australia.

Activities that explore student perceptions and imaginal experiences afford opportunities to heighten affective and aesthetic awareness, enhance flexible thinking, and increase original and creative production. These abilities are as necessary to good mathematical thinking as they are to visual thinking.
The importance of visual arts training has been summarised as:

1. *Aesthetic Perception:* awareness of the aesthetic qualities of works of art, involving the sensory and intellectual analysis of these perceptions.

2. *Creative Expression:* the making of art, either through production or performance; acquiring artistic knowledge and skills to express and communicate through visual explorations.

3. *Cultural Heritage:* knowledge about the historical and cultural background in which works of art are created, including socio-economic, political, intellectual, ethnic, religious, or philosophical considerations, and

4. *Aesthetic Valuing:* Involving the development of critical thinking skills and cultivating the ability to make intelligent and informed judgements regarding excellence in the arts

(Uldrick & Cross, 1992 in Gallagher & Gallagher, 1994:268).

Van Tassel-Baska (1994: 283) has also affirmed the important role that the visual arts fulfil, specifically that they provide:

1. A universal means of communication as both creator and observer

2. A mechanism to transmit and understand a culture across generations

3. A means to understand the underlying concepts of many subjects in the curriculum through the elements of sound, movement, colour, mass, energy, space, line, shape, and language

4. The medium for expressing deep emotions in verbal and non-verbal form

5. An integrating force that weaves through the humanities and provides and provides emotional voice and insight to knowledge

6. A connection to play and childhood essential to the development of sensitivity and creativity which can be applied to any human endeavour irrespective of age

7. Attention to personal observation, self-awareness, and self-expression which is important in the development of self-esteem, and

8. A sense of pleasure, challenge, and mystery that can bring learning to life.

The visual arts curriculum is often viewed in education as synonymous with the teaching of creativity. Many arts educators believe that instruction should involve freeing the creative impulse rather than channelling it. They maintain that creativity in the arts occurs naturally in all children and that arts talent will develop only if it is freed from the constraints of convention.

This observation reinforces the view that creativity in general is the goal of arts instruction. Creativity however, according to Pendarvis et al (1990: 182), cannot be the goal of arts instruction, because creativity does not function apart from a particular medium:

> *Although it is essential to encourage creative vision so that individuals can produce art, the encouragement of creativity cannot guide the development of arts talent.*

Pendarvis et al. (1990: 183) suggest that visual arts training is more intellectually relevant to the teaching of gifted children than specific creativity training. They also raise the fact that this point needs to be stressed because creativity tests are among the most frequently used methods of identifying artistically talented students.

They view general creativity training as "a global cognitive skill - like intelligence - and equally applicable to the study of mathematics or languages as to the study of dance or art".

This chapter has argued to date that visual intelligence does have specific links with advanced intelligence and that the visual arts curricula can have an impact on the development of this intelligence. The following section proposes that this visual intelligence has a universal language.

3.7. Visual universals: a grammar of form and analog drawings

Strangely enough, a grammar in art today still seems ominously dangerous to many

(Kandinsky, 1926 in 1979:84).

It is proposed in this thesis that ability in visual thinking as evidenced through figural or visual art ability, is a powerful general ability, albeit one that is difficult to measure. In much the same way that Chomsky proposed universal structures in language, so too Wassily Kandinsky (1926 in 1979) had earlier claimed that there is an "adherence to law" and a "universal grammar" of visual structure. Kandinsky's hypothesis was that there are basic elemental figural forms in the same way as there are basic structures of speech or verbal form which appear to be common or universal in all human beings.

Chomsky argued a child's language is genetically pre-programmed to equip it to pass from childhood to puberty and adulthood. Prior to his proposals, linguists had focussed attention upon collecting, analysing and building up the grammar of as many human languages as possible. Chomsky reversed the process. Rather than collecting all of the data of the grammars and analysing them to determine common or universal elements, he started with the assumption that the mind is in possession of an unknown 'universal grammar' which has variable parameters that can be set in different ways by different languages. His quest was to uncover the underlying universal grammar from studies of the particular languages that arise from it. Chomsky noted that we have an intuitive feel for the formal *structure* of language that is independent of its *meaning*. He paved the way for essential studies of linguistic form and function: graphonic, syntactic and semantic explorations of language use.
Just as the early linguists worked on the descriptions of the various grammars of the many languages to explain language itself, so too, most descriptors of spatial intelligence evident in major art movements generally relied on descriptors of their varying structures and approaches rather than trying to identify their common or universal elements.

Sless (1978: 16) took a similar approach to the early linguists and studied pictures across different cultures to look for common elements. He rejected the notion that "pictures could form the basis of a universal language … because different cultures develop different schemata and apply them in different social contexts". Those who adhere however, as Chomsky did, to a universal language in visual intelligence, do not start with 'pictures' for their analysis but with form and colour. Kandinsky would also argue that sound and movement complete the universal grammar of visual intelligence.

This chapter proposes that there are universal rules and structures underpinning visual thinking. The presence of such universals will be explored through the phenomenon of analog drawings initially, then through a study of Kandinsky's grammar of visual form.

Myers (1989: 4) proposed a basic structure underlying the grammar of verbal and visual forms:

> *for a clear communication in any language, written, spoken, or visual, the rules of grammar require that at least three conditions must be present:*
> *(1) semantics, that is, the recognition of the meaning of a word or image;*
> *(2) syntax, or structure, the way that the words, phrases, sentences, or images are put together … and...*
> *(3) pragmatics, the interconnection, or interrelationship with the reader, listener, or viewer – the existence of shared knowledge. When any one of these is missing, or unclear, meaning is likely to be impaired, distorted, or, simply, nonexistent.*

Chomsky claimed that, because language development is fixed in human genetic coding, we have an inherent 'feel' for its formal structure, even when one or other aspects of it (such as the semantics) are corrupted. He offered as an example the expression, "Colourless green ideas sleep furiously", which we might describe as an expression lacking in semantic sense yet one which maintains structural syntax and graphophonic integrity.

Since Chomsky's research, the term 'universals' has become common in the study of linguistics. Yet the term is rarely used in studies of visual language processing. Hoffman (1998: 14) claimed that universals do exist in visual thinking, arguing:

> *these innate rules, which grant visual mastery to the child by age one and lead to consensus in the visual constructions of all normal adults despite the infinite ambiguity of images, I call* the rules of universal vision.

Barthes (1974 in Cowie, 1992: 18) also noted that, when defining art in semiotic terms "one can only anticipate that for all these imitative arts – when common – the code of the connoted system is very likely constituted by a universal symbolic order."

What is the nature of these universals in visual art? Kandinsky (1926, in 1979: 84) used the term 'elemental figural forms' and he outlined a dictionary of these elemental figural forms with the following rationale for doing so:

> *The dictionary of a living language is immutable as it undergoes changes perpetually: words become submerged, die; words are created, come new into the world; foreign words are brought home from across the borders. Strangely enough, a grammar in art today still seems ominously dangerous to many.*

Kandinsky's dictionary relies on a lexicon of the interplay of a point (which may reflect circular, square or triangular forms) and a line (which may be straight, curved, angular) within a basic plane (or frame) to communicate.

Is it possible to isolate common or universal elements across the enormous range of figural art forms? What could Andy Warhol's *Campbell's Soup* have in common with Cabanell's *The Birth of Venus*? Is it possible that the mysterious and gentle smile of da Vinci's *La Giaconda* is in any way related to the distorted and frenzied faces of de Kooning's Women? Do Jackson Pollock's drips and drizzles speak the same language as Michaelangelo?

If there is a common grammar of form underpinning the many differing 'languages' in art forms, then is it possible that this grammar can be identified and assessed? Those observers of visual art forms whose eyes are trained to recognise realistic visual representations in art form might claim, for example, that a Constable countryside scene brings about a pleasurable sense of bucolic peace and relaxation, while Franz Marc's fauvist cows produce confusion and even distress with their red and yellow coats and Chagall-like flotation. Such confusion, and even disbelief or hilarity, which is witnessed daily in most contemporary sections of art galleries the world over, is accepted as part of the 'fun' of the modern gallery, and not held up as evidence of poor thinking on the part of the viewer. As commented earlier in this study, it is regarded as 'perfectly *ok*' to be visually and artistically ignorant in most western cultures, and viewers of art consequently show no reticence or embarrassment about their ignorance. Comments such as "a child could have done that – only children would paint yellow or red cows" are commonly overheard in art galleries. Yet if the same observer was to dismiss the poetry of Paul Verlaine as poor quality or infantile because he or she does not understand French, then that response would be universally judged as lacking in cognitive insight and plain common sense. If you do not have the language, of course you will not understand the communication.

Western culture's reluctance to understand or learn the cognitive insights underpinning visual art, particularly abstract or non-objective art, probably has its basis in the expectation that visual art must fulfil some function – it must be of some use, such as bringing a sense of peace, excitement, wonder, or sensuality to the viewer. In the depths of a cold winter, a warm image on the wall of a sparkling blue seascape or a garden of flowers should bring warmth, colour and movement to a still room. In the absence of any knowledge of the grammar of form and colour, most individuals reject abstract art because they do not understand it and it consequently has no *use* to them; it is outside of the frame of their understanding of realistic expectations of art. As Hamilton (1989: 17) has indicated "People often avoid the use of paintings that have little evidence of realism"

The move to a state of 'little evidence of realism' within visual thinking has been achieved with some of the greatest intellects devoting their skills to creating such a new vision. The visual arts movement has been characterised by 'quantum leaps' of thought in much the same way as mathematics and science have witnessed and documented original shifts in conceptualising their craft. The departure from realism that the Impressionists took for example, was a massive change in the field of visual thinking.

It was probably Manet who first made the move into Impressionism with his portrayal of direct light, usually executed *en plein air* rather than in the traditional studio, and his depiction, with paintings such as *le Déjeuner sur l'herbe* and *Olympia* of *real* women rather then the *vacuous nymphs* of the Paris salon. However it was not until Monet's *Impression, Sunrise* painting that the name and the movement became established. This painting exemplified the Impressionist aim of attempting to record the fleeting effects of light at a different time of day and in differing atmospheric conditions. As they needed to work fast, the short, choppy, open brushwork became characteristic but upset the critics, as a review of *Impression, Sunrise* reveals:

> *But these blotches were done the way they whitewash granite for a fountain: slip! slop! vlim! vlam! Any old how! It's unheard of, dreadful! It's going to give me a stroke!*
>
> *(in Murray-Harvey, 1996: 6).*

Despite such visceral reactions to Impressionism, the seeds of non-objective art were sown and Kandinsky's own reaction is recorded years later when, as a young artist he stood before Monet's *Haystack*; such a common, peasant-spawned, light-riddled image of no immediate interest to the *Salon:*

> *I had the impression that here painting itself comes to the foreground; I wondered if it would not be possible to go further in this direction"*
>
> *(Kandinsky, 1895 in 1979).*

Kandinsky's legacy is that he did 'go further' and his creativity suggested further possibilities in visual arts. Since Impressionism and Abstraction, a wide range of major art forms have emerged, such as Fauvism, Expressionism, Cubism, Purism, Orphism, Futurism, Vorticism, Dada and Surrealism, Suprematism, De Stijl, Constructivism, Abstract Expressionism, Kinetic Art, Pop Art, Op Art, Minimalism, and Conceptual Art (Stangos, 1991; Collings, 2000).

With such a range of significant changes in the conceptualisation of visual artists' expression, is it possible that there is a basic grammar of figural form common to all of these movements?

One of the main difficulties seems to be in the removal, in some of the visual arts movements, of the realistic or iconic representations of physical, sensual, intellectual, kinesthetic or emotional events or objects in the environment. As Hayakawa (in Kepes, 1969: 9) has stated, "Visually, the majority of us are still 'object-minded' and not 'relation-minded'. We are the prisoners of ancient orientations imbedded in the languages we have inherited"

The term 'analog drawings' has been used to describe drawings which remove the object to represent an emotion or an idea in figural form. The term 'abstract' is used here to describe figural representation which is non-objective, or which does not rely on reproducing known images or actual pictures. An analog is generally defined as "a physical object or quantity used to measure or represent another quantity" (Collins Australian Dictionary, 1999).

There is a common belief that words are the bearers of, or the descriptors of, thought and feelings. Although most people of sufficient intellect can manage to express thoughts and feelings in words, it is obvious that training in precise and accurate language skills will enhance this skill and that successful poets and authors are better skilled at it. In general if a human being is depressed, lonely or angry, he or she is able to speak about it or even write the feelings down to give a better 'shape' to them. The object of analog drawings is to express emotions or thoughts in a similarly visual yet abstract form, " to dredge up that inner life of the mind by using an alternative, visual language … to give it tangible form – in short, to make inner thought visible" (Edwards, 1986: 66).

Kandinsky's point and line to plane are proposed as universal to visual language. In a similar way the presence of analog drawings suggests a universal grammar of point and line within the basic frame to communicate.

This chapter has confirmed that no two people 'see' an image in exactly the same way. The limited research on analog drawings confirms that although no two drawings are alike, there is marked similarity in the structures of the drawings that express a single concept.

To illustrate the basic principles of the analog drawings some examples are provided. In general, if subjects are asked to represent the emotions of anger, joy, peacefulness and loneliness, using only the principles of point and line to plane, the following (reproduced below in Figure 3.9) will be common responses across the majority of students:

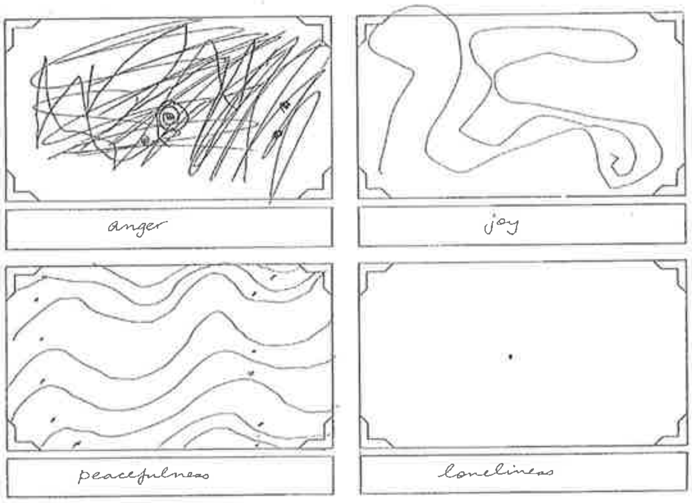


Figure 3.9: Examples of student analog drawings

These examples are reproduced with permission from student samples in the early training sessions for the *Turning World* program. The responses in analog almost universally depict the following:

- anger as sharp, pointed, vertical or oblique, violent strokes
- joy as soft, curling or swirling, usually vertical, light strokes
- peacefulness as horizontal, lengthy, soft or wavy strokes
- loneliness as a dot or a circular shape sometimes connected with a line

Further examples are reproduced in Figure 3.10 below:

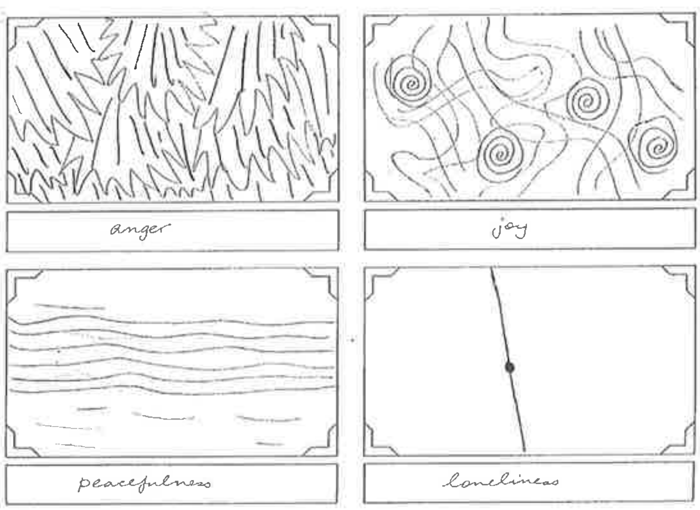
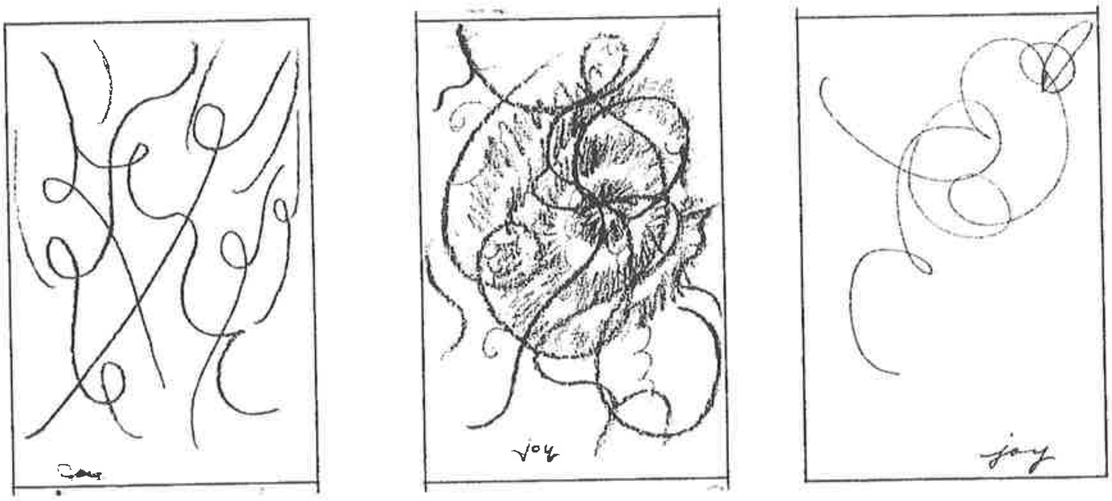
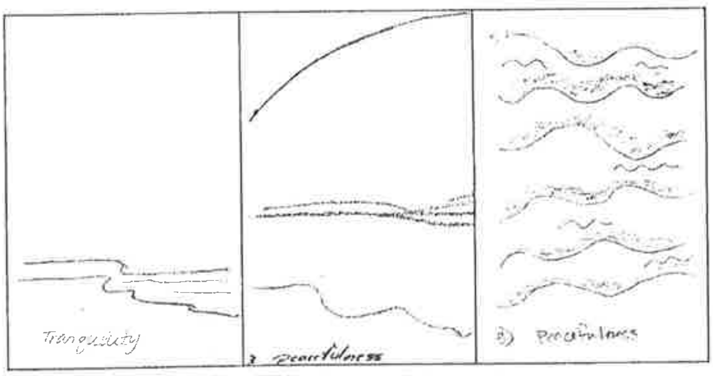


Figure 3.10: Examples of student analog drawings

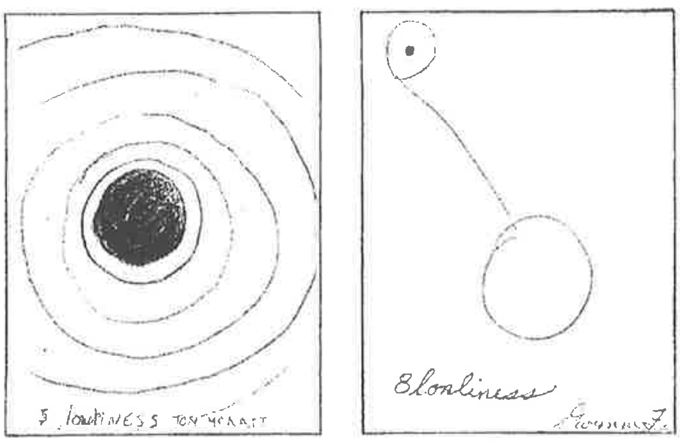
Any teacher who engages in this simple exercise with students will be surprised by the structural similarity of drawings that express a single concept. The following are some examples from Edwards'(1986) work on analog drawings and the similarities can be seen with the student samples:



Analog of 'Joy'



Analog of 'Peacefulness'



Analog of loneliness

Figure 3.11: Analog drawings of joy, loneliness, and peacefulness

The observations of analog drawings has raised the question of meaning in language and parallel meaning in drawings. If analog drawings do represent a basic visual language, the question must be asked, "does this parallel language read similarly for everyone, or at least for people from similar cultures?" If this is so, it would seem to provide additional evidence as Edwards (1986: 76) suggests that:

> *there might be a deep structure of visual form underlying human art that is wired into the human brain in a manner similar, perhaps, to the way in which Noam Chomsky has postulated such a structure for human verbal expression. The analog drawings seem to indicate the possible existence of such a structure.*

In terms of analog drawings it could be argued that there is an essential 'object' or 'image' present. Horizontal lines are almost exclusively used to represent peacefulness or tranquillity, and sunsets, sunrises, a sleeper in a bed evoke lateral images that are possibly universal in human experience. Yet the seemingly simplistic analog drawings do seem to have a basis in a richly structured theory of visual grammar.
Although we can be fairly certain that van Gogh did not know the term 'analog', a viewing of his *Cypresses* curling and swirling ever upward communicate in form rather than image his delight in nature.

It could be argued that even in words, the power of communication is in form rather than the image. As an example, the next chapter details one of the poems studied in the *Turning World* program, T.S. Eliot's *The love song of J. Alfred Prufrock*, which has as its famous opening line:

> *Let us go then, you and I,*
> *When the evening is spread out against the sky*
> *Like a patient etherised upon a table …*

Just as Chomsky's colourless green ideas sleep, the power of words lies in their *imaging*, in Prufrock's case an overwhelming *horizontalness*, rather than the elemental word itself. It is argued that the syntatic, semantic and graphophonic grammar of language is equally present in the corresponding form, meaning and *sound* of visual language.

The author selected the teaching of Kandinsky to further instruct the thesis that these elements are universal. The focus of this study is on visual intelligence, creativity and giftedness and it seemed appropriate to draw upon the work of one of the greatest visual artists known, especially one who is hailed as the true founder of a genre which strived to communicate visually through pure form or "pure feeling" (Collins, 1999 :165). One of the first painters to want to eliminate "traditional representation in art", Kandinsky is generally regarded as the founder of the abstract and the *non-*

objective art movements. It is interesting that for him the initial catalysts were not haystacks but "Russian motifs from old fairy tales and medieval chivalric legends, and subjects from folk art" (Dabrowski, 1995:15). This early inspiration also served as a guideline for the author's choice of the literature within the *Palace of Wisdom* and *Turning World* programs, specifically Chaucer's *Canterbury Tales* and the North American Indian folk-tale, *Loo-Wit The Firekeeper* (see Appendix 3).

Kandinsky was not just a great painter; he re-directed the course of visual artistic expression and was the first to link figures or form with sound, colour and movement. Just as Baudin, Monet and other great Impressionist artists changed visual thinking forever by painting light, movement, the passage of time, rather than realistic images 'camera-ready', so too Kandinsky made a quantum leap in the production and interpretation of visual art. He moved beyond Impressionism by empowering form and colour to communicate in a language that few at the time understood. Kandinsky's directives on the language of point, line, and colour within the basic plane fit well in the wider academic debate on the links between visual IQ and visual creativity upon which this study has focussed.

In the same way that the object-focussed artworld rejected the early Impressionists, so too Kandinsky initially struggled to have his abstract paintings accepted. Even in his formative environments of Munich (at the time referred to as the 'Athens of the Arts') and Vienna, Kandinsky's work was regarded as too *avant garde* to be accepted as a serious genre within the visual arts. He was probably the first visual artist to study elemental links with sound (music) and movement (dance). That Kandinsky's work and habitation coincided with an era and country which produced Gustav Mahler and Arnold Schoenberg is surely no coincidence. In Vienna, Kandinsky became friends with Schoenberg in particular and was able to sympathise with the composer in a society which was "deaf to the dissonances" of his work (Vezin & Vezin, 1992: 109). The links between the lyrical quality of form, colour, and music, were a source of inspiration for Kandinsky as Vezin & Vezin (1992: 110) further noted:

> *Schoenberg was, in fact, in the process of abandoning the tonal system, the keystone of western music since the Renaissance, and this break was to prove as crucial as Kandinsky's break with the representation of the object*

Kandinsky's major text, *Point and line to plane* (1926 in 1979) is not generally cited in later studies on vision or visual intelligence (Kepes, 1969; Chase 1973; Marr, 1982; Myers, 1989; Hoffman, 1998) previously referred to in this thesis, yet the common elements can be traced. Kepes (1969: 17) argued, for example, that there are basic 'forces' which are critical to understanding visual form:

The essential forces of visual attraction – a point, a line, an area – exist in an optical background and act on the optical field.

If these forces are universal then they must have been evident well before scientists studied them and they must occur before the intervention of formal schooling.

It is interesting to note that the original marks made by humans appear to be in the form of basic points and lines, or variations on them. If these forces are truly universal then they must have been evident well before scientists studied them and they must occur before the intervention of formal schooling. Kellogg (1970) claimed that all elemental or 'child' scribbles develop from this basic grammar with the point being the elemental form from which the line developed. Examples of children's scribbles, beginning with the use of point are reproduced below in Figure 3.12:

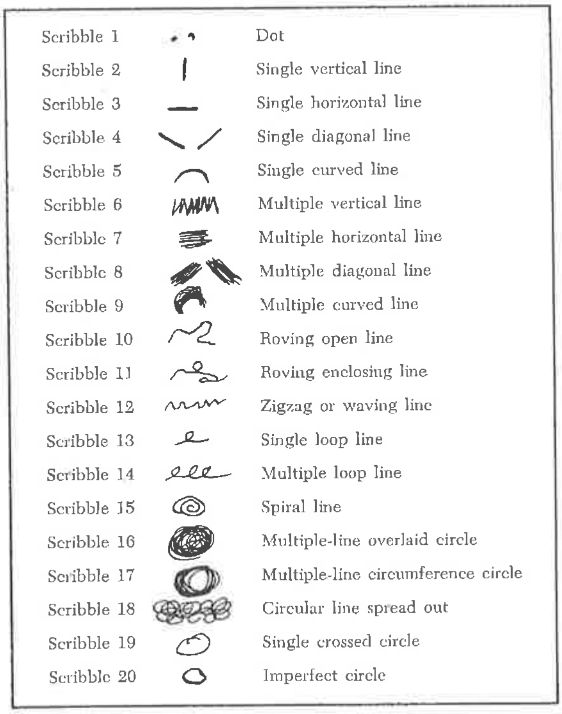


Figure 3.12: Early dot/scribbles (in Kellogg, 1970: 15)

Kandinsky's grammar of form, postulated well before such studies shows great similarity. According to Kandinsky the point is the ultimate 'ambidextrous' element in visual thinking. Kandinsky indicated that a point can take on many shapes and forms as represented in Figure 3.13 below:

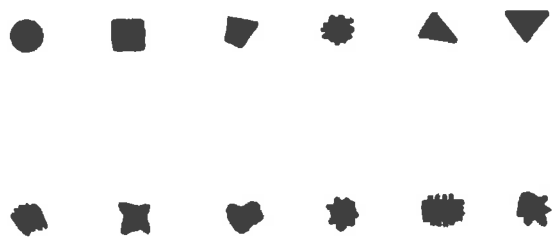


Figure 3.13: Kandinsky's Points (1926 in 1979: 31)

The ambidextrous element embedded in the point is explained as both a presence and an absence:

> *considered in terms of substance, it equals zero. Hidden in this zero, however are various attributes which are 'human' in nature. We think of this zero - the geometric point - in relation to the greatest possible brevity, i.e., to the highest degree of restraint which, nevertheless, speaks. Thus we look upon the geometric point as the ultimate and most singular* ***union of silence and speech***
>
> *(Kandinsky, 1926 in 1979: 25)*

From the point, Kandinsky argued that the second element within a grammar of universal form is the line. A line can be straight or curved, it may hang or float freely with the basic frame or it may connect within it. According to Kandinsky (1926 in 1979: 57).

> *... the line is the greatest antithesis to the pictorial proto-element - the point. Viewed in the strictest sense, it can be designated as a secondary element*

Children freely use point and line to communicate. A good example of the interplay of point (as dots and circles) and line in very early scribbles can be seen in Figure 3.14 below. Brittain has suggested that this drawing by a three-year old probably represents 'people':

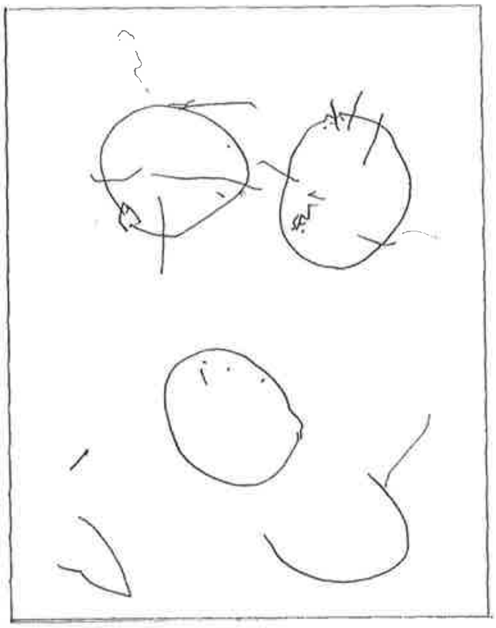


Figure 3.14: People (in Brittain, 1979: 31)

While much research (e.g. Kellogg, 1970; Brittain, 1979; Gardner, 1980) has established that children initially draw people as lines, then progress to circles with lines (or limbs), there is an element of activity and energy in the placement of these points and lines within the frame which undeniably communicates life, activity, 'people'. When art education teaches children to place people on a plane or flat surface (i.e. the ground, as people don't float) the sense of energy and the visual communication may be impaired. Chagall and Franz Marc understood this when they decided to make their points and lines navigate the plane of their artwork rather than be placed statically within it.

The third essential element of visual language, according to Kandinsky, is the basic plane or the frame within which the point and line communicate. A frame does not have to be literally, a gilt piece of wood. It may be the edges of a piece of paper or simply the corners and edges surrounding the image. A frame can be understood as a set of "basic principles that will affect and control the ways in which people involve themselves with and experience a situation" (Reber, 1985 in Benjafield, 1992: 103). as Sless (1978) has argued, frames can be seen in the same light as cognitive schemas. It is interesting to note that Gardner (1983) used the term 'frames' to delineate his separate intelligences.

In the example outlined in Figure 3.15 below, the exploration of space within the frame, or what Tufte (1990) called 'the white interval', is essential to the communication of mood and movement. The blank area is as important to the communication and the drawing as the interplay of point and line:

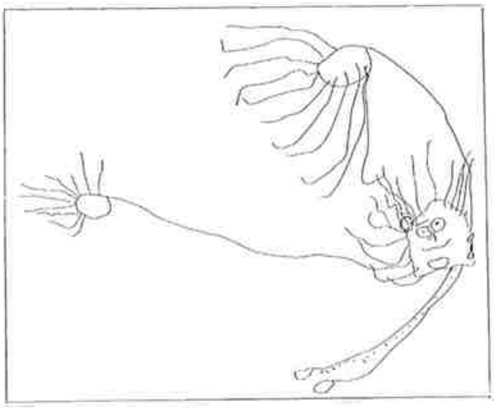


Figure 3.15: Valerie Dancing (in Brittain: 1979: 37)

Without an intuitive or perhaps even *primitive* feel for the space within the frame this drawing would not communicate the movement and joy that it does. The fact that Valerie's fingers number ten and eleven and that she is dancing with them rather than with her feet, is of no consquence to the communication of the drawing. The central points of her face, eyes and hands and the lines of her limbs do not connect with the frame and this creates both the tension and the energy of the suspended pose. She will only come to earth when there is a connection to the frame and a relief of the tension. This universal rule, as outlined by Kandinsky (who unfortunately never saw *Valerie dancing*!) was used as the basis for the design for Question 7 in the *Figures of Sound* instrument presented in Chapter 5.

The early Chinese and Japanese art forms which instructed the Impressionists and eventually the Abstract artists relied upon the use of space within the frame as Tufte (1990: 65) explains:

> *In every clear concept of the nature of vision and in every healthy approach to the spatial world, this dynamic unity of figure and background has been clearly understood. Loa Tse showed such grasp when he said: "A vessel is useful only through its emptiness. It is the space opened in a wall that serves as a window. Thus it is the nonexistent in things which makes them serviceable." Eastern visual culture has a deep understanding of the role of empty spaces in the image. Chinese and Japanese painters have the admirable courage to leave empty large paths of their picture surface so that the surface is divided into unequal intervals which, through their spacing, force the eye of the spectator to movements of varying velocity in following up relationships, and thus create the unity by the greatest possible variation of surface. Chinese and Japanese calligraphy also have a sound respect for the white interval. Characters are written in imaginary squares, the blank areas of which are given as much consideration as the graphic units and the strokes.*

Kandinsky (1926 in 1979: 42) argued that the principles of dance and music are essentially related to the notion of elemental figural form. He further drew the correlation with speech, both verbal and written, and elemental figural forms. If there does exist the visual equivalent of Chomsky's language universals then knowledge of these would be essential in any assessment of visual thinking ability or figural creative ability. Indeed this thesis claims that Aiken (1988: 257) would be quite incorrect in his assertion that: "the ultimate judge of artistic merit is the observer alone". This adage would never be accepted in the verbal/linguistic discipline where established and measurable standards of syntax, semantics, and graphophonic principles prevail. The ultimate judge of linguistic merit (is this a *good* poem?) has never been determined by the 'likes or dislikes' of the reader. In the same way, any visual judgement of artistic performance should not depend on whether the observer liked or disliked, understood or misunderstood the piece. In visual art the lighthearted and essentially ignorant corollary is the well-known, 'I like it, but is it *art*?'

This thesis has argued that there are universals in artistic or figural thinking abilities which are closer to the nature of encoding visual stimuli, rather than just decoding or copying it, and if the essence of these abilities can be identified then they can surely be measured. How closely aligned such abilities are to the nature of general intelligence is yet to be determined.

A belief in the existence of universal visual forms has been strengthened by the work of art historians such as Giedeon (1956) and Giedeon (1962) who traced the origins of humankind's "religion, mythology, culture, and customs in archaic man's art. Strangely enough, the dominant motifs they offer in evidence consist of Gestalts commonly produced by children today" (Kellogg, 1970: 212).
An example of some of these common motifs is reproduced below in Figure 3.16:

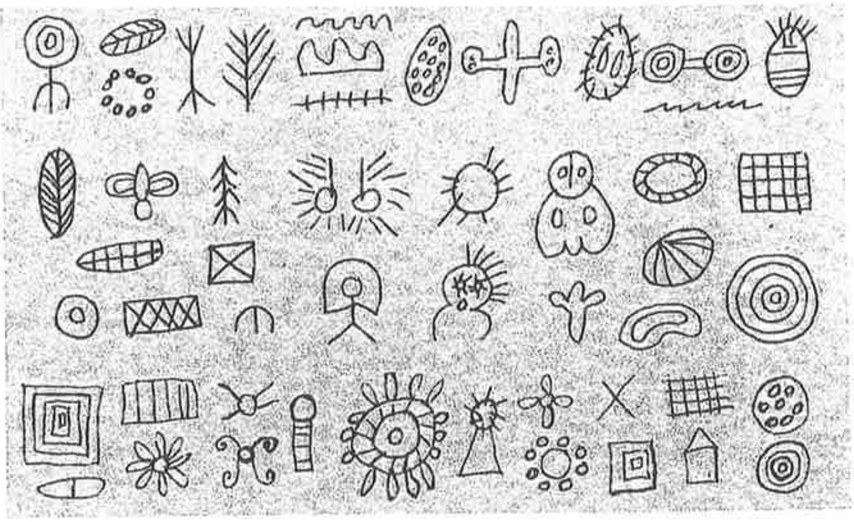


Figure 3.16: Common children's motifs and archaic art motifs (in Kellogg, 1970: 217)

Hoffman (1998: 15) has argued that language universals are an active part of visual cognition and that the existence of primitive motifs confirms that visual grammar is 'hard-wired' in human intelligence and humans are destined to follow the grammar of universal form albeit 'creating' the image with every experience of it:

> *complex vision is universal because children actually reinvent it, generation after generation – not because they are taught, not because they are generally smart, not because it is useful to them, but because they just can't help it.*

Cowie (1991: 4) confirmed from the evidence of the ancient galleries with their universal motifs that these are more than the

> *random marks of a pictorialist culture. The organisation of the galleries is the clearest indication of structural consciousness of a very advanced order. The earliest human fine artists were very gifted indeed, and yet, there seems to be little archaeology for the origins of this creative expression.*

Cowie's observation on the lack of 'archaeology' for these forms is evidenced in the lack of research on visual intelligence in comparison with verbal/linguistic intelligence.

A further insight into a possible universal grammar of visual thinking is to be found in the fact that motifs such as those outlined in Figure 3.16 are common to motifs found in nature.

The presence of these elemental or universal motifs, according to Khatena (1995b: 131) have a universal basis in motifs commonly found in nature, since, "Nature is the source of the alphabet and meaning of art". Khatena's research supported the notion of universal points and lines within the plane which "we abstract as motifs. These motifs make up the alphabet of visual art. They are universal and the language they represent is not culture bound as is the language of words".

Khatena claims that there are seven basic motifs in art derived from nature: "They are the spiral, circle, half-circle, two half-circles, wavy line, zigzag, and straight line" (1995: 131). The late Australian artist, Brett Whitely, would argue against the inclusion of the straight line as elemental form. His view of elemental or universal motifs and their basis in nature originated from his study of the human body and as he observed, "I have searched all over my body and I can't find one straight line" (Whitely, 1995: 1).

The universal principles of forms can also be found in the mathematical proportions documented in nature through the Fibonacci numbers and the 'Golden Ratio' or the 'Golden Section' identified by the Renaissance mathematicians and artists. The links with visual form are outlined in Chapter 5, as some of these universal principles were incorporated into the design of the *Figures of Sound* instrument.

It is generally accepted that a grammar of verbal structure relies on syntax, semantics, and graphophonic structures. Being able to intuitively, yet naively 'feel' for the colourless green ideas in their furious sleep is perhaps similar to being able to naively stand in front of an abstract or non-objective work of art, and without specific training in the principles of point, line, plane and colour, be able to provide an instinctual response. As an example, Kandinsky's *Painting with White Border* is reproduced in Plate 3.1 below:

Plate 3.1: 'Painting with White Border' by Wassily Kandinsky

This work of art is referred to in the next chapter as it was included in the enrichment program, the *Turning World* and is one of the artworks in Hamilton's (1989) Critical Thinking program. The most common responses from students to this work of art (McCann, 1996; 1999; 2001) have been that it is chaotic, scary, dark, foreboding, windy, and 'thunderstormy.' In addition, Hamilton's (1989: 18) compilation from students in the United States of America of possible titles for such a work of art are: "a scary day; thunder and lightning; wind, rain and hail; an exciting celebration; stormy weather". The responses by students to this work of art have been noted as very similar, even without the students' knowledge that Kandinsky, before he had decided on a non-objective title for it, had originally entitled the piece, *Composition: Storm* and *The Approaching Storm.*

The similarity in responses to Kandinsky's art is supported by the research of Giedion (1962 in Kellogg, 1970: 217) who studied the origins of pictorial representation: "art, indeed, began with abstractions ... abstraction is closely tied up with the creation of symbols". Cowie (1992) argued that the essential links between music and art can only be truly be understood "in the abstract" which is the universal form, rather than the word or the musical note.

It is proposed in this thesis that, with specific training in the grammar of visual form, students will be able to move to a deeper appreciation, to interpret and to extrapolate artworks, in a similar way that one confident in word form can engage with Chomsky and move from a basic or naive appreciation that it is *ok* for green ideas to be colourless and also to sleep.

Abstraction, in either word or form, can only communicate when it is infused or rich with the language of its genre. As an example, Barrow (1995: 26) reported that Hollander in his verse *Coiled Alizarene* (which he dedicated to Chomsky), managed to inject contextual and semantic meaning into Chomsky's famous example by writing the following:

> *Curiously deep, the slumber of crimson thoughts:*
> *While breathless, in stodgy viridian,*
> *Colourless green ideas sleep furiously.*

This study argues that, just as an expert in the grammar of verbal form can interpret and extrapolate from an abstract verbal work of art, so too those trained in visual intelligence are better equipped to communicate in the abstract. The fact that the 'elementary signs' of verbal language are a mere twenty-six while the number visual elements are 'prodigious' is significant to this argument, as Kepes (1969: 23) elaborates:

> *Just as the letters of the alphabet can be put together in innumerable ways to form words which convey meanings, so the optical measures and qualities can be brought together in innumerable ways, and each particular relationship generates a different sensation of space ... while the elementary signs of the English language are only twenty-six, the number of elementary forces with which the machinery of sight is provided is prodigious.*

The abstraction of visual language allows for a communication across cultures, centuries and human age ranges. Kandinsky was not the only one to understand this but he was probably the first to communicate it, not just in form but in words with his publications. The author first viewed his works in the Guggenheim Museum in New York in 1985 and the delight which attended this first communication gave birth to an idea for teaching as outlined in the following chapter and the *Figures of Sound* instrument which is presented in Chapter 5. Perhaps Hilda Rebay's comment in the preface to the 1979 edition of Kandinsky's (1926) text best explains the engagement with his work:

> *In loving Kandinsky's paintings, we assimilate ourselves with expressions of beauty with which he links us to a higher world. Kandinsky's message of non-objectivity is the message of eternity* .
>
> *(Hilda Rebay, in Kandinsky, 1979: 12).*

The following chapter presents the practical application of this study in the form of the design and implementation of the differentiated curriculum which constituted the *Turning World* program.

Chapter 4: Principles of Differentiated Curriculum and the Design of the *Turning World* Program

"In seed time learn, in harvest teach, in winter enjoy
Drive your cart and your plough over the bones of the dead
The road of excess leads to the ***Palace of Wisdom***
Prudence is a rich, ugly old maid courted by incapacity
He who desires, but acts not, breeds pestilence ..."
(William Blake, from The Marriage of Heaven and Hell)

[The purpose of this chapter is to detail the current status of differentiated curricula for gifted students in South Australia and presents the background to, and the design of the specialised enrichment program, the *Turning World,* which was taught in this study]

4.0. Introduction

Special education for those with special talents is not a new idea. Plato had recommended such training for those 'men of gold' whose abilities were perceived as superior. In reality, those selected for specialised training in Plato's republic tended to come from the upper classes and be in positions of power, as ability was deemed to be a purely inherited characteristic and in the domain of the privileged.

This chapter outlines the specialised enrichment program, the *Turning World,* and provides a rationale for it within general provisions for gifted students in Australia.

4.1. Specialised Provision for Gifted Students

Although the most common provision for gifted students in Australia is differentiated curriculum within the regular school setting, the *Turning World* was offered as an alternative to school programs and was taught in school time. Separating students into an ability group based on observed higher intellectual potential has not been a popular option in Australia. However the author has taught such enrichment programs within a university setting for many years. The justification for such an option has been that until more teachers receive specific training in the principles of differentiated curriculum within the regular school setting, gifted students should have access to enrichment, extension and acceleration elsewhere. An overview of provision in South Australia for gifted students is presented in Section 4.2.

There is no clear research to support a premise that gifted children learn better when they are with students of similar ability. The limited evaluations of enrichment programs which cluster students who have either tested as gifted or been nominated as gifted are inconclusive and ambiguous:

> *Enrichment programmes invoke strong support and also extensive criticism in the research literature. On the plus side able/gifted pupils do benefit from the stimulation of their intellectual peers (Shore, 2000) and increases in pace and complexity are easier to achieve in this kind of context … On the minus side, no research has proved significant long-term educational impact resulting from withdrawal programmes, although increases in motivation and enjoyment are widely reported*
>
> *(Freeman, 1998 in Eyre & McLure, 2001: 4).*

In 1990 the author designed and taught the first tertiary-based enrichment program, entitled the *Palace of Wisdom* which offered lower secondary students the opportunity to attend a ten week course at the Flinders University of South Australia, in school time. A brief summary of this original course, which was taught at Flinders University to five different classes of gifted students over the period of five years, is in Appendix 1. In addition, a video showing a compilation of extracts from the classes in the *Palace of Wisdom* is appended to this thesis which shows some essential features of this course. It was considered important to append this video as it shows students engaged in the study of the mathematical proportions of the Golden Section and its links with visual art. These principles are outlined in Chapter 5 as they influenced Questions 1 and 8 in the *Figures of Sound* (FoS) instrument which the author designed to explore visual thinking ability. The video also provides an important insight into the principles which led to the design of the *Turning World* program. The original *Palace of Wisdom* course was advertised across all Government and private metropolitan schools in Adelaide. Hundreds of applications followed the first advertisement, attesting to the fact that schools, parents, and students were immediately attracted to the idea of an enrichment course outside the regular school curriculum and within a university setting.

The theme of the *Palace of Wisdom* was 'Perception' and it fused or crossed over traditional subject areas such as creative writing and poetry, science, mathematics, visual art, music and drama. Students who participated were drawn from ten different schools in the public and private education sector. Entry to the course was entirely by teacher and parent nomination. The course was taught in school time, and consequently only those students who were outstanding 'achievers' in school and who could afford to miss half a day per week for one semester were nominated. IQ tests were not used for selection.

The basic principles underpinning the design of the *Palace of Wisdom* program were accelerated content, an open-ended, problem-solving approach and cross-subject teaching. The strongest feature was the cross-subject approach. The practice of restricting study within the confines of subject areas, such as mathematics, art, or music, is likely to result in 'low-level' learning such as that perceived to be at the bottom of the Bloom's Taxonomy: knowledge, comprehension and application. Throughout the *Palace of Wisdom* however, the students were taught to,

> *discover the art in the mathematics and the mathematics in the music, so that they quite naturally function at the levels of analysis, synthesis and evaluation. This is the theory and the philosophy behind the processes which drive this course*
>
> *(McCann in Bailey, Braggett & Robinson, 1990: 343).*

In addition to these principles, the students were enriched by the opportunity to access content which was pitched at a tertiary level and to interact with university staff, many of whom served as mentors and advisors for them.

Since 1994, another version of the *Palace of Wisdom* was taught to lower secondary students. This course had more of a focus on engaging the students in visual art techniques and appreciation and its links with creative writing. The title of this enrichment program was *Talking of Michelangelo* which is the recurring line from T.S. Eliot's poem *The love song of J. Alfred Prufrock*: *"In the room the women come and go talking of Michelangelo"*. This poem was studied as the main literary content for this program. The title was chosen as an appropriate one for a course which fused a visual study (epitomised by *Michelangelo*) with a verbal one (*talking*). Most of the content of the *Talking of Michelangelo* course was taught at the Art Gallery of South Australia.

Extending the principles of these two enrichment programs, the *Palace of Wisdom* and *Talking of Michelangelo*, the third enrichment program entitled the *Turning World* was designed as a specialised, visual thinking program to suit students at the Year 6 level of primary school, as this was the age group which best suited this study.

The title for the *Turning World* program was also drawn from a line of one of T.S. Eliot's poems, *Burnt Norton*, which embodies the synectic image, the *still* point of the *Turning World*, the extended extract being:

At the still point of the turning world. Neither flesh nor fleshless;
neither from nor towards; at the still point, there the dance is,
But neither arrest nor movement.
And do not call it fixity,
Where past and future are gathered. Neither movement from nor towards.
Neither ascent nor decline. Except for the point, the still point,
There would be no dance
and there is only
the dance.

T.S. Eliot: Burnt Norton

As the master of the synectic image: still/turning, flesh/fleshless, arrest/movement, past/future, dance/fixity, from/towards, ascent/decline, T.S. Eliot provided the ideal entrée to this enrichment program. In all three enrichment programs the principles of synectic images was taught and this most powerful image, *still*, yet *turning*; a *point* on the *round* (almost like Coleridge's *at the round earth's imagined corners*), served well not just as the title of the program but as an introduction to the art of Matisse and his 'Dancers' series (see Appendix 3 for an outline of the program and a set of some student worksheets).

The *Turning World* program was taught within the Graduate School of Education at the University of Adelaide as well as at the Art Gallery of South Australia which is situated next door to the University. In addition, two classes, in mathematical imaging and visualisation, were taught at the South Australian School of the Future, as the appropriate computing facilities and teaching expertise were there.

Classes were held over a ten week period on Friday afternoons from 1.00 – 4.00pm. Students travelled from the five separate schools to the classes with the help of teachers and parents. The notion of 'school' children attending a university seems to have great community and media interest. In the same way that the *Palace of Wisdom* had attracted media attention, so too the *Turning World* program attracted a deal of media attention. Examples of some articles are reproduced in Appendix 2. The *Turning World* program (TW) was specifically designed as an enrichment program for very advanced students. This thesis has highlighted differing views about the effects of the environment on the development of giftedness. Many explicit theorists would argue that an enriched environment will lead to optimal and enhanced learning but will not actually change intellectual growth, as Miller (1998: 51) believes:

> *No amount of education or hot house atmosphere can grow Einsteins or Picassos or, for that matter, Michael Jordans. Even the very gifted scientist, composer, or athlete practices their craft at great length daily and yet never reach the exalted heights of these, shall we say, super-gifted or super-genius people.*

Implicit theorists however, argue that enriched environments can lead to increased levels of intellectual development as evidenced in measurable brain cell growth or synaptogenesis. If this research is reliable then educators need to identify the exact nature of an 'enriched' environment for optimal intellectual development. Fogarty's coverage of educational visionaries, which she has called "Architects of the Intellect" has not only reported on the classic researchers such as Piaget and Vygotsky but also includes the neuroscientist Marian Diamond and her work on enriched environments. Diamond ascribes the growth of dendrites which she calls, "Magic trees of the mind"

(Diamond & Hopson, 1998), to enriched environments. Fogarty describes the typical Diamond teaching/learning environment as a type of cross between Montessori and Summerhill:

> *... Hallways dripping with printed posters, writings, mobiles, sculptures, and paintings. Classrooms overflowing with beanbag chairs, rugs and pillows, books, magazines, and newspapers. Science corners filled with greenery and tanks of fish, gerbil cages and rock collections. The listening station alive with classical music, pop songs, ballads and the blues ... these are the sights and sounds of an enriched environment ...*
>
> *(Fogarty, 1997: 78).*

While most teachers and students might aspire to such learning environments, it needs to be clarified if they necessarily enrich or extend the intelligence of the students. Jensen (2000), whose many teacher resource materials provide a commitment to brain science studies and their relevance to education has stated that:

> *Enrichment comes more from the process than from the (physical) structure. Challenge, feedback, novelty, coherence, and time are crucial ingredients for rewiring the brain. Given a choice between a pretty classroom and a good teacher, a parent should take the good teacher. Ideally, though, a student should have both*
>
> *(Jensen, 2000: 79).*

The 'pretty classroom'of the *Turning World* was predominantly the Art Gallery of South Australia, an environment which Perkins (1995) earlier recommended for its 'sensory anchoring' to, and 'personal engagement' with real works of art as well as its 'dispositional atmosphere'. Lowery's (1998) research on 'brain-based' classrooms recommends an interactive, knowledge-rich environment where the student has direct engagement with the learning. It is interesting to note his criticism of 'written formats such as the text books':

> *Constructions in a student's brain depend on the interest and prior knowledge of the student and on the richness of the environment ...*
> *Written formats, such as textbooks, give minimal help because symbols are not reality. They cannot be acted on or manipulated. Understanding what a symbol represents depends on prior experiential knowledge related to the symbol*
>
> *(Lowery, 1998: 3).*

According to Jensen (1998a, 1998b) and Sousa (1995), specific study of cognitive neuroscience can help direct the development of enriched learning environments. Two major examples are in challenge and feedback:

> *The critical ingredients in any purposeful program to enrich the learner's brain are that first the learning is challenging, with new information or experiences. Often novelty will do it, but it must be challenging. Second, there must be some way to learn from the experience through interactive feedback ... challenge is important; too much or too little and students will give up and get bored.*
>
> *(Jensen, 1998a: 32).*

Before the specific details of this enrichment program are given, it is important to provide the broader context within which special provision is made for gifted students and the rationale for the design of this program.

This chapter will initially overview the general provisions for gifted students in South Australia. Following this brief overview, the chapter will more specifically address the principles of designing differentiated teaching programs suitable for gifted students. Such programs have been designed with the understanding, outlined in the previous chapters, of what intelligence is in general, and the principles of creativity and giftedness specifically. The final section of this chapter provides the details of the design of the *Turning World* program.

4.2. An overview of general school provisions for gifted students

The most common option which schools adopt to cater for the special needs of gifted students is to establish special programs or provisions within the regular school curriculum. In general, the best programs utilise a differentiated curriculum based on a combination of the following three strategies:

- acceleration: where the students have early entry to the school curriculum or are moved more quickly through the grades or the subject material, generally engaging with more advanced content
- enrichment: where the students are exposed to a greater breadth within the curriculum, generally being introduced to novel, or sophisticated material beyond the regular scope of the standard curriculum, and
- extension: where students are allowed to strengthen their skill(s) in a particular area of expertise, studying at a greater depth within an already established area of strength

(Braggett, 1992; 1997)

More recent notions of differentiated curriculum add 'empowerment' to enrichment, extension and acceleration, reflecting postmodernist thinking which encourages students to actively engage in, and negotiate their own learning. Such environments are sometimes called 'constructivist' classrooms (Perkins, 2000) and are based on the 'new curriculums' which Lowery (1998: 4) has described:

> *The new curriculums do not "speed up" the student's development or "move down" advanced concepts. Rather, their intent is to make what the student is capable of learning more useful, effective, relevant, and interesting and to enable the student to progressively build, from grade level to grade level, an understanding of the grand ideas of a subject by relating subsequent knowledge to prior knowledge.*

Special provision of these 'new curriculums' within regular schools is more successful when the teachers are trained in the principles and design of differentiated curriculum. It is well documented in gifted education that a common flaw in provision for gifted students is 'more of the same' material. The common response of teachers (particularly those without any gifted education training) to students who finish their work early and accurately is often to 'reward' them with *harder* work (usually the extension questions or exercises found in some texts), or *more* work. Such 'reactive' measures on the part of the teacher train the very intelligent child to slow down quickly and to perhaps even choose to underachieve in an environment which rewards good work with more work, or harder work. Engaging students in successful principles of differentiated curricula within the regular school setting, does not just involve faster work or even harder work for them, instead it must involve them in qualitatively different experiences of learning. The *Turning World* program was designed to show clear evidence of the principles of enriched, extended, and accelerated curricula.

A second provision for gifted students is the option of selective entry into regular schools. South Australia for example, provides 'Lighthouse Schools' for students with specific talents in areas such as music and languages. Most States in Australia have some examples of the Lighthouse or 'Special interest' School concept. These schools provide a specialisation in a field at the secondary level, then utilise selective entry for students specifically talented in that field. These schools employ specialist teachers and selective entry students spend a disproportionate part of the curriculum on the area of specialisation. The general academic performance of students in Lighthouse Schools is not affected by the disproportional amount of time spent on the area of specialisation, such as music, for example. Tracking the final Year 12 results has shown that the students' overall academic performance is generally above the average in regular schools.

A third, and much more specific educational option for gifted students was introduced in 1993 in South Australia when the SHIP (Students with High Intellectual Potential) schools were established. These schools are regular, Government schools which offer specialised provision for training teachers in gifted education methodology. Seven Primary schools were initially selected and six others were included as networking schools over the ensuing couple of years. Each school was a regular Department for Education and Children's Services (DECS) school but which devoted SHIP funds to training the teachers in the principles of differentiating the curriculum as well as employing a resource teacher trained in Gifted Education. Each school was expected to model principles of differentiated curriculum and to offer some form of enrichment, extension and/or acceleration to the students identified as gifted. There was no special entry for gifted students. Five of the original seven SHIP Primary Focus Schools participated in this study. The remaining two were South Australian country schools and the distance from Adelaide prevented their inclusion.

The primary SHIP program was extended, in South Australia, to the secondary schools in 1997 and three government Secondary Schools were selected over the period 1997 – 2000. The SHIP secondary program differs from the primary one in that it does involve selective entry for one Year 8 class each year. Selection into the year eight special class of gifted students is based on the results of teacher nomination from their Primary School, school academic records, and achievement on the Advanced form of the Ravens Progressive Matrices. In addition, the identified students are interviewed together with their parents or caregivers to ascertain their level of interest and suitability to the program. The SHIP secondary schools also have acceleration built into the option, with the special entry gifted cohort generally studying Year 8 – Year 10 in two years instead of the usual three.

The value of selective programs within schools, including selective classes and even selective schools themselves has been debated. Craven & Marsh (1997) produced research which indicated that there is a drop in gifted students' self-esteem when they are grouped with other gifted students in selective programs. The researchers claim that such students find it hard to move from a position of 'top of the class', to a situation where they may be in the middle or even at the bottom of the ability level in a selective class:

> *… arguments for the formation of special GAT (Gifted and Talented) classes of relatively homogeneous high-ability students are often based on their assumed positive effects on self-concept. However GAT research has not capitalised on recent advances in self-concept research and hence such assumptions have not been adequately tested by empirical research. GAT researchers have seemed to assume that high ability GAT environments will improve students' self-concepts and therefore have failed to test such assumptions empirically*
>
> *(Craven & Marsh, 1997: 42)*

The arguments over selective versus non-selective schooling has been referred to as the *BFLP (Big Fish Little Pond)* debate. Gross (1997, 1998) argued in favour of selective grouping for gifted students, claiming that the perceived 'decrease in academic self-esteem' identified by Craven & Marsh (in Gross (1998: 19):

> *... may result less from a change in academic ranking* (BFLPE) *than from the opportunity to measure themselves, for the first time, against academic work which is commensurate with their abilities ...*

Gross argues that this is an option to be encouraged because of this.

The students who participated in the *Turning World* program were clearly in a selective program and functioning academically at the gifted level and although no empirical measures were taken regarding their social and emotional states, reduced self-esteem was not evidenced or reported by the students, their teachers or families. The *Turning World* program was designed as an out-of-school enrichment program, and with content which was completely novel to the students, consequently there was no pressure on the students to compete for grades during the program or at its completion. Indeed responses from the group, the schools and families indicated that academic self-esteem in the gifted students was enhanced by being able to 'attend University' for one half day each week in the semester, and also with popular media coverage of their participation.

Allowing gifted students increased access to tertiary and other forms of advanced studies has developed in South Australia, as a fourth specialised option designed to cater for their special educational needs. Although the *Palace of Wisdom* and *Turning World* courses were unique to South Australia, this option is becoming more popular across Australia as the barriers between schools and universities begin to break down. The move to a Middle Schooling focus in Australia has also highlighted the fact that the senior secondary years of the traditional school are not necessarily that different from the first or even second year of university study. A range of special options is now available in most States in Australia to allow students to:

- attend classes or enrichment programs at Universities
- study University courses through the internet or distance education
- study University-organised topics or programs within the school setting, and taught by university lecturers (McCann, 2000b, 2001, 2002b).

Although the *Palace of Wisdom* and *Turning World* programs were offered to the schools as University-based and funded enrichment programs, the benefits flow back to the Universities involved. It has been noted over the years that the gifted students often choose the familiar environment of the host university when it is time for them to embark on their formal degree. It is clearly in the interests of universities to attract exceptionally bright students.

The final option to be addressed in this overview is the most extreme one for meeting the needs of gifted students and that is to educate them, set apart from other students, in selective, separate schools.

Providing special schools for academically gifted students is not a regular option in most Western countries, however it is standard provision in other countries such as

China and Russia. In these countries, provision for gifted students has focussed on the establishment of special, selective schools, usually with very accelerated curricula. It is uncommon in these countries to find specific training in creativity, divergent thinking skills or other higher order thinking skills which are essential training in Western principles of differentiated curriculum (McCann, 1998 in Maitra, 2000; McCann, 2000a; Braggett & Moltzen, 2000).

With selective special schools there is an implied assumption that gifted students need to be selected out from the regular population and placed in the separate environment of a special school with other gifted students. Originally an uncommon (and unpopular) option in Australia, the notion of establishing special schools seems to be gaining momentum in Australia as the special needs of the *profoundly* gifted students become understood. Some schools in the private sector have established reputations of catering better for gifted students through the offer of scholarships, but issues of equity have always precluded entry based on high IQ alone. Certainly within the DECS in South Australia this has traditionally been the case. However, an example of one new venture can be found in the special school for students talented in mathematics and science which opened on the site of Flinders University in South Australia in February 2003. This school is a joint venture between the DECS and Flinders University with university lecturers as well as teachers specialised in mathematics and science comprising the teaching staff.

There is no doubt that in Australia the educational provisions for gifted students are becoming more diverse and accessible yet it is still the quality of the teacher, according to the research, which is as important in bringing about change in students' learning as a successfully differentiated program. In particular the role of the teacher as mentor and role model is raised as being of utmost importance:

> *teachers can create classroom environments that foster creativity or stifle it...teachers were nominated by previous students as positively or negatively influencing their creativity....the three most important traits of facilitating teachers were treating students as individuals, encouraging student independence, and functioning as a creative role model*
>
> *(Sternberg and Lubart, 1991: 22).*

4.3. Principles of differentiated curriculum influencing the design of the *Turning World* program

The *Turning World* program was a unique combination of all of the options outlined above, in the following ways: the students were taught by a highly trained instructor in gifted education; they were selected from five different schools to comprise a special class; they attended a University or other tertiary sector for the duration of the course; they had a special focus (visual thinking) to their curriculum; and they were taught in a highly specialised and differentiated curriculum with significantly accelerated content material. The *Turning World* program, in content and delivery, is based on a highly differentiated curriculum.

Differentiation of instruction for gifted learners has traditionally been based on a 'tailoring' model: assuming that different learners will require different sizes and styles of 'garments'. The analogy with the tailoring model suggests that those learners who appear to have intellectual capacity at the lower end of the ability scale are offered a streamlined model of curriculum where the seams have been 'taken in' or the content reduced or made easier. Conversely, advanced learners who need more breadth and scope in their curriculum may need to have the seams 'loosened' or expanded. Maker (1982) outlined this model indicating that a differentiated curriculum should be adjusted for the gifted students with:

- different input or **content**
- different **process** or sense making and
- different **products** or output.

This view of differentiation assumes that a teacher should respond to the special needs of the gifted students by following the guidelines outlined below:

- planning a variety of modes of learning
- assessing student readiness at the outset
- matching learning options to student interest and need
- using flexible groupings to ensure both challenge and equity
- creating a flexible learning environment
- serving as coach or mentor to students in reaching their goals
- assessing student progress based on individual goals and growth

(Maker, 1982)

While these principles of differentiation are useful and certainly better than ignoring the needs of the learners with differing abilities, they tend to rely on *re*active rather than *pro*active planning. In other words, teachers relying on such models tend to wait until they have identified gifted students and then plan to adapt or modify the regular curriculum so that it is more appropriate. Proactive planning for differentiation assumes from the outset of any regular educational interaction that there are gifted students in the class and that they will require a differentiated curriculum. Tomlinson (1995) outlined a continuum of instruction which she identified as moving from 'no differentiation' through to 'macro' differentiation, which is essentially proactive.

The first level, 'no differentiation', is based on the 'old' belief that all students should engage in the same work. This level follows the principles that:

- Class works as a whole on most projects
- Group pacing and grading standards apply
- Implied philosophy that all of the students need the same teaching/learning.

It is an observation of the author that most teachers, even without training in gifted education, do not operate at this level. The majority of teachers probably function at what Tomlinson calls the level of 'microdifferentiation' as outlined in the principles below:

- Adjusting questions in discussion
- Encouraging individuals to take an assignment further
- Variations in grading expectations
- Students pick own work groups
- If students finish early they can choose to do reading, puzzles, busy work
- Occasional exceptions to standard pacing and grading: students may not need to do all maths problems, may not need to show work or may move on to extension questions.

While the principles of microdifferentiation are to be applauded as they are likely to enable the gifted students to work closer to their level of ability, the next level of 'macrodifferentiation' is, according to Tomlinson, the one which teachers should be trained to utilise. Macrodifferentiation principles are set out below with the very first one encompassing the whole ethos of this level of differentiation:

- Articulated philosophy of student differences
- Planned assessment/compacting
- Variable pacing assumed from the beginning
- Planned variation in content/process/product
- Planned variation in physical environment of classroom
- Consistent use of flexible groups
- Adopting a mentor role.

(Tomlinson, 1995:81)

The principles of macrodifferentiation instructed the design and execution of the classes held in the *Turning World* program. The basic principles of microdifferentiation suggest that it relies on a *re*active response to perceived individual student's needs. Macrodifferentiation on the other hand, is based on the principles of articulating and developing a philosophy of differences in student abilities. It *pro*actively assumes, as the *Turning World* program could, that there are gifted students in the class.

The essential principles of macrodifferentiation are also embodied in other models and designs of a differentiated curriculum, such as Renzulli's Schoolwide Enrichment Model (SEM) (1994) and the Renzulli Enrichment Triad (1976) model. Models such as these help to develop a school philosophy which values difference and celebrates excellence.

The most basic principle underlying curriculum development for the gifted is that experiences for these children be *qualitatively* different from the basic program provided for all children. As the *Turning World* program was designed specifically for students who were clearly functioning in very advanced ways academically, it was easier to accelerate the content of the curriculum than if the class was comprised of the normal range of abilities found in regular classrooms.

Kaplan (1986) provided the following guidelines for differentiating learning within the curriculum. She argued that students should be allowed:
• *exposure:* to experiences, materials, information outside the bounds of the regular curriculum
• *extension:* to elaborate on the regular curriculum through additional allocation of time, materials, self-initiated or related study, and
• *development:* instruction which focuses on thorough, or new explanations of a concept or a skill which is part of a general learning activity.
These principles of *exposure, extension,* and *development* are similar to the three major categories of curriculum differentiation underpinning the Renzulli Enrichment Triad model which also helped instruct the design of the *Turning World* program.

Piirto's (1999) model of a differentiated curriculum rests on five precepts which include a directive that the curriculum should be based on the characteristics of gifted students, that it should have academic rigour, and that it should engage the students in some aspect of social adaptation or reconstruction (Piirto, 1999).

The requirement for social adaptation as part of a differentiated curriculum for gifted students is also set out in Braggett's (1997) eight categories of differentiation. These categories suggest a differentiation of the curriculum according to the following guidelines: appropriate speed; appropriate cognitive processes; enrichment and opportunities for extension; personal experience and autonomy; an adherence to a range of multiple intelligences; higher-order deductive thinking and lastly, social change and career and vocational education. Braggett's guidelines have much in common with Piirto's, especially Piirto's first precept which is that differentiated curriculum should be based on the characteristics of gifted children. These characteristics have been presented in this thesis and have instructed the design of the differentiated curriculum.

Piirto's requirement that the curriculum should have academic rigour, be interdisciplinary and have specific orientations such as personal relevance and insight, relies on advanced and appropriate content. Content of the curriculum for gifted students rests on a sound and enriched knowledge base. Knowledge has traditionally been placed at the bottom of the Bloom's Taxonomy, and many guidelines for differentiated curriculum indicate that knowledge attainment is 'low-level thinking', compared with the analysis, synthesis, evaluation and creation levels at the 'top' of the newly-revised Taxonomy (in Pohl, 2000). In particular, many earlier guidelines for differentiated curriculum for gifted students put limited importance on a knowledge base, claiming that gifted students should be spending more time than the other students at the 'higher' levels of thinking such as analysing, evaluating and creating. Figure 4.1 depicts a curriculum guideline which is typical of that presented in many texts advocating a differentiated curriculum for gifted students:

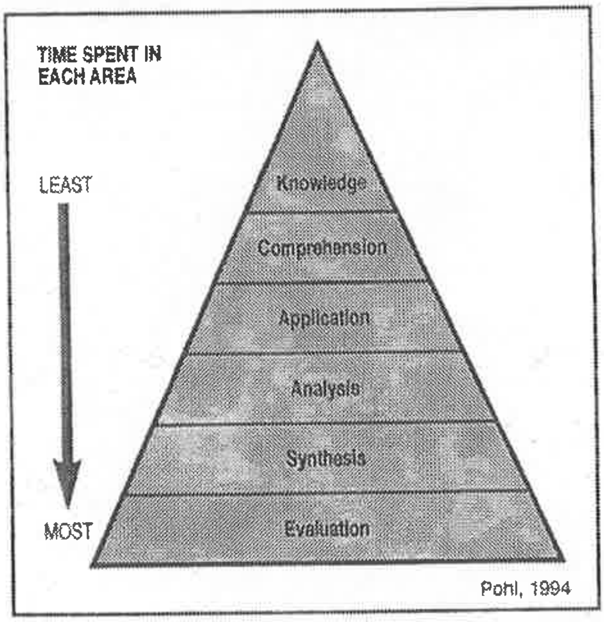


Figure 4.1: Bloom's Taxonomy for differentiated curriculum for gifted individuals (DECS, 1996)

Piirto's model however, reminds us that an excellent knowledge base must underpin good teaching and learning and that academic rigour in terms of subject knowledge is essential to higher order problem solving. No student can evaluate, synthesise or create in a knowledge-poor environment or where the content is deficient. It is interesting to note the return to status of the term, 'knowledge'.

A former Australian Prime Minister, Bob Hawke, proclaimed (in 1987) that Australia needed to move from being the 'lucky country' (as defined by Donald Horne), to becoming the 'clever county' and he was arguing that technological advances in Australia should underpin such a move. More recently, the then federal politician, Carmen Lawrence, argued that "the knowledge nation has to replace the clever country … there is no point in new technologies if they are content free" (Lawrence, 2000). It is argued that new technologies are only useful if they are rich in content.

Enriched and accelerated content was an essential feature of the *Turning World* program. Gallagher & Gallagher (1994:100) outlined a useful guideline for content modifications which help to instruct differentiation:

- **Content Acceleration**
  The teacher selects content material which should match the students' level of attainment rather than their age.
- **Content Enrichment**
  The teacher provides gifted students with a variety of materials or references that will elaborate on the basic concepts to be taught.
- **Content Sophistication**
  The teacher provides material that will allow gifted students to see larger systems of ideas and concepts related to the basic content of the course.
- **Content Novelty**
  The teacher introduces completely different and new material from the regular school curriculum.

The principles of a differentiated curriculum need to be kept in focus in the determination of enrichment programs in order to avoid the tendency to simply accelerate the content for gifted students, or to just make them 'work harder' on material which they may encounter at school. Although many of the principles of differentiated curricula outlined in this section were used in the design of the *Turning World* program, one model served as a 'map' for the design of the course in general and that model, designed by Joseph Renzulli (1976), is the Renzulli Enrichment Triad Model reproduced in Figure 4.2 below:

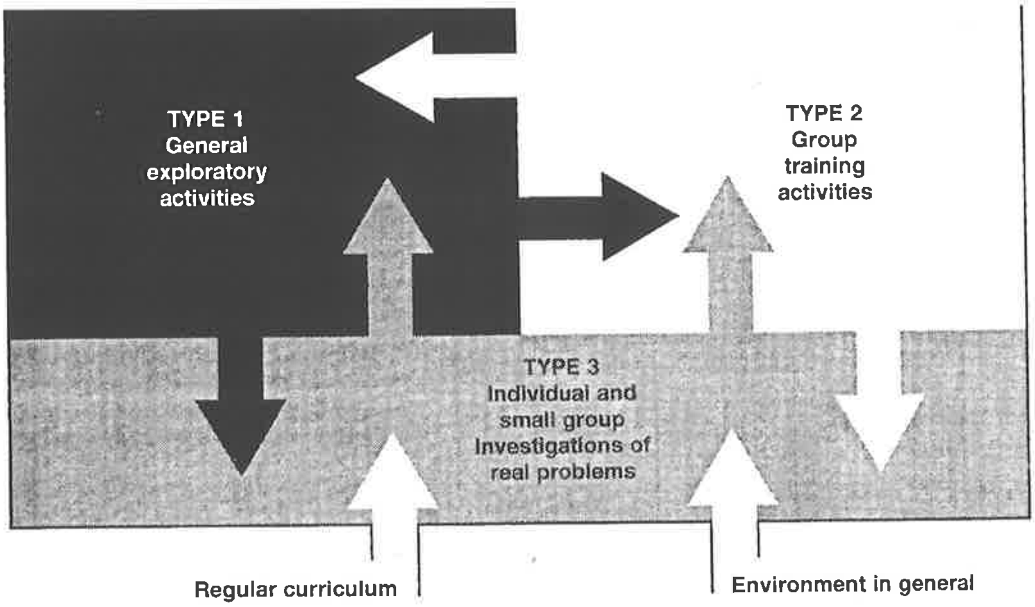


Figure 4.2 : The Renzulli Enrichment Triad

This model has been extensively used in special and regular programs for gifted students in many countries but is particularly popular in Australia, where Braggett has confirmed that "most States" have been influenced by its design, "as the basis for in-class enrichment" (Braggett & Moltzen, 2000: 782). Although the *Turning World* was an out-of-school enrichment program, many of the principles of the Renzulli Triad were relevant to its design.

Renzulli's model identifies the three 'Types' of teaching and learning activities which should underpin an enrichment program specifically designed for gifted students. The first, Type 1, is meant to 'expose' the students to new learning experiences and to 'immerse' them in general exploratory activities relevant to the theme of the program. The teacher's role is that of facilitator. The pedagogy is one of openness and naivety rather than directed teaching and learning. Type 1 learning is closest to the concept of 'enrichment' or broadening of the curriculum previously outlined.

Type 2 activities rely on the students learning new skills and require the teacher to become an active 'trainer' for the students. It is at the Type 2 level that students should be learning the principles of higher-order thinking skills. The McCann version (et al 1998; 2002b) of the Type 2 separates the training required of the teacher into the teaching of critical skills, creative skills and caring thinking skills as these characteristics are the three key ones already proposed to be at the heart of intellectual functioning, as outlined in Chapter 2. It needs to be remembered, as the Piirto (1999) model suggests, that differentiated curricula needs to be based primarily on the actual characteristics of gifted students. The Type 2 training sessions in the *Turning World* program were taught in the Graduate School of Education at the University of Adelaide, the Art Gallery of South Australia, and the S.A. School of the Future.

The Type 3 learning in the Renzulli Triad is designed to engage the students for a significant part of the enrichment program (approximately fifty percent of the time) in small group or individual, active learning experiences related to 'real world' problems. In the *Turning World* program more than fifty percent of the time was spent on Type 1 and Type 2 teaching and learning. As final projects were not required in this program, the Type 3 activities were of a shorter duration than those proposed by Renzulli and took the form of 'investigations' rather than long-term problem solving exercises. However, Renzulli's directive that the most important feature of Type 3 should be the term '*real* activities', was certainly fulfilled by the principles of the *Turning World* as the major art works studied are unique to the collection in the South Australian Art Gallery. These are paintings the students can return to at any time and which are owned and displayed as a part of their local community and culture.

In order to cater for the differing 'types' of abilities, as outlined in Gardner's MI Theory, and to plan activities at differing 'levels' across the spectrum of higher-order thinking skills as outlined in Bloom's Taxonomy, the Type 3 investigations were designed using a grid as set out in Table 4.1 below

TABLE 4.1:The Bloom/Gardner Grid
Type 3 – Individual and Small Group Investigations

MI (Types) / Bloom (Levels)	Verbal/ Linguistic	Logical/ Mathe-matical	Visual/ Spatial	Inter-personal	Intra-personal
Remember Know					
Understand					
Apply					
Analyse					
Evaluate					
Create					

The kinesthetic, musical and naturalist components of the MI theory are not incorporated into this grid, as they were not a focus of this program. In addition to the Bloom/Gardner grid, more general activities were designed around the Thinkers Keys, which were first designed by Ryan (1990). The keys were used across Types 2 and 3 activities as shorter enrichment and training activities to support the larger program.

Piirto has indicated that a differentiated curriculum should be based on the characteristics of gifted students. Chapter 2 concluded with the author's outline of gifted characteristics as those comprising the critical, the creative and the caring thinking skills. Consequently the Renzulli Triad has been modified to incorporate the full range of differentiated curricula models and principles, based on an assumption that the critical, creative and caring intelligences need to be trained, and that both *type* and *degree* of intelligences need to be catered for. This modified design is reproduced below in Table 4.2:

TABLE 4.2: The Renzulli Triad Adaptation

Type 1 – Exposure/Immersion	**Type 2 – Training**
General Exploratory Activities Galleries, museums, film, videos, newspapers, books, poetry, concerts	**Critical thinking skills:** Describing attributes Point & Line to Plane exercises Guiding Thoughts exercises Comparing, contrasting, categorising Graphic organisers Methods of inquiry, data collection, the internet **Creative thinking skills:** Analogies Synectics Janusian thinking PMI training Thinkers Hats Thinkers Keys Brainstorming techniques **Caring thinking skills:** Affective: Feelings Valuational: Values Active: real outcomes Normative: the ideal and the realistic
Type 3 – Individual,/ small group investigations Student activities based on the Bloom/Gardner grid to provide differing *levels* and differing *types* of investigations.	

The specific examples of the Type 1, 2 and 3 teaching and learning experiences which constituted the design of the *Turning World* program are outlined in the next section.

4.4. The Design of the *Turning World* program

"At the still point of the Turning World ...
at the still point, there the dance is ..."
T.S. Eliot: Burnt Norton

As stated at the beginning of this chapter, the *Turning World* program operated on similar principles to the *Palace of Wisdom* except that the focus was more specifically on visual thinking, visualisation, and visual art appreciation. In addition, the teaching was almost exclusively done by the author, while the *Palace of Wisdom* utilised the teaching expertise of a range of university lecturers at the Flinders University of South Australia.

Based on the general theme of 'Perception' which the *Palace of Wisdom* also utilised, the *Turning World* program was designed to teach the students the following:

- critical thinking
- visual thinking
- creative writing
- mathematical/spatial thinking and problem solving
- artistic/spatial thinking and problem solving.

The content of the program focused primarily on visual art forms but also linked this study with some poetry, as well as a short story. Many of the lessons utilised the principles outlined in Hamilton's (1989) program, *Picture Thoughts: Critical Thinking Through Visual Arts*.
The students in the *Turning World* program also attended the S.A. School of The Future for two of the sessions where they were introduced to the *Working Mathematically: Space* program. This program involved visual mathematical problem solving using an interactive CD Rom/Computer program. No previous experience with either computers or CD Rom was required of the students. Interested teachers and parents were invited to be present during all of the classes over the ten weeks.

A summary of the major Type 1 (enrichment and exposure) and Type 2 (extension, training) activities from the *Turning World* program, based on the Renzulli Triad Model, is reproduced in Table 4.3 below. The actual details of the content are presented in the following section.

TABLE 4.3: Summary of Type 1 and 2 Activities

Weeks 1 & 2	**Weeks 3, 4, 5 & 6**
Type 1 – Orientation, Exposure & Immersion: Viewing and discussing artworks in the Art Gallery of S.A. Specific focus on the following paintings: *Fish Catch Sydney Harbour,* *The Pinch of Poverty,* *Coco* Poetry: *The Prologue: The Canterbury Tales* by Geoffrey Chaucer (read in the original Middle English) *The Love Song of J. Alfred Prufrock* by T.S. Eliot	**Type 2 – Training:** **Critical Thinking:** Hamilton's *Guiding Thoughts*: Critical Thinking using Visual Arts Art works used: *The Pinch of Poverty, Coco* Point, Line and Plane exercises based on Kandinsky's principles Art works used: *Fish Catch* *The Pinch of Poverty* Mathematics/Spatial: *Working Mathematically: Space* **Creative Thinking:** Analogies Synectics/ dialectical thinking Janusian thinking Creative visualising Visual questioning Thinkers Keys: the *Brainstorming* and *Reverse Keys* Art works used: *Hilda Welcomed,* *The Anrep Family* Poetry used: *The Love Song of J. Alfred Prufrock* by T.S. Eliot *Fern Hill* by Dylan Thomas *The Door* by Miroslav Holub **Caring Thinking:** Values, Feelings, Active, Normative: Art works used: *Boy with Tyre* and *Cottonworkers* Story used: *Loo-Wit the Firekeeper* Poetry used: *Love Song of Prufrock*

Summary of Type 3 Activities:

In order to work at the Type 3 stage, the students were required to complete the activities designed around the Bloom/Gardner grid. Some of the key activities and investigations are summarised in Table 4.4 below using specific examples from the content of the program, based on MI *kinds* of intelligence, aligned with the differing *levels* of thinking from the revised Bloom's Taxonomy. Five of the eight intelligences as outlined by Gardner (1997) which the *Turning World* focussed on were: verbal/linguistic (utilising poetry and story); logical/mathematical (the Working Mathematically: Space program); visual/spatial (featuring art works in the Art Gallery of S.A. and reproduced paintings from Hamilton's program); interpersonal (utilising art works in the Art Gallery of S.A.) and intrapersonal (featuring poetry and art).

The Musical, Kinesthetic and Naturalist investigations have not been reproduced in this grid as they did not have the degree of focus as the others, although all three were incidentally incorporated as part of the *Turning World* program. For example a standard format for the teaching of the *Turning World* was to conduct the training (Type 2) in the Graduate School of Education for the first hour, then complete the activities (Type 3) in the Art Gallery for the remaining two hours. In the Gallery students would complete their work in small groups by interacting directly with the artworks, walking from one painting to the next to select out the most appropriate. In this way the Kinesthetic mode of learning was definitely utilised as there was a constant physical movement and interaction with the works across all the differing sections of the Gallery.

Each activity is generally attended by a visual exploration. Where activities require the students to 'find a painting', it is assumed that this activity is taking place in the Art Gallery.

Table 4.4 below summarises the basic design of these Type 3 activities. This table provides a general 'map' of the investigations while the specific content is presented in section 4.5 to follow.

TABLE 4.4: Type 3 Individual & Small Group Investigations (Weeks 7 - 10)

MI (Types) / Bloom (Levels)	Verbal/Linguistic Chaucer: *Prologue to Canterbury Tales*	Logical Mathematical *Working Mathematically: Space*	Visual/Spatial Hamilton's Visual Arts: *Boy* and *Cottonworkers*	Interpersonal Art Gallery of S.A: *Anrep Family* and *Hilda*	Intrapersonal T.S. Eliot's: *Prufrock*
Remember/ Know	From the tape, prepare a recitation of the Prologue in Middle English.	In 3D Constructor: reproduce one image using three colours	Identify the dominate points. lines and colours in each painting	Identify each scene to others in the group especially form and colour	Prepare a recitation from your favourite section of Prufrock.
Under-stand	Describe the time of year, the setting, the characters and the nature of the journey. Find a painting with a setting which would be an ideal backdrop to the Prologue	Using transformation: make a mirror image of one shape you have reproduced in 3D. Describe how you did this in your Journal.	Describe how the use of point, line, plane and colour reflect the tone of each painting. Find a painting of the boy and explain your selection to the group	Describe the relationship between Hilda and her family with Mrs. Anrep and her family. How do the lights/colours tell the story of each family.	Which features of Prufrock indicate he has problems with his own self-esteem. Find a painting where the protagonist looks insecure or frightened.
Apply	Apply your understanding of the pilgrimage to some modern-day equivalents. Find paintings which depict quests of a different kind	Animate your design in the 3D. In your Journal indicate how the animation could be varied.	Cut out similar images from newspapers. Find paintings which depict enslavery or isolation.	Write comments from one person to another in each painting. Draw 'sacré conversation' lines over copy of each scene.	Find images in the media which look most Prufrock as you imagine him. Where is Prufrock? Find a painting of him in the Gallery.
Analyse	Analyse the differences between the poem in Middle English and the modern translation. Compare two paintings which represent an ancient and a modern journey.	Rotate and view your design from all different sides. In your Journal describe how it should look from above and below.	Compare/contrast dominant forms and colours in these paintings with two other art works in the Gallery.	Compare/contrast different family lives and relationships. Find two different paintings which represent Hilda and Mrs Anrep or women stereotypes	Indicate in what ways are you like or unlike Prufrock. Where are you? Find a painting of yourself which shows a feature of yourself as outlined above.
Evaluate	Evaluate the effectiveness of the lyrics, the visual images and the use of metaphor. Find one painting which shows the 'drout' metaphor. Find one painting of 'Aprile'.	Judge the best angle from which to construct your design In your Journal write how you achieved this.	Evaluate the different uses of colour and their links to the differing themes in each work. Find an energetic and a still painting.	Prepare a 5-min talk on aspects of modern life which may lead to family alienation.	Prufrock is a painting: indicate which colours would dominate the canvas and why. The mermaids did not sing: find a painting that explains why.
Create	Modelling the tone, the time setting and mood of the poem, write your own poem about 'setting out'. Make a paper-cut motif suitable for the dustcover of the Prologue.	Design, rotate, and animate your own original design. In the journal write a descriptive narrative to accompany your animation.	Modelling the dominant points and lines of each painting, make a non-objective paper cut of each. Design a poster to show problems of dislocated groups like refugees	Record a phone message from Mr Anrep explaining why he will be late home. Make a paper-cut of Hilda's homecoming.	Write your own similes/metaphors for a sunset, a fog, a hero, the ocean, the passing of time. Make a paper-cut of how you would feel 'in the room'.

4.5. Content and delivery of the *Turning World*

As the basic design of the TW has been established, this section will now provide the details of the content and delivery of this differentiated program. This section is not designed to 're-create' a teaching/learning experience such as this as that would be impossible however a summary of the essential features along with some examples from the student workbooks have been presented.

Type 1: Exposure and Immersion, Weeks 1 & 2

The first two sessions of the *Turning World* program involved visits to the Art Gallery of South Australia. It was interesting to note that, when asked, approximately half of the class indicated that they had never visited the Art Gallery before. This observation has been made with every other class which the author has held in the Art Gallery over a period of fifteen years. It is in keeping with the earlier observation in this thesis, which is that education in general does not value visual thinking. It is noteworthy that a free, public institution with a wealth of visual resources to offer, is rarely accessed by schools and the wider community.

On the very first visit, no specific artworks were selected for study. The author took the group on an orientation tour to familiarise them with the differing galleries and the general layout and design of the Gallery. The students were then allowed, either individually or in small groups, to freely select and discuss works of art (including the installation art and photographs) and indicate to the rest of the class the reasons why these pieces interested them. Open worksheets were provided to give some structure to this activity. The students recorded their choice of interesting works and wrote a brief summary outlining what interested them before verbally sharing this with the rest of the class in front of the artwork itself.

Students selected works across the whole spectrum of the individual galleries in the Art gallery of South Australia from the early European, Colonial Australian, Contemporary and Modern Australian, Contemporary and Modern European including the Impressionists, Traditional and Modern Aboriginal art through to the Modern abstract, non-objective, installation and photographic works. Artworks depicting a 'storyline' or a realistic scene were most commonly chosen by the students.

On the second visit the students were directed to examine and discuss three specific works which this author had selected as the basis for their Type 2 learning. The key works initially chosen (which are all acquisitions of the Art Gallery of S.A.), were 'The

Pinch of Poverty' by T.B. Kennington, 'Coco (the artist's youngest son, Claude)' by August Renoir and 'Fish Catch and Dawes Point, Sydney Harbour' by John Lewin.

For the purposes of discussion and clarification, these art works have been scanned into the text of this chapter. In order to accurately outline this enrichment program, it was considered important to show the content of the program, especially the visual art examples.

The initial Type 1 exposure in the Art Gallery was to familiarise the students with the works. These works will be discussed in more detail in the following Type 2 Section which engaged the students in active exploration of, and training in visual thinking based on the paintings.

In the first two weeks the students were also exposed to two of the three works of literature selected for study in the program. The very first reading was the *Prologue to The Canterbury Tales* by Geoffrey Chaucer (week 1) and the second was *The Love Song of J. Alfred Prufrock* by T.S. Eliot (week 2). Recitations of these works were given by the author, with the Chaucerian poem presented in its original middle English. A translation into modern English was provided as a point of discussion and comparison between the two. The discussion on the Chaucerian work initially focussed on the general theme of 'setting out' on a new journey of discovery and the students were reminded that they were also setting out on a new journey in the *Turning World* program. In addition, discussions centred on the differing 'sounds' and 'movements' between the original middle English version and the translation into modern English.

The students were given an audio tape of the first section of the Prologue and encouraged to learn, in their own time, a brief recitation (in middle English) from the poem to recite to the class over the following weeks. This aspect of the *Turning World* also features in the *Palace of Wisdom* videotape where a student is recorded presenting a recitation to the class in only the second week of the course. The students were not required to learn a recitation yet many chose to do so. The principle behind this exercise is not just one of 'modelling'. Rather, the purpose was to actively engage the students with the material, to allow them to 'feel' the music in the poem (as opposed to the translation in prose) so that they could then analyse and evaluate the power of such works.

Discussion on the T.S. Eliot poem centred around the nature of the character of Prufrock himself and some of the visual images, specifically the similes, evoked by the poem, such as the evening comparison with an 'etherised patient' and the 'yellow fog' with a cat. Each poem is linked with works of art in the gallery which are set out in the student worksheets.

Type 2 Training in higher-order visual thinking skills – Weeks 3, 4, 5, & 6

Initially, Kandinsky's principle of the interplay between point and line to plane was taught and the students experimented with their drawings (using only point, line and plane), of some core emotions such as joy, anger, peacefulness and loneliness. Examples of these have already been presented in Chapter Three. The students shared and discussed their individual responses, noting the similarities and differences between them.

Type 2 training was divided into the three sections of critical thinking, creative and caring thinking skills. The focus of most training activities was on critical and creative skills however the caring thinking activities were also included.

Type 2 Training: Critical Thinking Skills

The use of point, line and plane was explored through exposure to the selected paintings in the S.A. Art Gallery. John Lewin's 'Fish Catch' was the first painting selected for this purpose. It is reproduced below in Plate 4.1:

Plate 4.1: 'Fish Catch and Dawes Point, Sydney Harbour' by John Lewin (Art Gallery of S.A.)

As a 'warm-up' the students were required to do a point and line representation of this work, taking care not to copy or reproduce any specific forms or images such as a fish tail or fin. Through this activity the students came to appreciate the strong use of the point (which they identified as predominantly the fish eyes) and the fluid use of line, basically the outline of the fish bodies, suggesting strength and even movement in what is essentially a 'still-life' drawing. The use of colour, identified to be vibrant and arresting with the red and silver scales, supported the mood of this painting as one of life and abundance.

Students in general noted that if they had not done a *point and line to plane* exercise on this painting prior to discussing it, they would have dismissed it as a 'picture of dead fish'. The point and line gave them an insight into the language of the form and the colour and allowed a deeper appreciation of such a work.
The point and line exercise provided a natural progression to the *Guiding Thoughts* Exercise as outlined by Hamilton.

As part of the Type 2 (Critical Thinking) training, the students were taught the principles of Hamilton's *Guiding Thoughts*, requiring them to identify, describe, and interpret a work of art and then extrapolate from it. One of the central features of Hamilton's program was to train the students to engage with a work of art at different levels. The *Guiding Thoughts* proforma is reproduced below in Figure 4.3:

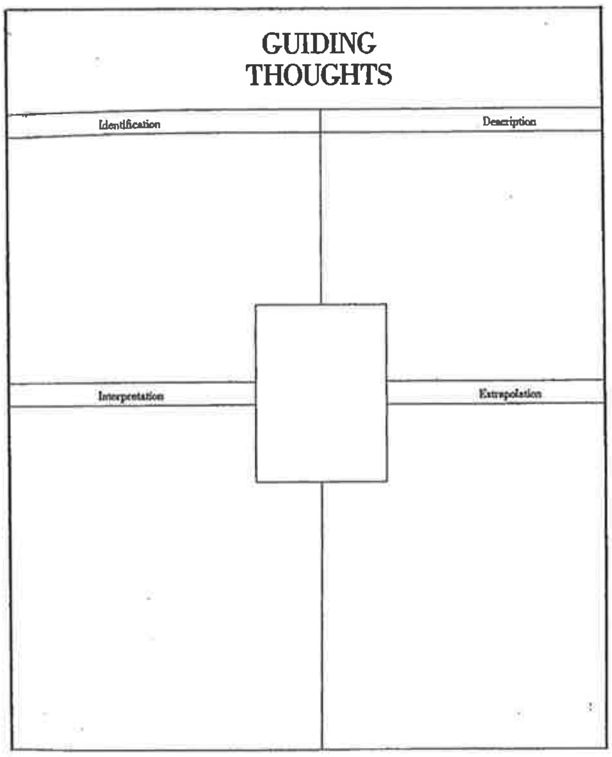


Figure 4.3: Hamilton's Guiding Thoughts Outline

The Hamilton's *Guiding Thoughts* exercise is similar in concept to the Bloom's Taxonomy of a hierarchy in cognitive functioning, and provides the students with a structure to look at art and appreciate a work of art, from the basic *identification* and *description* of artworks to the higher-order insights of *interpretation* and *extrapolation*. The first two stages coincide approximately with the 'know, understand, apply' levels of the Blooms taxonomy, while the second two stages relate more to the 'analyse, evaluate and create', stages.

The 'Identification' stage of *Guiding Thoughts* requires the students to name things they can see in the picture or to identify things that fit into specific categories, such as colour, animate/inanimate, natural features or made by humans.
The 'Description' stage asks the students to "look at the items in a picture in relationship to each other and to consider size, colour, shape, and placement. Through this process, students see the subject of a picture as it relates to its surroundings, which are limited by the frame or the artist's perspective"(Hamilton, 1989: 19).

The 'Interpretation' stage takes the students deeper into the art work to questioning which requires the students to:

> *Note the effects that people and objects are having on each other*
> *Predict conversations that people and even animals might be having with each other*
> *Discuss the season of the year, the geographical setting, the time of day, or the period of history that the painting portrays*
> *Compare and/or contrast any of these aspects with those of another art work in the gallery*
>
> *(Hamilton, 1989: 19).*

The final section of the *Guiding Thoughts* model, the 'Extrapolation' from the artwork, is the most difficult exercise required of the students. Hamilton has outlined extrapolation as basically 'going beyond' the frame to look at a painting: "Carefully formulated extrapolation questions will cause imaginations and thinking powers to soar as students jump beyond what they *see* to think about *what might be*".
Hamilton gives examples of extrapolation type of questions as:

> *What if some items were not in the picture?*
> *What if the picture were of a different season, setting, historical period, or time of day?*
> *What if you could talk to the artist about the circumstances that motivated him/her to produce the picture?*
> *What would it be like if you were in the picture?*
> *What could you see if you could extend the picture beyond the limits of the canvas, or the frame?*
>
> *(Hamilton, 1989:19)*

In addition, the author extended the extrapolation stage to raising questions such as: Do you think the artist had any particular reason for painting this? How do you think he/she was feeling at the time? Was the artist trying to make any social commentary or explore any particular human emotion by painting this picture?

The first painting selected for a *Guiding Thoughts* exercise in the S.A. Art Gallery was T.B. Kennington's "The Pinch of Poverty", reproduced below in Plate 4.2. This painting was selected by the author for its 'ease of access' to relatively untrained eyes, as it so clearly 'tells a story' to the viewer. It is also a very large canvas (167.6 x 148.5cm) and allowed for easy whole class access, before the smaller group work began.

Plate 4.2: 'The Pinch of Poverty' by T.B Kennington (Art Gallery of S.A.)

Prior to engaging in the *Guiding Thoughts* exercise, the students were encouraged to note the use of point, line, plane and colour in this artwork. It was agreed that key points were represented by the faces, especially the baby's milk-white round head and the smaller round of the yellow daffodils (a point indicating hope and new life) as opposed to the harsh, domineering, black/grey lines of the fences and buildings in the background, representing darkness and even imprisonment in a desperate condition of life.

The *Guiding Thoughts* exercises done by the students in general arrived at the observations shown in Table 4.5:

TABLE 4.5: Guiding Thoughts Exercise: 'The Pinch of Poverty'

GUIDING THOUGHTS: The Pinch of Poverty	
Identification	**Description**
It is a painting of a poor woman with a baby and two young children. They must be begging because the young girl is trying to sell a daffodil. From the design of their clothes and the buildings, it looks like the painting is set in the 1800's in an English city.	The faces of the woman and children are sad and they look tired and hungry. Although they are probably as well-dressed and respectable as they can be, their clothes and shoes are ragged and torn. The weather around them looks to be wet and cold. The buildings look dark and the big fence which the mother is leaning against is dark and shiny with the wet. The girl has a look of hope on her face that she might sell a flower, but it is a sad look.
Interpretation	**Extrapolation**
The harsh, dark lines of the fence seem to suggest the exclusion of this poor family from the wealth beyond the fence as well as perhaps symbolising the locking of them into their state of poverty. The heavy vertical and horizontal lines of the fence and the box-like, lavish buildings in the background, contrast with the simple rounded head of the sleeping babe (a central *point*), emphasising her vulnerability in a cruel landscape. Similarly, the rounded shape and the bright yellow of the daffodil (another key *point*), especially with the colour yellow representing life, sunshine and happiness, contrast with the dull, cold wet colours and lines of the environment surrounding the family. Hope is there, but it is fragile and seemingly overcome by the surrounding conditions.	The artist might have been wanting to make some social commentary by painting this picture. The fact that the woman appears to be alone and destitute suggest that she does not have the support of a man which was so essential to women at this time in history. A further extrapolation might be that society is to blame for allowing conditions to develop whereby the rich can flourish with grand homes, fences and gardens while the poor perish. Despite the obvious 'pinch of poverty' stamped onto this family, there is a dignity, in the face of hopelessness, which the painter has captured. Perhaps he also wanted to make a comment on the strength of human beings, even in adversity.

The students found that the *Guiding Thoughts* exercise gave them a framework for viewing and relating to the paintings. The *identification* and *description* stages were necessary to any high-order *interpretation* or *extrapolation* and so were no less important. The initial point and line exercise forced the students to look at line and form in the painting rather than just the 'storyline' and this enabled the deeper interpretation and extrapolation of the painting. Just as understanding the techniques of scansion allows for a deeper appreciation of the form and meaning of a complex poem, so too the point and line exercise helped the students engage in a higher level of critical analysis and evaluation of the artworks.

The second work selected for a *Guiding Thoughts* exercise was Renoir's painting 'Coco' which is reproduced below in Plate 4.3. This painting was selected from other works in the S.A. Art Gallery because it was a step further away from the sharply realistic portrayal of a 'story' in form and colour which the 'Pinch of Poverty' provided. While not being 'Impressionistic' in the true sense of the word, 'Coco' is a suggestive painting yet with identifiable images and characteristics.

Plate 4.3: 'Coco – the Artist's youngest Son, Claude' by Auguste Renoir (Art Gallery of S.A.)

The *Guiding Thoughts* observations which the author and students collectively arrived at are summarised below:

TABLE 4.6: Guiding Thoughts Exercise: 'Coco'

GUIDING THOUGHTS: Coco	
Identification	**Description**
It is a painting of a young boy, Renoir's son named Claude but nicknamed 'Coco".	The little boy is sitting side-on, playing with something in his hands. His gaze is focussed on the activity. He has shoulder-length golden hair with a red bow and a matching red jacket. Coco looks more like a girl. His skin is very white. The painting is a back view of him and his hair dominates the centre of the frame, being red/copper/gold and with the bright red ribbon on top. There is a warm soft light on him which looks like sunshine. His jacket is a very strong orange/red colour. He is looking down slightly and seems to be focused on something in his hands. We can't see his face clearly.
Interpretation	**Extrapolation**
This is a warm and peaceful painting. The colours of red and gold which dominate the painting seem to reflect the feeling of youth and beauty which this painting exudes. The brushed lines suggest the artist was working quickly. It is likely he had very little time to paint this as the young boy was no doubt quite active. The green backdrop to the frame suggests new life and youthfulness: it could even be new grass.	Coco may have been privately absorbed in play while the painting took place. It is almost as if the artist's presence was unknown to him. The atmosphere of the painting is like a snap-shot of a brief moment in the father and son's life. In the Impressionist style, the painter seemed to want to convey a feeling from a moment in time and there is much joy in this moment. From the light it could be summer: warm and golden. From the tones and texture we could extrapolate that the artist had a close loving relationship with his son. This was a painting done in love, not anger. The artist probably enjoyed painting this.

These two paintings (the 'Pinch of Poverty' and 'Coco') have been outlined here as just two examples of the content and delivery of the *Turning World* program. Some other exercises are outlined in the *Turning World* Worksheets reproduced in Appendix 3. The Critical Thinking skills taught were the *Guiding Thoughts* and *Point, Line to Plane* exercises as these are designed to take the students to a higher-order view of, and interpretation of the art works. As the enrichment model for Type 2 has indicated, training is not just in Critical Thinking but also in Creative Thinking skills. The following section details the training program based more precisely on creative thinking principles.

Type 2 Training: Creative Thinking

Training in creative thinking skills crossed over all sections of the *Turning World* program, but some artworks in the Gallery were selected especially to instruct the students, through a visual medium, in principles of original, fluent, flexible and elaborative interpretations of the visual art. In terms of instructing the differentiated curriculum the four elements of creative thinking have been the most useful:

1. *Fluency*: designed to encourage the flood of ideas, the generation of many responses to a work of art.

2. *Flexibility*: designed to provide opportunities for the students to look for 'another way' of viewing or conceptualising the artwork.

3. *Originality*: designed to encourage and value the production of new ideas: The students were required to create novel responses to, or outcomes from the artworks and

4 *Elaboration*: designed to provide opportunities for students to build upon or to extend from an original work of art to a potentially new idea.

The following Table 4.7 summarises some of the activities designed to train creative thinking in this section of the *Turning World* program. The categories of fluency, flexibility, originality and elaboration are set out as examples of some of the Thinkers Keys used, particularly the Brainstorming (fluency), Reverse (flexibility), Invention (originality) and Interpretation (elaboration) Keys. These creative training activities were not initially linked to specific artworks but designed to allow the students to select and explore their own examples from any section of the art gallery.

TABLE 4.7: A summary of Creative Thinking activities

CREATIVITY / THINKERS KEYS	FLUENCY	FLEXIBILITY	ORIGINALITY	ELABORATION
BRAINSTORMING KEY PMI (Plus, Minus, Interesting)	List all of the things which you can lose: Find paintings which represent something now lost.	Find as many paintings which ask or answer the question, When?	Find as many different ways of representing movement and light in the artworks. Identify paintings which have found a new way.	Find as many paintings which depict the sustaining of life. The Thylacine has been cloned : Do a PMI
INTERPRETATION KEY (Analogies: comparing, contrasting)	Find paintings which reflect the themes of isolation or enslavery.	Select a painting which represents energy: Give it a new title. Explain why you chose the title.	Provide new titles for five artworks in the gallery. Be prepared to justify your choice of new titles.	Using only point and line depict 'freedom': find an artwork which best reflects your sketch. Explain why you selected the artwork.
REVERSE KEY (Synectics, Janusian, oppositional thinking)	List all of the things you could *never* lose: Find paintings which represent something which you could never lose.	The answer is 'Isolation': Find an artwork which asks the question.	Find a painting which gives you a new way of looking at the sea. Find a painting which is the opposite of freedom	Is there something a painting could *never* express? Identify two paintings which represent opposite views of the world.
INVENTION KEY (Original, novel ideas or outcomes)	Find as many artworks which represent fish in different ways.	Artworks in the gallery are generally on canvas. Suggest different mediums which could be used. Find examples in the gallery	In the Aboriginal art section identify some traditional symbols, e.g. … for women and for kangaroos: Invent some new ones to represent important things in your life.	Write the dialogue between two characters in your selected painting. Create your own visualisation by walking into a painting such as Battersey Park. Describe your journey through this painting.

Under the general guideline of Type 2 Creative Thinking activities, two artworks were selected by the author for a comparative study. These works were selected because they were appropriate for a creative study of analogies and synectic images. The works are, *"Hilda Welcomed"* by Stanley Spencer, and *"The Anrep Family"* by Henry Lamb. Both artworks are in the Art Gallery of S.A.

The first, 'Hilda Welcomed' is reproduced in Plate 4.4 below:

Plate 4.4: 'Hilda Welcomed' by Stanley Spencer (Art Gallery of S.A.)

This painting was selected for study because of its dominate use of point and line (the rounded cubist bodies and the surrounding lines of arms and wrapped skirts) and its almost fauvist use of bright colour and light.

After spending time just viewing the painting, the students were required to do a point and line representation of the artwork and to also note the use of colour. This point and line activity was conducted prior to the *Guiding Thoughts* exercise in order to focus the students on the visual representation of form and colour, rather than the 'storyline' which could be read from the painting.

In general the point and line representations of 'Hilda Welcomed' were of flowing, swirling lines, generally with a dominant circle or point (representing Hilda herself) in the centre, with smaller points (representing family heads, eyes, and spots of colour on the skirts and walls) around the centre.

A typical point and line representation of 'Hilda Welcomed' is reproduced below in Figure 4.4

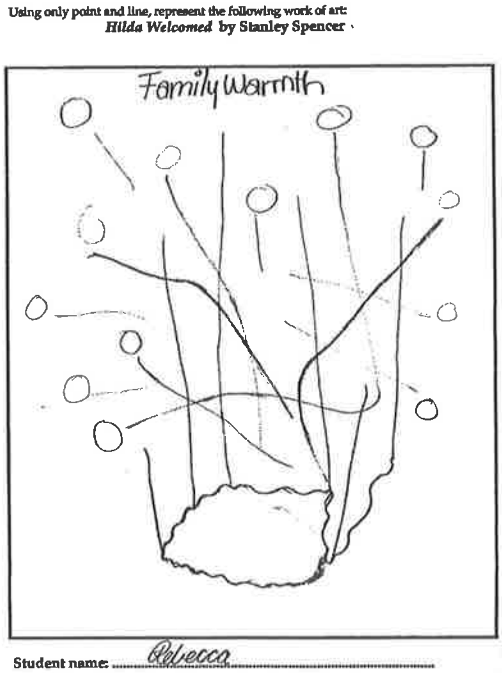


Figure 4.4: Point and Line Representation of 'Hilda Welcomed'

In addition to form, students were asked to comment on the use of colour in this painting. Students noted soft green and gold colours with the points of bright red on Hilda's skirt and bright green on her daughters' clothes. They agreed that these were generally 'happy' colours. The students suggested that the artist deliberately connected and crossed over the dominant body lines to suggest love and closeness.

In comparison, the students then engaged in the same exercise with the painting of 'The Anrep Family', reproduced below in Plate 4.5:

Plate 4.5: 'The Anrep Family' by Henry Lamb (Art Gallery of S.A.)

The students' point and line representation of this painting was in stark contrast to 'Hilda Welcomed'. One example by the same student is reproduced below in Figure 4.5. It is interesting to note that in Rebecca's *point and line to plane* exercise, despite the clear directive on the worksheet, she still felt the need to add words:

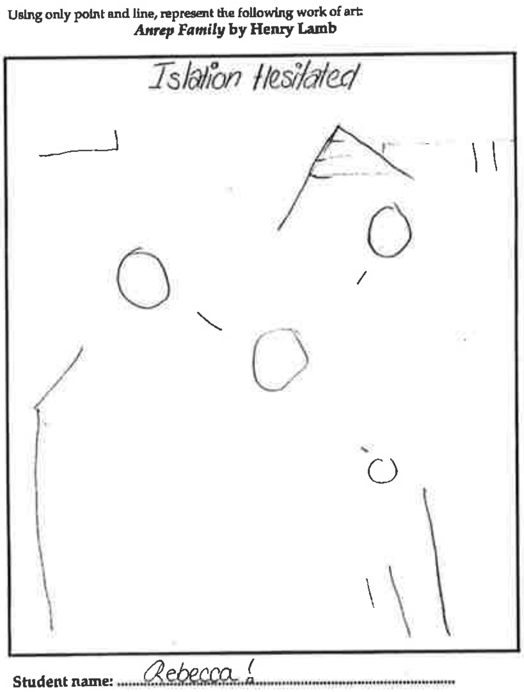


Figure 4.5: Point and Line representation of 'The Anrep Family'

In general the students represented the painting with straight lines, the only points or circles being the four heads of the family members. These points were usually represented as quite separate from each other rather than connected by lines. Many students noted the sharp lines of the ladder and table in the background. They noted the use of black and generally 'dull' colours throughout the painting. Following the figural exploration of these activities, the students set about in groups to complete their *Guiding Thoughts* exercise. All agreed that without the prior point and line exercise they would not have looked so deeply 'into' these paintings. The following Table 4.8 summarises the Guiding Thought exercise on 'Hilda Welcomed'.

TABLE 4.8: Guiding Thoughts exercise: 'Hilda Welcomed'

GUIDING THOUGHTS: Hilda Welcomed	
Identification	**Description**
A woman called Hilda is being hugged by her children and kissed by her husband.	All of the children's arms are wrapped around each other and Hilda. They are holding onto her skirt. There is a lot of green colour on the background wall and the clothes. Hilda's skirt has bright red flowers on it. There is a soft golden sunlight in the room.
Interpretation	**Extrapolation**
The sunlight is washing in from one side of the painting as if Hilda had just opened the door and walked in, bringing the sun with her. There is movement and energy in the embraces. This would have to be a happy, close family and the reunion reflects this.	From the welcome it would seem that Hilda does not go away very often. There is probably a welcoming meal on the table and much news and gossip to catch up on. The colours of the home reflect love and warmth. Hilda's cubist dominant form suggests her essential place in the home and the hearts of her family. She is a powerful central point suggesting maternal strength and stability in the home.

In comparison the Guiding Thoughts exercise with 'The Anrep Family' is summarised in Table 4.9 below:

TABLE 4.9: Guiding Thoughts exercise: 'The Anrep Family'

GUIDING THOUGHTS: The Anrep Family	
Identification	**Description**
A father, mother, son and daughter are in their home with the parents seated and the children standing. Because of the title we assume this is a real family.	Mr Anrep and his wife are both looking away off the frame as if deep in their own thoughts. Only the girl is making contact as she is looking at her father's face and holding onto her mother's hand. The colours are dull and muted and the father is dressed in a very dark black suit. The lines are sharp, vertical and horizontal rather than curvy. There is a ladder and table in the background.
Interpretation	**Extrapolation**
The father is represented as very dominant. His size and large black shape suggest he has a powerful role in the family. His face looks hard. The mother looks sad and cut off. This does not seem to be a family which laughs or kisses very often. The home feels cold. The girl holding onto the mother's hand could almost be a desperate attempt to keep the family connected.	This is probably a family where the father is very busy and successful but not very affectionate or loving. The mother is isolated but she won't leave him because she has a duty as a wife and mother. She is resigned to her role and she would not work outside of the home. That is the man's job. The ladder is a point of interest perhaps reflecting the father's determination to make it to the top regardless of the effect on his family. It is interesting to think how the family felt when they saw this painting.

In summary the students agreed that the muted, soft tones in 'Hilda Welcomed' speak of warmth and love. Cold lighting and isolated figures in 'The Anrep Family' speak of disaffection and separation, lack of communication. Sharp, angular features of the mother and children in 'The Anrep Family' contrast with rounded, cubist, *alive* figures in Hilda Welcomed.

From *form* and *colour*, the students were required to focus on *sound* and *movement* in the paintings. Kandinsky's proposals, outlined earlier in this thesis, that the interplay of point and line within the frame will resonate sound and movement, was presented to the students by returning to their earlier point and line representations of energy, anger, joy and peacefulness. As the creativity section incorporated poetry, with its analysis of sound and movement, it was important at this stage to introduce these concepts into an appreciation of the paintings.

When asked to report on sound and movement, students agreed that '*The Anrep Family*' was a 'still and quiet painting'(most also said it was 'cold'). In contrast the wrapping, grappling of arms and hands holding onto Hilda attested to movement and sound (and 'warmth'). The students agreed that 'Hilda Welcomed' was a 'noisy' and 'active' painting. Engaging the students in further analogies they were then asked to compare the two paintings directly.

In summary they noted, particularly from the point and line exercises, the waving, crossing, fluid lines of 'Hilda Welcomed' as opposed to the short, straight, cold lines of 'The Anrep Family'. The students interpreted and extrapolated much from these paintings, agreeing that the former is a representation of love, warmth and joy emanating from a connected family restored to each other whilst the latter was one of coldness and disaffection.

Although form (i.e. point, line, plane) was the focus, colour was certainly part of the visual explorations made in the *Turning World* program. However the actual use of colour (e.g. watercolours or oils) in response to artworks was not a practical option as art facilities were not available in the Graduate School of Education.

The students in the *Turning World* were introduced to the artistic expression of paper-cuts, a technique perfected by Matisse, particularly with his 'Dancers' and 'Cirque' series. These works were studied by the students and they spent time in the gallery finding examples of similar use, particularly examples from the work of Australian artist John Coburn whose work so clearly shows the influence of Matisse and his paper-cuts. After a short lesson in colour and the art of paper-cutting by an accomplished artist and colourist (Flood-Evans, 1996), the students were asked to reproduce a point-and-line representation of 'Hilda Welcomed' using paper-cuts:

Plate 4.6: 'Hilda Welcomed' paper-cut

In contrast, an example of a paper cut representation of 'The Anrep Family' is reproduced below in Plate 4.7:

Plate 4.7: 'Anrep Family' paper cut

Following the *point and line*, the *Guiding Thoughts* exercise and the paper cuts the students were required to represent in words, the essential differences in the paintings. At this stage in the *Turning World* the analogy between art and literature was made with the study of the poem *'Fern Hill'* by Dylan Thomas. Through Fern Hill's fluid, almost stream-of-consciousness method of writing an exploration was made of the links with the two paintings. Students noted both the movement and colour images and agreed that it was impossible to recite this poem slowly as this brief extract shows:

"Now as I was young and easy under the apple boughs
About the lilting house and happy as the grass was green,
The night above the dingle starry,
Time let me hail and climb golden in the heydays of his eyes …"

The students were then taught to note that the physical or visual representation (i.e. the *shape* and not just the *sound*) of written lines can equally reflect the intent of the speaker or the poet, for example long flowing lines of words as opposed to short statements. The lyrical quality of poems is not just in the juxtaposition of sound but also in the physical structure of the lines. As Cowie (1991: 5) has stated" There are obviously relationships between the long line, the long sentence, and the lengthy musical phrase …".

Following the study of 'Fern Hill' the students were required to work together in groups to produce a short piece of writing based on the two artworks. Two opening phrases were given in their workbooks a stimulus for student writing:

Hilda is home ...
and
My Father is a good man...

In small groups the students wrote their responses to each painting. The collective responses were then merged into a group response, edited and reproduced below:

'Hilda Welcomed':

Hilda is home and the sun is shining and everyone is laughing and kissing and singing and the arms around Hilda are warm and tight and Dad is crying and kissing her and the walls of the house are now shining with the smiles and the sighs and there is music and colour once again because Hilda has come home.

'The Anrep Family':

My father is a good man. He works hard for us. He stays long hours in the office. We try not to distress him. We try to keep quiet. He doesn't sleep well and worries. Of course I love him. He is my father.

Following the colour analogies which emerged in a study of the paintings, the students were introduced to the concept of analogies in words. The power of paradox and conflict in writing was incorporated into the students' workbooks and they discussed responses to questions such as:

Which is thinner, red or yellow?
Which is thicker, love or hate?
Which is greener, joy or unhappiness?

From the movement, sound and colour images which flow from 'Fern Hill' analogies were made with the colours and sounds of 'Hilda Welcomed' and 'The Anrep Family'. The students worked on extending the written response to 'Hilda Welcomed' so that it incorporated more colour, movement and the flowing stream-of-consciousness approach which the painting reflected so well. The students also agreed that there was not only colour and movement in this painting but also sound. While the following outcome might, in literary terms be judged as "over the top" (Mem Fox, 1996: *pers com*) by an accomplished writer, the essence of stream-of-consciousness writing is evident:

> *Hilda is home and the sun is yellow and singing and everyone is green and happy and laughing and cherry kisses float in the orange sunlight and the chirping and cheering with the dancing and hugging to the music in our heads and the ringing in our hearts because Hilda is home again.*

Type 2 Training: Caring (Social and Emotional) Thinking

Although the focus of this enrichment program was on the critical and creative intelligences, it was a very natural progression to include activities based on caring thinking skills as so many of the artworks and literature allowed for in-depth study into emotional and social responses to the world.

This section of the Type 2 training relied for structure on the Lipman Inventory of Caring Thinking skills, outlined in Chapter 2. In summary these skills are:
Affective thinking (training in *feelings*)
Valuational thinking (training in *values*)
Normative thinking (training in *ideal* outcomes within *realistic* situations)
Active thinking (training to *act* upon beliefs or opinions).
In order to incorporate both range and levels of training skills, the Lipman Inventory was designed in a grid against the Bloom's Taxonomy. However these activities will not make sense until the content of this section is clarified.

Using the Taxonomy this inventory focussed on training students to:

- *Identify* and understand *Feelings*
- *Analyse* and apply *Values*
- *Evaluate* what is ideal yet realistic or *Normative* and
- *Create* or design, *Active* outcomes in the resolution of a problem.

The use of analogy, as outlined in the previous section on creativity also served as a guideline for this section.
The use of visual and verbal analogy was then extended to the study of the poem 'The Love Song of J. Alfred Prufrock'. The students were required to complete a 'personal analogy' exercise asking them to consider how they are 'like' or 'unlike' the character of Prufrock.

Two examples of the student response to personal analogy are represented below in Figure 4.6. It is interesting to note how the student has incorporated colour into her analogy in the first example, as well as the degree of introspection which this in-class response engendered:

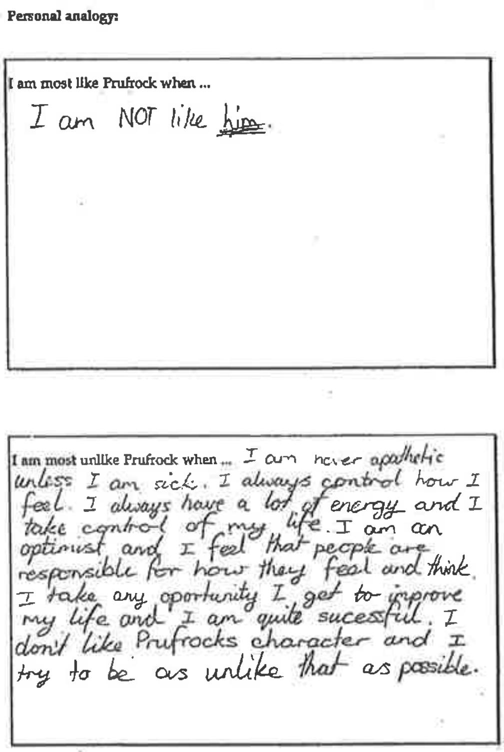
Personal analogy:

I am most like Prufrock ~~when~~ because ... Sometimes I feel like I'm transperant, like every one sees straight through my body. Like my mind is the only thing on this plane of existance, as I've said below I'm a bright gold light, and when I feel like this it's like a lamp shade has been put over my light. I'm afraid that one day someone will totally douse that light, then even if my body isn't dead, I, me, my essence, will be dead, all dull white.

I am most unlike Prufrock ~~when~~ because ... I am not insecure, I am not old, I am not frail. I am very much into laughing (I don't think he laughed at all) I think of myself as a bright golden light, and I think of Prufrock as a very pale gray, almost white and white is dead.

Figure 4.6: Student Response: Personal Analogy 1

A second example of personal analogy is reproduced below in Figure 4.7. This example was chosen as it was written by an outstandingly academically successful student with a very high sense of self-esteem who could not make the 'breakthrough' to find any likeness:


Personal analogy:

I am most like Prufrock when ...

I am NOT like him.

I am most unlike Prufrock when ... I am never apathetic unless I am sick. I always control how I feel. I always have a lot of energy and I take control of my life. I am an optimist and I feel that people are responsible for how they feal and think. I take any oportunity I get to improve my life and I am quite sucessful. I don't like Prufrocks character and I try to be as unlike that as possible.

Figure 4.7: Student response: Personal Analogy 2

This aspect of the *Turning World* program which dealt with the 'caring' or 'social-emotional' thinking skills engaged the students in a range of similar personal analogies, some with poetry and others with artworks.

The content for this section was based mainly on two paintings reproduced from Hamilton's program: 'Boy with Tyre' and 'Cottonworkers'. The main works of literature supporting this section were the poem, 'The Love Song of J. Alfred Prufrock', and the folk-tale, 'Loo-Wit the Firekeeper'.

Although the S.A. Art Gallery provided access to the 'real' and original artworks which were essential to the content of the *Turning World* program, the reproduced paintings from Hamilton's program were also studied and served well as classroom-based art materials. These artworks were used to develop the students' critical, creative and caring thinking skills. The paintings, reproduced on solid board and measuring 90cm x 60cm were obtained by the author directly from Hamilton Associates. Although only three examples are presented here, most of the ten artworks were used at various stages in the *Turning World* program.

The first painting selected was 'Boy with a Tyre' by Hughie Lee-Smith.

Plate 4.8: 'Boy with a Tyre' by Hughie Lee-Smith (Hamilton Associates)

The point and line to plane representation revealed the central point as the tyre, followed by the head and eyes of the boy as well as the windows in the background. Following this exercise the students collectively produced the *Guiding Thoughts* analysis of the painting which is summarised below in Table 4.10:

TABLE 4.10: Guiding Thoughts exercise: 'Boy with Tyre'

GUIDING THOUGHTS: Boy with Tyre	
Identification	**Description**
A boy is standing alone in a street. He is holding onto a tyre.	The boy looks to be African-American kid. His eyes are looking off to something outside the frame. The colours of the painting are pale and dirty. The street is littered and the houses in the background look vacant. The lines of the fence and the shadows are dark and very straight.
Interpretation	**Extrapolation**
The main points are the round of the boy's head and the round tyre. Smaller points are the white of the boys eyes (making him look fearful) and the pebbles littering the street. The landscape, including the buildings in the background look to be empty and totally devoid of life. You cannot imagine people living and eating and laughing in those buildings. The dark shadows and sharp lines of the fence suggest something sinister outside of the frame where the boy is looking.	It might be that the boy is frightened of being bullied or even assaulted by someone or something beyond the fence line. The tyre could represent escape – it is round and originates as a part of cars or trucks or some form of transport. The boy gripping it could suggest the desire to go elsewhere to a place where there is no fear and no discrimination. This painting seems to have a racial message that perhaps the poor black kids are trapped in their condition. He is very alone. Society alienates when it practices racism. The artist probably wanted to make this statement as part of his art.

In comparison the students were asked to respond to the second painting, 'Cottonworkers' by Hale Woodruff. This painting is reproduced in Plate 4.9:

Plate 4.9: 'Cottonworkers' by Hale Woodruff (Hamilton Associates)

Following their point and line representation, the *Guiding Thoughts* exercise with this painting allowed the students to explore in greater depth the essential themes it was communicating and to compare them with the previous work.

The obvious points in this work are the colourful hats of the workers and the white cottonballs themselves scattered throughout the painting. The students' point-and-line representation of this work revealed strong energy lines, swirling and connected. It was agreed that the use of colour in general was to represent warm, fresh new life and energy. The yellows used were the colour of sunshine in comparison to the insipid, lifeless, dirty yellow used in 'Boy with Tyre'.

The students agreed that common elements in both paintings were that they both portrayed a black, probably oppressed and even enslaved peoples. The extrapolation from this work was that despite the poor condition of these people they connected, worked together and no doubt sang together at the end of the day. Although slaves, the energy lines and the use of colour in this painting suggested that in their hearts they were liberated.

TABLE 4.11: Guiding Thoughts exercise: 'Cottonworkers'

GUIDING THOUGHTS: Cottonworkers	
Identification	**Description**
This is a painting of workers in a field. They are digging with hoes. From the title we identify the field as cotton and there are cotton balls scattered all around.	The workers are wearing clothes in bright primary colours and they are swinging the hoes with a lot of movement. They have round, coloured hats on. You can't see their faces and it is hard to even tell if they are males or females. There seems to be bright sunshine. They look like African-Americans.
Interpretation	**Extrapolation**
As these people are black and working in a cottonfield they are probably slaves. The main points in the painting seem to be the coloured hats and the little colours of cotton balls scattered throughout the painting. These points seem to drag our eyes through the painting and to give it lots of movement. There is a central energy line swaying like a wave through the bodies which seem to give them movement and strength. The bright yellow light seems to also suggest vitality and life	Although these people are probably slaves and oppressed by the white people they are connected and powerful together. They make a lot of noise and probably laugh and sing together. Although in chains, these people are free and alive in their hearts and in their community and cultural love and support. The artist probably wanted to make this social commentary as part of his painting.

A study of the Native American Indian folk tale 'Loo Wit the Firekeeper' was included in this section (a copy is reproduced in Appendix 3). This was chosen because of its largely visual symbols and its connectedness to the themes in the artworks studied. Student worksheets directed the students to identify the dominant visual symbols or motifs in the story and make analogies with the dominant themes already explored through the artworks. In summary the students noted the following dominant symbols and themes:

The bridge – peace and communion
Sunshine – goodness
Youth – beauty
The river – a divide
Volcano – anger
The land – possession and dispossession.

The students worked in small groups to engage in the themes of isolation, loneliness, greed, envy, violence and peace. The analogies with the artworks are set out in the summary of some of the Caring thinking activities in Table 4.12 below:

TABLE 4.12: A Summary of Caring Thinking activities

	AFFECTIVE KNOW UNDERSTAND FEELINGS.	VALUATIONAL APPLY/ ANALYSE VALUES.	NORMATIVE EVALUATE THE IDEAL AND THE REALISTIC	ACTIVE CREATE OR DESIGN A NEW OUTCOME OR POINT OF VIEW.
PRUFROCK	How did Prufrock feel 'in the room'? In what situations do you feel inferior or insecure? Select a painting that represents how Prufrock felt.	Why did the bald spot and thin legs matter to Prufrock? What body image is constantly set for you to follow? Find a painting that speaks to you of great physical beauty.	Is it necessary or important for all people to like you? What is bad about being popular? Find a painting that shows great inner strength.	Find the mermaids in the Gallery. The mermaids decide to sing to Prufrock. What would they say? Write the words to their song.
BOY WITH TYRE	Tell the group how the boy is feeling. What physical characteristics of the boy suggest fear? Find a painting of fear.	Return to your 'isolation' artwork in the Gallery: how is it like the boy? In groups brainstorm the human characteristics which lead to racism.	People can no longer be identified by race. Do a PMI.	Create a new title for the painting. Write a letter from the boy to his family back in Africa.
COTTON - WORKERS	Identify all of the feelings you can observe in Cottonworkers. Identify times in your life when you experience similar feelings.	What sounds are in this painting. Listen to the tape, 'Sounds of freedom'. How does it fit the painting? List the values upon which strong communities are based?	All work is a form of slavery: discuss. All people are self-employed – bosses don't exist Do a PMI.	Design some slogans suitable for encouraging local community collaboration in your area.
LOO-WIT THE FIREKEEPER	Identify the main feelings of : The creator Loo-Wit The brothers. Indicate how the feelings changed during the tale.	Find a painting of vanity. Find a painting of greed. Find a painting of freedom. Find a painting of beauty.	Identify all things which you consider beautiful. When could it be bad to be beautiful? All wars are now ended: do a PMI.	Design a symbol of freedom. Re-write the tale but make the brothers, sisters.

Only one Kandinsky painting (Plate 3.1) was incorporated into the *Turning World* program. Although there has been a very strong influence from Kandinsky's work in the *Turning World*, it was not intended that an actual study of his work would constitute the enrichment program. None of his works were actually in the Art Gallery at the time. Plate 3.1 presented in Chapter 3 is copied from Hamilton's reproduction of his painting. What was intended was to use his guidelines, specifically the point and line to plane activities, in conjunction with Hamilton's guidelines, to take the students into a deeper understanding of form and colour to communicate.

Rather than constantly looking for a 'storyline' in a painting, students were trained to look for the abstract representation first, before interpreting or extrapolating from a work of art. Hamilton claimed that abstract artworks, that is those with "little evidence of realism … are often those which cause the most thought"(1989: 17). In addition she cites Phenix (1964) as justifying the inclusion of abstract art in education because, "the transforming power of art can be released by bringing students into the presence of works that do not at once disclose their meaning and by showing them how to view these works sensitively and expectantly" (in Hamilton, 1989: 17).

Before Kandinsky's painting was introduced to the students the painting of van Gogh's 'Iris', which is part of the Hamilton collection was presented for discussion and study. Although 'Iris' is not an abstract work the author used it as a lead in to the students' linking of pure form and colour with message, insight and extrapolation.
Before viewing 'Iris' students were asked to do a *point and line to plane* representation of 'energy'. Common elements of these representations revealed mainly vertical lines shooting up from a base. Edwards (1986) also collected energy analogs and they had a striking similarity, with a central, almost circular base with harsh vertical to diagonal lines seemingly arching beyond the frame as Figure 4.8 reveals:

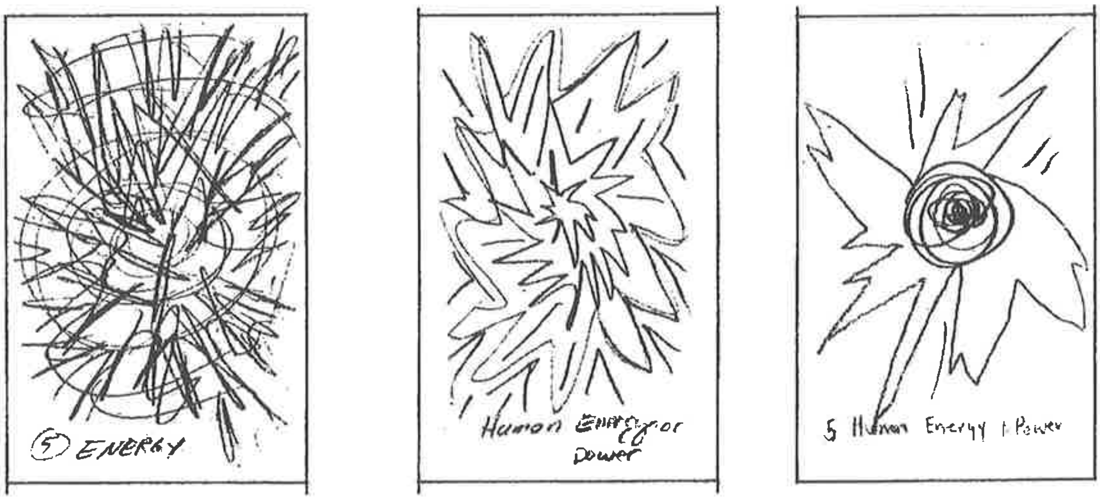


Figure 4.8: Analogs of 'Energy'

It was only after this exercise was completed that the author showed the students the painting of 'Iris' reproduced below in Plate 4.10:

Plate 4.10: 'Iris' by Vincent van Gogh

From the earlier analysis of 'energy' in analog form, the students gained a deeper insight into a painting which most agreed they would normally 'walk past'. The *Guiding Thoughts* exercise reproduced below in Table 4.13 reveals the different levels of engagement in the artwork which the point and line to plane exercise provided:

TABLE 4.13: Guiding Thoughts exercise: 'Iris'

GUIDING THOUGHTS: Iris	
Identification	**Description**
This is a painting of a blue iris growing out of the earth with green leaves and grass around it and some small yellow buds.	Most of the lines are vertical – shooting up from the earth in strong, thick, oily lines.. The blue flower is quite large and is the only blue in the whole painting with the other dominant colours being green and yellow.
Interpretation	**Extrapolation**
The main point is the fragile blue iris but the smaller points of yellow drag our eye through the painting, as if to keep us looking. The powerful, thick brush strokes upwards give great energy to the painting. The iris is not just passively supported by the green earth with its foliage, it is shooting from the earth with its own power. The base at the meeting of the plant with the earth is circular and the lines radiate from it almost like an explosion. The reflecting energy lines from this explosion spread out right up to the frame and seemingly travel beyond it.	This painting was done by a painter who found making and maintaining relationships with other human beings very difficult. He had a great passion for nature. It is possible this painting was therapeutic for him and possibly his way of expressing love. Vincent didn't just want to paint this, he probably needed to.

4.6. Computer graphic explorations: Working Mathematically: Space

This section on creative visualisation was extended by the inclusion of the Working Mathematically: Space program. The visits to the School of the Future took place in the two weeks in the middle of the *Turning World* program as the author did not want to 'lose contact' with the Art Gallery during the more mathematical exploration.

This program was selected as it provided a mathematical/technological exploration to the *Turning World* program, at the same time maintaining the focus on visual thinking and creative production. The students attended the South Australian School of the Future for these two sessions where they had direct access to the technology and the expertise necessary to engage with this material. The authors of the program, Kevin Olssen and Steve Walsh were available to teach the program and other teachers of mathematics from the Mathematical Association of South Australia (MASA) were in attendance as well. The program was designed as a joint project between the Curriculum Corporation, based in Victoria, and the Department for Education and Children's Services (DECS) in South Australia.

Working Mathematically: Space (WM:S) is an interactive CD-Rom based program designed primarily for middle primary through to junior secondary students. However it was selected, not just because of its primarily visual training approach but because it also offers investigations at three levels of difficulty "and in some ways also has the capacity to extend the best of senior secondary students" (Olssen & Walsh, 1996: 6). This made it particularly appropriate for the students in the *Turning World* program who were already functioning academically at the gifted level.

The designers of this interactive package created work environments in which students can explore and record spatially-based mathematical ideas. Students were encouraged to:

- investigate, discuss and describe mathematical situations
- visualise and be creative with models
- conjecture and test views of models from different perspectives
- contemplate, reconsider and extend understanding of mathematical ideas
- generalise from visual images to written text in electronic journal
- become more sophisticated in their use of mathematical language and their ability to apply mathematics in situations of interest or importance.

Using the computer, students 'enter' the program through a simulated theatre where they can select the level of difficulty for their spatial exploration. A representation of this is in Figure 4.9 below:

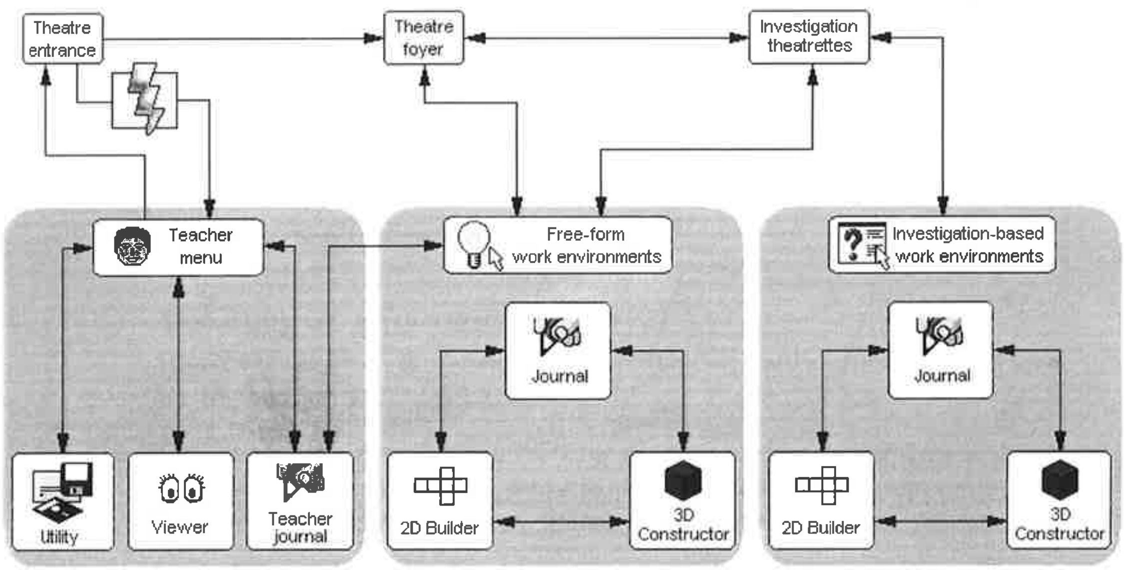


Figure 4.9: The design of WM:S (Olssen & Walsh, 1996:7)

This section of the *Turning World* program linked well with the 'creative visualisation' exercises in front of the various artworks whereby the students were required to 'walk into' the painting and record their journey as a piece of writing. The 'creative visualisations' in the Art Gallery worked best with the more abstract artworks and it always surprised the students as to how similar their written 'journeys' were.

In the WM:S there are 134 separate investigations within the program and they are organised into three different classes: patterns, 2D-3D, and transformations. The three levels of difficulty range from blue (the easiest) through to yellow and red (the most difficult). The students were initially given exercises from the blue level in order to learn to operate the program but then they all progressed to select activities from the red section. Each 'construction' has a section for a journal entry so that the students could explain in writing how they had set about to create their pattern, their 2D – 3D investigation or their transformations. In the Patterns investigations section the students worked on:

Creating and then explaining linear patterns
Building a tower
Designing a mosaic box, and
Designing a cartoon character.

In the 2D-3D investigations students worked on producing their own designs such as:

Designing a 3D mosaic box
Creating an original architectural drawing
Comparing mosaic structures and
Hiding a cube within a 3D construction

In the Transformations investigations the students worked on:

Exploding and imploding a construction
Rotating symmetrical constructions
Animated symmetry
Animated cartoon character
Repeated reflections
Rotations using coordinates

(Olssen & Walsh, 1996: 24 – 25)

The student work created in the 3D Constructor and the 2D Builder was copied and pasted into their Journal. The Journal also had the capacity to run animations created in the 3D constructor "enabling students to present their mathematical work in ways that will make them proud of their achievements"(Olssen & Walsh, 1996: 5).

The information technology revolution has opened opportunities for enhancing the learning environment in schools. The computer provides the vehicle for individuals with the capacity and willingness to learn new ways of thinking creatively. Students use computers to write, to draw, to invent, to communicate, to acquire information. A graphic representation of the differing work environments is set out in Figure 4.10:

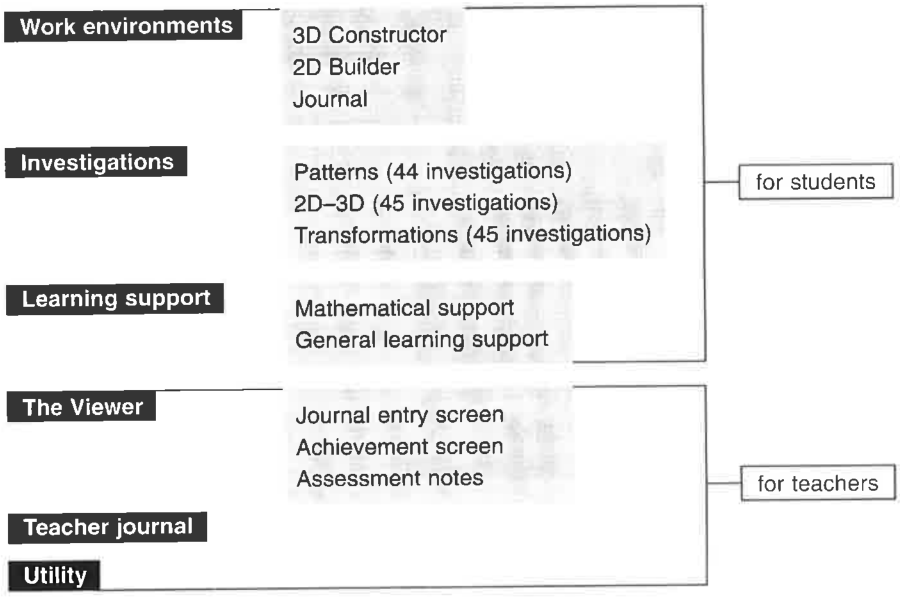


Figure 4.10: Structure of Working Mathematically:Space (Olssen & Walsh, 1996:7)

The creator of *Logo*, Seymour Papert, considers that, "seeing the world through computational concepts leads to insights into familiar phenomena that have no direct connections with computers" (Papert, 1993: 52). When students use the computer to create images, their visual-verbal thinking ability, according to Considine & Haley (1992) is improved.

This section of the *Turning World* program provided the students with a different work environment (The School of the Future) and a new view of visualisation which linked very well to their work in the Graduate School of Education and the Art Gallery.

The following chapter details the more quantitative aspect of this thesis with an evaluation of the measurements of creativity and visual thinking which underpinned this study.

A STUDY OF VISUAL INTELLIGENCE AND THE INFLUENCE OF A VISUAL ENRICHMENT PROGRAM ON MEASURES OF IQ AND CREATIVITY ON 10 AND 11 YEAR-OLD STUDENTS NOMINATED AS GIFTED

VOLUME TWO
(Chapters 5 to Appendices)

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Chapter 5: Measuring Creativity and Visual Thinking: A Critique of Creativity Tests and the Design of the *Figures of Sound* Instrument

Without a conception of virtue, one cannot evaluate anything

(Elliot Eisner, 1985: 5)

[The purpose of this chapter is to analyse some of the traditional tests of creative intelligence and outline the design of the *Figures of Sound* instrument which was designed to identify key markers of visual intelligence and possible links to creativity and giftedness]

5.0. Introduction

Traditionally, creative thinking ability has not been *measured* but rather *observed* through the generation of creative products and evaluated by the dominant culture accordingly. There is not one accepted, standardised test of creative thinking ability. Similarly, visual thinking ability whilst often linked with measures of creativity, does not have standardised instruments available to measure it. This chapter evaluates the effectiveness of tests of creativity, particularly the Torrance Tests of Creativity (TTCT) as they were used in this study. In addition, this chapter details the design and scoring procedure for the *Figures of Sound* instrument which was designed to identify markers of visual thinking ability.

5.1. Measuring Creativity as an Aspect of Intelligence

Creativity is a complex set of abilities and it is reasonable to anticipate that measuring the differing *levels* and *kinds* of creative functioning would be a complex exercise. Colangelo & Davies, (2003: 312) indicated that there is not one simple approach and "recognising creative talent can be based on informal, subjective evaluations by teachers, parents, peers, or the students themselves, or on formal creativity tests or inventory scores".

Although a standardised creativity test served this study well (e.g. the TTCT), the research has highlighted many limitations of testing for creativity. In addition the fact that some creativity tests have been standardised puts them into the category which Gardner (1993: 20) called "psychometric creativity" with the result that few practising classroom teachers utilise them. In the absence of standardised tests of creativity checklists and inventories are becoming popular as a means of identifying creative intelligence. Hunsaker and Callaghan (1995: 113) have identified this move as an outcome of the research confirming the complex nature of creativity and particularly its role in identifying gifted students, predicting "this may tentatively signal that the second generation of thinking about creativity, that of complex thinking processes, is moving into the identification of gifted students."

This 'second generation' may be critical of arriving at a single score for creative behaviours, preferring to identify a range of complex abilities which might be surer indicators. Fishkin & Johnson (1998: 8) indicated that standardised testing for creative ability is only one avenue and indicated the strengths of other measures such as

> *attitude, personality, interest, and biographical measures ... (whereby) ... information about a child's creativity can be obtained from ratings by teachers and others who have had sufficient opportunity to observe the child in situations when creative behaviour may emerge.*

While there are many benefits in the use of checklists or rating scales of creativity, the disadvantages of relying on them as measures of assessing creativity in students are, in the author's opinion, twofold.

First, is the general lack of training available for teachers in principles of creative behaviours. It is not a criticism of the teachers but rather of most tertiary systems that so few have had specific training to nurture or identify creativity in students. Cropley & Urban (2003: 493) identified this as a problem when they argued, "Rather than pursuing a vague, global goal of 'fostering creativity' teachers need to be aware of which aspects of creativity they wish to promote". Creativity testing is usually presented as part of 'the gifted program' in schools but as Gallagher (2003: 21) has observed, "If there are no systematic approaches to special personnel preparation, then there will be no profession of gifted education."

The second disadvantage of the use of creativity checklists is that if 'observations' are to take place then it is necessary to provide an environment wherein creative behaviours may be *evident*. Classroom environments which rely on convergent thinking and problem-solving, group pacing and group grading, are not classrooms which will be conducive to allowing creativity to be assessed. Creativity will not be observed in settings which are "inimical to the development of creativity", as Csikszentmihalyi & Wolfe (2000: 81) point out. These researchers also highlight the earlier research of Getzels & Jackson (1962) who found that teachers in general disliked creative students and favoured more academically oriented students. Csikszentmihalyi & Wolfe (2000: 81) further report on a recent study of a highly gifted cohort, including Nobel-prize winners who "almost never mentioned their elementary or secondary schools as having helped them to develop the interest and expertise that led to their later accomplishments ... classroom activities as such were generally remembered as boring and repressive." In such environments, Fishkin &

Johnson's (1998) suggestion that checklists should be supplemented by classroom assessments of creative products and other informal, alternative methods of assessing student creative performance, would also seem to be limited.

This thesis has already stated (Chapter 2) that standardised tests such as IQ tests constitute the basis of most formal measurements of *g*, or general intelligence. Tests of creativity have occasionally been included in measurements of intelligence, but generally as an 'adjunct' to the IQ test. Many researchers, as stated previously in this study, have been critical of the narrow range of IQ tests currently in use and advocate the need for a different way of measuring the diverse nature of human intellectual ability. Given the general level of disillusionment regarding the use of the IQ measure as an assessment of intelligence, and in many cases the sole assessment used, alternative measures need to be explored.

Collecting scores on such disparate and complex abilities such as fluency, originality or elaboration may constitute the proverbial '*herding of cats*' dilemma. Many problems are raised but possibly one of the essential questions relating to formalised creativity testing is, if it is to be encapsulated in a score, under what conditions will this occur? As Michael & Wright (in Glover, Ronning & Reynolds, 1989: 41) question:

> *Does the creative behaviour occur under a structured situation during testing or does it manifest itself in an unstructured situation? Stated another way, does the creative behaviour take place under specified demand characteristics that are determined in part by restricted materials or delimiting problem statements, or does the creative behaviour arise in response to an open-ended question or situation?*

If the notion of creativity is as central to the notion of intelligence as previously stated, then reliable assessment of creativity must be of value to researchers and educators working in the field. Despite its cited limitations, the IQ test has generally served the study and identification of intelligence well, although this thesis proposes that intelligence is comprised of more abilities than can be measured by an IQ test. In particular, the author argues that at the highest levels, defined within the range of giftedness, the concept of creativity is an essential component, although one which is difficult to measure.

Only during the last 50 years have serious questions been asked about the inclusion of creativity in concepts of intelligence. Wallach & Kogan (1965), who designed one of the early tests of creativity, viewed creativity as an essential component of intelligence, yet independent of IQ scores:

> *interest has been growing concerning the possible limitations of the concept of intelligence in understanding individual differences in cognitive functioning. The term "creativity" ... represents an aspect of thinking which is as important to assess in its own right as is intelligence.*

Hattie & Rogers (1986: 483) highlighted the basic claim of Wallach & Kogan's research (1965) which was that "a creativity factor, which was distinct from intelligence, could emerge only if the creativity tests were administered individually under untimed, gamelike conditions ...". This reveals a view of creativity testing which is quite different from IQ testing, in the sense that creativity will become evident in an environment with few guidelines or strictures. Tannenbaum (1983: 278) was critical of this aspect of Wallach & Kogan's recommendations and cited Hattie's (1980) research as confirming that "the conventional testlike conditions appeared to produce optimal test results".

However, similarly with the identified limitations of the IQ test, the apparent weakness of a theoretical basis underpinning formal assessments of creativity has been raised by the research to date. Problems with content validity and reliability have been previously cited, and much research is almost damning of the concept of measuring or evaluating creativity, claiming, "creativity tests are incomplete" (Davis in Colangelo & Davis, 2003: 313) as measures of general intelligence and that, "there is good reason to doubt the validity of *all* of the available divergent thinking tests" (Baer, 1994: 80). Hunsaker & Callaghan, (1995: 113) highlight this problem, citing as an example a test "frequently used" in the USA, which "reports a weak reliability and validity data, even in its own technical manual".

Gardner (1993: 19), despite his criticisms of creativity tests as falling into the same trap as IQ tests, has stated that "Creativity tests are *reliable*. That is, if an individual takes the same creativity test more than once, he or she is likely to get a similar score ... " however his conclusion on the value of creativity tests in general was:

> *devastating for the enterprise of measuring creativity using pencil and paper tests. Despite a few suggestive findings, it has not been possible to demonstrate that creativity tests are* **valid**. *That is, high scores on a creativity test do not signal that one is necessarily creative in one's actual vocation or avocation, nor is there convincing evidence that individuals deemed creative by their discipline or culture necessarily exhibit the kinds of divergent-thinking skills that are the hallmark of creativity tests.*

If creativity tests are reliable but not valid, then as Runco (1993: 21) observes, the whole purpose of testing for creativity needs to be challenged: "If we know how fluent a child is with ideas, what do we really know? Just that the child can be fluent with ideas."

Others have defended the creativity tests as useful predictors of the 'likelihood' of later creative performance, while acknowledging that performance on the test is not to be equated with real-world creative performance:

> *Divergent thinking measures yield observable, quantifiable data representing the individual's likelihood of responding creatively to real-life situations (Runco, 1991; Torrance 1987). These products or ideas as responses to divergent thinking items are restricted to the behaviours being elicited. Thus they are not as fully representative of the individual's creativity as a finished creative product of artist, scientist, or even a young child*
>
> *(Fishkin & Johnson, 1998: 7).*

The problem of the discrepancy between the items on a test of creativity and actual domain specific performance has been identified. Csikszentmihalyi & Wolfe (2000: 87) argued that there are validity weaknesses regarding creativity tests, specifically "how the hypothetical problems presented in divergent thinking tests translate into real life. Whether generating numerous fantastic uses for a box really predicts any sort of creative achievement is unclear."

In addition to these concerns, formalised tests of creativity have been criticised, not only on the basis of "their weak real-world predictive validities" (Albert 1990: 15) but also on the very subjective nature of their scoring systems and the necessity for highly trained assessors to all agree on the relevant criteria. This has been a complaint of practising classroom teachers, wishing to gain keener insights into assessing and teaching for higher-order creative outcomes, as, "evaluations of creativity are restricted to an elite group of judges" (Csikszentmihalyi, 1988 in Sternberg & Lubart, 1991: 17), and left out of the hands of those for whom the information would be most useful. Even in the most rigorous research programs into assessing creativity, this issue of the subjective scoring of responses is a major concern:

> *In general we expect some degree of consensus in judgement of creativity (Amabile, 1982) although the consensus will be imperfect because each rater will be coming from a slightly different context with values that are likely to differ ... our judgements of creativity will depend upon these evaluations and therefore may not always be the same (Sternberg & Lubart, 1991: 6).*

Finke et al (1996: 41) also raised this problem, indicating that even when scorers adhere to guidelines the makeup of creativity is so complex and the degree of subjectivity so varied, that "judges may disagree in their ratings because of differences in their backgrounds, experiences, and preferences. What one person regards as original may be regarded as commonplace by another, who has already seen the invention or heard the idea many times before".

The problems of subjectivity of scoring, as well as the necessity for the scorer to be part of the 'elite group of judges' are compounded by the additional factors of age or prior training of the subjects. For example, according to Benjafield, when completing figural creativity tests, students at differing age levels or with art training are at an advantage: "Students under the age of 6 (preconventional) and past the age of postconvention (i.e. after actual knowledge/training intervention) are also at a distinct advantage within these assessments" (Benjafield, 1992: 307).

Another criticism of creativity tests is that they sample a very narrow range of creative behaviours and that they are more aligned to white, high socio-economic and cultural standards of creative behaviours (Borland; 1996). While similar arguments have beset proponents of IQ testing, the absence of any creativity-equivalent to the standardised IQ test score may explain why "the creativity equivalent of Spearman's *g*, or general intellectual factor, appears to be the Holy Grail of creativity researchers" (Brown, in Glover et al, 1989: 4).

This *Holy Grail* for researchers who are convinced that creativity is a surer measure of intelligence than IQ has been a complex and frustrating quest, albeit one that has produced some very useful measurements, despite all of the cited limitations. The challenge for the researchers in the past forty years has been to design a test of creative intelligence which identifies the key markers of creativity in much the same way that the IQ test has been cited as identifying the key markers, at differing levels, and in differing kinds, of cognitive skill. That creativity is an essential feature of intelligence, and one which differentiates the gifted population from the other levels of intellectual ability, particularly in the visual/figural sphere, is a central hypothesis of this study.

Why is it that tests of creativity have generally been regarded in the research as unreliable? The simple answer could be that they have never enjoyed the stability of the IQ measure as reported in the research to date. Despite the limitations of the IQ tests, most researchers agree that, for *what they measure*, (e.g. speed of processing, language, knowledge, logic), and when administered to an *appropriate population* (e.g. excluding those for whom English is a second language or who are from cultural minority groupings vastly different from those on whom the tests were normed), the IQ test is an exceptionally stable and reliable way of highlighting individual differences in some specific intellectual spheres. The main method of testing any equivalent stability with tests of creativity has been to correlate them with IQ measures. To date, such correlations have been inconclusive, particularly at the upper levels of IQ scores.

The studies which have examined the correlations of creativity measures with psychometric measures of intelligence have generally found only a moderate to low correlation (Mitzel, 1982; Tannenbaum, 1983; Davis and Rimm, 1989; Runco, 1990; Cropley, 1997; Phillipson, 1999). Studies have consistently found that "beyond the IQ of 120 the correlation seems to be negligible" (Ochse, 1990 in Rudowicz, Kitto & Lok, 1999: 4). Conversely, whilst advanced measures of psychometric intelligence do not guarantee advanced creativity measures, low creativity scores generally attend low IQ scores (McNemar, 1964 in Khatena, 1992).

Some studies have reported low correlations between giftedness, as measured by IQ testing and measures of creativity (Getzels & Jackson, 1962, 1963; Wallach & Kogan, 1965). In particular the early findings of Wallach & Kogan confirmed that "the creativity and intelligence measures are relatively independent of each other" (Wallach & Kogan, 1965: 48). This is an interesting phenomenon as, "on the surface it would seem clear that creativity should be the highest manifestation of intellectual performance, not separate from it (Gallagher & Courtright in Sternberg & Davidson, 1986 :103). Other studies have indicated that there is a correlation between intelligence (as indicated by the IQ assessment) and creativity, but only up until a mild to moderate evaluation of each criteria. Yamamoto (1974) found that there is an IQ/creativity threshold, "above which creativity and intelligence are distinct attributes" (in Hattie & Rogers, 1986), and that at the levels of moderate to profound creativity or intellectual giftedness, the correlations have not been found. If high creativity is the dominant form of intelligence, the weakness of the tests (IQ and creativity) to agree needs to be addressed.

The early studies of Torrance (1962), used to justify the TTCT as measures of intelligence, indicated that approximately 70% of highly creative students would not be identified as gifted if IQ scores alone were used. Torrance (1974) and Getzels and Jackson (1962 in McCabe, 1991) claimed that above a certain minimum level of intelligence, being more intelligence does not guarantee a corresponding increase in creativity.

Weinstein & Bobko (1985) found that IQ and creativity only correlated within a particular IQ range. The range in general indicated that subjects with average to above average IQ scores were more likely to obtain corresponding creativity scores. However at the moderate to profound levels of IQ the correlations were not evident. The later work of Khatena (1992) also confirmed that creativity tests fail to identify subjects at the upper levels of IQ. Generally the studies suggest that IQ 120 is the upper limit at which IQ and creativity scores plateau. This asymptotic relationship between IQ scores and creativity scores has generated much debate. Weinstein & Bobko (1980) concluded, from their earlier observations, that, "intelligence is somewhat necessary but not sufficient, for creative behaviour" however, it is the author's opinion that other key questions need to be asked, such as:

- are the tests of creativity not accurate enough to differentiate high IQ subjects' creative abilities?
- does the 'differentiation hypothesis', already identified in IQ testing (i.e. that mental abilities as measured by IQ tests correlate more strongly at lower ability levels) also apply for creativity testing?
- are exceptionally high IQ subjects generally more variable in utilising divergent thinking skills, in a way which may disadvantage their scores on standardised tests of creativity?

Higher order use of metacognitive processes has been identified in high IQ subjects and it could be argued that such skills support the gaining of a high IQ score. IQ tests generally do not require divergent thinking such as original or flexible responses and it is possible that such responses are likely to adversely affect performance on a standardised IQ test. In the IQ test, *one right answer* rules.

Cropley (1997: 8) observed that the difference between creativity testing as opposed to IQ testing, was raised as early as Guilford's (1950) pronouncements on thinking as, "convergent … emphasising the best, correct answer, of which there is usually only one … and divergent … which involves branching out from the known to find unexpected, novel answers, of which there may be many." Piirto (1999) is critical of the research which has attempted to correlate such different abilities, convergent and divergent, often by using different types of testing instruments.

It needs to be remembered that the strength of tests of *g* lies in their reliability in terms of measurements of speed, knowledge and logic. It is uncommon for creative thinking to be regarded as in any way logical or rational and this no doubt explains its exclusion from standardised testing. Yet as Nickerson et al (1985: 86) claimed:

The ability to look at things in new and unconventional ways is undoubtedly an important problem-solving skill. Indeed, many of the methods that have been proposed for the *improvement of problem-solving skills, especially for the breaking away from constraining approaches to problems, emphasise alogical or even non-rational styles of thinking.*

Having an exceptionally high IQ places a subject within largely 'unchartered' territory. Hall's (1985) research indicated that the *level* of IQ was a determining factor in whether any consistent relationship was found with IQ and/or school achievement, with IQ and school success generally correlating. However, having an IQ score in the 130+ category tended to place the student more 'at risk' of adjusting well to school-related tasks. Perhaps a similar argument can be made when examining the responses of exceptionally high IQ subjects to open-ended, divergent tasks.

The following section of this Chapter details what creativity tests have tried to measure and the design of some creativity tests used in research to date. In particular the Torrance Tests of Creative Thinking (TTCT), which were used in this study, are outlined and evaluated. The section also raises the alternative use of checklists to identify creative behaviour.

5.2. What Creativity Tests and Checklists Measure

"How can one appropriately measure individual creativity?
By definition, the ability to develop useful products
never before developed seems quite unpredictable."
(Csikszentmihalyi & Wolfe, 2000: 86).

The range of creativity tests has traditionally attempted to measure performance in both the *verbal* and the *figural* spheres of intellectual functioning. The verbal sphere dominated the earlier tests, probably for the same reasons it has dominated IQ testing: the rules of language, as opposed to figural form, have been researched in detail, and aspects of fluency, flexibility and originality in language can be incorporated with relative ease into a test. The figural aspect of creativity seemed much more difficult to conceptualise.

There has been a reluctance to judge or 'measure the worth' of children's figural responses, probably because of the earlier cited beliefs that such abilities are 'in the eye of the beholder' and that there are no ultimate good or bad measures of figural performance, and certainly none that would suggest a link with intelligence. As there is an assumption that all children can draw, measuring such ability is not generally popular as Kellogg, (1970: 207) has argued, " any mental test via art that pretended to yield precise, quantified gradations of intelligence would be an insult to the children".

This chapter details the TTCT which does provide 'qualified gradations' of figural creative ability. The value and limitations of this test can be seen in relation to others developed before and after the TTCT.

The use of visual stimulus material as a spur or incentive to supposed creative behaviour was expounded by Wallach and Kogan (1965) in their 'Patterns Meaning Procedure' which was a part of their own range of instruments for assessing creativity. In the assessment of this instrument they relied on two criteria, *fluency* and *originality*, as the variables most related to creativity. This instrument purported to measure both verbal and figural creativity by using both verbal and visual stimulus materials. In the verbal stimulus part of the instrument students were required to respond to three categories of questions:

Instances:

name all of the round things you can think of
name all of the things you can think of that will make a noise
name all of the square things you can think of

Alternate Uses:

tell me all the different ways you could use a newspaper
tell me all the different ways you could use a knife
tell me all the different ways you could use a cork

Similarities:

tell me all the ways in which a carrot and a potato are alike
tell me all the ways in which a cat and a mouse are alike
tell me all the ways in which a desk and a table are alike.

Subjects were scored on the number of differing responses as well as the originality of their responses. Test items such as these and others developed in the era of de Bono's lateral thinking (i.e. newspaper *Po* knife), ideational fluency (all of the things), remote associates (*how* are the following *alike*?) and flexibility (find a *different* way).

The aspects of the instrument using *visual* stimulus materials were divided into the following two sections; 'Pattern meanings' and 'Line meanings'. An example of *Pattern Meanings* is reproduced below in Figure 5.1. In this section of the test, the subjects were given the following patterns on separate cards and asked to "tell me all the things you think this could be":

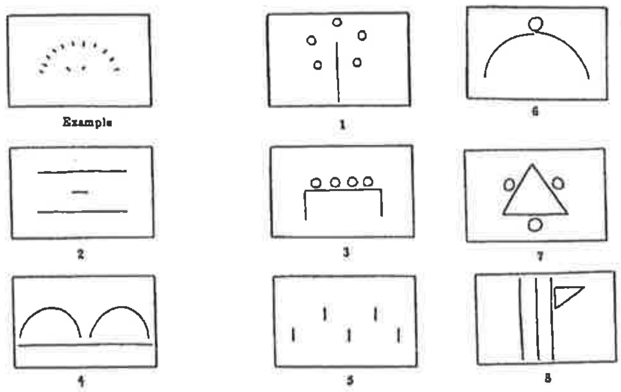


Figure 5.1: Pattern Meanings

Subjects were scored again on the number of responses and their originality. The scoring for item 1, for example, indicates 'lollipop bursting into pieces' is evaluated as a unique response, while 'flower' is not.

While tests such as these have merit and have been successfully evaluated in many research studies, including comparisons with the TTCT, it is the author's opinion that their weakness is in the scorers' subjective analysis of what exactly determines creative intelligence. It is argued that if a subject has not had *original* or *different* ideas rewarded by the experience of education, then they will not suddenly display them in such a test. The problem of subjectivity of scoring is equally apparent. It could be argued, for example, that 'a flower' is a perfectly reasonable aesthetic response while 'lollipop bursting' is nonsensical as they do not normally explode.

The second section utilising visual stimulus is *Line Meanings* and is reproduced below in Figure 5.2. In this test, the subjects were given more lines on cards and asked to, "tell me all the things you can about it":

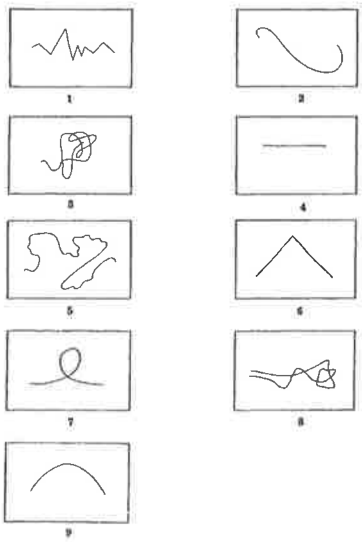


Figure 5.2: Line Meanings

The scoring guidelines indicate that, for example, for Item 1, "a squished piece of paper" is evaluated as a unique response, while "mountains" is not. In Item 3, "squeezing paint out of a tube" is unique, while "a piece of string" is not (Wallach & Kogan, 1965: 35). As with the verbal stimulus material, the variables of uniqueness (originality) and number (fluency) of responses are scored for each of the items.

The Wallach & Kogan tests have been influential in designs for other tests of creativity and have contributed much to this new field. However their limitations can be seen not just in the concerns raised but also in their predominant reliance on a verbal response to the problems. For example whether the 'squiggle' is a 'squished bit of paper' or a 'mountain' is effectively measuring the subjects' originality, fluency or flexibility with words, and perhaps verbal ideation or elaboration. It is argued that this does not necessarily measure figural or visual creativity. In addition, the 'domain-knowledge' weak basis to these tests, which provide a remote association between a visual fragment and a verbal description, which is a criticism which has also been directed against the TTCT, is evident. As Runco, (1990: 674) indicated:

> *Divergent thinking tests, for example, typically contain tasks (e.g. 'Name all of the things you can think of that move on wheels') which are only remotely associated with meaningful activities in the natural environment … tasks can be made more realistic if they contain items that resemble activities which are found in the natural environment.*

Wallach & Kogan (1965: 64) concluded from their research that creative ability is quite independent from general intelligence particularly as it is measured on an IQ test:

> *This view of creativity relies on an associational conception of figural or visual stimulus … and that creativity ... the ability to generate many cognitive associates and many that are unique, is strikingly independent of the conventional realm of general intelligence, while at the same time being a unitary and pervasive dimension of individual difference in its own right ... we can assert with confidence ... that the ability of a child to display creativity as we here conceive of it, has little to do with ... high scores on measures of general intelligence.*

A second test of creativity which has dominated the research in this field has been the Getzels & Jackson's (1963) study, which also concluded that IQ did not correlate significantly with their measurement of creativity. This test relied on the following five criteria in their assessment of creativity:

Word Association:

The subject was asked to give as many definitions as possible to stimulus words such as bolt, bark, and sack.

Use for Things:

> The subject was required to give as many uses as possible for objects that customarily have a stereotyped function attached to them, e.g. a brick, or a paper-clip.

Hidden Shapes:

> The subject was required to find a given geometric form that was hidden in more complex geometric forms or patterns.

Fables:

> The subject was given four fables in which the last lines were missing. Subject was required to compose three different endings for each fable: moralistic, humorous, and sad.

Make-Up Problems:

> The subject was presented with four complex paragraphs each of which contained a number of numerical statements, e.g., the costs involved in building a house. The subject was required to make up as many mathematical problems as possible that might be solved with the information given.
>
> *(Getzels & Jackson, in Taylor & Barron, 1963: 163-164)*

These test items address abilities such as verbal fluency, ideational fluency and flexibility, visual closure and verbal elaboration. It is clear that there is also a heavy reliance on language skills in this creativity test, with only the 'hidden shapes' section requiring visual or figural response. It is proposed that these instruments designed to assess figural and verbal creative ability also have limitations in that they rely on the subjective scoring (by a supposedly trained or expert scorer) of students' responses to figural stimuli.

This thesis has already highlighted characteristics of highly creative individuals (i.e. those whose products have been judged by the culture as creative), who have regularly exhibited traits such as risk-taking, sensation seeking, production of odd or unusual ideas, fluent, original responses to stimuli. Tests of creativity have not generally been able to identify, let alone measure, such a diverse array of characteristics.

The use of taxonomies and checklists while not replacing tests of creativity, have become prominent not only in the research on creativity but also in school settings where teachers are given the opportunity to identify characteristics in students which may or may not be conducive to academic success but which may indicate giftedness in the creative sphere. In the sense that the tests are often removed from the educators who would most benefit from their results, the checklist or taxonomy is accessible.

Most screening checklists currently used in schools to help identify gifted students include the characteristics of creative ability. One example of this has been set out in Chapter 2. The problems of validation and reliability with standardised tests of creativity have led to researchers such as
Kirschenbaum (1998) to recommend the testing of creativity through the use of a 'Creativity Classification System' (CCS) which offers a taxonomy of creativity that consists of nine essential dimensions of creative activity. This taxonomy is reproduced in Table 5.1 below:

TABLE 5.1: CCS Dimensions, Behavioural Characteristics, and Assessment Methods

Contact	Sensation seeking, curious, sensitive, preference for novelty, memory for details, open to experience
Conscience	Flexible thinker, inquisitive, prefers complexity, reflective, recognises patterns & problems
Interest	Task commitment, persistent, flow, self-motivated to develop mastery
Fantasy	Imaginative, sense of humour, playful, spontaneous, refers to fantasies in speech or drawing
Incubation	Multi-tasking, creative/artistic hobbies
Creative contact	Insightful, belief in paranormal activity, visionary
Inspiration	Seeks creative stimulation and new ideas
Production	Prolific, stays focused for long time, personal style
Verification	High personal standards, communicates/ assesses results

Kirshenbaum's (1998) taxonomy is designed to be used as a checklist for teachers or other practitioners to observe characteristics of creativity in students. The taxonomy was intended as a more accurate and useful alternative to what Kirshenbaum regarded as unreliable tests of creativity.

Moving beyond *identifying* characterises of creativity from a taxonomy to *measuring* the multiplicity of such characteristics is becoming more popular, particularly as teachers and researchers have, over the past twenty years become more cognisant of what skills to look for. The problem of training has already been raised and needs to be addressed if this option is to be successfully used in schools. The use of rating scales and checklists is supported by researchers such as Plucker & Runco (1998: 3):

> *Research and debate on predictive validity, content specificity-generality, and implicit theories provide concrete reasons for the use of multiple indicators of creativity … while research has led to improved teacher, parent, peer, and product rating scales, the scales can still be improved to produce more reliable and valid results than those presently attainable.*

Some of these rating scales have been designed specifically to help identify the creatively gifted population, recognising the research already presented in this thesis that the profiles of gifted students are not always just 'more' ability but 'different' ability. The Renzulli et al (2001) 'Scales for Rating Behavioural Characteristics of Superior Students', based on the premise that, "Creative people are unique individuals, but they have a lot in common … " has recently been evaluated as, "a shining example of on-target efficiency"(Colangelo & Davis, 2003: 315), in the quest to assess creative behaviours.

An example of this checklist is reproduced below in Table 5.2:

TABLE 5.2: Characteristics of Superior Students: Colangelo & Davis, 2003

1. Displays a great deal of curiosity about many things; is constantly asking questions about anything and everything.	____	____	____	____
2. Generates a large number of ideas or solutions to problems and questions; often offers unusual ("way out"), unique, clever responses.	____	____	____	____
3. Is uninhibited in expressing opinion; is sometimes radical and spirited in disagreement; is tenacious.	____	____	____	____
4. Is a high risk taker; is adventurous and speculative.	____	____	____	____
5. Displays a good deal of intellectual playfulness; fantasizes; imagines ("I wonder what would happen if . . ."); manipulates ideas (i.e., changes, elaborates upon them); is often concerned with adapting, improving, and modifying institutions, objects, and systems.	____	____	____	____
6. Displays a keen sense of humor and sees humor in situations that may not appear to be humorous to others.	____	____	____	____
7. Is unusually aware of his or her impulses and more open to the irrational in himself or herself (freer expression of feminine interest for boys, greater than usual amount of independence for girls); shows emotional sensitivity.	____	____	____	____
8. Is sensitive to beauty; attends to aesthetic characteristics of things.	____	____	____	____
9. Is nonconforming; accepts disorder; is not interested in details; is individualistic; does not mind being different.	____	____	____	____
10. Criticizes constructively; is unwilling to accept authoritarian pronouncements without critical examination.	____	____	____	____

Total Score ____

It is interesting to note characteristics such as sensitivity to beauty, nonconforming, accepts disorder, high risk-taker, and intellectual playfulness as the possible markers of high creativity which have eluded standardised tests of creativity to date.

The following section of this chapter will outline the Test of Creative Thinking–Drawing Production (TCT–DP) (Jellen & Urban 1989; Urban & Jellen, 1996), followed by the TTCTs with a rationale for their inclusion in this study.

5.3. The Test for Creative Thinking–Drawing Production (TCT-DP)

A "unique newcomer" (Colangelo & Davis, 2003: 318) to the field of creativity testing is Urban and Jellen's 'Test for Creative Thinking – Drawing Production' (TCT-DP) (Jellen & Urban, 1989; Urban & Jellen, 1993). Jellen & Urban (1989) followed some of the basic principles of the TTCTs when they produced the TCT-DP. These researchers decided on figural stimuli rather than verbal in order to achieve what they claim to be culture fairness which they present as one of the greatest strengths of this measure of creativity. Indeed the researchers have used this test in collaborative studies across different countries and claim a high level of validity of results (Urban, 1999).

The figural stimulus design for the test (reproduced below in Figure 5.3) relies on presenting the subject with six incomplete figural fragments which mirror diverse characteristics that are:

(1) different in design
(2) geometric and nongeometric
(3) round and straight
(4) singular and compositional
(5) broken and unbroken
(6) within and outside a given frame
(7) placed irregularly on the space provided, and
(8) incomplete

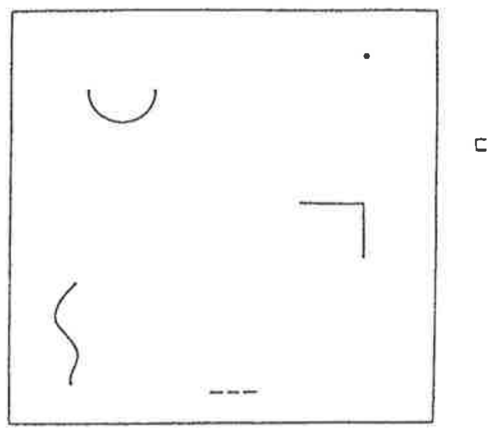


Figure 5.3: Jellen & Urban Test for Creative Thinking Drawing Production (TCT – DP)

Subjects are given this stimulus and then required to use it as the basis for their own drawing. Evaluation of subject responses to the TCT-DP is based on 11 key elements:

- *completion:* any continuation and extension of the six given figural fragments
- *addition:* any additions made to the extended figural fragments
- *new elements:* any new figure, symbol or element
- *connections made with a line:* between one figural fragment and another
- *connections made to produce a theme:* any figure contributing to a compositional theme or "Gestalt"
- *boundary breaking that is fragment dependent:* any extension or continuation of the 'small open square' located outside the frame
- boundary breaking that is fragment independent:
- *perspective:* any breaking away from two dimensionality
- *humour:* any drawing which elicits a humorous response
- *unconventionality:* any manipulation of the material; surrealistic or abstract elements; any combinations of figures, signs, and/or symbols; unconventional figures
- *speed:* a breakdown of points according to the time spent on the drawing production

(Jellen & Urban, 1989: 80).

An example of a drawing which would attract a low creativity score has been provided by the researchers and is reproduced below in Figure 5.4. This drawing would not elicit a high creativity score on the TCT-DP as the subject has simply completed the drawings of the circle, square and line (originally the row of dots) and has reproduced the point (or dot) without unconventionality, humour, perspective or any other of the characteristics which, according to Jellen and Urban, indicate creativity.

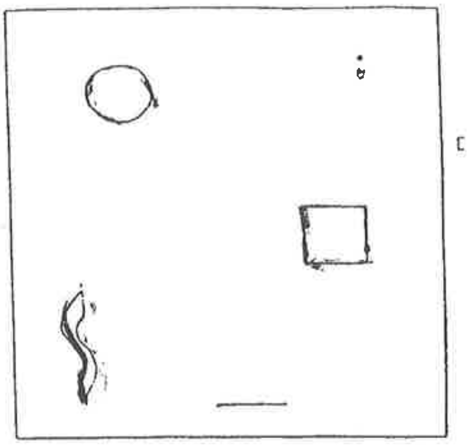


Figure 5.4: Example of a low-scoring response on the TCT-DP

According to the authors of the test, performance on this item "is highly stereotypical reflecting inhibition, insecurity, hesitancy and timidity. Diagnostic-prescriptive pedagogy should isolate this case exposing this twelve year-old male to situations that require risk-taking, self-initiative and indolence" (Jellen & Urban, 1989: 85).

An example of a subject's response to the TCT –DP which would elicit a high creativity score is reproduced below in Figure 5.5:

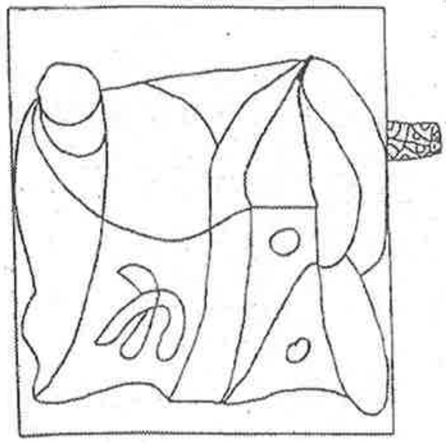


Figure 5.5: Example of a high-scoring response on the TCT-DP

The subject's response to the figural stimulus in this example, according to Jellen and Urban (1989: 85) displays "very high degrees of variability. Boldness, abstractness, fluency and unconventionality. This particular subject requires maximum freedom of expression and exposure to other types of media allowing this eleven year-old female to develop her high creative potential to the fullest".

According to the authors of the TCT-DP, the presentation of "basic stimuli" in the form of their figural elements or 'fragments', were,

> *intentionally designed in an incomplete and irregular fashion in order to achieve maximum flexibility as an imperative for creativity. Instead of concepts, symbols, or holistic figures, we decided to use figural fragments which possessed only vague conventional meanings*
>
> *(in Cropley, 1986:166).*

However it could be argued that the 'fragments' used in the TCT – DP are not 'vague' but highly suggestive of classic shapes such as the line, the circle, the triangle and the square. This figural test provides interesting links with the 'gestalt'. By providing such highly suggestive 'fragments' of the classic line (curved and straight), and point (the circle, square and triangle), the TCT-DP claims to provide "an imperative for creativity" yet, the author would argue, one which discriminates against the subjects' natural reaction to 'complete' the pattern. Once a subject has completed the patterns of, for example, circle, square, line, if is difficult to elaborate further images. It is argued that an 'imperative' for creativity cannot be made on the basis of a 'fragment' of form.

Although the exhortation in the TCT – DP to the subjects is to 'be creative', it could be argued that the very nature of the test 'frames' the subjects into what could be judged as low-level creative output. The rationale underpinning this test reveals two basic beliefs about figural ability specifically, and the notion of creativity in general which is adopted by the researchers. These are that:

- creativity will blossom and will somehow be released in an environment without guidelines or strictures: their 'imperative for creativity' is not supported by the 'trap-like' quality of the semi-completed images
- no theoretical basis is necessary for the choice of the figural fragments, other than a vague, gestalt, suggestive incompleteness.

The fact that the elemental forms of the universal point and line (which are not identified by Jellen and Urban (1989) as having instructed its design) were used in this test, might also suggest that it has great potential for identifying visual intelligence in a new and exciting way. Whether this intelligence has its basis in visual or figural *creative* intelligence still needs to be established. In addition, Jellen and Urban (1989: 78) claim that, "many of the items collected have clinical value or potential for further diagnostic and prescriptive work in the psychological and educational arena of human service delivery". It is argued that this is an ambitious claim which also needs to be verified with more research.

Rudowicz et al (1999: 4) observed of the TCT – DP that only "moderate correlation was found between the means of the TCT–DP and the level of academic achievements whereas no correlation between individual IQ scores and the creativity test was observed". Despite the potential strengths of the TCT-DP, the Torrance Tests of figural Creativity were used in this study, instead of the TCT-DP because of the more robust body of research supporting the validity and reliability of the TTCT, as well as its closer links to the nature of visual thinking which is a main focus of this study.

Chapter 8 of this thesis suggests further explorations in testing for creativity using the TCT – DP, as it has great potential however, as Davis (in Colangelo & Davis, 2003: 319) confirms: "Regarding divergent thinking tests, the Torrance Tests must remain at the top of the list, although Jellen & Urbana's TCT–DP seems promising."

5.4. The Torrance Tests of Creative Thinking (TTCT)

Torrance has argued (1979: 361) that to identify intelligence in general the use of the IQ test alone is not sufficient and he has defended the necessity of creativity testing in the determination of giftedness:

> *it seems obvious that the rational and logical processes involved in intelligence tests are called into play in the process of creative thinking, especially in evaluating alternatives, making decisions, and the like.*

Evaluations of the Torrance Tests of Creative Thinking (TTCT) established that they are "the most extensively researched … and provide adequate updated norms. In addition, both the TTCT and the Wallach-Kogan tests have shown evidence of long-term predictive validity with measures of adult productivity as much as 18 to 22 years later" (Torrance & Salter, 1989 in Fishkin & Johnson, 1998: 7).

McCabe (1991: 116) claimed that the TTCT are "the most widely validated test of creative thinking". Colangelo & Davis (2003: 316) have confirmed that the TTCT are still the best tests of creativity and that they "remain the most popular creativity tests of any kind". In addition, they argue that Torrance's original assertion that his TTCT are more reliable indicators of giftedness than IQ tests is supported by the fact that:

> *The TTCT have been the most validated of any other tests of creativity, including a twenty-two-year longitudinal validation by Torrance (1981). Plucker's (1999) reanalysis of Torrance's longitudinal data indicated that the TTCT predicted adult creativeness three times better than IQ scores*
>
> *(in Colangelo & Davis, 2003: 317).*

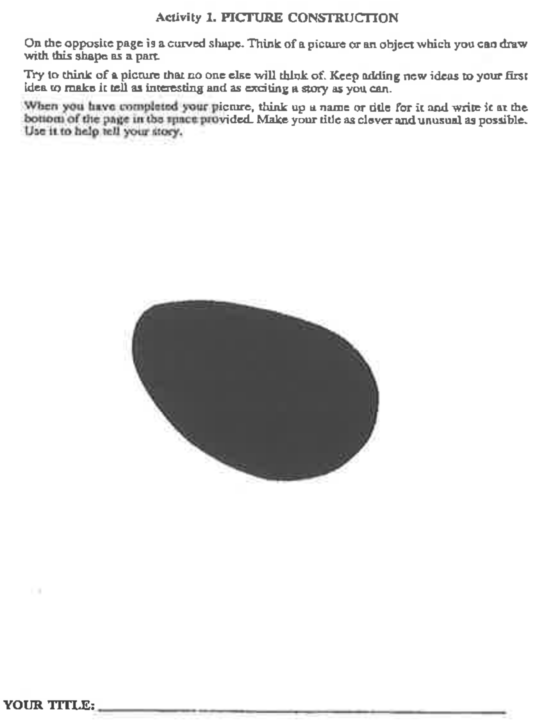
Cropley (2001 :106) has indicated that the TTCT battery is, "the best known and most widely used of the tests based on divergent thinking … it has established itself on a worldwide basis among practitioners as well as researchers and its role in defining creativity … can scarcely be overestimated". The TTCT have been cited as the "most popular" of all the Divergent Thinking (DT) measures of creativity (Plucker & Runco, 1998: 36) with DT tests, as opposed to just the use of checklists, being cited as the most reliable method of assessing creativity.

Torrance's Tests of Creative Thinking drew upon Guilford's original Structure of the Intellect (SOI) model, focusing on the four markers of creative intelligence or 'divergent production' identified in the SOI:

Fluency - the production of many ideas
Originality - the uniqueness or novelty of ideas
Flexibility - the modifiability of ideas, and
Elaboration - the extension of ideas.

The TTCT are comprised of parallel forms of both figural and verbal creativity. Only the figural forms were used in this study, predominantly because the major research focus was on visual thinking skills, but also because the figural sphere has been cited as the more reliable as it avoids the cultural bias that is inherent in assessments of creativity relying on a language basis (Torrance, 1966, 1981a, 1981b; Jellen & Urban, 1989). The most recent analyses confirm that within the TTCT, "the Figural tests are more culture-fair" than their verbal equivalent (Davis in Colangelo & Davis, 2003 :317). A copy of the TTCT Figural Form A is in Appendix 4. Torrance has indicated that the format of the test booklet itself, "was designed deliberately to facilitate the 'warm-up' process necessary for any kind of creative behaviour. The design on the cover consists of apparently unrelated combinations of elements and usually evokes curiosity, imaginative activity, and interest" (Torrance, 1990: 2). The administrator is requested not to use the word 'test' with the subjects as it could detract from the necessity for a relaxed atmosphere which Torrance claims is important to the test.

Although the full test battery was administered to the subjects in this study, individual items can be administered as a shortened version of the test battery. As an example, the Activity 1 in Figural Form A is sometimes used by teachers as a single insight into figural creative production. It is the basic presentation of a figural stimulus, reproduced below in Figure 5.6:



Activity 1. PICTURE CONSTRUCTION

On the opposite page is a curved shape. Think of a picture or an object which you can draw with this shape as a part.

Try to think of a picture that no one else will think of. Keep adding new ideas to your first idea to make it tell as interesting and as exciting a story as you can.

When you have completed your picture, think up a name or title for it and write it at the bottom of the page in the space provided. Make your title as clever and unusual as possible. Use it to help tell your story.

YOUR TITLE: ______________________________

Figure 5.6: Activity 1: Figural Form A, TTCT

To evaluate the responses to such a stimulus the scorer follows the guidelines as set out in the manual which specify the drawings as creative in their responses with fluency being the basic number of responses coded, originality scored according to the guidelines on novelty of response, and elaboration scores the extent to which the subject has used imagination to build upon the original idea, such as deliberate shading or decoration. The scores can be enhanced by identifying markers of 'creative strength' such as emotional expressiveness or humour.

Perhaps what gives the TTCT a strength over the other tests outlined to date in this section is that it does accept that all children can communicate in form and that verbal response is a secondary consideration. For example although the subjects completing the TTCT are asked to provide titles for their drawings, this aspect of the test can actually be scored together with the verbal parallel versions of the TTCT. This study chose to incorporate the titles, (as would normally be done), as part of the figural score. The titles score makes up a very small part of the figural test scores but does allow for insight into characteristics such as humour to be identified. If the population being tested was predominantly subjects for whom English is a second language, for example, this aspect of the figural tests would not have been scored.

In addition, a great strength of this first item in the TTCT is that the black shape, *is a shape*: it is not a fragment seeking clozure, which is closer to the design of the TCT–DP. While the 'blob' shape is certainly suggestive, it is, in Kandinsky's terms a point within a frame, which, in the author's opinion, must have more universal communication than the more culturally oriented fragments suggesting 'lollipops' or 'toothpaste tubes'.

The Activities 2 section of the TTCT is closer to the figural concepts outlined in the Wallach & Kogan tests. The strength of the TTCT is that they require the subject to respond to the figural stimulus *in figural form*. The verbal response is secondary to the question. The other examples of the figural forms provide the subjects with 'squiggles' and ask them to respond. An example of the 'squiggle' stimulus from Figural Form A is reproduced below in Figure 5.7:

Activity 2. PICTURE COMPLETION

By adding lines to the incomplete figures on this and the next page, you can sketch some interesting objects or pictures. Again, try to think of some picture or object that no one else will think of. Try to make it tell as complete and as interesting a story as you can by adding to and building up your first idea. Make up an interesting title for each of your drawings and write it at the bottom of each block next to the number of the figure.

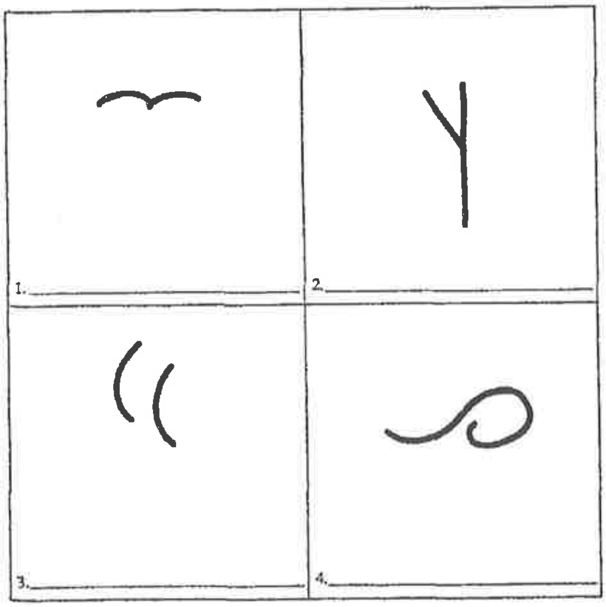


Figure 5.7: Activity 2, Figural Form A, TTCT

Subjects who provide highly predicted responses, such as a bird and a tree for the first two items are scored as less creative than those who provide much more original and elaborative responses. It is the author's opinion that although the 'squiggles' are undeniably suggestive of shape, (a bird, a tree …), each still has the integrity of line rather than corrupted elements of form. The figural items on the TTCT are designed to stimulate figural expression rather than figural closure. Although the TTCT are time-consuming to score, strict adherence to the scoring guide, which is very detailed in its guidelines, provides the task with a clear structure and direction.

The Activities 3 section provides a series of varying straight lines, as other versions of the TTCT provide circles. While the TTCT have been criticised as attempting to measure creativity in a 'knowledge poor' domain (e.g. Sternberg, 1990) the author's opinion is that *line*, similarly to *point* (as seen in Activities 1) are universal forms and hence not knowledge poor. These lines are not 'suggestive' in any way of form but they do exhort the subject to provide original, fluent and elaborative responses to form, and *in* form, rather than language. The lines do not deliberately suggest 'mountains' or 'squished bits of paper', they just represent line. This aspect of the design of the TTCT connects it to the principles of universal form or grammar of figural intelligence which has been previously outlined in this thesis.

The next section details the design of the *Figures of Sound* instrument which, along with the TTCT and RPM comprised the data collected for this aspect of the study.

5.5. The Background and Rationale for the design of the *Figures of Sound* instrument

The instrument designed for the purpose of this study has reversed the process taken by other projects examining figural and creative intelligence. Rather than eliciting artistic or figural responses from the subjects and then coding or evaluating them, this study examined the possible nature of what constitutes figural form, as represented primarily in the non-objective art form, particularly as outlined by Kandinsky, and has traced back through the principles of this art the design of the questions contained in the instrument.

The title of the instrument, *Figures of Sound* was drawn from the poetry of T.S. Eliot but also has a basis within the art of Kandinsky, who claimed that non-objective art, alongside words, did have 'sounds':

> *This abstract adherence to law peculiar to one of the arts, finds in this art a constant, more or less conscious application, which can be compared with nature's adherence to law and which in both cases - art and nature - affords the inner human being a very peculiar satisfaction. Fundamentally, this same abstract, law-abiding quality is most certainly the property of other art expressions. The spatial elements in sculpture and architecture, the tonal elements in music, the elements of movement in dance, and the word elements in poetry, all have need of a similar uncovering and a similar elementary comparison with respect to their external and their inner characteristics, which I call '**sounds**'*
>
> *(Kandinsky, 1912 in 1981: 4).*

Kandinsky's fascination with the links between sound and form have been discussed in Chapter 3. He published his book 'Klange' (or 'Sounds') in 1912. It is a collection of thirty-eight of his poems and fifty-six woodcuts and attests to the phenomenon of being *doubly gifted* as outlined by Hertjer's (1986) text, "Doubly gifted: the author as visual artist". Another artist profiled in this text is Dylan Thomas. It is interesting to note that Thomas first used the term, "figures of sound," to describe his use of language in poetry:

> *What I like to do is to treat words as a craftsman does his wood or stone or what-have-you, to hew, carve, mould, coil, polish and plane them into patterns, sequences, sculptures, **figures of***

> ***sound** expressing some lyrical impulse, some spiritual doubt or conviction, some dimly-raised truth I must try to reach and realise*
>
> *(Dylan Thomas in Hjerter, 1986 :138).*

Drawing upon the common element of 'sounds' as evidenced by two great masters, each gifted in the written word and visual form, the title for this instrument was devised, *Figures of Sound* (FoS). This instrument is not presented as a 'final' product but as the beginning of an original idea. In the final Chapter of this thesis, the author has proposed a revision of aspects of the *Figures of Sound* which will form the basis of future explorations into this field.

The rationale for the *Figures of Sound* is essentially based on the directives of Kandinsky as to what constitutes elemental figural form. Other sources for the design of the *Figures of Sound* were the principles of 'selective encoding' and 'selective combination' as outlined by Sternberg & Lupart (1991) in their 'Investment theory of creativity'. In addition, the mathematical principles of the Golden Section, based on the Fibonacci numbers, which reflect proportions found commonly in nature provided a further guideline for the design of the items in the *Figures of Sound.*

The basic principles of point and line to plane comprise most of the items in the FoS and these will be outlined in more detail in the next section.

The original design of the *Figures of Sound* instrument was based upon ten questions. Questions 1 and 8 were designed to identify any link between visual intelligence and/or creativity and the identification of the mathematical proportions of the Golden Section and the Fibonacci numbers (outlined in Question 1 below). Questions 2 to 7 were all based on Kandinsky's principles of point and line to plane. Question 2 in the *Figures of Sound* does ask the students to visualise a colour and connect it with a shape and this is the only item which draws upon Kandinsky's principles underpinning the use of colour. All other items focus on form. Questions 9 and 10 were based upon the principles of selective encoding and selective combination as outlined by Sternberg & Lubart (1991).

A description and discussion of each question in the *Figures of Sound* follows. Where relevant, the background rationale, whether mathematical or artistic, is included to justify the context set for the design of each item.

FoS Question 1

The question asked the students to explore an empty space, the rectangle, and supply a presence in the form of a point. The term 'dot' is used because it was assumed that the term 'point' might confuse subjects.

Question 1

Here is a rectangle. There is nothing inside the rectangle.

Now imagine that I want you to put a dot inside this rectangle in a place where you think it looks best.

Look at the rectangle and imagine where the dot would look best.

Now take up your pencil and place a dot into the rectangle in a place where you think it looks best.

Place only one dot inside the rectangle.

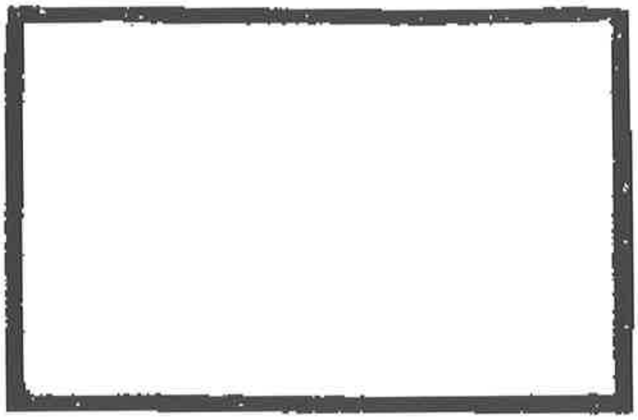


Figure 5.8: FoS Question 1

This first question originated from the principles underpinning the 'Golden Section', as embodied in the 'Golden Rectangle' and its possible links with visual thinking or visual intelligence. The rectangle in this question was drawn according to the specific mathematical proportions of the Golden Rectangle. The rectangle was deliberately given a frame-like border rather than a clean line, in order to elicit an aesthetic sense of space, rather than a strictly mathematical form.

From the early Greek philosophers, mathematicians and architects this 'form', the rectangle, has held a fascination. It originated from Pythagoras' experiments with the ratio between certain numbers and its relationship with the length of a vibrating string, in music. As the artists of the Renaissance called it, the Golden Section is the division of a line into two parts in a 'most pleasing and satisfactory way'. A line divided in half is 'static' and so, not very interesting. Dividing a line close to one end would leave one small piece 'unbalanced' against a large piece and so would also 'feel' very unsatisfactory. Most people seem to compromise between these two extremes when given a choice, and divide the line close to the specifications of the Golden Section.

The mathematical principle of the division of a line according to the Golden section, relates to the Fibonacci Numbers which are repeatedly found in measures in nature. The mathematical proportions of the Golden Section occur particularly in phenomena such as snail shells, pineapples, flowers, pine cones and trees. The early Renaissance artists took these mathematical proportions from nature and fused them into the essential element of the basic plane, or frame.

> *There appears to be a link between Fibonacci numbers, the golden proportion, and biological growth that excites the curiosity not only of many mathematicians but of biologists and philosophers as well*
>
> (Garland, 1988: 3).

The Golden Section is studied in the *Palace of Wisdom* program (see Appendix 1 for a short video coverage) but was not studied in the *Turning World* program. As this phenomenon is embedded in nature, and regarded as part of the natural language of the early classical artists, its inclusion in the FoS instrument was warranted in order to discover any links between visual thinking ability and any possible elemental form.

If a line AB has been divided internally at C according to the Golden Section, then mathematically AB:AC as AC:CB. In practice, this means that, if ϕ is used to denote the numerical value of this ratio, then $\frac{AB}{AC}=\frac{AC}{CB}=\phi$ which leads to the equations $\phi^2-\phi-1=0 \ or \ \phi=\frac{1+\sqrt{5}}{2}=1.61803.....$ Thus, for example, with internal division, AB is 1.618... times as long as AC, and AC is 1.618... times as long as CB (McCann, 1990: 345).

This question was constructed, based on the work of the 19th Century psychologist, Gustav Fechner, who was the first to examine the claim of special aesthetic interest of the Golden Section. Fechner's investigations from 1876, focussed on the rectangle (see FoS Q. 8).

Some of the greatest visual artists, painters, sculptors and architects followed the principles of the Golden Section when they worked. Da Vinci's 'The Last Supper' and Renoir's 'Luncheon of the Boating Party', Rodin's many sculptures of human form. In architecture from the Parthenon, to many Middle Ages Christian cathedrals, to le Courbousier's 20th Century work, there are outstanding examples using this mathematical technique.

The mathematical proportions within the rectangle are set out below in Figure 5.9 and these proportions served as the template for the marking scheme for Question 1.

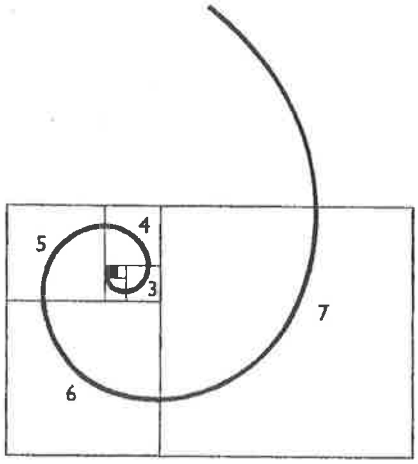


Figure 5.9: Golden Rectangle and Spiral (Huntley, 1970)

Subjects were scored on Question 1 with zero, one or two marks according to how close their 'dot' fitted into the specifications of the Golden Rectangle, the proportions of which are reproduced below. The specifications were mathematically determined then put onto a transparent overlay for ease of scoring. Figure 5.10 below shows the scoring sheet.

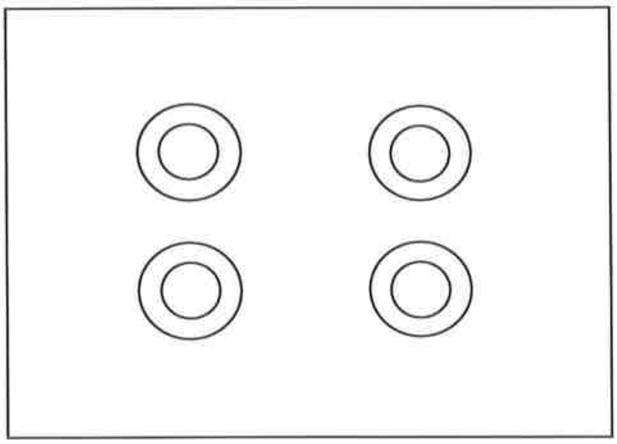


Figure 5.10: Scoring Template for FoS Question 1

FoS Question 2

The second question in the FoS was based on Kandinsky's guidelines that there are three elemental forms of the point: the square, the triangle and the circle.

Kandinsky was not the only one to suggest these, and Zusne also indicated that, in terms of the ideal 'gestalt', these three elemental forms provided a common base from which other variations could follow:

> *Gestalt psychologists seemed to know what a 'good' figure was: the circle, the square, the equilateral triangle, and other regular and symmetric figures ...*
>
> *(Zusne, 1970: 11).*

Kandinsky maintained that each shape is not just in *form* part of a universal of visual language, but also in *colour.*

Question 2

Here are three shapes – a triangle, a square, and a circle.
Each shape is inside a frame.
Now imagine that you have three coloured pencils:
Red (R)
Blue (B)
Yellow (Y).
Look at each shape and imagine one colour to suit each shape.
Ask yourself: what colour will best suit each shape?
Which shape looks best as Yellow? Which shape looks best as Blue?
And which shape looks best as Red?

Now take up your pencil and write either Y, B, or R inside each shape to indicate which colour best suits each shape.
Use only one colour for each shape and give each shape a different colour.

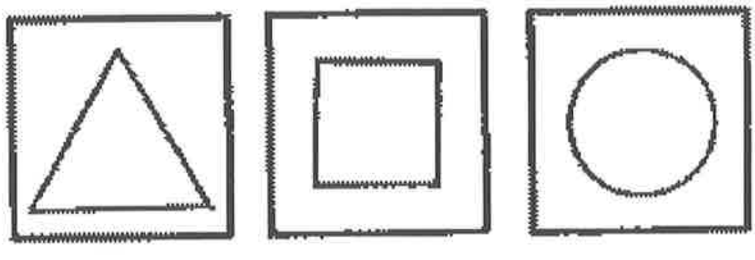


Figure 5.11: FoS Question 2

The stimulus for this question originated from Kandinsky's principles of plane and colour whereby the triangle represents yellow, the square represents red, and the circle represents blue.

Of the triangle, Kandinsky indicated:

> *... it is necessary to emphasise a special angle which lies between the right and acute angles ... when the openings of two such angles are bought together, they produce an equilateral triangle - three sharp, active angles - and become the signpost to yellow. Thus the acute angle has a yellow colour within*

of the square

> *The cold-warm of the square and its definite plane-like nature, immediately become signposts pointing to red ... it is not, therefore without justification that the right angle is placed on a parallel with red*

and of the circle

> *The obtuse angle increasingly loses its aggression, its piercing quality, its warmth, and is thereby distantly related to a line without angles which ... constitutes the third primary, typical form - the circle. The passiveness in the obtuse angle, the almost missing forward tension, gives this angle a light blue tone ...*
>
> *(Kandinsky, 1926 in 1979: 73).*

Kandinsky has not been the only one to link form with colour as, according to Kepes (1969: 168), "Colour remains as a universal keyboard of feelings … a spatial element that can be organised structurally as well as used as an elementary sensory quality with an emotional effect on the beholder."

Students were scored zero, one or three on this question.

FoS Question 3

The third question in the FoS was designed to explore Kandinsky's notion that form not only has essential elements of colour, sound and movement but also emotion and temperature. An ability to appreciate non-objective art forms stems in part from the ability to identify, in this instance, 'hot', 'warm' or 'cold' lines:

Question 3

Here are three lines.
Each line is inside a frame.
At the bottom of the page are three words: *cold, warm* and *hot.*
Give each line a separate name or title by writing *cold, warm* or *hot* on the line under it.

Look at the lines first and ask yourself: what line will be called, *cold;* what line will be called *warm;* and what line will be called *hot*?

Now take up your pencil and write one title on the line under each frame. Give each line a different name or title.

________ ________ ________

cold
warm
hot

Figure 5.12: FoS Question 3

The vertical line was designed to elicit the answer, 'hot'. Kandinsky argued that this line is,

> *In complete contrast to the horizontal line, which stands at right angles to it, and in which flatness is supplanted by height, and coldness by warmth. Therefore the vertical line is the most concise form of the potentiality for endless warm movement (Kandinsky, 1926 in 1979: 59)*

The middle figure was designed to elicit the response, 'cold', as according to Kandinsky:

> *The simplest form of the straight line is the horizontal. In the human imagination this corresponds to the line or the plane on which the human being stands or moves. The horizontal line is also a cold supporting base which can be extended on the level in various directions.*

> *Coldness and flatness are the basic sounds of this line, and it can be designated as the most concise form of the potentiality for endless cold movement … (Kandinsky, 1926 in 1979: 58.)*

The diagonal was designed to elicit the response, 'warm':

> *The third type of straight line is the diagonal which, in schematic form, diverges from both of the above at the same angle and, therefore has the same inclination to both of them; a circumstance which determines its inner sound - equal union of cold and warmth. Therefore the diagonal line is the most concise form of the potentiality for endless cold-warm movement (Kandinsky, 1926 in 1979: 59).*

The links between this item and the analog drawings outlined in Chapter 3 are relevant to note. Kandinsky's principles of the vertical being *hot* and the diagonal *warm* clearly connect with the bases of the analog drawings, specifically *energy* and *anger* from the vertical and joy from the diagonal movement.

Students were scored zero, one or three for this item.

FoS Question 4

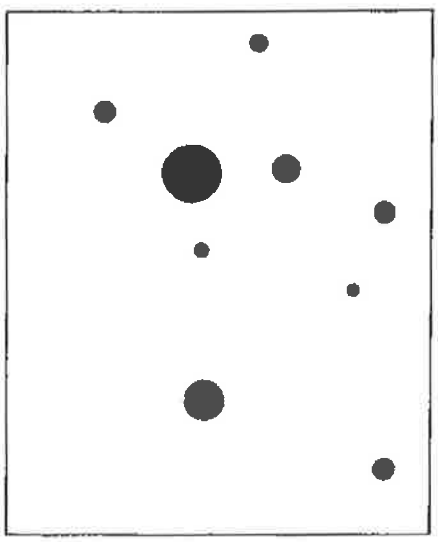
The fourth question in the FoS was based on a drawing of Kandinsky's, "Nine points in ascent" (Kandinsky, 1926 in 1979). His adherence to a universal grammar of form, which directs principles of feeling and movement were used as the basis of this question. If the shapes were squares or rectangles, for example, they would not exude the sense of movement.

It is interesting to note here the use of the term 'points' rather than 'circles' was accepted by all subjects who completed the FoS. Not one subject indicated a confusion with the use of the term 'point' within the frame.

Question 4

Here is a drawing of some points. They are in a frame.

Look at these points and ask yourself: are they rising up, are they falling down, or are they still?
Take some time to look at the points.
Now take up your pencil and tick one box for your answer.



☐ the points are rising

☐ the points are falling

☐ the points are still

Figure 5.13: FoS Question 4

Kandinsky has used the space in this rectangle to represent a movement upwards, claiming that form itself, along with the appropriate use of the point (in this case circles) can speak a language of movement.

The correct answer for this question was 'rising up'.

Kandinsky has indicated that the use of space in this drawing is as important as the positioning of the points to bring about movement upwards. The use of 'the diagonal' (warm) line through this sketch combined with the 'weight' of the points communicates the rising up movement.

Students were scored one or zero on this question.

FoS Question 5

This question also reproduces a drawing of Kandinsky's, entitled, "Cool tension toward the centre" (Kandinsky, 1926 in 1979). Although Kandinsky again used circles for movement, he showed in this work that circles do not have to rise, balloon-like, if they are placed appropriately within the frame.

Question 5

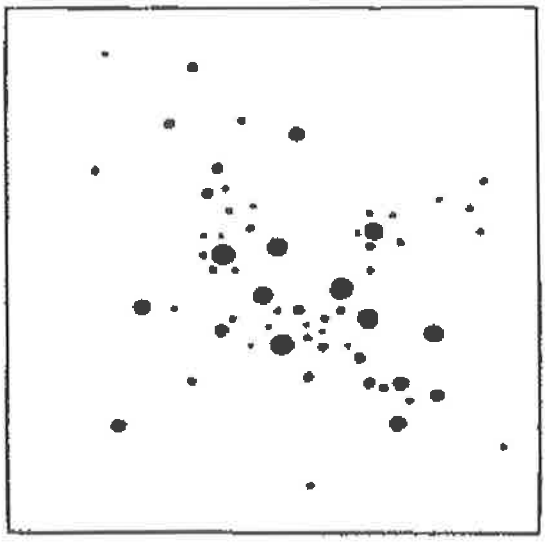
Here is a drawing of some more points. They are also in a frame.

Look at these points and ask yourself:

Are these points still, or are they moving in towards the centre, or are they moving out towards the edges?

Take some time to look at these points.

Now take up your pencil and tick one box for your answer.



☐ still

☐ moving in towards the centre

☐ moving out towards the edges

Figure 5.14: FoS Question 5

The grammar of form that Kandinsky claims would underpin this work relies on the horizontal/vertical/diagonal positioning of the points which drag them into the centre of the frame. The use of free space just inside the frame also reinforces this movement. The correct answer was 'moving in towards the centre' and subjects were scored one or zero on this question.

FoS Question 6

This question is based on a reproduction of Kandinsky's graphic point and line representation of the leap of the dancer Palucca.

According to Kandinsky, just as 'points' exist in classical ballet, where the leap constituted a straight, vertical direction, so too in modern dance, the leap:

> *frequently forms a five-pointed plane with its five extremities - head, two feet and two hands, whereby the ten fingers form ten smaller points ... thus we have active and passive point formations which bear a relationship to the musical form of the point*
>
> *(Kandinsky, 1926 in 1979: 42).*

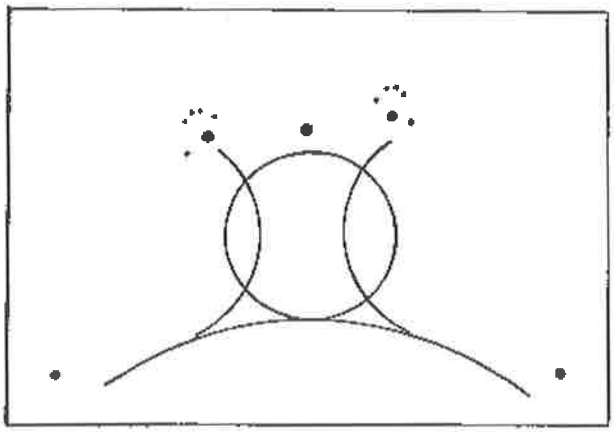
Question 6

Here is a drawing inside a frame.

Give this drawing a title by ticking one of the boxes below.

Look at the drawing and ask yourself: which name or title suits this drawing best - running, swimming or jumping? Choose only one of these names or titles for this drawing.

Now take up your pencil and tick the box which gives the best title or name for this drawing.



☐ running

☐ swimming

☐ jumping

Figure 5.15: FoS Question 6

The use of the central dominant point of the body along with the semi-circular forms of the lines (the circle representing rolling or movement) give this drawing its upwards movement. In addition, the 'weights' of the points at the top take the movement upwards.

The term, 'leaping' was felt to be too 'emotive' and hence a possible distracter, compared with the more common terms 'swimming' or 'running', and so the term, 'jumping' was incorporated as the correct response to this figure.

The photograph from which the point and line sketch was made (Kandinsky, 1926 in 1979: 42) is reproduced below in Figure 5.16:

Figure 5.16: Leap of the dancer Palucca by Kandinsky

The subjects scored zero or one on this question.

FoS Question 7

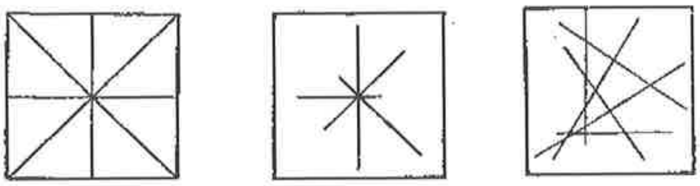
Of all the questions in the *Figures of Sound* instrument, Question 7 possibly engendered the most ideas for further exploration and discussion.

The stimulus for this item came from Kandinsky's belief that form can communicate sound. Relying just on form (i.e. point and line to plane), and utilising reproductions of Kandinsky's own sketches, this question required the subjects to identify a sound (including silence) with each form.

Question 7

Here are three frames with different sets of lines inside them.
At the bottom of the page there are three names or titles: laughter (a), silence (b) and scream (c).
Look at the drawings and ask yourself, which one should have the title, laughter, which one should have the title, silence and which one should have the title, scream?

Now take up your pencil and provide a title for each drawing by placing either a, b, or c on the line under it:



___ ___ ___

a. laughter
b. silence
c. scream

Figure 5.17: FoS Question 7

The first item reproduced on the left is what Kandinsky would call the "silent lyric" (Kandinsky, 1979: 138). This sketch has four elementary lines converging in a central point with a complete "release of tension" as all lines connect in "an expression of rigidity" with the frame. This figure was designed by the author to elicit the answer "silence".

The second item, centred in the middle, represents what Kandinsky calls the "dramatization" of the same elementary lines. Although they converge in a central point, there is a "complex pulsating expression" and a distinct tension as none of the lines connect with the frame. Without this release of tension, which a connection with the frame would bring, there is a focused yet uneasy, tense expression. A scream is generally focussed and tense, and the answer "scream" was intended for this figure.

The third item represents all acentric lines, with "the diagonals strengthened through their repetition, " and there is a "restraint of the dramatic sound at the point of contact above" (Kandinsky, 1997: 138). In other words, this is a repetitive, multi-layered sound with the release of tension as the line connects with the frame. It was felt that this best represented the layered, releasing sound of laughter.

This question was deliberately incorporated into the FoS after the initial 'warm-up' of easier questions such as Question 3. The complexity of the interplay between the point, line and plane and its links with sound and emotion is, in the opinion of the author, firmly established in this item.

However, as is detailed in the Results (Chapter 7), and following Discussion and Conclusions (Chapter 8) to this thesis, the large majority of subjects identified the 'silence' figure yet transposed the 'scream' and the 'laughter' representations.

Subjects scored zero, one or three for this question.

FoS Question 8

This question was designed to reinforce any possible findings from Question 1, regarding the strength of the Golden Section and its possible links with visual intelligence. The question was constructed, based on Fechner's graph, which appears in Figure 5.18.

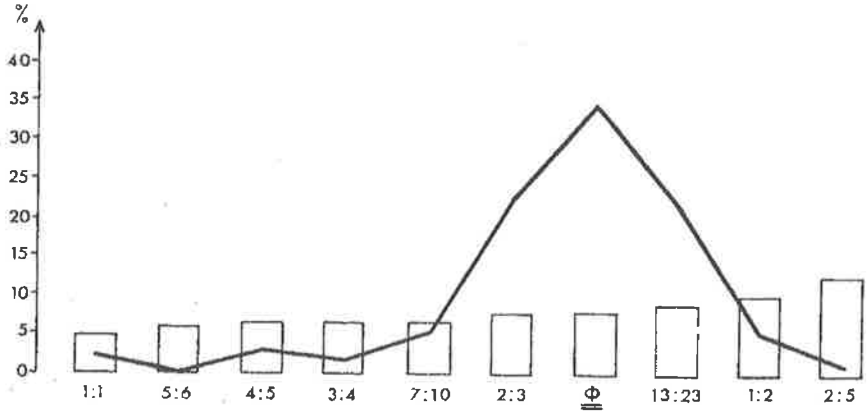


Figure 5.18: Fechner's graph (in Huntley, 1970: 64)

The box fourth from the right was mathematically constructed to conform to the exact proportions of the Golden Section.

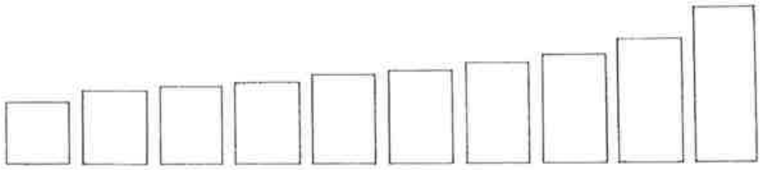


Figure 5.19: Fechner's boxes

The FoS Question 8 however, used only nine of Fechner's original ten boxes, to focus the subjects' attention and heighten discrimination. The box fourth from the right in Question 8 (Figure 5.20 below) was drawn (Murray-Harvey, 1996) to the exact proportions of the Golden Section:

Question 8

Here are some boxes. They are different shapes and sizes.
Take a look at all of the boxes and put a cross inside the one which you think looks the best.
Which box appeals most to you?

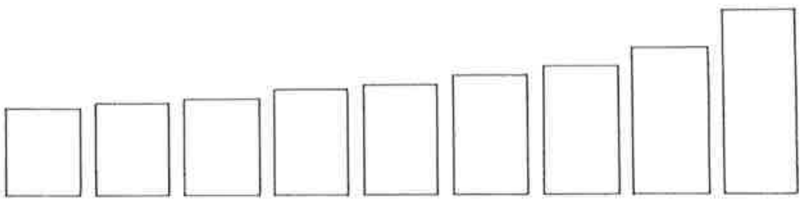


Figure 5.20: FoS Question 8

Subjects scored two points if they chose the 'golden rectangle' box, one point if they chose a box adjacent and zero if any other box.

Although this item generated some interesting findings (see Chapter 7), it was possibly misleading to include the square box at the far left, as this proved to be the most popular, and possibly represented a distractor from the rectangles or skewed the subjects' field of focus.

It is pertinent to note here, as the results in Chapter 7 confirm, that a majority (72%) of subjects scored zero on this question. An improved variation, removing the square box and reducing the number overall or refining the scoring regime for improved discrimination, is proposed in Chapter 8 of this thesis.

FoS Question 9

The principle of selective encoding (Sternberg & Lubart, 1991) formed the basis for the design of this question, which was originally designed to ascertain if the subjects could envisage the uniqueness of the point by using the example of a grain of sand. Kandinsky provided many examples of point forms which have been reproduced in Chapter 3 and it was anticipated that this question might elicit variations on these point forms.

Question 9

Here is an empty frame.
Now I want you to picture a scene in your mind.
Picture a sandy desert.
Think about this:
  A desert is a sea of sand.
  Each grain of sand is different.
Now take up your pencil and draw one grain of sand.

Figure 5.21: FoS Question 9

This question has its origins in notions of 'creative' visual thinking rather than visual 'universals' upon which Q. 2–7 focussed. Sternberg & Lubart (1991: 19) indicated that, " … fluid ability tests and our own measures of selective encoding, comparison, and combination skills were strongly correlated with creativity".

It was anticipated that the subjects might selectively encode from a 'string of information' (empty frame … scene … sandy desert … sea of sand … each grain different …) the idea to produce a point which had an original or different version of a dot, which would be a normal sketch of a grain of sand.

Some subjects did 'encode' the information in a creative way and two examples are reproduced below in Figure 5.22. to show that the concept of a multi-faceted grain, or point, was certainly grasped by some:

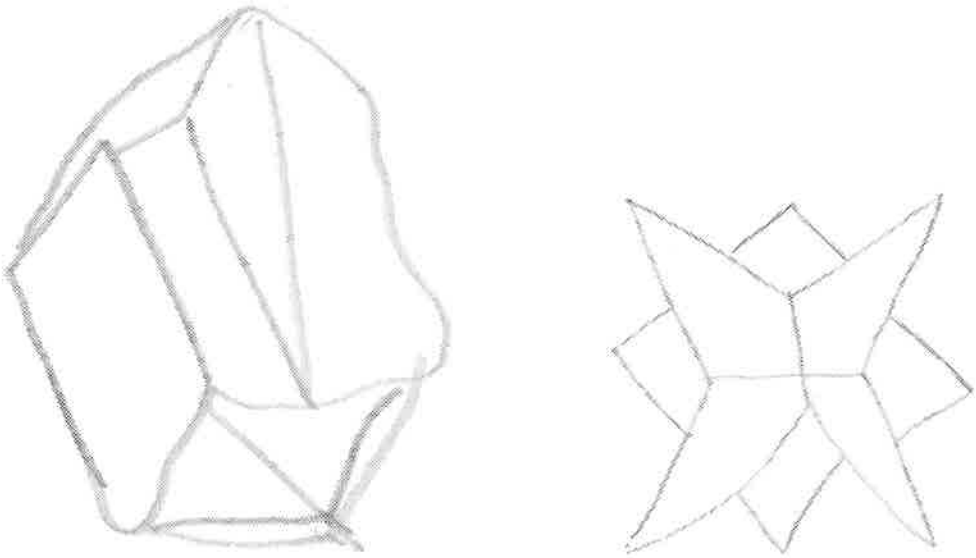


Figure 5.22: Student Examples: A Grain of Sand

These points have been reproduced in their actual size in order to show that these subjects diverged from the concept of a grain of sand as a single spot, undifferentiated from all of the other grains, to multi-dimensional points whose size is totally out of proportion to a real grain of sand.

The scoring for this question was designed to give three points to students with three or more points or planes to their grain (as the examples above would have scored); two points for the equivalent two or more points or planes; one point for a variation on a point (such as a small circular or square shape); and zero points for a dot.

FoS Question 10

This question was designed to build upon Question 9 to see if subjects could 'selectively combine' the principles of the uniqueness yet insignificance of the point, or grain of sand, with the vastness of a desert.

The concept behind this item, which along with Question 9 had a focus on visual creative output, was to ascertain if the students could elaborate upon the suggestion in Question 9 and then continue the idea of visual differences even in each grain of sand, i.e. to visually represent this in a desert formation.

Question 10

Here is another empty frame.
Now take up your pencil and draw a desert.

Figure 5.23: FoS Question 10

It was anticipated that subjects might be able to combine the visual image of millions of unique grains to make up a new view of a desert. Some students did this in quite abstract ways, but the majority represented typical desert scenes complete with palm trees. Although the initial stimulus for this question may not have been strong enough to allow the subjects to 'combine' the idea of uniqueness of grains of sand with the sea of the desert, some interesting insights warrant future investigation into this idea.
For the purposes of this thesis, Questions 9 and 10 were not included in the results as it was clear from the raw data that the majority of students reproduced a dot for Question 9 and a typical desert scene for Question 10. However a more detailed discussion of this instrument and suggestions for variations on these questions, which will be incorporated into a future design of the FoS, and is raised in Chapter 8.

Chapter 6: Research Design and Testing Procedures

For close Designs and crooked Counsels fit,
Sagacious, Bold and Turbulent of wit …
(John Dryden, Absalom & Achitophel)

[The purpose of this chapter is to detail the research design and testing procedures carried out for this study, which compared scores on a visual test of *g*, (the RPM), a figural test of creativity, (the TTCT), and the visual thinking instrument, *Figures of Sound*]

6.0. Rationale

This thesis has highlighted the links between intelligence, creativity and giftedness, focussing on visual thinking skills. From the research reviewed, it is clear that attempts to identify the markers of such abilities, especially tests of creativity, all have significant limitations. However, the essential integrity of the RPM and TTCT, as standardised measures of figural IQ and figural creativity respectively, has been established. Whilst it has never been proposed that the FoS is a standardised measure in the same way that the RPM and TTCT are, its inclusion was warranted as a point of comparison with the standardised measures and as an original contribution to the on-going exploration of visual thinking and its links with IQ and creativity.

Lubinsky (2003), whose research has been predominantly with the Studies of Mathematically Precocious Youth (SMPY) program at Johns Hopkins University, has highlighted the need for more 'spatial' measures of gifted students, indicating that the SAT-Math and SAT-Verbal tests, which are used to select students for the SMPY program, have been successfully used for years to identify these traditional markers of giftedness, but that spatial ability, despite its well-established links with mathematical thinking, has been largely overlooked. Lubinski suggests a new model of 'talent search' for the SMPY which includes the identification of spatial abilities:

> *The next logical step suggested by this model is reaching out to a population of intellectually precocious youth that are currently underserved by modern talent searches. Excellent evidence suggests that a population of intellectually precocious youth, with especially high spatial reasoning ability, is neglected … they are an inconspicuous population …*
>
> *(Lubinski, 2003: 522).*

While some 'tests' of spatial ability are cited in the research, the most common one being the spatial ability composite of the Differential Abilities Test (DAT–C), there is clearly a need for more research which specifically focuses on this aspect of intellectual functioning.

The rationale for the inclusion of the RPM, the TTCT and the FoS in this study was to test the central hypothesis raised which is that visual thinking is a rarely-cited yet essential determinant of advanced intelligence and creativity, and an ability which can be measured and enhanced with appropriate instruments and teaching interventions. In addition the role that creativity plays in the determination of advanced intelligence, and the links with measures of giftedness and visual thinking abilities was posed as central to this exploration.

The stability of the two popular assessments of figural IQ (RPM) and figural creativity (TTCT) was also presented as a key question underpinning this study.

The following chapter will detail the results of testing and re-testing in 15 Adelaide primary schools, using the Raven's Progressive Matrices (RPM Standard form), the Torrance Tests of Creative Thinking (Figural Forms A and B), and the *Figures of Sound* instrument.

6.1. Selection and distribution of subjects

In order to examine the stability of the IQ test and the creativity test over a period of one year, a significant number of subjects was needed, with approximately 300 proposed as an initial target. Such a population was considered large enough to also examine possible correlations or links between measures of psychometric intelligence, measures of creativity, and scores on the visual thinking instrument. The subjects were chosen at the Year 5/6 level of schooling, as the age range of 10 – 11 years old is identified in the research as a very reliable period for testing. It was pragmatic to choose the upper primary level which was much easier to access than the secondary level. In addition, the South Australian Department of Education and Children's Services (DECS) had established, two years previously, seven Primary Focus Schools which had, during that time, been trialing special higher-order thinking programs and teacher training programs in the development of Students with High Intellectual Potential (SHIP). The researcher sought and gained permission from DETE to include four of these SHIP schools in the data collection in order to ascertain if there would be any significant differences in the subjects' scores.

It should be noted, however, as outlined in Chapter 4, that the SHIP schools were not selective schools for gifted students but regular Government schools which had a special SHIP focus. The initial target number of 300 subjects translated into approximately 15 classes. Consequently, 15 primary schools in metropolitan Adelaide were identified according to their geographic location and socio-economic status

(*SES*), with three schools from each of five districts: north, south, east, west and central. The choice of location across all five areas was chosen as a factor in order to access and monitor the full range of SES locations. Previous studies in Adelaide have indicated that higher *SES* locations provide more programs for the identification of, and provision for, gifted students (McCann & Start, 1983).

All schools selected for this study were Government schools and included four of the South Australian State Primary SHIP Focus Schools: one each from north, south, east and west. Permission was obtained from the DECS to test one Year 5 class within each of the 15 schools. Ethics clearance was also sought and obtained from DETE. Numbers of students within each class averaged 26 but on the days allocated for testing some students were absent, or unavailable, and consequently the total initial group tested across all 15 schools totalled 305.

6.2. Nomination of the students

In each school the Year 5 teacher, in consultation with the Principal, was asked to nominate five students from the Year 5 group most likely to have the highest intellectual potential. This information was requested and the nominations, given voluntarily, were treated confidentially. It was sought in order to examine the possible correlations between teacher perceptions and nominations of the brightest students and their actual performances on the test battery. In the ten schools which completed this aspect of the study, the Year 5 Form teacher completed the nomination form and then conferred with the Principal for a second opinion. Five schools declined to participate in this voluntary aspect of the study, claiming that naming five out of a class was counter to the ethos of equality within the school. The correlations between scores obtained by *nominated* students and those designated as *regular*, from the schools who did participate in this aspect of the study, are discussed later in this chapter.

6.3. Testing Procedures

The entire population of 305 students at the Year Five level of schooling was tested in Year 1 of the study with the timed version (30 minutes) of the Ravens Standard Progressive Matrices (RPM), the Torrance Test of Creative Thinking (TTCT) (Figural Form A) and the *Figures of Sound* instrument. The TTCT took approximately 30 minutes to complete and the FoS took approximately 15 minutes.

All tests, the TTCT, the RPM and the FoS, were administered solely by the author to one whole class at a time. The DECS permission had been obtained to allow the students in each school to be tested over a period of approximately two hours, including rest breaks between the more time-consuming tests such as the TTCT and the RPM. For both the TTCT and the FoS, the author read through each question with the class in order to minimise possible confusion that students with reading difficulties might have had regarding the test administration and directions. Testing the 15 classes took approximately three months to complete, and was done at the end of the first year of the study (October - December) as this time of the year allowed the teachers the necessary period for observation and reflection required for reliable student nomination. It was also the optimal time for getting reliable scores on the Ravens Progressive Matrices, as according to the RPM Handbook, "norms for the Standard Progressive Matrices are based on testing undertaken at the end of the school year (October to November)" (de Lemos, 1989: 22).

6.4. The Integrity of the Data Collection

For the duration of the quantitative aspect of the study, the author made a minimum of six visits to each of the 15 schools involved. The first visit was to explain and discuss the project with the Principal, to satisfy the appropriate ethics clearance and to assure the school of the full written support of DECS for the project.

Once support was offered, (usually after the Principal conferred with the staff), the second visit by the author was to meet with the Year 5 teacher to clarify the details, to ask the teacher to complete the teacher nomination form, to collect a class list of names in preparation for testing and to check out the physical lay-out of the classroom for the testing day. In addition, during this time, the support of each Principal was requested to enquire of the whole staff if any previously known testing of this nature had ever been conducted in the school. Each participating school confirmed that no previous testing (e.g. with RPM or TTCT) had been conducted. Actual proformas of the test materials were not given to the teachers prior to the testing. Letters were sent by the author to all parents/caregivers to request consent for the testing and to assure them of the school's full support for the study and of the DECS ethics clearance. The teachers agreed to collect the consent forms prior to the testing date. From all schools which had agreed to participate in the study only seven students were unable to do the tests: five did not return the consent forms and were excluded on the day of testing and two declined to be tested on religious grounds.

The third visit by the author was to conduct the testing. Most of the teachers elected to stay in the classroom during the testing but they were not required to do so. The timed version of the RPM was given for pragmatic reasons. With such a large number of subjects and the requirement for minimal disruption of the school day, allowing the untimed delivery of the RPM was not feasible. The students were given short breaks between the administration of each test and all copies of proformas, including any blank ones, were collected at the completion of testing. As the students found all of the materials novel and interesting, they remained completely on-task for the entire time. Even during the completion of the RPM, no doubt perceived by the students as the 'hardest' of the tests, there was no evidence of frustration or stress from the students as they obviously had the option of simply guessing once they began to reach their plateau.

The fourth visit to each school was to give feedback to the teacher and the Principal on the general performance of the students on the RPM and the TTCT. For the RPM, specific names and scores were not given which was in accordance with the ethics clearance that the author obtained from DECS which was an assurance that no student would be identified by IQ score. No feedback was given to the students in the first year of the testing as this could have affected their performances when testing was conducted again one year later.

The fifth visit took place at the same time (October to early December)the following year to conduct the second round of testing with the students who were available to do so. In a way similar to the previous year, consent forms were sent to parents/caregivers and returned to the teachers by the students.

The numbers of students tested in the second year, whilst still quite adequate to sustain such a study, were reduced, partly because some students did not return consent forms, some had changed classes or schools, but mainly because two schools could not participate in this second stage. One such school had a change in leadership from the previous year and the new Principal felt that the use of the RPM was not in keeping with the principles of equity which the school valued. The second school had agreed to participate but in the final stages of November school engagements, could not actually commit to a testing date. This school offered access to the students early in the following year ("when everything is not in chaos!") but this extra time, in terms of student maturity, would have invalidated the data. Both schools were thanked in writing for their interest and participation.

The sixth visit to the schools took place at the conclusion of all testing in the second year of data collection, (when the students were still in Yea 6). Although the RPM scores could not be revealed, because of the previously mentioned ethics clearance from DECS, the performance of students on the TTCT could be shared with teachers and students as there is no clear indication on the TTCT test instrument of the actual scores gained on fluency, originality and elaboration. Consequently the author re-visited every class and gave them detailed feedback on both years of their TTCT, returning their year one proformas for discussion and comparison with their year two performance.

These were very valuable experiences for the students and they freely swapped and discussed their responses on the parallel Figural Forms of the TTCT. In addition, the teachers were interested to note performances on the TTCT as most had never seen a test of creativity before. The author explained the basic methods of interpreting such instruments, such as fluency being the number of responses and originality being the statistical concept of an 'outlier', or '*the only student in the class who thought of turning the shape into …*' This aspect of the study, while very time-consuming for the author, was considered important to the integrity of the study as it was the opportunity to give feedback to the schools and students who had volunteered to engage a significant amount of their time.

At the conclusion of the Year 1 testing, 20 students were selected from the original group, by teacher nomination, to participate in the *Turning World* Program (as outlined in Chapter 5 and detailed in Appendix 3). The use of teacher nomination (rather than selecting the twenty top IQ scores, for example) was the preferred method of selection for the following reasons:

1). this allowed for an examination of the accuracy of teacher nomination and the 'closeness of fit' between the teachers' observations of the students so nominated and their actual performances on the RPM, TTCT and FoS. It needs to be remembered that the twenty students chosen (categorised as the *ng* subjects) were actually part of a larger group (n= 50) who were all nominated by teachers from the schools which agreed to participate in this aspect of the study.

2). the *Turning World* program was designed by the author as an accelerated, enriched and extended academic program and it was important that the students attending were already performing at a significantly advanced academic level. The *Turning World* was not designed for disaffected or underachieving gifted students (who may still have scored highly, for example, on the RPM but who would not have been nominated by teachers). Participating schools would not have allowed such students to 'fall behind' even further, academically, by attending an out-of-school enrichment program.

3). the form of nomination allowed for students to attend in a group of four from each school, thus providing them some sense of familiarity with each other and facilitating ease of transportation (usually one car per school) to and from the University. If twenty individual students had been selected from 15 different schools there might have been a sense of isolation or alienation within the group and difficulties with transportation.

The final group of 20 who attended the *Turning World* program comprised four students each nominated from five schools, each school representing one of the geographic locations (N, S, E, W and Central). The five participating schools offered to provide some teacher release time to observe the program and had full parental support with issues such as transport. The students selected attended the University of Adelaide over a period of ten weeks, with special classes being held at the Art Gallery of South Australia and the South Australian School of the Future.

One year after the initial testing round, in the corresponding period of October to December, the original population was re-tested with the Ravens Progressive Matrices and the TTCT (Figural Form B). By the time of re-testing, the number of students from the original group had dropped to 193, as many students had changed schools or classes over the year or were otherwise unavailable for re-testing. In addition, two schools were unable to participate in the second year of testing. Within this retested cohort were 18 of the 20 students who had completed the Turning World program. A mild 'practice effect' was noted for the whole group on the test results for the RPM in the second year. This was expected and is in keeping with the research (de Lemos: 1989) as outlined in the following chapter which details the results of all testing.

For the second year of testing it is important for the integrity of the data collection to note that the re-tested students were *all* tested together in their classes at the same time as their other classmates, and under the same conditions as the previous year. The students who had participated in the *Turning World* program, for example, and who were obviously well-known to the author in the second year, were just members of their regular class for the re-testing. They were not tested separately, i.e. at the University of Adelaide, at any different time, or under different conditions from the regular group.

TABLE 6.1: Testing and Teaching Schedule

TIME OF TESTING/ TEACHING	TOTAL NUMBER OF STUDENTS	SCHOOLS SELECTED	SUBJECTS BY AREA	TESTS/ TEACHING
FIRST YEAR OCTOBER - DECEMBER	15 Year 5 classes tested comprising 305 Subjects	3 Northern 3 Southern 3 Central 3 Eastern 3 Western	65 61 55 63 61	1. Ravens Standard Progressive Matrices 2. Torrance Tests of Creative Thinking Figural Form A 3. *Figures of Sound*
SECOND YEAR APRIL - JUNE	20 Year 6 students nominated by teachers as gifted from the above group	1 Northern 1 Southern 1 Central 1 Eastern 1 Western	4 4 4 4 4	The *Turning World* Enrichment Program taught over a 10 week period.
SECOND YEAR OCTOBER - DECEMBER	13 Year 6 classes tested comprising 193 subjects *	3 Northern 2 Southern 3 Central 3 Eastern 2 Western	44 32 41 51 25	1. Ravens Standard Progressive Matrices 2. Torrance Tests of Creative Thinking Figural Form B 3. *Figures of Sound* given to the students who completed the *Turning World* Program

(The same students tested in the first year were re-tested the following year. The smaller number results from students who had moved schools or were unavailable for the re-testing, including two complete classes, one year later)*

6.5. Scoring the data:

The data for the RPM Years 1 and 2 was scored directly from the Directions Manual and Scoring Guide (de Lemos, 1989). The RPM has been extensively normed on Australian populations.

The scoring is relatively easy with the use of a transparency overlay to the answer sheets. The scores yield a Raw Score (out of a total score of 60) which is then transformed into the Scaled Score (SS) which equates to the IQ. The data is analysed in Chapter 7 according to both raw and scaled scores.

The TTCT Years 1 and 2 was scored directly from the TTCT "Directions Manual and Scoring Guide" (Torrance, 1970) with different manuals for Figural Forms A and B. Unlike the Urban & Jellen TCT–DP, which the authors claim can be scored in "one to two minutes" (Davis in Colangelo & Davis, 2003), the TTCT are very time consuming to score. However, when consideration is given to the kinds of results yielded in terms of fluency, originality and elaboration, and keeping in mind Torrance's claim that the TTCT identify gifted students more accurately than IQ tests, then it is reasonable that scoring should take some time. The Literature Review for this study confirmed that such significant claims regarding human intellectual abilities should not be sought after lightly nor in haste.

The RPM tests and the TTCT were designed, normed, and released at similar times, and the RPM in particular has had extensive norming on Australian populations. The extensive, reliable use of the TTCT across many countries, and its status as the most commonly utilised measure of creativity has already been documented in this thesis. The 1981 longitudinal study (Torrance, 1981), based on the Torrance 1970 norms and scoring guides, in addition to the "multitudes of validation studies" (Davis in Colangelo & Davis, 2003) that exist, confirmed the reliability of this test, particularly for the figural forms. Updated norms and scoring guides for the TTCT were just being released as this study was beginning. Consequently, a follow-up study re-scoring the Year1 and Year 2 TTCT original data with the updated norms and scoring guides is already in progress. For the purposes of this study, however, the main objective in scoring the TTCT was to adhere strictly to the guidelines for scoring as set out in the manual. Whilst the scorer was trained in the process of scoring this test, Torrance has confirmed that "it is not necessary to have special training in scoring these tests to assure reliable results. What does appear to be necessary is that the scorer read and follow the scoring guide as precisely as possible, accepting the standards of the guide as a basis for judgement" (Torrance, 1970: 10).

The aim of this study was not to critique creativity testing *per se*, but to explore the links between measures of creativity, giftedness and visual thinking. The TTCT, RPM, and FoS analyses certainly fulfilled this function. The TTCT have been revised (Torrance, 1999) since the data was collected for this study but the integrity of the original tests has been maintained, even in the most recent evaluations (Colangelo & Davis, 2003; Cropley, 2001; Heller et al, 2000). The scoring for the FoS, whilst not a standardised test, has already been detailed in the previous chapter.

The author scored all of the Year 1 (n=305) and Year 2 (n=193) RPM tests as well as the Year 1 (n=305) FoS instruments.

The Years 1 and 2 TTCT tests were scored by a graduate of the Master of Gifted Education degree from Flinders University. Although the TTCT has a high level of reliability in scoring, particularly if strict adherence to the scoring manual is maintained, it was important, for the integrity of the data, that the author did not score the TTCT tests, especially the TTCT2 data. Unlike the RPM and the FoS, which have one specific response to score, the TTCT could be subject to scorer subjectivity and interpretation. The scorer for the TTCT2 tests had no knowledge for example, of the twenty subjects within the data (n=193) who had completed the *Turning World* program. If the author of this study had been scoring these tests the subjectivity of interpretation might have been called into question.

All scores were entered into an Excel© spreadsheet before being statistically analysed. A spreadsheet copy of the raw data is reproduced in Appendix 7, however in keeping with the DECS ethics clearance guidelines data identifying IQ by area (N, S, E, W, C) is not presented.

6.6. Procedures for analysing the data

The procedures for analysing the data for the quantitative aspect of the study have been kept as relatively simple correlational explorations as the data is not complex enough to sustain higher-order statistical analyses. Basically the aim of the exploration was to identify correlates of figural IQ, figural creativity, and visual thinking ability. The data were analysed using the JMP® Discovering Statistics program, Version 3.1.6 (1995). JMP® began development by the SAS Institute Inc., Cary, North Carolina, USA, in 1989. It was extensively field-tested and trialled during six years, through several versions in a variety of academic and industrial placements, on both Macintosh and PC compatible desktop platforms. A Macintosh G4 computer was used to operate the statistical program. The visual nature of the data presentation of the JMP® program, detailed in the next chapter, suited this study. A Statistical Glossary is reproduced in Appendix 6 which explains the format of the data analyses and presentation and the parametric and non-parametric analyses which are accessed by this program.

Chapter 7 presents the results of the analysis of the data and these results are discussed further in Chapter 8.

Chapter 7: Results

Miss Vorontosov, how old do you weigh? enquires Mohi.
(Sylvia Ashton Warner, Teacher)

[The purpose of this chapter is to present the results of the testing procedures over two years, initially comparing stability and changes in scores on the RPM and the TTCT, then correlating scores on both tests with scores on the FoS. Results obtained by the students who attended the *Turning World* program are compared with the scores of the students who did not]

7.0. Analysis of results

The scope of this analysis was, in broad terms, an assessment of changes in measures of IQ (Ravens Progressive Matrices (RPM)), creativity (Torrance Test of Creative Thinking (TTCT) Figural Forms A and B) their correlates and other analyses as appropriate. The instrument designed by the author and described in Chapter 5 called the *Figures of Sound (FoS)*, also featured in the analyses. Correlations between the above tests' scores, as well as differences in the scores between the two applications of the RPM and TTCT tests in years one and two (eg. R2 – R1), known hereafter as 'change scores', were computed and analysed. Correlations of these scores and substrates of the TTCT: fluency, originality, elaboration, and of the FoS, were used to examine possible differences between subgroups such as gender, geographical area (loosely suggestive of socio-economic status), and teacher nomination (as 'gifted' or 'regular' subjects).

The analyses commence with an examination of the assumed normality of all measures. This requires an assessment of the degree of departure from normality of the data. This is important statistically, given that so many statistical procedures (Pearson Product-Moment correlation coefficients, ANOVA, multiple and pairwise comparisons of means and variances etc.) are based on the underlying normality of the data's distribution. In practical terms some of these procedures are robust to departures from normality (especially the *t–test*). Where this is not the case, non-parametric (i.e. distribution-free) measures based on ranks, were used in addition to or in place of distribution-sensitive measures.

The identification of 'outliers' on either pairs of tests (the RPM and the TTCT) lead to the elimination of six subjects, whose variation on measures of the same well-established and validated construct (the RPM) were such that serious doubts over the subject's reliability on such, or similar, tests had to be addressed.

The structure of the analysis of the data is summarised in nine sections. Each Section is then elaborated with the details of the analyses of results.

Section 1: Distribution, stability and analysis of the Ravens Progressive Matrices (RPM) scores

The first analyses in this study examined the normality and stability of the RPM scores over the period of one year. In general, the research supported the fact that these scores should remain stable and so comparisons were made between scores on the RPM1 (Ravens Year 1 scores) and the RPM2 (Ravens Year 2 scores). The data was analysed using both the raw scores (R1 or R2) obtained as well as the standardised scores (IQ1 or IQ2), commonly called the IQ scores. An analysis of the RPM by gender and by level of IQ was also conducted. Presentations of all of these analyses are contained in Figures 7.1.1 – 7.1.24.

Section 2. Distribution, stability and analysis of the Torrance Tests of Creative Thinking (TTCT) scores

The second set of statistical investigations was an examination of the normality and stability of the TTCT scores over a period of one year. The two figural forms of this test are parallel in content and form but utilise different figural stimuli (see Appendix 4). The TTCT data is analysed over the year, with the largest group obviously comprising the Year 1 cohort. Inter-test stability was examined across TTCT1 and TTCT2 and intra-test analyses compare results gained on the fluency, originality and elaboration substrates. These three subscores are available from the TTCT, despite the fact that the configuration of creativity in general, as outlined in Chapter 2, was for *fluency, flexibility, originality* and *elaboration*. However, scores for flexibility cannot be reliably determined (see Appendix 4 for a copy of the TTCT Figural Form A and analyses of the TTCT is presented in Figures 7.2.1 – 7.2.33).

Section 3. Comparisons between the TTCT and RPM in Year 1

This thesis has already highlighted the literature concerning the low correlation, particularly for students within the high IQ range, between scores on creativity tests and scores on IQ tests. This study consequently sought a comparison between the measures of creativity and IQ. The results of the data for the Year 1 cohort, comparing their IQ (RPM1) and creativity (TTCT1) are analysed in Figures 7.3.1 – 7.3.11. This is an important part of the overall analyses as it highlights some interesting findings on the creativity/IQ interface referred to in the Literature Review (Chapter 2). As it deals with the first year of the testing, these analyses are based on the largest cohort tested.

Specific analyses between IQ (RPM1) and the overall creativity (TTCT1) score, as well as by the TTCT's components of fluency, originality and elaboration scores are reported. In addition, these analyses and the *levels* of intellectual functioning, as determined by performance on the RPM1 (categorised as low, below average, average, above average and high, based on the Ravens Manual), are examined.

Section 4. Comparisons between the TTCT and RPM in Year 2

The results of the data comparing the RPM2 results in Year 2 and the TTCT2 results are analysed across Figures 7.4.1 – 7.4.13.

The specific analyses outlined for TTCT1 and RPM1, and their components, are replicated for the Year 2 data.

Section 5. Comparisons between performances on RPM Year 1 and Year 2 of students nominated by teachers and those not so nominated.

A Van der Waerden Normal Quantiles and an Analysis of Variance (ANOVA) was used in this section to compare the performance on the RPM1 and RPM2, and the change scores for the following four groups:

(i) those subjects nominated by their teachers as, 'most likely to do well on a test of high intellectual potential (n= 19)', (*ng*)

(ii) the sub-set of the nominated group (n=17) who attended the *Turning World* program, and completed all testing in the research program, (*n*)

(iii) the subjects not nominated, (*r*) and

(iv) subjects from schools which declined to make any nominations. (*u*)

As reported in this section, this study found a very high correlation between teacher nomination and actual performance on the RPM. The accuracy of teacher nomination, as reported in the research to date, will be discussed in more detail in Chapter 8 (Figures 7.5.1 – 7.5.3 deal with these analyses).

The second part of the analysis of data in this Section was a Chi-squared (χ^2) analysis between the four categories of nomination and the five levels of intellectual functioning on the RPM as referred to in Section 3 (Figures 7.5.4 – 7.5.6).

Section 6. Comparisons between performances on TTCT Years 1 and 2 of students nominated by teachers and those not so nominated.

This section presents an analysis of the data for the TTCT Year 1 and Year 2 between the categories of nomination as outlined in Section 5.

A specific analysis is then conducted on the subsets of the TTCT Year 2: fluency, originality and elaboration.

Figures 7.6.1 – 7.6.16 report on this data.

Section 7. Comparisons between performances on RPM Year 1 and the Figures of Sound (FoS) instrument.

For the whole group, the *Figures of Sound* (FoS) was only administered in the first year of testing. As it has no parallel form, and is not a standardised test, there was little point in administering it in the second year of the study. The main aim of its inclusion in Year 1 was to explore any possible validation with either a figural test of *g*, (the RPM) or a figural test of creativity (the TTCT). Data was analysed on the total scores for the RPM and total scores for the FoS, and then individual analyses were conducted on Q1–8 of the FoS and correlations with the RPM.

Figures 7.7.1 – 7.7.13 report on the results.

Section 8. Comparisons between performances on TTCT year 1 and the Figures of Sound (FoS) instrument.

This section reports a corresponding set of analyses to Section 7 using the TTCT scores and performance data on the FoS totals and then by Q1–8 of the FoS.

Specific correlations are again made with fluency, originality and elaboration.

Figures 7.8.1 – 7.8.3 report on these results.

Section 9. Analyses of results on the RPM, TTCT and FoS, by Gender and Area

Some of the analyses which were considered non-essential to this study are presented in Figures 7.9.1 – 7.9.19 .

The results of this data highlight related aspects of this study and provide useful indicators for possible future studies.

Section 10. Analyses of results on the RPM, TTCT and FoS, by SHIP schools and Others

Two of the five SHIP schools in the study chose not to provide a nomination of giftedness (*n*) as against regular (*r*) talent of their students. One of these two also, following an intervening change of School Principal, withdrew from the IQ testing in Year 2 (RPM2) on equity grounds. In all, 89 subjects were not given any form of nomination by their teachers and were consequently classified as *u* (unclassified) for the purposes of this study (Figures 7.10.1 – 7.10.8. report on these results).

7.1. Ravens Progressive Matrices Year 1 and Year 2 (RPM1, RPM2)

The first analysis checked the nature of the distribution of data for the whole group tested in each year. Figure 7.1.1 showed a non-normal distribution for RPM1 as can be seen from the Normal Quantile plot and the associated histogram (with fitted normal curve).

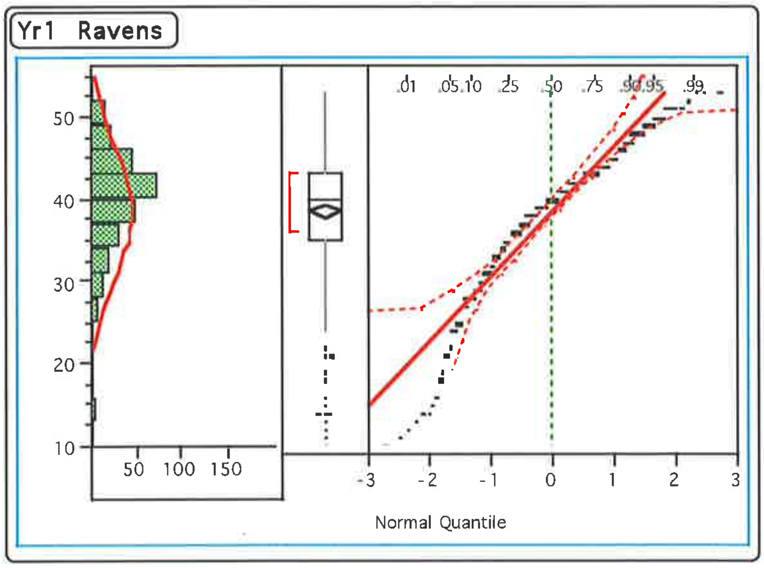


Figure 7.1.1: Distribution of the scores on the RPM in Year 1

Figure 7.1.2 provides the statistical description of the RPM1 data. The Shapiro-Wilk test for normality is included in Figure 7.1.2. Assessing the normality of the distribution was important to validate the pursuant statistical procedures, many of which are based on the assumption of 'underlying normality, or near-normality' in their derivation (Pearson Product-Moment correlation coefficient, ANOVA, *t-tests*). The author was careful to use 'distribution-free' or rank-based statistics (Spearman Rank correlation, Kruskal-Wallis ANOVA by ranks, Chi Square, Van der Waerden Pairs Comparisons, etc) for valid non-normal distribution-based calculations.

The departure from normality appeared to be mainly in the tails (see the Quantile Plot) and was sufficient to give a severe bias to the Shapiro-Wilk W statistic. (the 'p' value associated with the criterion measure needs to be in *excess* of 0.05 (i.e. p > .05) to conclude that the distribution is truly normal). Here the p-value ('Prob<W' is "-0"), that is, the distribution was significantly non-normal (beyond the 1% level).

Yr1 Ravens

Quantiles

maximum	100.0%	53.000
	99.5%	53.000
	97.5%	51.000
	90.0%	47.400
quartile	75.0%	43.000
median	50.0%	40.000
quartile	25.0%	35.000
	10.0%	28.000
	2.5%	14.650
	0.5%	10.530
minimum	0.0%	10.000

Moments

Mean	38.5738
Std Dev	7.8808
Std Error Mean	0.4513
Upper 95% Mean	39.4618
Lower 95% Mean	37.6858
N	305.0000
Sum Weights	305.0000

Test for Normality

Shapiro-Wilk W Test

W	Prob<W
0.909260	-0

Figure 7.1.2: Analysis of the scores on the RPM in Year 1

The mean raw score on the RPM1 was 38.57, and according to the Ravens manual, normed on an Australian population of the same age provided a mean IQ of 103 on standardised data.

It was then necessary to examine the results of the RPM2 obtained one year later for those subjects who were available for testing (n = 193), from the previous year. Figure 7.1.3 indicates that a similar, non-normal distribution of scores was achieved in the second year of testing, but showing in the Quantile Plot a similar curvature of departure from the 'perfect fit' straight line which represents 'perfect normality' for the data (as for the Year 1 Ravens data).

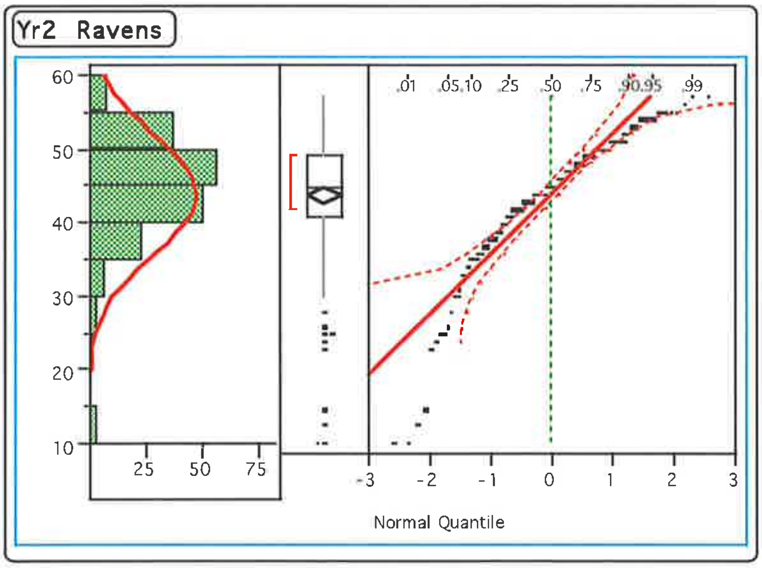


Figure 7.1.3: Distribution of the scores on the RPM in Year 2

Yr2 Ravens

Quantiles

maximum	100.0%	57.000
	99.5%	57.000
	97.5%	55.000
	90.0%	52.000
quartile	75.0%	49.000
median	50.0%	45.000
quartile	25.0%	41.000
	10.0%	35.000
	2.5%	21.800
	0.5%	10.000
minimum	0.0%	10.000

Moments

Mean	43.9119
Std Dev	8.0511
Std Error Mean	0.5795
Upper 95% Mean	45.0550
Lower 95% Mean	42.7688
N	193.0000
Sum Weights	193.0000

Test for Normality

Shapiro-Wilk W Test

W	Prob<W
0.880720	-0

Figure 7.1.4: Analysis of the scores on the RPM in Year 2

The Shapiro-Wilk test statistic again reported that the Year 2 Ravens data was significantly non-normal, at the 1% level.

Close analysis of the scores on the RPM in Year 2, detailed in Figure 7.1.4, revealed a higher mean score (44.0) than the RPM1 data. This translated into a Scaled Score ('IQ') between 107 – 110, higher than would usually be expected. This partly reflected the three point practice effect expected when giving repeated applications of the test within a calendar year. However, the figure was higher than predicted by the research which reports that over the period of one year

> *"a mean increase of approximately three points was noted in the case of students who took the timed version of the Standard progressive matrices as a second test" (de Lemos, 1989: 22).*

Given this, the mean should have averaged at around 42 for the second year.

Importantly, a fuller explanation of this 'practice effect' would note the inflation in scores on IQ tests in recent years. For instance, from 1955 to 1986 Australian mean score norms increased eight to ten points overall for the 10 to 12 years age-group (de Lemos, 1989: 22), so it may be reasonable to anticipate an even greater differential in the increasing mean score norm for testing completed in 1995 to 1996. The fact that the mean raw scores for *both* years were higher than predicted by the manual, supports the stability and validity of the results.

The non-parametric Measure of Association, Spearman's ρ ('rho') correlation was used, given the non-normality of the both data sets. Scores between the RPM (Year 1) and the RPM (Year 2) were correlated in order to verify the stability of the IQ data in general and specifically within sub-population groups (see Figures 7.1.11 – 7.1.19) and to verify the stability of the Ravens scores over the period of a year. Figure 7.1.5 details the results of the correlation of the scores from one year to the next:

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
Yr2 Ravens	Yr1 Ravens	0.8096	<.0001

Figure 7.1.5: Analysis of Whole group, undifferentiated

As expected, a highly significant ($p < .01$) correlation between scores on the two tests was obtained. To identify any extreme IQ data ('outliers'), the change scores (R2 – R1), between the two applications of the test were examined. The resulting distribution of R2 – R1 was significantly non-normal (Shapiro – Wilk W = 0.9574). Figure 7.1.6 identifies the presence of extreme outliers, shown in the boxplot as isolated dots.

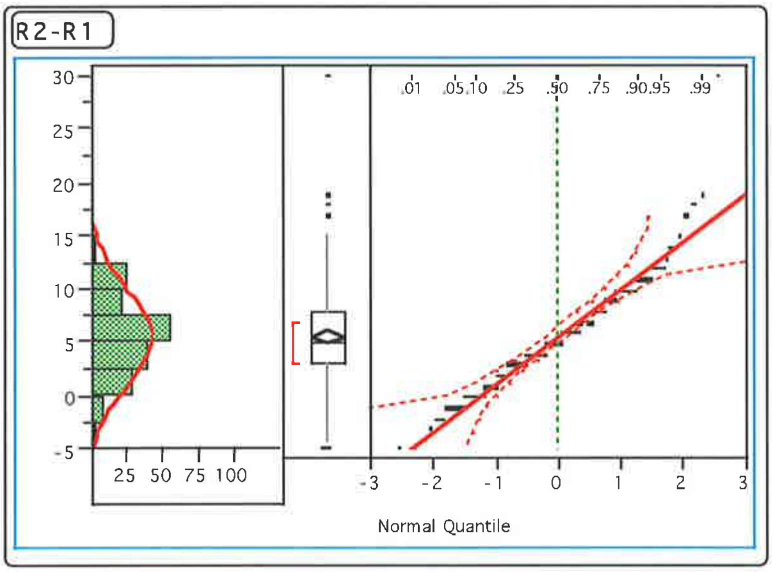


Figure 7.1.6: Distribution of the change scores on the RPM in Years 1 & 2

These data tended to distort the otherwise 'normal looking' histogram, and ensured that the W-statistic of the Shapiro-Wilk Test for Normality identified a significantly non-normal distribution result (see Figure 7.1.7).

R2-R1

Quantiles

maximum	100.0%	30.000
	99.5%	30.000
	97.5%	15.300
	90.0%	11.000
quartile	75.0%	8.000
median	50.0%	5.000
quartile	25.0%	3.000
	10.0%	0.000
	2.5%	-2.150
	0.5%	-5.000
minimum	0.0%	-5.000

Moments

Mean	5.5959
Std Dev	4.4596
Std Error Mean	0.3210
Upper 95% Mean	6.2290
Lower 95% Mean	4.9627
N	193.0000
Sum Weights	193.0000

Test for Normality

Shapiro-Wilk W Test

W	Prob<W
0.957430	0.0001

Figure 7.1.7: Analysis of the change scores on the RPM in Years 1 & 2

An analysis of the data revealed that six subjects out of the whole retested group in Year 2 of the study (n=193) obtained scores on the RPM1 and RPM2 that differed in such a way that, either a mis-recording on the test record form or a more profound misunderstanding of the requirements of the test in either of the two years, could only explain the differences in the results. After checking, and dismissing, the former possible explanation, the latter was accepted. Usually, measures of intelligence as determined by IQ tests, do not change significantly from one year to the next. Given the gross differences for these six students, they were considered 'outliers' on both statistical and research bases. Consequently, excluding these outliers from further analysis to curtail their influence on statistics of interest was deemed appropriate when dealing with data whose essential distributions were reasonably similar, as reported in Figures 7.1.1 and 7.1.3.

Eliminating the outliers where the difference in Ravens scores from Year 2 to Year 1 (R2 – R1) was less than, or equal to –5 or more than or equal to 16, that is, retaining data where $-4 \leq (R2-R1) \leq 15$), the distribution in Figure 7.1.8 resulted:

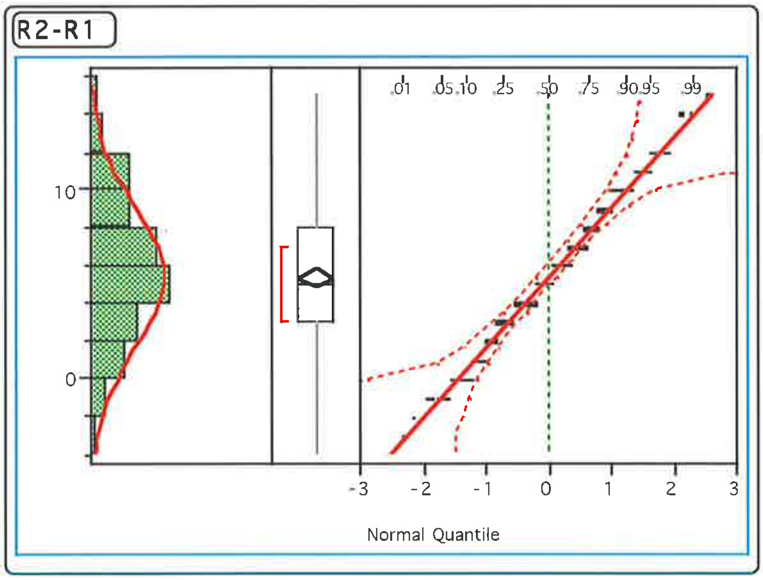


Figure 7.1.8: Distribution of the change scores on the RPM in Years 1 & 2 (outliers excluded)

These data appeared, visually, to be normally distributed, a perception now strongly supported by the Shapiro-Wilk W Test ($W = 0.9763$) for Normality in Figure 7.1.9.

R2-R1

Quantiles

maximum	100.0%	15.000
	99.5%	15.000
	97.5%	12.300
	90.0%	10.000
quartile	75.0%	8.000
median	50.0%	5.000
quartile	25.0%	3.000
	10.0%	0.000
	2.5%	-1.300
	0.5%	-4.000
minimum	0.0%	-4.000

Moments

Mean	5.3797
Std Dev	3.6852
Std Error Mean	0.2695
Upper 95% Mean	5.9113
Lower 95% Mean	4.8480
N	187.0000
Sum Weights	187.0000

Test for Normality

Shapiro-Wilk W Test

W	Prob<W
0.976262	0.1539

Figure 7.1.9: Analysis of the change scores on the RPM in Years 1 & 2 (outliers excluded)

Even with outliers excluded, both raw distributions of Ravens scores were still non-normal, with respective Shapiro-Wilk W's of 0.9188 and 0.8718, leading to rejection of 'normality' at beyond the 0.1% level.

The whole data set (n = 187 with the outliers excluded) was re-examined. A highly significant correlation ($p < .01$) between scores on the two tests was observed, again using the non-parametric Spearman ρ statistic, as Ravens scores in both years still presented as significantly non-normal, even with the outliers excluded.

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>IRhoI
Yr2 Ravens	Yr1 Ravens	0.8366	<.0001

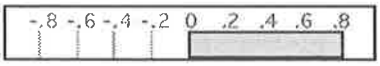


Figure 7.1.10: Ravens Year 1 & 2 Correlation Whole group (outliers excluded)

Thus, there was a sound basis for the appropriateness for further interrogation of the data, excluding outliers, in various subgroupings, using non-parametric correlational methods and other non-parametric statistical techniques.

In previous chapters of this thesis the issue of degrees of intellectual ability has been raised as a possibly significant factor when determining links with creativity scores or other possible 'markers' of general ability. The stability of the RPM scores over the period of a year was analysed according to the five categories identified within the RPM Manual as representative of scores which are categorised as High, Above Average, Average, Below Average and Low. The specific relationship between the Standardised scores, the Percentile Ranks, the Stanine Scores and the Percentage of students expected at each level is summarised in Table 7.1 as follows:

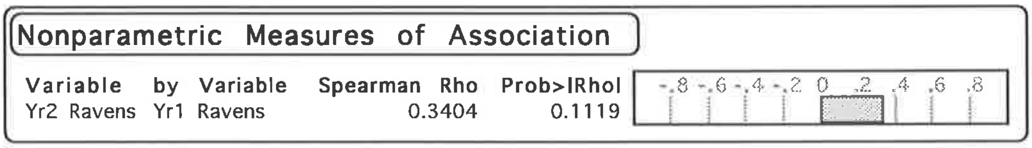
TABLE 7.1: Relationship between Standardised Score, Percentile Ranks and Stanines

Descriptive Category	Range of Standardised Scores	Range of Percentile Ranks	Stanine Score	Expected % of Students at each Stanine Level
High (4%)	≥ 127	≥ 96	9	4
Above Average (19%)	119-126 112-118	89-95 77-88	8 7	7 12
Average (54%)	104-111 97-102 89-96	60-76 40-59 23-39	6 5 4	17 20 17
Below Average (19%)	82-88 74-81	11-22 4-10	3 2	12 7
Low (4%)	≤ 73	≤ 4	1	4

(de Lemos, 1989: 20).

On the basis of these five categories the data was re-examined to detect correlations, irregularities or other points of interest within the various subgroupings.

There were strong correlations between the two Ravens scores, across all levels of intelligence, except the highest, as measured by the RPM1 score. These findings are reported in Figures 7.1.11 to 7.1.15.

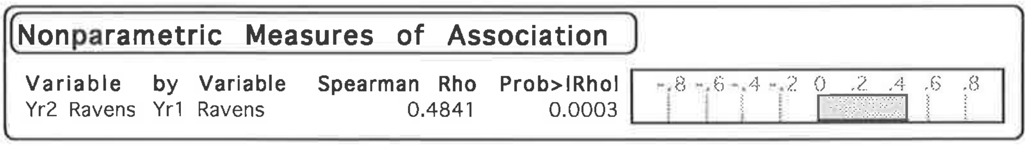


Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>lRhol
Yr2 Ravens	Yr1 Ravens	0.3404	0.1119

Figure 7.1.11: High IQ1 group (outliers excluded)

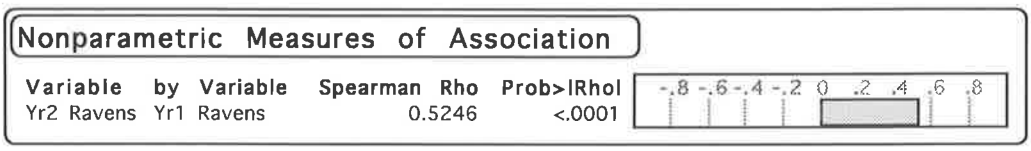
The correlations were strong to very strong for the 'middle' (above average ($p < .001$), average ($p < .001$) and below average ($p < .05$)) ability ranges.



Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>lRhol
Yr2 Ravens	Yr1 Ravens	0.4841	0.0003

Figure 7.1.12: Above Average IQ1 group (outliers excluded)



Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>lRhol
Yr2 Ravens	Yr1 Ravens	0.5246	<.0001

Figure 7.1.13: Average IQ1 group (outliers excluded)

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
Yr2 Ravens	Yr1 Ravens	0.4869	0.0252

Figure 7.1.14: Below Average IQ1 group (outliers excluded)

However, for the 'low' ability group, a surprisingly strong correlation was found (significant at the 0.1% level, $p < .0001$) in Figure 7.1.15

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
Yr2 Ravens	Yr1 Ravens	0.5246	<.0001

Figure 7.1.15: Low IQ1 group (outliers excluded)

From the literature, it is noted that, "the practice effect tends to be greater for scores that occur in the middle of the range than for scores that occur at the upper or lower extremes of the range" (de Lemos, 1989: 22). This practice effect could be assessed as the difference between the two Ravens' scores, a year apart, measured by (R2 – R1).

Given the normality of the (R2 – R1) data, an Analysis of Variance (ANOVA) was conducted between the coarse grouping of subjects into one of two extreme groups: high (IQ1 $\geq$ 127) or low (IQ1 $\leq$ 73) or of a third middle group (above average, average and below average (74 $\leq$ IQ1 $\leq$ 126). From Figure 7.1.16, it was clear that the means of the differences in Ravens scores between the two administrations of the tests were very highly significantly different ($p < .001$).

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	2	282.8644	141.432	11.6012
Error	184	2243.1784	12.191	**Prob>F**
C Total	186	2526.0428	13.581	<.0001

Figure 7.1.16: Overall Changes in Ravens scores by Extreme IQ1 groups (outliers excluded)

Given the overall significance of the ANOVA, follow-up means' comparisons on individual pairs showed a significant difference between the 'high' group and the average group ($p < .05$), as reported in Figure 7.1.17.

Alpha= 0.05

Comparisons for each pair using Student's t

t
1.97296

Abs(Dif)-LSD	avg	low	high
avg	-0.78000	-0.58696	2.11073
low	-0.58696	-3.44439	-1.08844
high	2.11073	-1.08844	-2.03139

Positive values show pairs of means that are significantly different.

Figure 7.1.17: Pairwise Changes in Ravens scores by Extreme IQ1 groups (outliers excluded)

Positive values in the Means Comparisons table in the figure above, indicate significance at the 'alpha level' indicated (here, the 5% level, i.e. $p = .05$).

Furthermore, a test for the equality of variances revealed, in Figure 7.1.18, that these coarse groupings differed significantly ($p < .01$) but even so, a comparable ANOVA allowing for unequal variances of groups, still showed highly significant differences between the groups' means (reported as the Welch ANOVA test statistic).

Tests that the Variances are Equal

Level	Count	Std Dev	MeanAbsDif to Mean	MeanAbsDif to Median
avg	156	3.423584	2.773833	2.769231
high	23	2.666584	2.313800	2.217391
low	8	6.210590	5.000000	5.000000

Test	F Ratio	DF Num	DF Den	Prob>F
O'Brien[.5]	12.5828	2	184	<.0001
Brown-Forsythe	5.6085	2	184	0.0043
Levene	5.6541	2	184	0.0041
Bartlett	4.7963	2	•	0.0083

Welch Anova testing Means Equal, allowing Std's Not Equal

F Ratio	DF Num	DF Den	Prob>F
16.7654	2	15.76	0.0001

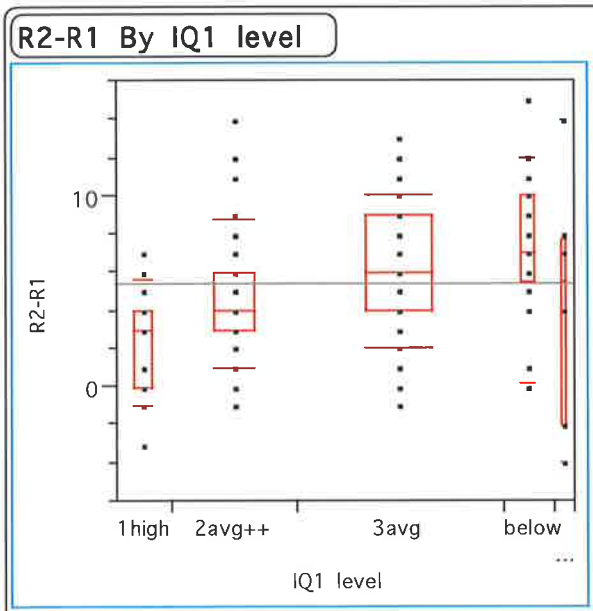
Figure 7.1.18: Variance Differences in Ravens scores by Extreme IQ1 groups (outliers excluded)

In concrete terms, this data supported the literature that the practice effect in the 'middle' subgroup showed a real difference from that in the 'high' subgroup. However, this data showed no real difference in the practice effect for the 'middle' and 'low' subgroups.

Even when a finer grouping was used to examine the differences (R2 – R1) between the two years, corresponding significant differences occurred.

For example, five subgroups were identified from the Raven's manual (see Table 7.1) as low (≤ 73), below average ($74 \leq IQ1 \leq 88$), average ($89 \leq IQ1 \leq 111$), above average ($112 \leq IQ1 \leq 126$) and high (≥ 127). These appear in the graphics' outputs which were sequenced as 'low', 'below', '3avg', 2avg++' and '1high' respectively, to force the output from the statistical package to present the groups logically, when presented visually. Note that the widths of the quantile plots is proportional to the number in each subgroup

Using an ANOVA on the R2 – R1 data, with these five IQ subgroups as 'levels' a highly significant difference was observed (Figure 7.1.19):



Oneway Anova

Summary of Fit

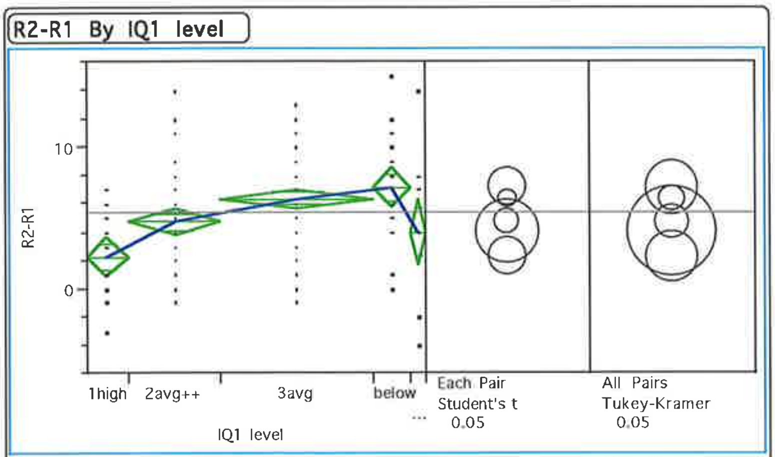
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	4	396.0506	99.0126	8.4603
Error	182	2129.9922	11.7033	Prob>F
C Total	186	2526.0428	13.5809	<.0001

Means for Oneway Anova

Figure 7.1.19: Overall Differences in Ravens scores by IQ1 level groups (outliers excluded)

An expected significance (at the 5% level) between the 'high' subgroup's mean and those of each of the above average (2avg++), average (3avg) and below average (below) subgroups, but not between 'high' and 'low' subgroups. Figure 7.1.20 reported these findings.



Means Comparisons

Dif=Mean[i]-Mean[j]	below	3avg	2avg++	low	1high
below	0.00000	0.90476	2.42577	3.19048	4.92961
3avg	-0.90476	0.00000	1.52101	2.28571	4.02484
2avg++	-2.42577	-1.52101	0.00000	0.76471	2.50384
low	-3.19048	-2.28571	-0.76471	0.00000	1.73913
1high	-4.92961	-4.02484	-2.50384	-1.73913	0.00000

Alpha= 0.05

Comparisons for each pair using Student's t

t
1.97311

Abs(Dif)-LSD	below	3avg	2avg++	low	1high
below	-2.08309	-0.74207	0.67562	0.38602	2.89230
3avg	-0.74207	-1.04155	0.32276	-0.21183	2.43633
2avg++	0.67562	0.32276	-1.33670	-1.80214	0.80844
low	0.38602	-0.21183	-1.80214	-3.37500	-1.03148
1high	2.89230	2.43633	0.80844	-1.03148	-1.99047

Positive values show pairs of means that are significantly different.

Comparisons for all pairs using Tukey-Kramer HSD

q *
2.75532

Abs(Dif)-LSD	below	3avg	2avg++	low	1high
below	-2.90892	-1.39494	-0.01821	-0.72577	2.08463
3avg	-1.39494	-1.45446	-0.15227	-1.20195	1.80658
2avg++	-0.01821	-0.15227	-1.86662	-2.81974	0.13632
low	-0.72577	-1.20195	-2.81974	-4.71298	-2.12986
1high	2.08463	1.80658	0.13632	-2.12986	-2.77957

Positive values show pairs of means that are significantly different.

Figure 7.1.20: Pairwise Differences in Ravens scores by IQ1 level groups (outliers excluded)

A visual representation in Figure 7.1.20 using "comparison circles" (see Appendix 6: Statistical Glossary) pictures the meaning implicit in the statistics reported in the numerical table in (Figure 7.1.20). These circles which do *not* intersect illustrate highly significantly different means of the groups (the diameter of each circle being proportional to the group's size). Intersecting circles can still represent significantly different groups when the angle between the tangents to each circle at a point of intersection is $\geq 90°$.

Also, examining the differences between the variances of the subgroups, Figure 7.1.21 reports that the hypothesis that the subgroups' variances are equal was rejected (at least at the 5% level) by the differing kinds of tests available. The Bartlett test was actually the most appropriate here, as it utilised underlying normality of the data, which was known to be the case, as reported in Figure 7.1.9.

Tests that the Variances are Equal

Level	Count	Std Dev	MeanAbsDif to Mean	MeanAbsDif to Median
1high	23	2.666584	2.313800	2.217391
2avg++	51	3.121463	2.329873	2.254902
3avg	84	3.305969	2.721088	2.714286
below	21	3.932163	3.056689	3.095238
low	8	6.210590	5.000000	5.000000

Test	F Ratio	DF Num	DF Den	Prob>F
O'Brien[.5]	6.3514	4	182	<.0001
Brown-Forsythe	3.4351	4	182	0.0098
Levene	3.5441	4	182	0.0082
Bartlett	2.9069	4	•	0.0203

Welch Anova testing Means Equal, allowing Std's Not Equal

F Ratio	DF Num	DF Den	Prob>F
10.3206	4	35.347	<.0001

Figure 7.1.21: Variance Differences in Ravens scores by IQ1 level groups (outliers excluded)

Given the significant difference in variances, the Welch ANOVA in Figure 7.1.21 was more appropriately reported than Figure 7.1.19, however, this too led to a rejection of the 'equal means' hypothesis, at the 0.1% level.

By amalgamating the two below average groups ('below' and 'low') into one ('below'), a similar ANOVA resulted, with the follow-up means comparisons showing difference, this time at the 1% level between the 'high' group and each of the others.

Means Comparisons

Dif=Mean[i]-Mean[j]	below	3avg	2avg++	1high
below	0.00000	0.02463	1.54564	4.04948
3avg	-0.02463	0.00000	1.52101	4.02484
2avg++	-1.54564	-1.52101	0.00000	2.50384
1high	-4.04948	-4.02484	-2.50384	0.00000

Alpha= 0.01

Comparisons for each pair using Student's t

t
2.60294

Abs(Dif)-LSD	below	3avg	2avg++	1high
below	-2.36414	-1.91428	-0.54808	1.53587
3avg	-1.91428	-1.38910	-0.07708	1.90626
2avg++	-0.54808	-0.07708	-1.78274	0.24271
1high	1.53587	1.90626	0.24271	-2.65466

Positive values show pairs of means that are significantly different.

Figure 7.1.22: Change Score Differences in Ravens by IQ1 level groups

In conclusion, these groups may certainly be regarded as 'different' in both mean values and variability of the change.

When the change scores were examined by teacher nomination (*ng*, *n*, *r* or *u*), there was no difference in the average change scores between nominated groups.

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	3	44.1827	14.7276	1.0859
Error	183	2481.8601	13.5621	Prob>F
C Total	186	2526.0428	13.5809	0.3564

Figure 7.1.23: Change Score Differences in Ravens by Teacher Nomination

This persisted, even when the *u* group was withheld from the analysis:

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	2	8.3108	4.1554	0.2999
Error	136	1884.6101	13.8574	Prob>F
C Total	138	1892.9209	13.7168	0.7414

Figure 7.1.24: Change Score Differences in Ravens by active Teacher Nomination

7.2. Torrance Tests of Creative Thinking Year 1 and Year 2

The overall distribution of the Year 1 Torrance Test (TTCT1) was non-normal although variation from normality in Figure 7.2.1 appeared to be mild,

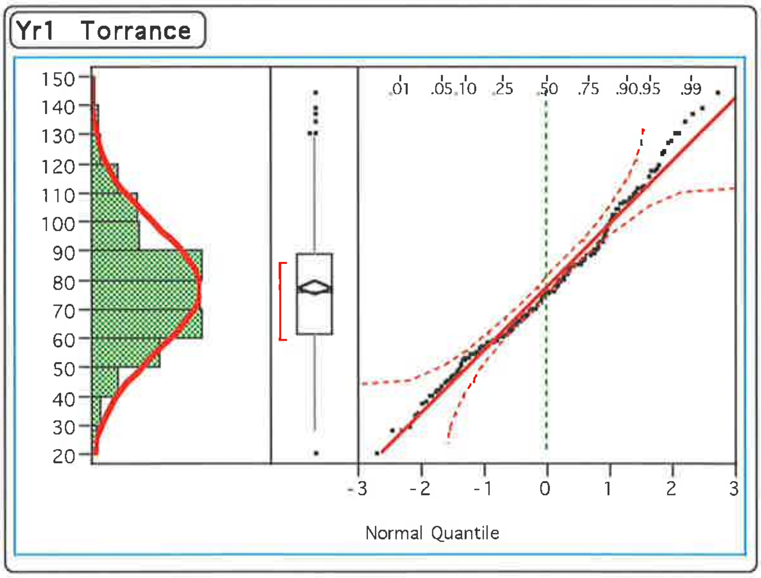


Figure 7.2.1: Distribution of results on the Year 1 Torrance Test of Creative Thinking (TTCT1)

it was statistically significantly different from normal at the 5% level ($p < .0028$), from the Shapiro–Wilk W statistic (in Figure 7.2.2).

Moments

Mean	77.7329
Std Dev	21.6905
Std Error Mean	1.2693
Upper 95% Mean	80.2312
Lower 95% Mean	75.2346
N	292.0000
Sum Weights	292.0000

Test for Normality

Shapiro-Wilk W Test

W	Prob<W
0.974239	0.0228

Figure 7.2.2: Analysis of results on the Year 1 Torrance Test of Creative Thinking (TTCT1)

For practical purposes, this again required the use of non-parametric statistical techniques based ranks.

Figures 7.2.3 – 7.2.8 examine the nature of the distribution across each sub-group partitioned by fluency, originality and elaboration. The analysis clearly showed the 'elaboration sub-population' differed from the others. Using the Shapiro-Wilk W test for normality of data, all three sets of data were significantly non-normal.

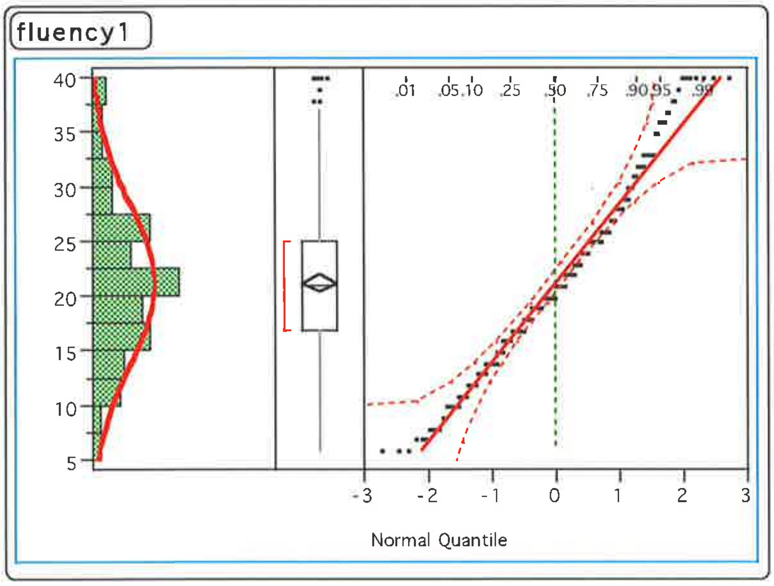


Figure 7.2.3: Distribution of fluency scores on the TTCT1

Moments

Mean	21.2603
Std Dev	7.2719
Std Error Mean	0.4256
Upper 95% Mean	22.0978
Lower 95% Mean	20.4227
N	292.0000
Sum Weights	292.0000

Test for Normality

Shapiro-Wilk W Test

W	Prob<W
0.960001	<.0001

Figure 7.2.4: Analysis of fluency scores TTCT1

For practical purposes, this implied the use of non-parametric techniques only.

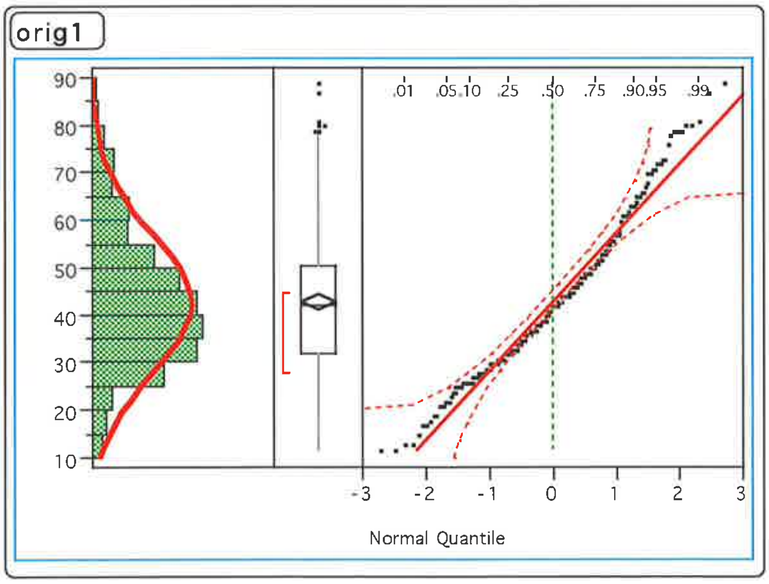


Figure 7.2.5: Distribution of originality scores on the TTCT1

Moments	
Mean	42.9384
Std Dev	14.5806
Std Error Mean	0.8533
Upper 95% Mean	44.6177
Lower 95% Mean	41.2590
N	292.0000
Sum Weights	292.0000

Test for Normality	
Shapiro-Wilk W Test	
W	Prob<W
0.958932	<.0001

Figure 7.2.6: Analysis of originality scores TTCT1

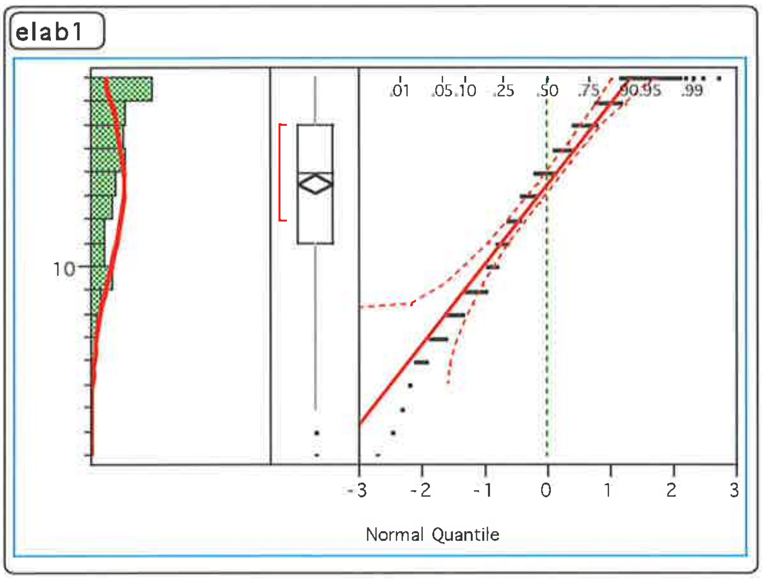


Figure 7.2.7: Distribution of elaboration scores on the TTCT1

Moments	
Mean	13.5342
Std Dev	3.4115
Std Error Mean	0.1996
Upper 95% Mean	13.9272
Lower 95% Mean	13.1413
N	292.0000
Sum Weights	292.0000

Test for Normality	
Shapiro-Wilk W Test	
W	Prob<W
0.920589	-0

Figure 7.2.8: Analysis of elaboration scores TTCT1

As would be expected, there was a high correlation between total TTCT1 scores and each substrate (fluency, originality and elaboration). It is interesting to note also, a very strong within-test correlation between the scores for the various pairs of the substrates was observed, especially between originality and fluency.

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
fluency1	Yr1 Torrance	0.8576	<.0001
orig1	Yr1 Torrance	0.9566	<.0001
orig1	fluency1	0.7339	<.0001
elab1	Yr1 Torrance	0.3662	<.0001
elab1	fluency1	0.1560	0.0076
elab1	orig1	0.2426	<.0001

Figure 7.2.9: Correlations for TTCT1 and its Substrates

Again, non-parametric correlation coefficients are presented as these are insensitive to variations from normality. Very high levels of significance ($p < .001$) were reported from this data.

The overall distribution of the Year 2 Torrance Test of Creative Thinking (TTCT2) was statistically non-normal at the 1% level, the variation seen in the Normal Quantile plot (Figure 7.2.10), and the Shapiro Wilk W statistic in Figure 7.2.11. For practical purposes, this again required the use of non-parametric statistical techniques .

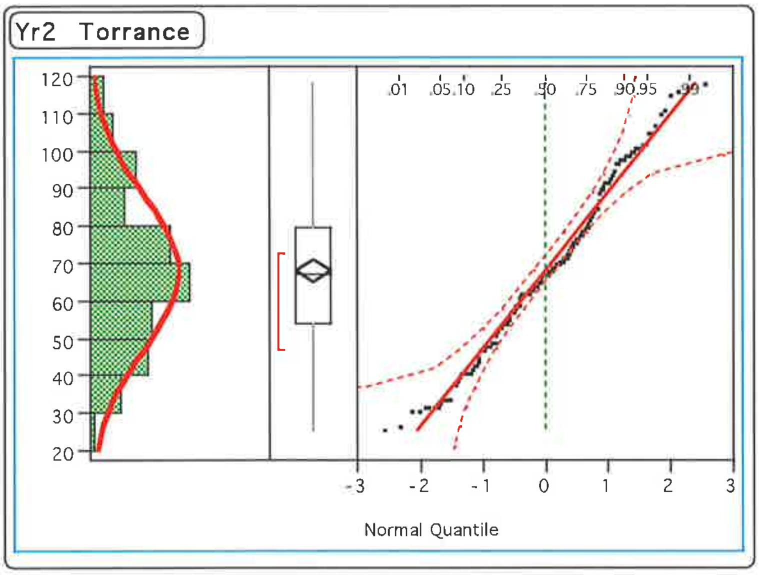


Figure 7.2.10: Distribution of results on the Year 2 Torrance Test of Creative Thinking (TTCT2)

Moments

Mean	68.1176
Std Dev	20.7358
Std Error Mean	1.5164
Upper 95% Mean	71.1091
Lower 95% Mean	65.1261
N	187.0000
Sum Weights	187.0000

Test for Normality

Shapiro-Wilk W Test

W	Prob<W
0.964448	0.0033

Figure 7.2.11: Analysis of results on the Year 2 Torrance Test of Creative Thinking (TTCT2)

Figures 7.2.12 – 7.2.17 examined the nature of the distribution across each sub-population partitioned by fluency, originality and elaboration. The analysis clearly showed the 'elaboration sub-population' differed from the other two. Using the Shapiro-Wilk W test for normality of data, all three sets of data were, at the 5%level, non-normal, although the Year 2 data was 'closer' to normality than the Year 1 data.

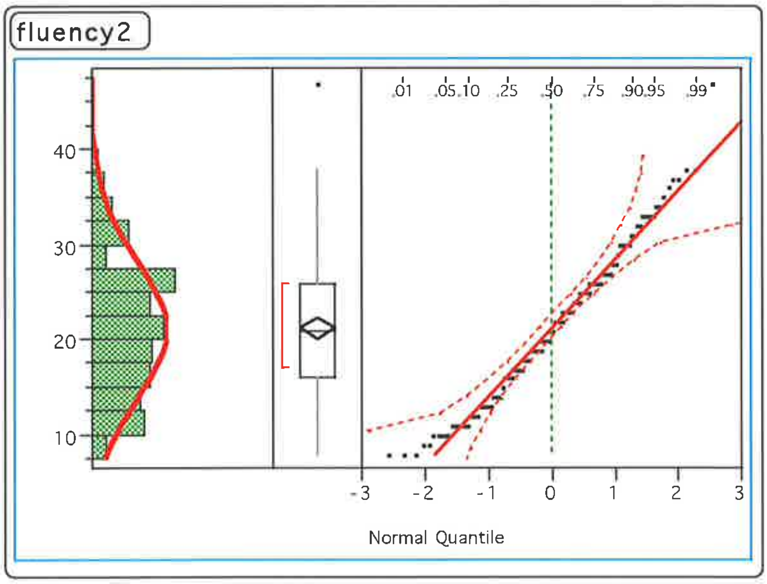


Figure 7.2.12: Distribution of fluency scores on the TTCT2

Moments

Mean	21.2567
Std Dev	7.2318
Std Error Mean	0.5288
Upper 95% Mean	22.3000
Lower 95% Mean	20.2134
N	187.0000
Sum Weights	187.0000

Test for Normality

Shapiro-Wilk W Test

W	Prob<W
0.970480	0.0294

Figure 7.2.13: Analysis of fluency scores TTCT2

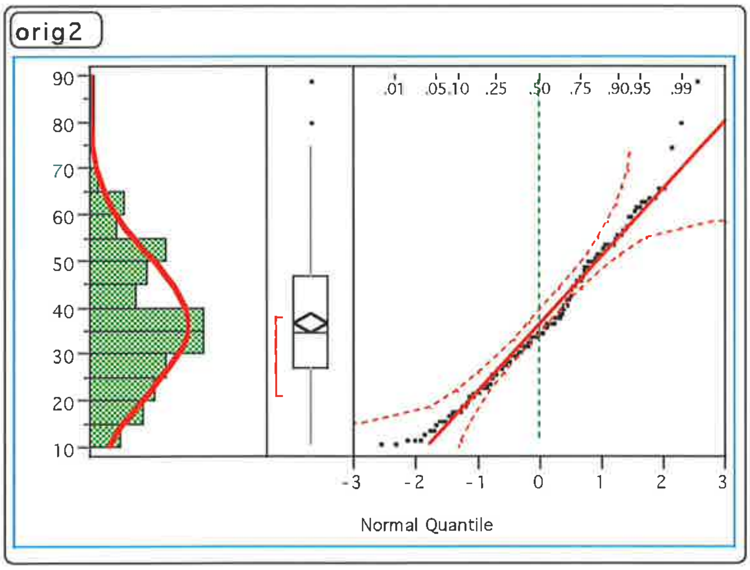


Figure 7.2.14: Distribution of originality scores on the TTCT2

Moments	
Mean	36.8930
Std Dev	14.4925
Std Error Mean	1.0598
Upper 95% Mean	38.9838
Lower 95% Mean	34.8023
N	187.0000
Sum Weights	187.0000

Test for Normality	
Shapiro-Wilk W Test	
W	Prob<W
0.963798	0.0025

Figure 7.2.15: Analysis of originality scores TTCT2

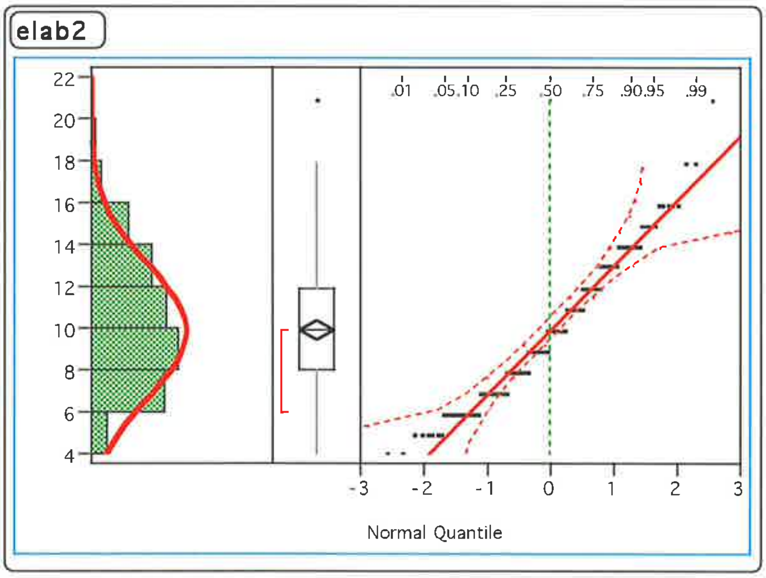


Figure 7.2.16: Distribution of elaboration scores on the TTCT2

Moments	
Mean	9.9679
Std Dev	3.0968
Std Error Mean	0.2265
Upper 95% Mean	10.4147
Lower 95% Mean	9.5211
N	187.0000
Sum Weights	187.0000

Test for Normality	
Shapiro-Wilk W Test	
W	Prob<W
0.959872	0.0005

Figure 7.2.17: Analysis of elaboration scores TTCT2

As with the TTCT1 data, there was a high correlation between total TTCT scores and each substrate (fluency, originality and elaboration) in the TTCT2 scores. It is significant to note the very strong correlation within the test, between the scores for the various pairs of the substrates, especially between originality and fluency.

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
fluency2	Yr2 Torrance	0.7790	<.0001
orig2	Yr2 Torrance	0.9428	<.0001
orig2	fluency2	0.5923	<.0001
elab2	Yr2 Torrance	0.4586	<.0001
elab2	fluency2	0.2585	0.0004
elab2	orig2	0.3338	<.0001

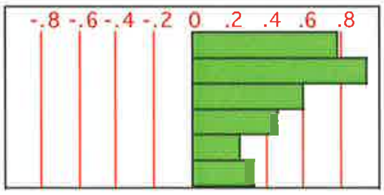


Figure 7.2.18: Correlations for TTCT2 and its Substrates

As can be seen from Figure 7.2.18, there were very high levels of significance ($p < .001$).

Comparing the two administrations of the TTCT test revealed some interesting changes (and stabilities). Overall, the correlation between the two applications of the Torrance Test for Creativity (Figural Forms A and B) showed 'stability' in a very highly significant correlation ($p < .0001$).

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
Yr2 Torrance	Yr1 Torrance	0.4465	<.0001

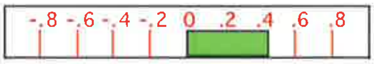


Figure 7.2.19: Correlations for Year 1 and Year 2 Torrance Tests of Creative Thinking

The correlations between the two applications of the Torrance Tests for each of the differing IQ1 levels (the distributions of which were all acceptably normal, using the Shapiro-Wilk W statistic), were:

Pairwise Correlations

Variable	by Variable	Correlation	Count	Signif Prob
Yr2 Torrance	Yr1 Torrance	0.2617	23	0.2277

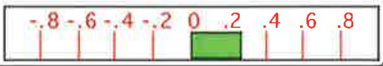


Figure 7.2.20: Correlations for Year 1 and Year 2 TTCT (high IQ1: top 4%)

Pairwise Correlations

Variable	by Variable	Correlation	Count	Signif Prob
Yr2 Torrance	Yr1 Torrance	0.4587	49	0.0009

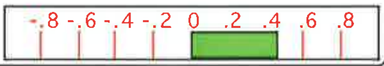


Figure 7.2.21: Correlations for Year 1 and Year 2 TTCT (above average IQ1: next highest 19%)

Pairwise Correlations

Variable	by Variable	Correlation	Count	Signif Prob
Yr2 Torrance	Yr1 Torrance	0.4810	85	0.0000

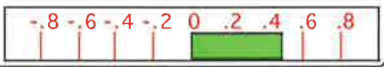


Figure 7.2.22: Correlations for Year 1 and Year 2 TTCT (average IQ1: middle 54%)

Pairwise Correlations

Variable	by Variable	Correlation	Count	Signif Prob
Yr2 Torrance	Yr1 Torrance	0.5219	20	0.0183

Figure 7.2.23: Correlations for Year 1 and Year 2 TTCT (below IQ1: next lowest 19%)

Pairwise Correlations

Variable	by Variable	Correlation	Count	Signif Prob
Yr2 Torrance	Yr1 Torrance	0.7713	8	0.0250

Figure 7.2.24: Correlations for Year 1 and Year 2 TTCT (low IQ1: bottom 4%)

Within the comparisons of the two tests' substrates (fluency, originality, elaboration) some interesting results arose. For *only one* pairing of the substrates (fluency in year two and elaboration in year one) were the correlations reported, *not* significant. All other pairs but this, showed significance beyond the 1% level ($p < .01$).

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
orig1	fluency1	0.7339	<.0001
elab1	fluency1	0.1560	0.0076
elab1	orig1	0.2426	<.0001
fluency2	fluency1	0.2430	0.0009
fluency2	orig1	0.2955	<.0001
fluency2	elab1	0.1206	0.1021
orig2	fluency1	0.3131	<.0001
orig2	orig1	0.3993	<.0001
orig2	elab1	0.1777	0.0155
orig2	fluency2	0.5923	<.0001
elab2	fluency1	0.2422	0.0009
elab2	orig1	0.2725	0.0002
elab2	elab1	0.3808	<.0001
elab2	fluency2	0.2585	0.0004
elab2	orig2	0.3338	<.0001

Figure 7.2.25: Correlations of substrates of TTCT (Year 1 & Year 2) and change scores (T2-T1)

Rather than simply accepting the (predictable) correlations between the Torrance tests' substrates, the author took the analysis further by examining the 'change scores' connected with the two applications of the TTCT.

Examining the difference in scores for each subject who sat the two applications of the TTCT tests generated the following distribution of the statistic T2 - T1:

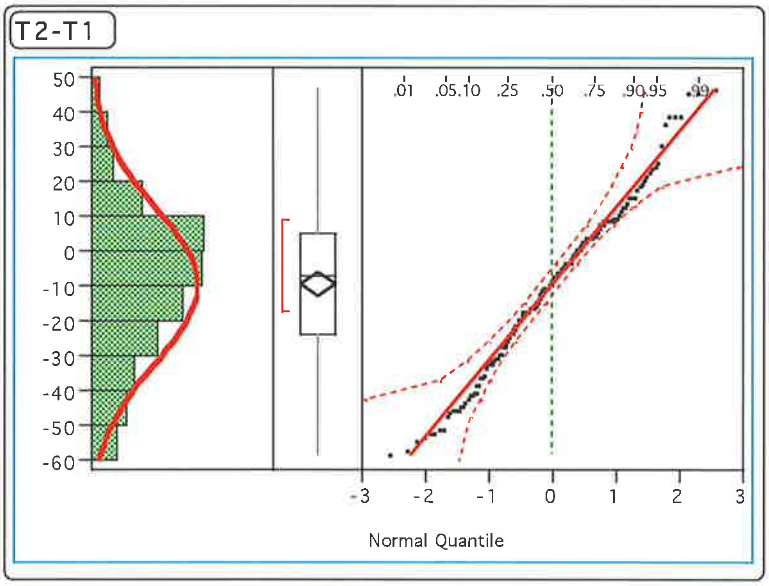


Figure 7.2.26: Distribution of the change scores of T2 - T1

The lack of other outliers in the boxplot, plus the visual fit of the normal curve overlay, suggested that these data were acceptably normally distributed (and thus able to be analysed by more sophisticated means), than were the raw T1 and T2 data (and their substrates) as single variable arrays.

This was statistically affirmed (at the 5%level,) by the Shapiro-Wilk W Test for Normality, used throughout this study.

Moments

Mean	-9.1514
Std Dev	22.0550
Std Error Mean	1.6215
Upper 95% Mean	-5.9522
Lower 95% Mean	-12.3505
N	185.0000
Sum Weights	185.0000

Test for Normality

Shapiro-Wilk W Test

W	Prob<W
0.972701	0.0605

Figure 7.2.27: Analysis of the change scores of T2 - T1

Also, the change scores for the corresponding substrates of the tests revealed correspondingly normal data, using the Shapiro-Wilk Test for Normality.

flu2-flu1

Quantiles

Moments

Mean	0.4541
Std Dev	8.6338
Std Error Mean	0.6348
Upper 95% Mean	1.7064
Lower 95% Mean	-0.7983
N	185.0000
Sum Weights	185.0000

Test for Normality

Shapiro-Wilk W Test

W	Prob<W
0.986261	0.7750

ori2-ori1

Quantiles

Moments

Mean	-6.1081
Std Dev	15.7856
Std Error Mean	1.1606
Upper 95% Mean	-3.8183
Lower 95% Mean	-8.3979
N	185.0000
Sum Weights	185.0000

Test for Normality

Shapiro-Wilk W Test

W	Prob<W
0.987026	0.8190

elb2-elb1

Quantiles

Moments

Mean	-3.4973
Std Dev	3.6042
Std Error Mean	0.2650
Upper 95% Mean	-2.9745
Lower 95% Mean	-4.0201
N	185.0000
Sum Weights	185.0000

Test for Normality

Shapiro-Wilk W Test

W	Prob<W
0.973615	0.0786

Figure 7.2.28: Normality of change scores for the substrates of the statistic T2 - T1

In each case, given the normality of the data, the use of the more sensitive Pearson Product Moment Correlation statistic was justified. Figure 7.2.29 details these data.

Pairwise Correlations

Variable	by Variable	Correlation	Count	Signif Prob
flu2-flu1	T2-T1	0.7892	185	0.0000
ori2-ori1	T2-T1	0.9318	185	0.0000
ori2-ori1	flu2-flu1	0.5586	185	0.0000
elb2-elb1	T2-T1	0.1473	185	0.0453
elb2-elb1	flu2-flu1	-0.0124	185	0.8665
elb2-elb1	ori2-ori1	-0.0157	185	0.8324

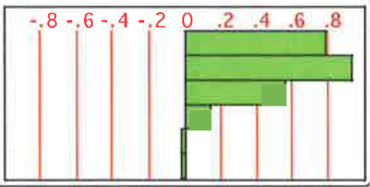
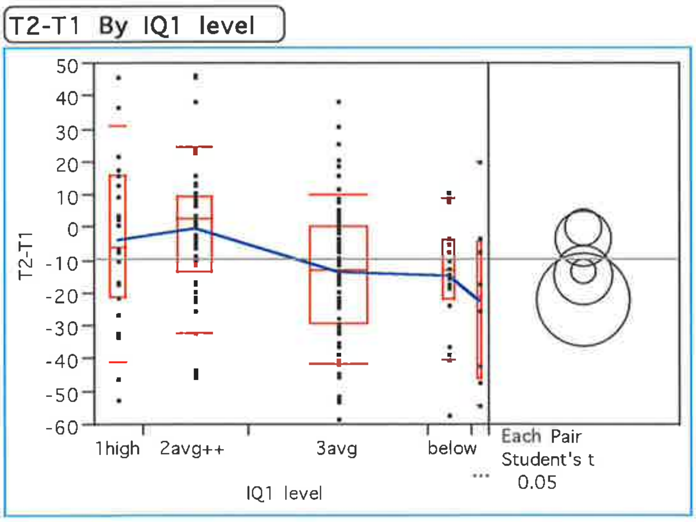


Figure 7.2.29: Correlations of change scores for the substrates of the statistic T2 - T1

Only the Year 2 elaboration component's pair comparisons did *not* show a significant correlation. This clearly indicates that 'elaboration' was measuring something different from the other measures, fluency, originality and their differences.



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	4	8233.282	2058.32	4.5589
Error	180	81268.480	451.49	Prob>F
C Total	184	89501.762	486.42	0.0016

Figure 7.2.30: ANOVA of IQ1 Level and Torrance Test change scores (T2-T1)

The author examined these differences stratified by differing intelligence levels (as classified by the Ravens Test Manual), the author observed a very highly significant difference between the mean scores of the groups.

Alpha= 0.05

Comparisons for each pair using Student's t

t

1.97325

Abs(Dif)-LSD	2avg++	1high	3avg	below	low
2avg++	-8.4708	-6.7743	6.0026	3.2653	5.9275
1high	-6.7743	-12.3640	-0.1550	-2.2519	0.8825
3avg	6.0026	-0.1550	-6.4315	-9.5526	-7.1132
below	3.2653	-2.2519	-9.5526	-13.2589	-10.0149
low	5.9275	0.8825	-7.1132	-10.0149	-20.9642

Positive values show pairs of means that are significantly different.

Figure 7.2.31: Pairs Comparisons of IQ1 Level and Torrance Test change scores (T2-T1)

Using follow-up *t-tests*, it was evident that this overall result was attributable to the individual differences between the above average group with the three 'lower' groups, and also the differences between the two extreme groupings, paired. A follow-up 'coarse filter' analysis, using just three groupings (high (1high & 2avg++), average (3avg), low as (below and low) again revealed a significant difference, at the 5% level, between the groups, overall as detailed in Figure 7.2.32 below:

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	2	7680.886	3840.44	8.5426
Error	182	81820.876	449.57	Prob>F
C Total	184	89501.762	486.42	0.0003

Figure 7.2.32: ANOVA of Change in IQ1 and Torrance Test change scores (T2-T1)

Alpha= 0.05

Comparisons for each pair using Student's t

t

1.97311

Abs(Dif)-LSD	high	avg	low
high	-6.9726	5.6011	6.0019
avg	5.6011	-6.4173	-6.0982
low	6.0019	-6.0982	-11.1811

Positive values show pairs of means that are significantly different.

Figure 7.2.33: Differences in Means of levels of IQ1 and Torrance Test change scores (T2-T1)

These analyses (Figures 7.2.32/33) clearly emphasise that the high IQ group had a significantly smaller variation in TTCT scores from year 1 to year 2 than either of the (enlarged) 'average' group or the 'low' group.

7.3. Torrance and Ravens in Year 1

The relationship between performance in the first year on the Torrance (TTCT1) and the Ravens (RPM1) tests was of particular interest in this study, given the inconclusive research previously cited comparing results on creativity tests and on measures of *g*.

This group was the largest in the study (299 subjects on RPM after outliers were omitted) and so a thorough analysis of the data was possible.

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
Yr1 Torrance	Yr1 Ravens	0.1175	0.0448

Figure 7.3.1: Correlations for Year 1 Ravens and Year 1 Torrance Test of Creative Thinking

The correlation reported in Figure 7.3.1 is significant at the 5% level (p = .0448) for the nonparametric correlational measure. Looking at the substrates of the Torrance instrument, in comparison with the Ravens1, the data indicated:

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
fluency1	Yr1 Ravens	0.0050	0.9317
orig1	Yr1 Ravens	0.1161	0.0474
orig1	fluency1	0.7339	<.0001
elab1	Yr1 Ravens	0.2631	<.0001
elab1	fluency1	0.1560	0.0076
elab1	orig1	0.2426	<.0001

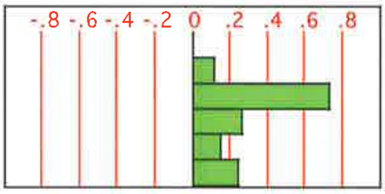


Figure 7.3.2: Correlations for Year 1 Ravens and substrates of the Year 1 Torrance Test of Creative Thinking

Between the originality and elaboration components of the Torrance measure and the Ravens data in Year 1 were correlations (0.1161 and 0.2631) significant at the 5% level ($p < .05$) and beyond the 0.1% level ($p < .0001$), whilst the fluency component and Ravens (Year 1) showed no connection whatsoever ($\rho = 0.005$, $p = 0.93$).

At this stage in the data analyses, it was appropriate to examine the correlations between creativity and the measure of *g*, according to the degrees of intellectual functioning. Upon partitioning intelligence, as measured by IQ1 scores, into levels, those contributing mostly to the overall significance of correlations could be identified, as reported in Figures 7.3.3 – 7.3.5. For the 175 subjects in the three groups (avg, below, low) combined into a single entity, a statistically significant correlation at the 5% level ($p < .05$) was obtained:

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
Yr1 Torrance	Yr1 Ravens	0.1615	0.0327

Figure 7.3.3: Ravens & Torrance (Year 1) Correlations for Average, Below & Low IQ groups

Research outlined in the earlier chapters indicated a positive correlation between creativity and IQ measures but that these scores were more likely to be significant within the average to above average IQ group, not at the highest levels of IQ. However, the results of this research were in direct opposition to this evidence (Figure 7.3.4).

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
Yr1 Torrance	Yr1 Ravens	0.0195	0.7750

Figure 7.3.4: Ravens & Torrance (Year 1) Correlations for Above Average & Average IQ groups

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
Yr1 Torrance	Yr1 Ravens	0.2705	0.0032

Figure 7.3.5: Ravens & Torrance (Year 1) Correlations for High and Above Average IQ groups

Figure 7.3.5 reports a highly significant correlation ($p < .01$) between Ravens and Torrance scores for this large subgroup. The values obtained clearly indicated that for 'High and Above Average IQ' scorers, a plausible connection between scores on the Ravens and Torrance tests could exist. However, upon examining the two subgroups separately, the author found that for neither the highest nor the 'above average' IQ levels (see Figures 7.3.6 & 7.3.7 below) did the creativity and IQ correlate significantly, at the 5% level, although 'nearly' so.

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
Yr1 Torrance	Yr1 Ravens	0.3379	0.0678

Figure 7.3.6: Ravens & Torrance (Year 1) Correlations for High IQ group

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
Yr1 Torrance	Yr1 Ravens	0.2052	0.0566

Figure 7.3.7: Ravens & Torrance (Year 1) Correlations for Above Average IQ group

For those subjects rated either average or less, clearly there was no feasible connection whatsoever (Figures 7.3.8–7.3.10).

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
Yr1 Torrance	Yr1 Ravens	0.1198	0.1729

Figure 7.3.8: Ravens & Torrance (Year 1) Correlations for Average IQ group

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
Yr1 Torrance	Yr1 Ravens	-0.1125	0.5200

Figure 7.3.9: Ravens & Torrance (Year 1) Correlations for Below Average IQ group

Interestingly, the performance of these Below Average IQ students on the Torrance Creativity test correlated negatively, although not significantly so, with their performances on the Ravens. That is, despite quite low IQ scores, some students posted quite reasonable scores on the creativity test.

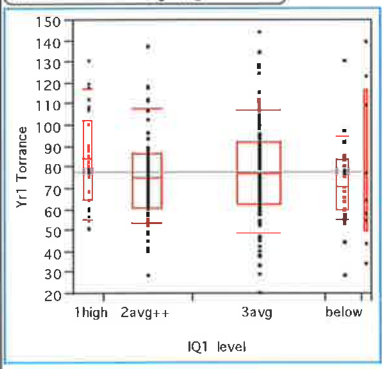
Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
Yr1 Torrance	Yr1 Ravens	0.2941	0.4423

Figure 7.3.10: Ravens & Torrance (Year 1) Correlations for Low IQ group

The author examined the Year 1 TTCT performance, stratified by intelligence groupings from the RPM1 scores, however no significant differences were observed, so no follow-up analysis was possible.

Yr1 Torrance By IQ1 level



Van der Waerden Test (Normal Quantiles)

Level	Count	Score Sum	Score Mean	(Mean-Mean0)/Std0
1high	30	9.431194	0.314373	1.846
2avg++	87	-5.482984	-0.06302	-0.712
3avg	131	5.243619	0.040028	0.627
below	35	-8.649315	-0.24712	-1.582
low	9	-0.542514	-0.06028	-0.187

1-way Test, Chi-Square Approximation

ChiSquare	DF	Prob>ChiSq
5.8677	4	0.2092

Figure 7.3.11: Chi-Square for IQ levels (Year 1) and Torrance (Year 1)

7.4. Torrance and Ravens in Year 2

For the second year, only two of the subjects identified in the 'outliers group' in the first year were present, so when these outliers were omitted, the correlation between final scores on the TTCT2 and RPM2, given in Figure 7.4.1 below, was:

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
Yr2 Torrance	Yr2 Ravens	0.2527	0.0005

Figure 7.4.1: Ravens & Torrance (Year 2) Correlations for Whole group (outliers excluded)

However, as this group was the largest one in the second year of the study (n=186, after outliers were omitted), the relationship between performance on the TTCT2 and RPM2 was of particular interest. The correlation of their results over the two tests was significant at the 0.1% level ($p < .001$). Thus, the substrates of the Torrance test were then compared with the Year 2 raw scores (RPM2) (Figure 7.4.2)

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
fluency2	Yr2 Ravens	0.1606	0.0286
orig2	Yr2 Ravens	0.2289	0.0017
orig2	fluency2	0.5923	<.0001
elab2	Yr2 Ravens	0.2791	0.0001
elab2	fluency2	0.2585	0.0004
elab2	orig2	0.3338	<.0001

Figure 7.4.2: Ravens & Torrance (Year 2) Pairwise Correlations (outliers excluded)

The author observed that between the originality and elaboration components of the Torrance measure and the Ravens in Year 2, there were significant correlations (0.2289 and 0.2791), both at the 0.1% level ($p < .001$). However, contrary to the result in Year 1, the fluency component and the Ravens score in Year 2 showed a positive correlation of 0.1606, significant at the 5% level ($p < .05$).

It should be remembered that the research outlined in the earlier chapters does anticipate a positive correlation between measures of creativity and IQ, but that these scores are more likely to be significant within the average to above average IQ group, rather than at the upper levels of IQ.

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
Yr2 Torrance	Yr2 Ravens	0.1421	0.1332

Figure 7.4.3: Ravens & Torrance (Year 2) Correlations for Average, Below & Low IQ groups

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
Yr2 Torrance	Yr2 Ravens	0.1651	0.0566

Figure 7.4.4: Ravens & Torrance (Year 2) Correlations for Above Average & Average IQ groups

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
Yr2 Torrance	Yr2 Ravens	0.1132	0.3402

Figure 7.4.5: Ravens & Torrance (Year 2) Correlations for High and Above Average IQ groups

Upon partitioning the data by levels of intelligence as measured by the Ravens (RPM2) scores, the author identified those levels contributing mostly to the overall correlation, 'significant at the 0.1% level' reported in Figure 7.4.1. This investigation reported a weak positive correlation between Ravens and Torrance scores for all subgroups.

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
Yr2 Torrance	Yr2 Ravens	0.0580	0.7926

Figure 7.4.6: Ravens & Torrance (Year 2) Correlations for High IQ group

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
Yr2 Torrance	Yr2 Ravens	0.0900	0.5344

Figure 7.4.7: Ravens & Torrance (Year 2) Correlations for Above Average IQ group

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
Yr2 Torrance	Yr2 Ravens	0.0998	0.3665

Figure 7.4.8: Ravens & Torrance (Year 2) Correlations for Average IQ group

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
Yr2 Torrance	Yr2 Ravens	0.0994	0.6682

Figure 7.4.9: Ravens & Torrance (Year 2) Correlations for IQ Below Average group

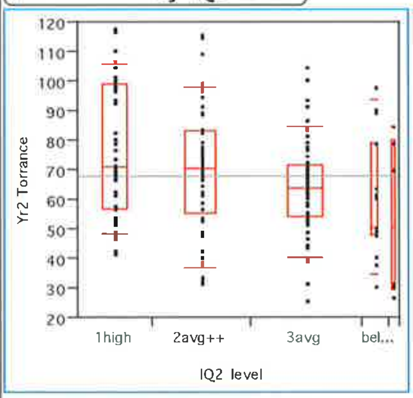
Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
Yr2 Torrance	Yr2 Ravens	0.4192	0.3013

Figure 7.4.10: Ravens & Torrance (Year 2) Correlations for IQ Low Ability group

By using the standard scores resulting from the Ravens (Year 2) data, the IQ2 data were generated, using the Raven's manual (Ravens; 1963). These data were then partitioned into five subgroups, as used elsewhere in this thesis, using the manual.

Yr2 Torrance By IQ2 level



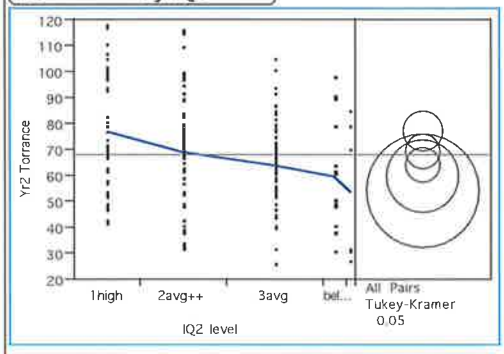
Van der Waerden Test (Normal Quantiles)

Level	Count	Score Sum	Score Mean	(Mean-Mean0)/Std0
1high	44	18.80540	0.427395	3.317
2avg++	57	3.87095	0.067911	0.629
3avg	64	-11.67862	-0.18248	-1.843
below	15	-6.41013	-0.42734	-1.765
low	6	-4.58760	-0.7646	-1.946

1-way Test, Chi-Square Approximation

ChiSquare	DF	Prob>ChiSq
17.4288	4	0.0016

Yr2 Torrance By IQ2 level



Means Comparisons

Dif=Mean[i]-Mean[j]	1high	2avg++	3avg	below	low
1high	0.0000	7.6874	13.1690	17.1576	23.0909
2avg++	-7.6874	0.0000	5.4816	9.4702	15.4035
3avg	-13.1690	-5.4816	0.0000	3.9885	9.9219
below	-17.1576	-9.4702	-3.9885	0.0000	5.9333
low	-23.0909	-15.4035	-9.9219	-5.9333	0.0000

Alpha= 0.05

Comparisons for all pairs using Tukey-Kramer HSD

q*
2.75548

Abs(Dif)-LSD	1high	2avg++	3avg	below	low
1high	-11.7938	-3.4136	2.3357	0.6181	-0.9832
2avg++	-3.4136	-10.3620	-4.5931	-6.5826	-8.3389
3avg	2.3357	-4.5931	-9.7789	-11.8803	-13.6965
below	0.6181	-6.5826	-11.8803	-20.1993	-20.7878
low	-0.9832	-8.3389	-13.6965	-20.7878	-31.9379

Positive values show pairs of means that are significantly different.

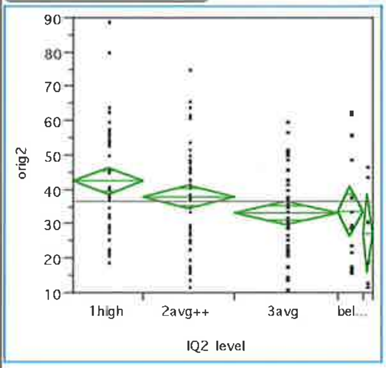
Figure 7.4.11: Chi-Square & and Pairwise Differences for IQ levels (Year 2) and Torrance (Year 2)

The analyses in Figure 7.4.11 gave powerful support to the contention that indeed, the means of the IQ-partitioned groups' scores on the TTCT2 were significantly different from each other (at the 1% level, $p < .0016$). The follow-up means comparisons showed that it was the highest IQ group's clearly significant differences from the middle 'average' (54% of the whole sample, called '3avg' here), as well as the 'below' and 'low' IQ groups.

Following this overall difference between the means, further investigations looked at the substrates of the Year 2 Torrance test. The fluency component was found to show no significance when analysed with respect to IQ levels ($\chi^2 = 7.222$, $p > 0.1246$)

The author then examined the other two components: originality and elaboration.

orig2 By IQ2 level



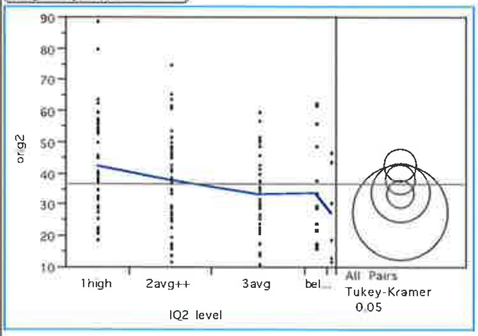
Van der Waerden Test (Normal Quantiles)

Level	Count	Score Sum	Score Mean	(Mean-Mean0)/Std0
1high	44	16.27606	0.369910	2.871
2avg++	57	5.03759	0.088379	0.819
3avg	64	-13.41117	-0.20955	-2.116
below	15	-3.64976	-0.24332	-1.005
low	6	-4.25272	-0.70879	-1.805

1-way Test, Chi-Square Approximation

ChiSquare	DF	Prob>ChiSq
13.7776	4	0.0080

orig2 By IQ2 level



Means Comparisons

Dif=Mean[i]-Mean[j]	1high	2avg++	below	3avg	low
1high	0.0000	4.3194	8.8773	8.9773	14.8106
2avg++	-4.3194	0.0000	4.5579	4.6579	10.4912
below	-8.8773	-4.5579	0.0000	0.1000	5.9333
3avg	-8.9773	-4.6579	-0.1000	0.0000	5.8333
low	-14.8106	-10.4912	-5.9333	-5.8333	0.0000

Alpha= 0.05

Comparisons for all pairs using Tukey-Kramer HSD

q*
2.75548

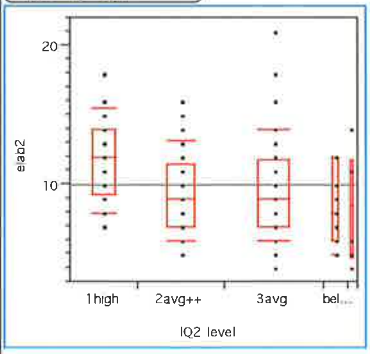
Abs(Dif)-LSD	1high	2avg++	below	3avg	low
1high	-8.3053	-3.4980	-2.7698	1.3484	-2.1424
2avg++	-3.4980	-7.2970	-6.7465	-2.4367	-6.2282
below	-2.7698	-6.7465	-14.2244	-11.0749	-12.8838
3avg	1.3484	-2.4367	-11.0749	-6.8864	-10.7988
low	-2.1424	-6.2282	-12.8838	-10.7988	-22.4907

Positive values show pairs of means that are significantly different.

Figure 7.4.12: Chi-Square & Pairwise Differences for IQ and Originality component of Torrance (Year 2)

This overall significance ($p < .05$) was examined further by comparing each pair of means, again to find that the highest IQ subgroup differed significantly ($p < .05$) from the average IQ subgroup (Figure 7.4.13), however, there were no other significant differences in the data.

elab2 By IQ2 level



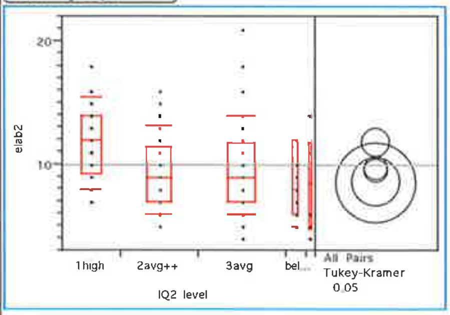
Van der Waerden Test (Normal Quantiles)

Level	Count	Score Sum	Score Mean	(Mean-Mean0)/Std0
1high	44	25.85579	0.587632	4.585
2avg++	57	-9.09003	-0.15947	-1.486
3avg	64	-5.69395	-0.08897	-0.903
below	15	-7.31664	-0.48778	-2.025
low	6	-3.75517	-0.62586	-1.601

1-way Test, Chi-Square Approximation

ChiSquare	DF	Prob>ChiSq
24.3627	4	<.0001

elab2 By IQ2 level



Means Comparisons

Dif=Mean[i]-Mean[j]	1high	3avg	2avg++	below	low
1high	0.00000	2.10795	2.39195	3.26212	3.29545
3avg	-2.10795	0.00000	0.28399	1.15417	1.18750
2avg++	-2.39195	-0.28399	0.00000	0.87018	0.90351
below	-3.26212	-1.15417	-0.87018	0.00000	0.03333
low	-3.29545	-1.18750	-0.90351	-0.03333	0.00000

Alpha= 0.05

Comparisons for all pairs using Tukey-Kramer HSD

q*
2.75548

Abs(Dif)-LSD	1high	3avg	2avg++	below	low
1high	-1.73012	0.51874	0.76346	0.83583	-0.23614
3avg	0.51874	-1.43454	-1.19394	-1.17374	-2.27725
2avg++	0.76346	-1.19394	-1.52008	-1.48472	-2.57943
below	0.83583	-1.17374	-1.48472	-2.96318	-3.88658
low	-0.23614	-2.27725	-2.57943	-3.88658	-4.68519

Positive values show pairs of means that are significantly different.

Figure 7.4.13: Chi-Square & Pairwise Differences for IQ and Elaboration component of Torrance (Year 2)

From the Van der Waerden Test of overall difference between the various means, Which was highly significant, a follow-up means comparison of each pair of means found that the (very) high ability group mean differed significantly (p < .05) from each of the other groups' means, however no other pairs differed significantly.

7.5. Ravens Year 1 and Year 2 with Teacher Nomination.

As mentioned earlier (Chapter 6), five schools felt unable to participate in this aspect of the study, whilst the other ten schools had no such reservations. To assess the intuitive accuracy of the teachers' nominations, the actual IQ scores (IQ 1, the standardised scores) were analysed by the various categories of teacher nomination. The subjects in the five schools which chose not to make any nomination were coded as *u* (for unclassified, n=89), whilst those in the other ten schools which did make nominations were coded as *n, ng* or *r*.

The following analyses of scores on the RPM (Years 1 and 2) were obtained by subjects nominated by teachers as gifted and those not nominated as gifted. These nominations were done 'blind' in the sense that the teachers had no numerical information concerning the Ravens and Torrance tests. The teachers were asked to 'nominate' on the basis of "general intelligence" as they had 'observed' it in day-to-day classroom work.

The *n* category indicates those subjects (n=31) nominated by the teachers as likely to exhibit high intellectual potential, in the absence of any actual data on IQ. The *ng* coding, identifies the small subset (n=19) of the group who were both nominated by their teachers and also completed the *Turning World* program, whilst the final category, *r* (n= 160) indicates those who were regarded as regular students, i.e. were not nominated 'as likely to exhibit high intellectual potential' by their teachers.

Van der Waerden Test (Normal Quantiles)

Level	Count	Score Sum	Score Mean	(Mean-Mean0)/Std0
n	31	21.05791	0.679287	4.061
ng	19	16.94060	0.891611	4.082
r	160	-25.50877	-0.15943	-3.006
u	89	-12.48975	-0.14033	-1.606

1-way Test, Chi-Square Approximation

ChiSquare	DF	Prob>ChiSq
36.3982	3	<.0001

Alpha= 0.05

Comparisons for all pairs using Tukey-Kramer HSD

q *
2.58376

Abs(Dif)-LSD	ng	n	u	r
ng	-12.4303	-7.8181	6.4542	7.2269
n	-7.8181	-9.7314	4.8018	5.6608
u	6.4542	4.8018	-5.7433	-4.6792
r	7.2269	5.6608	-4.6792	-4.2835

Positive values show pairs of means that are significantly different.

Van der Waerden Test (Normal Quantiles)

Level	Count	Score Sum	Score Mean	(Mean-Mean0)/Std0
n	19	6.17389	0.324942	1.532
ng	17	15.69933	0.923490	4.094
r	103	-11.85528	-0.1151	-1.787
u	48	-10.01794	-0.20871	-1.719

1-way Test, Chi-Square Approximation

ChiSquare	DF	Prob>ChiSq
20.9738	3	0.0001

Alpha= 0.05

Comparisons for all pairs using Tukey-Kramer HSD

q *
2.59281

Abs(Dif)-LSD	ng	n	r	u
ng	-15.7070	-5.3685	5.8006	6.6858
n	-5.3685	-14.8573	-3.5645	-2.7212
r	5.8006	-3.5645	-6.3811	-6.1814
u	6.6858	-2.7212	-6.1814	-9.3475

Positive values show pairs of means that are significantly different.

Figure 7.5.1: Analyses and Means Comparisons of IQ 1 (Year 1) and IQ 2 (Year 2) by Nomination

The *u* group was dropped from the analysis in this Section 7.5, on the reasonable assumption that, as a heterogeneous group they would confound analyses trying to identify nuances in the data dealing with *teacher nomination:* its 'accuracy', reliability and predictive validity on a range of markers.

As can be seen in the Van der Waerden Tests in Figure 7.5.1, there were highly significant differences overall, between the means of the groups ($p < .01$) in both years.

The consequent examination of the groups, pair by pair, identifies the source of these variations in the second part of Figure 7.5.1, and these differences were significant at the 5% level. The *ng* group (both nominated by their teachers and also those who completed the *Turning World* enrichment program) differed significantly from the 'regular' and 'un-nominated' groups for both year's data. The *n* group (nominated as gifted, but did not participate in the *Turning World* enrichment program) differed from the *r* and *u* groups only in Year 1.

This was an important finding, in terms of this thesis' research questions, as the data presented evidence that the *ng* group's experiences had, in effect, a sufficient impact to account for the significant difference between this group and the *r* group. Indeed the actual difference between the means of *ng* and all other groups increased from the first to the second year and, in particular, the difference between the means of the *ng* group and the *n* group trebled in that period. Relative to the much bigger differences between the other groups, however, this trebling was not statistically significant, but as a trend, is important to note.

The author examined the change scores in the IQ data (IQ2 – IQ1) subdivided by the differing nomination categories (*n*, *ng*, and *r*).

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	2	58.559	29.2793	0.3262
Error	136	12207.513	89.7611	Prob>F
C Total	138	12266.072	88.8846	0.7222

Figure 7.5.2: IQ change scores (IQ2-IQ1) by Nomination

Had the IQ data been known to the teachers, it was likely that their nominations would have differed from those given in this study. By reversing the dependent and independent variables, the author believed it provided a basis for a plausible conjecture as to how the given nominations might have been affected by knowledge of IQ, that is, had nomination been dependent on IQ rating:

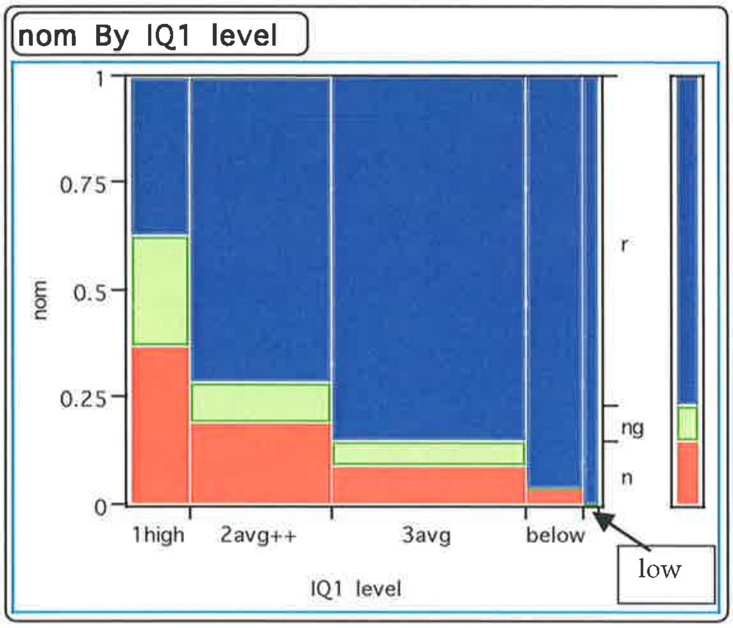


Figure 7.5.3: IQ1 level (Year 1) by Nomination
(The widths of the columns in the graphic are proportional to the subgroup's size, the n and ng groups constituting 63% of very high IQ 1 ('1high') and 29% of the above average ('2avg++') group).

Interestingly, those nominated as 'gifted' by the teachers comprise 23% of the total group (49 of 210), yet represent 39% (35 of 90) of the IQ scores, above the 'average'.

nom By IQ1 level

Crosstabs

IQ1 level

nom / Count	1high	2avg++	3avg	below	low	
n	10	12	8	1	0	31
ng	7	6	5	0	0	18
r	10	45	75	24	7	161
	27	63	88	25	7	210

Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	8	18.13351	0.1239
Error	200	128.17267	
C Total	208	146.30618	
Total Count	210		

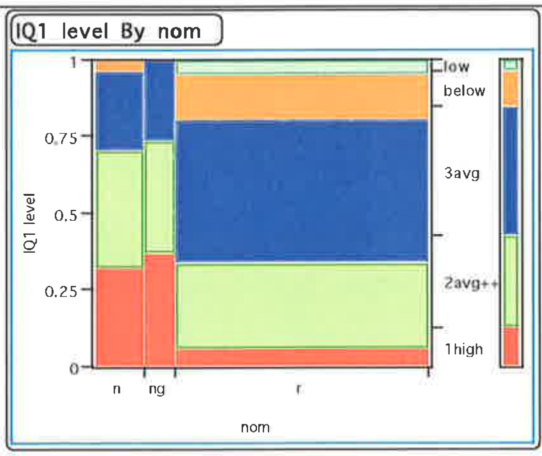
Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	36.267	<.0001
Pearson	36.239	<.0001

Warning: 20% of cells have expected count less than 5, Chi-squares suspect

Figure 7.5.4: Analysis of Nomination by IQ 1 level (Year 1)

It was clear from the Chi-squared analysis table that the nomination category would have been regarded as statistically significantly affected by the IQ rating (as determined by the Ravens test in Year 1), had the teachers known the IQ data. However it is important to emphasise and must be remembered here that the teachers did *not* have recourse to this statistical information at the time of nomination.

To assess how intuitively accurate the teachers' nominations were, based on "assumed IQ", the following graphic (Figure 7.5.4) and analysis (Figure 7.5.5) were made. The *n* category included here *all* students nominated as 'gifted' (i.e. *n* and *ng*). These figures emphatically suggested that these nominations were very reliable: the consequent Chi–squared analysis showing high levels of significance (p < .001)



IQ1 level By nom

Crosstabs

nom

Count (IQ1 level)	n	ng	r	
1high	10	7	10	27
2avg++	12	7	44	63
3avg	8	5	75	88
below	1	0	24	25
low	0	0	7	7
	31	19	160	210

Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	8	18.36950	0.0645
Error	198	266.41909	
C Total	206	284.78859	
Total Count	210		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	36.739	<.0001
Pearson	36.084	<.0001

Warning: 20% of cells have expected count less than 5, Chi-squares suspect

Figure 7.5.5: Distribution and Analysis of IQ 1 level (Year 1) by Nomination

Looking at the first year's results (IQ1 level) between those nominated (*n* and *ng*) and regular (*r*), based on the first year's nominations, there was a highly significant difference (p < .01) in the mean IQs of the two groups, as was expected from the overall analysis of Figure 7.5.1. The *change* in IQ scores (R2 – R1) was expected from the literature to be three points, but for the *ng* group it was significantly higher than that, at the 5% level

Test for Normality

Shapiro-Wilk W Test

W	Prob<W
0.904959	0.0835

Test Mean=value

Hypothesized Value	3
Actual Estimate	5.05882
Using Std Dev of	4.91771
	z Test
Test Statistic	1.7262
Prob > |z|	0.0843
Prob > z	0.0422
Prob < z	0.9578

Figure 7.5.6: Analysis of change in Ravens scores (R2 – R1) for 'ng' group

A similar result was observed for both the *n* and *r* groups.

There was no appreciable difference between the *ng* and *n* groups, when looking at the changes in Ravens scores (R2 – R1):

7.6. Torrance Year 1 and Year 2 by Teacher Nomination.

As the Torrance scores in both years were non-normal (see Section 7.2) appropriate non-parametric means were used to find correlations between the various nomination groups' TTCT scores in both applications of the test.

Overall, but excluding the unclassified group (*u*) for the reason cited in Section 7.5, there was a highly significant correlation between the two tests at the 0.1% level (n = 138). The data for this subgroup and for the *ng* and *r* subgroups were non-normal, whilst for *n*, normal, hence the differing modes of correlational analysis.

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
Yr2 Torrance	Yr1 Torrance	0.4310	<.0001

Figure 7.6.1: Correlation of Torrance tests (Years 1 & 2) by Nomination (all, except 'u' group)

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
Yr2 Torrance	Yr1 Torrance	0.0167	0.9493

Figure 7.6.2: Correlation of Torrance tests (Years 1 & 2) by Nomination ('ng' group)

Pairwise Correlations

Variable	by Variable	Correlation	Count	Signif Prob
Yr2 Torrance	Yr1 Torrance	0.5026	19	0.0283

Figure 7.6.3: Correlation of Torrance tests (Years 1 & 2) by Nomination ('n' group)

Nonparametric Measures of Association

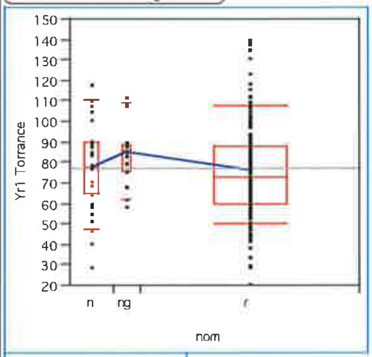
Variable	by Variable	Spearman Rho	Prob>|Rho|
Yr2 Torrance	Yr1 Torrance	0.4289	<.0001

Figure 7.6.4: Correlation of Torrance tests (Years 1 & 2) by Nomination ('r' group)

Teacher nomination then, appeared to be *a reliable technique* for the *n* and *r* groups, as far as stability of TTCT measures go.

The *ng* group's result was only understandable in the light of later analysis (see Figure 7.6.5) in that, at the start of the research, there was no overall significant difference between the means of the subgroups. However, by the following year, there was a statistically, highly significant difference (at the 1% level) between the subgroup which undertook the intervention program, the *Turning World* and which had also been nominated as 'gifted' by teachers, and *each* of the other subgroups. This was strikingly seen in the 'comparison circles' visual associated with the analysis.

Yr1 Torrance By nom



Analysis Display

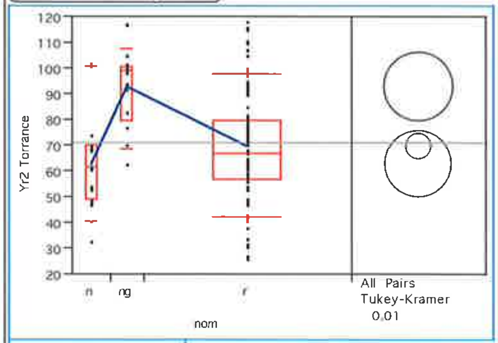
Van der Waerden Test (Normal Quantiles)

Level	Count	Score Sum	Score Mean	(Mean-Mean0)/Std0
n	31	0.835496	0.026951	0.166
ng	19	7.626030	0.401370	1.875
r	154	-8.461526	-0.05494	-1.406

1-way Test, Chi-Square Approximation

ChiSquare	DF	Prob>ChiSq
3.6960	2	0.1576

Yr2 Torrance By nom



Analysis Display

Van der Waerden Test (Normal Quantiles)

Level	Count	Score Sum	Score Mean	(Mean-Mean0)/Std0
n	19	-7.20555	-0.37924	-1.829
ng	17	16.15855	0.950503	4.300
r	103	-8.95300	-0.08692	-1.782

1-way Test, Chi-Square Approximation

ChiSquare	DF	Prob>ChiSq
19.9384	2	<.0001

Means Comparisons

Dif=Mean[i]-Mean[j]	ng	r	n
ng	0.0000	23.2404	30.0279
r	-23.2404	0.0000	6.7874
n	-30.0279	-6.7874	0.0000

Alpha= 0.01

Comparisons for all pairs using Tukey-Kramer HSD

q *
2.96311

Abs(Dif)-LSD	ng	r	n
ng	-19.7184	8.1907	10.8354
r	8.1907	-8.0108	-7.5663
n	10.8354	-7.5663	-18.6517

Positive values show pairs of means that are significantly different.

Figure 7.6.5: Distribution and Analysis of Torrance tests (Years 1 & 2) by Nomination

Given the nature of the design of this research, it could be reasonably, indeed confidently, concluded that the *Turning World* intervention program had a significantly different, differential effect on this group, compared with any other.

This was an exciting result and certainly suggests further research involving the effects of intervention, perhaps in a variety of modes, should be undertaken in this area.

The author then examined change scores for the different nomination groups, which emphasised the difference between the *ng* group and the others.

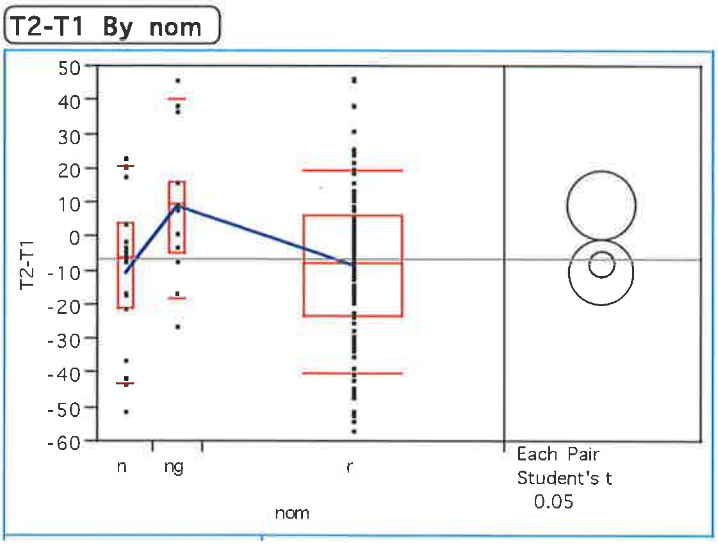


Figure 7.6.6: Distribution of Torrance change scores (T2 – T1) by Nomination

The distribution of the T2 – T1 data was acceptably normal (Section 7.2), so the use of parametric techniques was justified:

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	2	4822.845	2411.42	5.0429
Error	135	64554.264	478.18	**Prob>F**
C Total	137	69377.109	506.40	0.0077

Figure 7.6.7: Analysis of Torrance change scores (T2 – T1) by Nomination

An overall difference existed between the means (at the 1% level: p > .0077), and follow-up means comparisons, showed the *ng* group to be significantly different from *n* or *r* at the 1% level:

Alpha= 0.01

Comparisons for each pair using Student's t

t
2.61272

Abs(Dif)-LSD	**ng**	**r**	**n**
ng	-19.5965	2.4054	0.9107
r	2.4054	-8.0003	-11.6640
n	0.9107	-11.6640	-18.5365

Positive values show pairs of means that are significantly different.

Figure 7.6.8: Means Comparisons of Torrance change scores (T2 – T1) by Nomination

To determine the possible effects of the intervention program, the *Turning World*, conducted in the period between the two applications of the (matched, equivalent) Torrance tests, the following analyses were conducted. Interestingly, for all those who had not participated in the *Turning World* program, there was an overall *reduction* in the Torrance scores (i.e. T2 – T1 is negative).

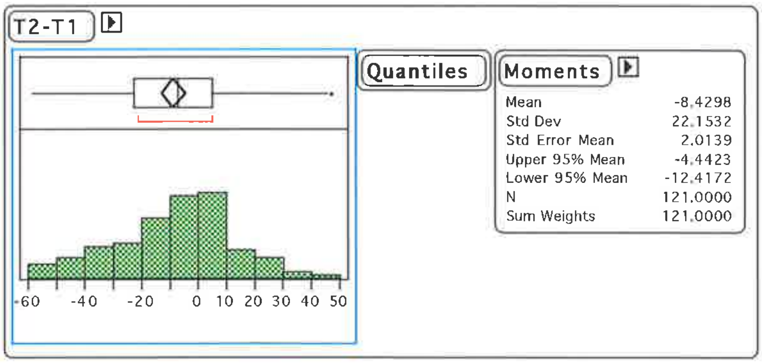


Figure 7.6.9: Distribution of Change in Torrance scores (T2 – T1) for 'n & 'r' grouped

As there had been no intervention program for these subjects, a two-sided test was conducted (that is, the author looked for *any* difference between the means of the two data sets). The expectation was then, that T2 – T1 ≠ 0, and was supported by the emphatic rejection of the null hypothesis (i.e. T2 – T1 = 0), returning a statistic indicating a significant difference (from 'zero difference') at the 0.1% level (p = 0.000).

Test for Normality

Shapiro-Wilk W Test	
W	Prob<W
0.975052	0.2338

Test Mean=value

Hypothesized Value	0
Actual Estimate	-8.4298
Using Std Dev of	22.1532
	z Test
Test Statistic	-4.1857
Prob > |z|	<.0001
Prob > z	1.0000
Prob < z	<.0001

Figure 7.6.10: Analysis of Change in Torrance scores (T2 – T1) for 'n & 'r' grouped

Similarly, for those subjects nominated by their teachers, but were not participants in the *Turning World* intervention program (i.e. the *n* subgroup), the distribution was acceptably normal:

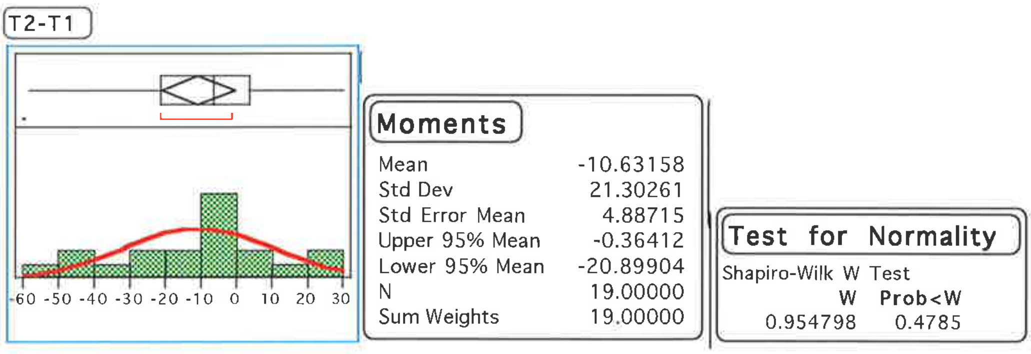


Figure 7.6.11: Distribution of Change in Torrance scores (T2 – T1) for 'n' group

The difference between the scores (T2 – T1) was still, on average, negative. Indeed the conjecture that the Torrance scores increased for this subgroup could be confidently rejected at the 5% level (in fact, $p < 0.0148$), thus leading to the obvious conclusion that even for students nominated as 'gifted' by their teachers, their creativity scores, as measured by the Torrance test, worsened.

Test Mean=value

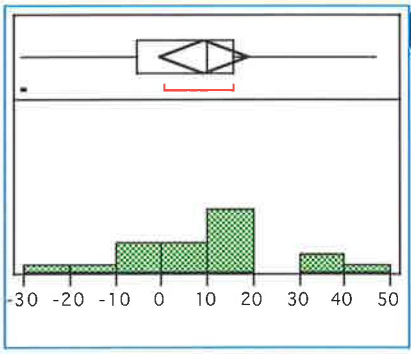
Hypothesized Value	0
Actual Estimate	-10.632
Using Std Dev of	21.3026
	z Test
Test Statistic	-2.1754
Prob > |z|	0.0296
Prob > z	0.9852
Prob < z	0.0148

Figure 7.6.12: Analysis of Change in Torrance scores (T2 – T1) for 'n' group

However, the situation for the *ng* subgroup was dramatically different!

Most subjects nominated by their teachers, and who *did* participate in the *Turning World* intervention program (the *ng* subgroup), had Torrance increased scores:

T2-T1



Quantiles

Moments

Mean	9.35294
Std Dev	18.99323
Std Error Mean	4.60653
Upper 95% Mean	19.11831
Lower 95% Mean	-0.41243
N	17.00000
Sum Weights	17.00000

Figure 7.6.13: Distribution of Change in Torrance scores (T2 – T1) for 'ng' group

and so it was feasible to conduct a directional test, that is, hypothesise that $T2 - T1 \geq 0$. This conjecture was strongly supported by the analysis (significant at the 5% level, $p = 0.0212$; Figure 7.6.14)

Test for Normality

Shapiro-Wilk W Test

W	Prob<W
0.954880	0.5285

Test Mean=value

Hypothesized Value	0
Actual Estimate	9.35294
Using Std Dev of	18.9932
	z Test
Test Statistic	2.0304
Prob > |z|	0.0423
Prob > z	0.0212
Prob < z	0.9788

Figure 7.6.14: Analysis of Change in Torrance scores (T2 – T1) for 'ng' group

The conclusion then, is that the intervention program the *Turning World*, directly contributed to an increase in creative thinking, as measured by the Torrance test.

For the *ng* group, the differential changes in both IQ and creativity measures were also significantly correlated at the 5% level:

Pairwise Correlations

Variable	by Variable	Correlation	Count	Signif Prob
T2-T1	R2-R1	0.4968	17	0.0425

Figure 7.6.15: Analysis of Torrance v RPM Change scores for 'ng' group

Exploring the possibility that some low IQ1 group subjects may have scored well on Torrance tests in either year, the author found that in each year, nearly half of this group scored above the mean for all subjects in each year (in fact, two subjects beyond the 75th percentile each year).

Stem and Leaf (Year 1)

Stem	Leaf	Count
14	0	1
13		
12	4	1
11	0	1
10		
9		
8		
7	8	1
6	5	1
5	59	2
4	4	1
3	5	1
2		

Multiply Stem.Leaf by 10

Stem and Leaf (Year 2)

Stem	Leaf	Count
9	8	1
8	5	1
7	09	2
6		
5		
4	8	1
3	12	2
2	7	1

Multiply Stem.Leaf by 10

Year 1 *Year 2*

Figure 7.6.16: Distribution of Torrance scores for Low IQ1 level subjects

7.7. Ravens tests and the *Figures of Sound*.

There was a highly significant correlation (at the 0.1% level) for the whole group between the total scores on the *Figures of Sound* instrument and the Ravens, Year 1 (RPM1).

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
FoSTot8	Yr1 Ravens	0.2316	<.0001

Figure 7.7.1: Correlation of Figures of Sound with Ravens (Year 1)

...and also for the whole group in Year 2:

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
FoSTot8	Yr2 Ravens	0.2677	0.0002

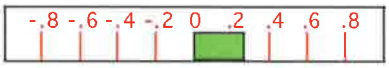


Figure 7.7.2: Correlation of Figures of Sound with Ravens (Year 2)

To discern how individual questions on the FoS test contributed to these overall significant correlations, the author calculated correlations for each question on the *Figures of Sound* (FoS) and the Year 1 and Year 2 Ravens scores, respectively. As the search was for *any* possible clue to the contributing questions, a 10% level of significance was chosen. Even with such a coarse filter only the following questions appeared to contribute, individually, anything much to the overall significance: questions Q2, Q3 and Q8 with Spearman ρ of 0.0913, 0.0887 and 0.1918 respectively. The associated 'p-values' of 0.1159, 0.1266 and 0.0009 respectively, suggested that with nearly a '1 in 10 chance' of accepting a false result, (i.e. almost 10% level of significance) that for Q2 and Q3 there might be some linkage with IQ scores (i.e. RPM1), although there was quite a high likelihood (significance at the 0.1% level) that Q8 and Year 1 Ravens had some (underlying) connection.

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
FoSq2	Yr1 Ravens	0.0913	0.1159
FoSq3	Yr1 Ravens	0.0887	0.1266
FoSq3	FoSq2	0.1120	0.0534
FoSq8	Yr1 Ravens	0.1918	0.0009
FoSq8	FoSq2	0.0301	0.6044
FoSq8	FoSq3	-0.0895	0.1233

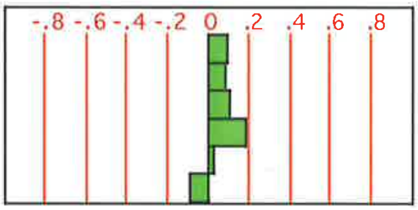
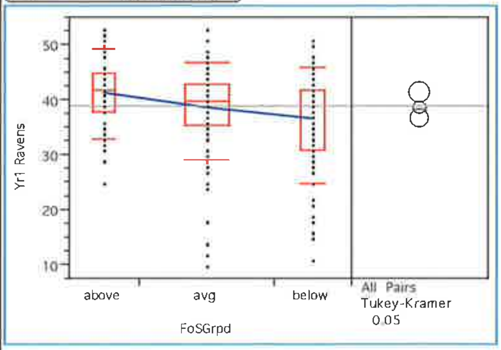


Figure 7.7.3: Correlations of Figures of Sound questions with Ravens (Years 1 & 2)

The FoS Total scores were then grouped into three categories 'above' (score ≥ 8), 'avg' (4 ≤ score ≤ 7) and 'below' (score ≤ 3) and non-parametric analysis was used to identify overall and pairwise differences between the categories, relative to IQ scores from both years.

Yr1 Ravens By FoSGrpd



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean
above	75	41.4800	5.70765	0.65906
avg	141	38.5674	7.49696	0.63136
below	82	36.5976	8.59207	0.94884

Van der Waerden Test (Normal Quantiles)

Level	Count	Score Sum	Score Mean	(Mean-Mean0)/Std0
above	75	26.03103	0.347080	3.532
avg	141	-5.12441	-0.03634	-0.604
below	82	-20.90662	-0.25496	-2.756

1-way Test, Chi-Square Approximation

ChiSquare	DF	Prob>ChiSq
15.0337	2	0.0005

Means Comparisons

Dif=Mean[i]-Mean[j]	above	avg	below
above	0.00000	2.91262	4.88244
avg	-2.91262	0.00000	1.96981
below	-4.88244	-1.96981	0.00000

Alpha= 0.05

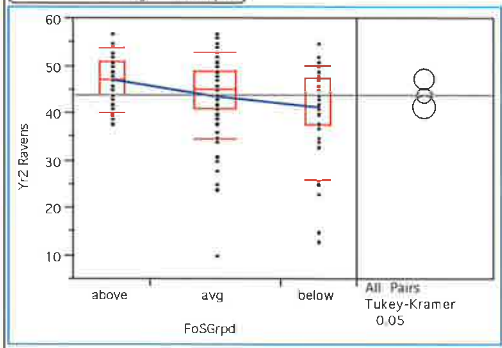
Comparisons for all pairs using Tukey-Kramer HSD

q *
2.35568

Abs(Dif)-LSD	above	avg	below
above	-2.85586	0.41320	2.08819
avg	0.41320	-2.08285	-0.45897
below	2.08819	-0.45897	-2.73124

Positive values show pairs of means that are significantly different.

Yr2 Ravens By FoSGrpd



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean
above	51	47.1373	4.69476	0.6574
avg	86	43.7093	8.54588	0.9215
below	49	41.3061	8.96568	1.2808

Van der Waerden Test (Normal Quantiles)

Level	Count	Score Sum	Score Mean	(Mean-Mean0)/Std0
above	51	19.09937	0.374497	3.213
avg	86	-2.53714	-0.0295	-0.382
below	49	-16.56223	-0.338	-2.822

1-way Test, Chi-Square Approximation

ChiSquare	DF	Prob>ChiSq
13.4359	2	0.0012

Means Comparisons

Dif=Mean[i]-Mean[j]	above	avg	below
above	0.00000	3.42795	5.83113
avg	-3.42795	0.00000	2.40318
below	-5.83113	-2.40318	0.00000

Alpha= 0.05

Comparisons for all pairs using Tukey-Kramer HSD

q *
2.36299

Abs(Dif)-LSD	above	avg	below
above	-3.65559	0.16543	2.13843
avg	0.16543	-2.81510	-0.90087
below	2.13843	-0.90087	-3.72945

Positive values show pairs of means that are significantly different.

Figure 7.7.4: Analysis of Figures of Sound grouped data by Ravens (Years 1 & 2)

Figure 7.7.4, shows that there were significant differences overall (beyond the 0.1% level), and pairwise between the above average scorers on the FoS ('above') and either of the other two groupings (average and 'below average') at the 5% level.

No further insight to the data was provided by an analysis of *change* in Ravens scores (R2 – R1), which were normally distributed) relative to these groupings, an ANOVA demonstrating that the null hypothesis of "no differences between these groups' means" had to be accepted.

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	2	8.8819	4.4409	0.3282
Error	183	2476.2418	13.5314	**Prob>F**
C Total	185	2485.1237	13.4331	0.7206

Figure 7.7.5: Analysis of Figures of Sound (Grouped) by Change scores for Ravens

Those nominated as gifted by their teachers (*ng* and *n*) as a united group showed no significant correlations in either year, between their FoS and Ravens scores. In the first year this group numbered 50, but only 36 remained by the second year of testing.

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
FoSTot8	Yr1 Ravens	0.0818	0.5721

Figure 7.7.6: Correlation of Figures of Sound with Ravens (Year 1) for 'ng + n' group

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
FoSTot8	Yr2 Ravens	-0.0118	0.9457

Figure 7.7.7: Correlation of Figures of Sound with Ravens (Year 2) for 'ng + n' group

For those who completed the intervention program, *Turning World* (the *ng* subgroup), no appreciable correlation was found in this aspect of the research:

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
FoSTot8	Yr1 Ravens	-0.0063	0.9797

Figure 7.7.8: Correlation of Figures of Sound with Ravens (Year 1) for 'ng' group

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
FoSTot8	Yr2 Ravens	-0.0711	0.7862

Figure 7.7.9: Correlation of Figures of Sound with Ravens (Year 2) for 'ng' group

Likewise, looking at those who were also 'nominated gifted' but did not complete the intervention program, *Turning World* (the *n* subgroup), no appreciable correlation was found:

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
FoSTot8	Yr1 Ravens	0.1455	0.4348

Figure 7.7.10: Correlation of Figures of Sound with Ravens (Year 1) for 'n' group

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
FoSTot8	Yr2 Ravens	0.0786	0.7490

Figure 7.7.11: Correlation of Figures of Sound with Ravens (Year 2) for 'n' group

For both years this lack of association persisted for the heterogeneous *u* group (those not given any nomination by their teachers):

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|	-.8 -.6 -.4 -.2 0 .2 .4 .6 .8
FoSTot8	Yr1 Ravens	0.0816	0.4497	

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|	-.8 -.6 -.4 -.2 0 .2 .4 .6 .8
FoSTot8	Yr2 Ravens	0.1207	0.4188	

Figure 7.7.12: Correlation of Figures of Sound with Ravens (Years 1 & 2) for 'u' group

But there was a very strong, significant correlation evident in both years, for those designated as 'regular' (*r*) by their teachers.

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|	-.8 -.6 -.4 -.2 0 .2 .4 .6 .8
FoSTot8	Yr1 Ravens	0.2961	0.0001	

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|	-.8 -.6 -.4 -.2 0 .2 .4 .6 .8
FoSTot8	Yr2 Ravens	0.3945	<.0001	

Figure 7.7.13: Correlation of Figures of Sound with Ravens (Years 1 & 2) for 'r' group

7.8. Torrance Tests and the *Figures of Sound* (FoS).

For the total group, there was, in either year, no significant correlation, at the 5% level found between the TTCT (Year 1) scores and the total scores on the FoS instrument.

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
FoSTot8	Yr1 Torrance	-0.0134	0.8202

Figure 7.8.1: Correlation of Figures of Sound with Torrance (Year 1)

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|
FoSTot8	Yr2 Torrance	0.0774	0.2938

Figure 7.8.2: Correlation of Figures of Sound with Torrance (Year 2)

This was also true for the various groupings of the subjects, according to nomination by teachers. That is, for the subgroups *ng*, *n*, *r* and *u*, there were no statistically appreciable measures of association.

This lack of association between these two variables persisted despite partitioning on the bases of IQ (using IQ1 levels), or gender, or whether subjects attended SHIP schools or not.

By examining the changes in scores between the two applications of the TTCT test, relative to nomination category, only the *ng* subgroup, which uniquely experienced the *Turning World* intervention program, came anywhere 'near' a statistically significant correlation (p = 0.0806)

Pairwise Correlations

Variable	by Variable	Correlation	Count	Signif Prob
FoSTot8	T2-T1	0.4355	17	0.0806

Figure 7.8.3: Correlation of 'ng' group Figures of Sound with Changes in Torrance scores (T2 – T1)

The other groups in turn, all showed no discernable strength of association, returning significance probabilities of 0.45, 0.11 and 0.19 for *n*, *r* and *u* groups respectively.

7.9. Ravens and Torrance by Gender and Area

The first of these interrogations of the data (without outliers) was to examine possible gender differences. The research in Chapter 2 of this thesis reported that IQ scores do not vary significantly between males and females.

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|	-.8 -.6 -.4 -.2 0 .2 .4 .6 .8
Yr2 Ravens	Yr1 Ravens	0.8417	<.0001	

Figure 7.9.1: Correlations of IQ for Female group

Figures 7.9.1 and 7.9.2 showed a highly significant correlation ($p < .01$) between the two administrations of the Ravens tests for both females and males.

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|	-.8 -.6 -.4 -.2 0 .2 .4 .6 .8
Yr2 Ravens	Yr1 Ravens	0.8302	<.0001	

Figure 7.9.2: Correlations of IQ for Male group

Thus, the Ravens scores for both female and male groups (females n = 85; males n =102) showed consistency over the two applications of the test(s) during the research, even though each distribution was significantly non-normal (the 'Prob<W' value must exceed 0.05 to accept the hypothesis of normality at the 5% level):

Test for Normality

Shapiro-Wilk W Test

W	Prob<W
0.895641	<.0001

for Year 1

Test for Normality

Shapiro-Wilk W Test

W	Prob<W
0.880921	<.0001

for Year 2

Figure 7.9.3: Test of Normality of female Ravens scores

Test for Normality

Shapiro-Wilk W Test

W	Prob<W
0.933715	<.0001

for Year 1

Test for Normality

Shapiro-Wilk W Test

W	Prob<W
0.863273	<.0001

for Year 2

Figure 7.9.4: Test of Normality of male Ravens scores

As predicted by the research literature, there were no differences between the means of the two gender-based groups (Figure 7.9.5):

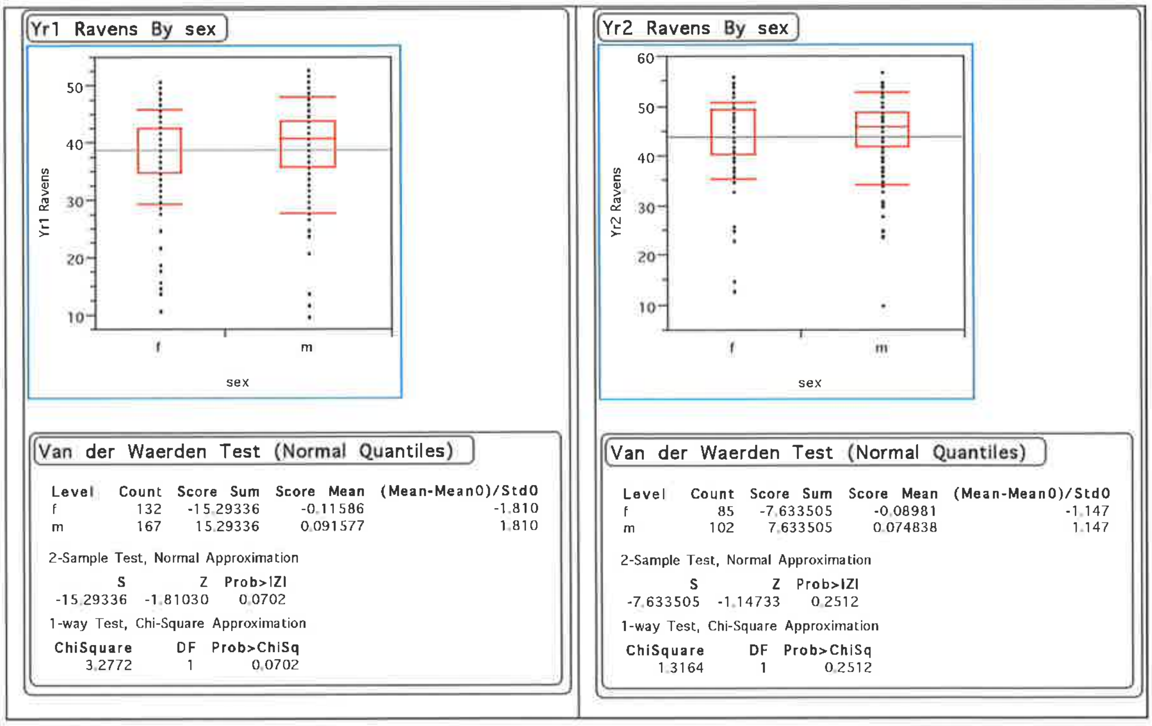


Figure 7.9.5: Analysis of RPM (Year 1) and RPM (Year 2) by Gender

An examination of the nature of the female and male subgroup's change scores' distributions (R2 – R1) was warranted (Figure 7.9.6), before any further analysis took place. This revealed that each was acceptably normal.

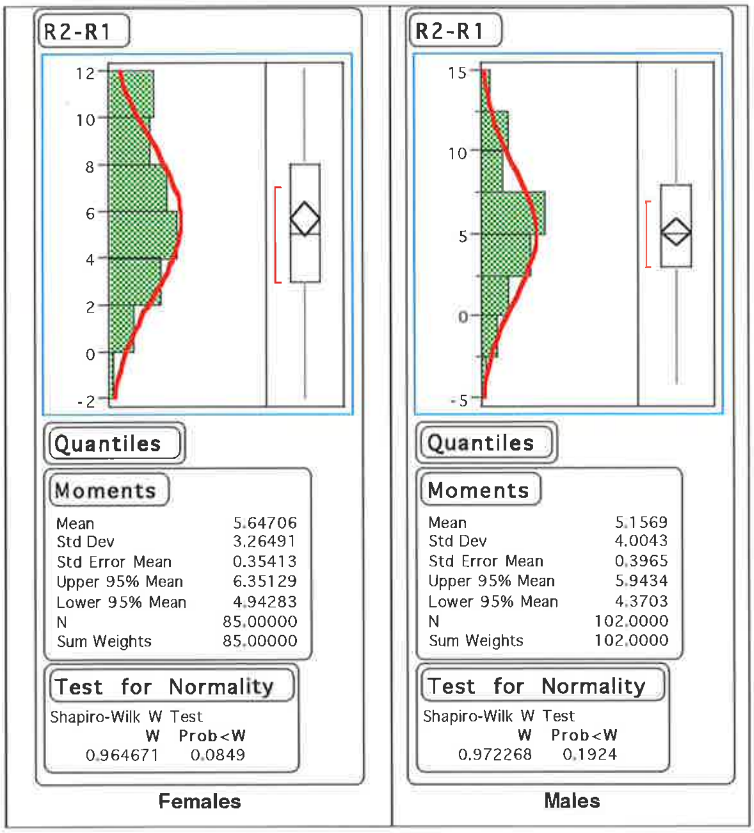


Figure 7.9.6: Distributions of change scores for Female and Male subgroups

There was no statistical difference, at the 5% level, between the scores, in either year (the *t-test* being used, as the two distributions Ravens (male) and Ravens (female), were acceptably normal).

Means Comparisons

Dif=Mean[i]-Mean[j]	f	m
f	0.000000	0.490196
m	-0.4902	0.000000

Alpha= 0.05

Comparisons for each pair using Student's t

t
1.97289

Abs(Dif)-LSD	f	m
f	-1.11579	-0.57809
m	-0.57809	-1.01857

Positive values show pairs of means that are significantly different.

Figure 7.9.7: Comparison of Means of change scores for Female and Male subgroups

However, the change that occurred between testing in years one and two, for females and males, based on the hypothesised increase by three points in the Ravens scores, was statistically significantly greater than that, at the 0.1% level.

Test Mean=value

Hypothesized Value	3
Actual Estimate	5.64706
Using Std Dev of	3.2649
	z Test
Test Statistic	7.4749
Prob > lzl	0.0000
Prob > z	0.0000
Prob < z	1.0000

for females

Test Mean=value

Hypothesized Value	3
Actual Estimate	5.15686
Using Std Dev of	4.004
	z Test
Test Statistic	5.4404
Prob > lzl	<.0001
Prob > z	<.0001
Prob < z	1.0000

for males

Figure 7.9.8: Change in RPM scores (R2 – R1)

The Torrance scores for both female and male groups showed consistency over the two applications of the test(s) during the research (see Figures 7.9.7/8), the two gender-based groups having highly significant correlations ($p < 0.0001$):

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>lRhol
Yr2 Torrance	Yr1 Torrance	0.5161	<.0001

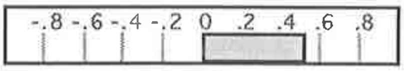


Figure 7.9.9: Correlations of Torrance scores for females

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>lRhol
Yr2 Torrance	Yr1 Torrance	0.4015	<.0001

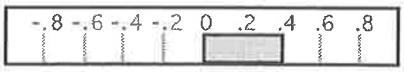


Figure 7.9.10: Correlations of Torrance scores for males

but there was no statistical difference between the means of the two gender groups (Figure 7.9.3), at the 5% level, in either year. Again, the Van der Waerden Test was used, as the two distributions Torrance (male) and Torrance (female), are (just) significantly non-normal at the 5% level.

Test for Normality

Shapiro-Wilk W Test

W	Prob<W
0.980752	0.4326

for Year 1

Test for Normality

Shapiro-Wilk W Test

W	Prob<W
0.963922	0.0464

for Year 2

Figure 7.9.11: Test of Normality of female Torrance scores

Test for Normality

Shapiro-Wilk W Test

W	Prob<W
0.953079	0.0009

for Year 1

Test for Normality

Shapiro-Wilk W Test

W	Prob<W
0.960925	0.0449

for Year 2

Figure 7.9.12: Test of Normality of male Torrance scores

Van der Waerden Test (Normal Quantiles)

Level	Count	Score Sum	Score Mean	(Mean-Mean0)/Std0
f	130	0.4493501	0.003457	0.054
m	162	-0.44935	-0.00277	-0.054

2-Sample Test, Normal Approximation

S	Z	Prob>|Z|
0.4493501	0.05373	0.9572

1-way Test, Chi-Square Approximation

ChiSquare	DF	Prob>ChiSq
0.0029	1	0.9572

Van der Waerden Test (Normal Quantiles)

Level	Count	Score Sum	Score Mean	(Mean-Mean0)/Std0
f	86	-0.480123	-0.00558	-0.072
m	101	0.4801231	0.004754	0.072

2-Sample Test, Normal Approximation

S	Z	Prob>|Z|
-0.480123	-0.07201	0.9426

1-way Test, Chi-Square Approximation

ChiSquare	DF	Prob>ChiSq
0.0052	1	0.9426

Figure 7.9.13: Analysis of TTCT (Year 1) and TTCT (Year 2) by Gender

In an analysis of change scores an interesting gender difference for the *ng* group occurred: a significant correlation for females, but not so for males, at the 5% level.

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|	-.8 -.6 -.4 -.2 0 .2 .4 .6 .8
T2-T1	R2-R1	0.3460	0.3617	

Figure 7.9.14: Correlation of Change scores for IQ & Creativity by 'ng' Male

Nonparametric Measures of Association

Variable	by Variable	Spearman Rho	Prob>|Rho|	-.8 -.6 -.4 -.2 0 .2 .4 .6 .8
T2-T1	R2-R1	0.7531	0.0310	

Figure 7.9.15: Correlation of Change scores for IQ & Creativity by 'ng' Female

An examination of the same measures (TTCT1 & TTCT2), differentiated by the suburban area where the subjects were located, was undertaken.

Van der Waerden Test (Normal Quantiles)

Level	Count	Score Sum	Score Mean	(Mean-Mean0)/Std0
c	54	-14.50958	-0.2687	-2.217
e	61	19.19925	0.314742	2.800
n	64	-0.28910	-0.00452	-0.041
s	61	16.60347	0.272188	2.422
w	59	-21.00404	-0.356	-3.102

1-way Test, Chi-Square Approximation

ChiSquare	DF	Prob>ChiSq
22.6642	4	0.0001

Van der Waerden Test (Normal Quantiles)

Level	Count	Score Sum	Score Mean	(Mean-Mean0)/Std0
c	40	-8.71247	-0.21781	-1.590
e	49	21.65290	0.441896	3.685
n	43	-2.06360	-0.04799	-0.367
s	32	2.48086	0.077527	0.493
w	23	-13.35769	-0.58077	-3.044

1-way Test, Chi-Square Approximation

ChiSquare	DF	Prob>ChiSq
20.4399	4	0.0004

Figure 7.9.16: Analysis of RPM (Year 1) and RPM (Year 2) by Area

These highly significant results prompted follow-up using pairwise comparisons of means, between the five groups.

Alpha= 0.05

Comparisons for each pair using Student's t

t

1.96809

Abs(Dif)-LSD	e	s	n	c	w
e	-2.63963	-2.44291	-0.61159	1.21060	2.25557
s	-2.44291	-2.63963	-0.80831	1.01388	2.05885
n	-0.61159	-0.80831	-2.57702	-0.75619	0.28950
c	1.21060	1.01388	-0.75619	-2.80550	-1.76237
w	2.25557	2.05885	0.28950	-1.76237	-2.68400

Positive values show pairs of means that are significantly different.

Alpha= 0.05

Comparisons for each pair using Student's t

t

1.97311

Abs(Dif)-LSD	e	s	n	c	w
e	-3.08712	-1.24597	-0.09096	1.49589	3.97891
s	-1.24597	-3.82012	-2.69245	-1.09908	1.43699
n	-0.09096	-2.69245	-3.29547	-1.70669	0.79173
c	1.49589	-1.09908	-1.70669	-3.41682	-0.90952
w	3.97891	1.43699	0.79173	-0.90952	-4.50597

Positive values show pairs of means that are significantly different.

Figure 7.9.17: Means Comparisons of RPM (Year 1) and RPM (Year 2) by Area

Again highly significant differences existed between the various areas, however as Figure 7.9.18 shows, the change scores between areas in the two applications of the Ravens tests, grouped by area, showed no significant differences.

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	4	85.2657	21.3164	1.5895
Error	182	2440.7771	13.4109	Prob>F
C Total	186	2526.0428	13.5809	0.1789

Figure 7.9.18: Change in RPM scores (R2 – R1) by Area

Van der Waerden Test (Normal Quantiles)

Level	Count	Score Sum	Score Mean	(Mean-Mean0)/Std0
c	54	-7.21358	-0.13358	-1.104
e	60	5.47696	0.091283	0.806
n	61	15.23165	0.249699	2.227
s	61	-9.23265	-0.15135	-1.350
w	56	-4.26238	-0.07611	-0.643

1-way Test, Chi-Square Approximation

ChiSquare	DF	Prob>ChiSq
7.2063	4	0.1254

Van der Waerden Test (Normal Quantiles)

Level	Count	Score Sum	Score Mean	(Mean-Mean0)/Std0
c	40	-11.43275	-0.28582	-2.084
e	48	4.63814	0.096628	0.794
n	43	5.43453	0.126384	0.965
s	32	4.51944	0.141233	0.897
w	24	-3.15936	-0.13164	-0.706

1-way Test, Chi-Square Approximation

ChiSquare	DF	Prob>ChiSq
5.7014	4	0.2226

Figure 7.9.19: Analysis of TTCT (Year 1) and TTCT (Year 2) by Area

There were no significant differences observed for the creativity tests either, so no further analysis was appropriate.

7.10. SHIP schools and Others on the RPM, TTCT and FoS

Two of the five SHIP ('Students with High Intellectual Potential') schools in the study chose not to provide the author with a nomination of student giftedness (*n*) as against regular (*r*) talent. One of these schools, following an intervening change of School Principal, withdrew from the IQ testing in year 2 (RPM2) citing equity concerns.

In all, 89 subjects were not given any form of nomination by their teachers and were consequently classified as *u* (unclassified) for the purposes of this study.

As the raw distributions of each of the two Ravens and Torrance tests were non-normal, then, as before, non-parametric techniques were used in the analysis.

Means Comparisons

Dif=Mean[i]-Mean[j]	y	n
y	0.00000	2.44471
n	-2.44471	0.00000

Alpha= 0.01

Comparisons for all pairs using Tukey-Kramer HSD

q *
2.59266

Abs(Dif)-LSD	y	n
y	-2.64576	0.09781
n	0.09781	-2.00395

Positive values show pairs of means that are significantly different.

Figure 7.10.1: Analysis of Ravens (Year 1) and SHIP schools

For both years of testing on the IQ measure (RPM) categorised by attendance ('y') or not ('*n*') at a SHIP school, it was clear (at the 1% level and beyond) that the mean IQ scores for the two groups was significantly different, for both years (Figures 7.10.1–2). This result was not expected. Participation in the SHIP program is governed by equity considerations (area distribution, SES levels, gender balance) and preparedness for staff to participate in training and development to ensure their students are exposed to 'out of the ordinary' classroom (and external) experiences. Inclusion in the program is *not* based on IQ scores, thus the author reasonably expected no difference between SHIP and non-SHIP RPM scores.

Means Comparisons

Dif=Mean[i]-Mean[j]	y	n
y	0.00000	4.55931
n	-4.55931	0.00000

Alpha= 0.00

Comparisons for all pairs using Tukey-Kramer HSD

q *
3.34397

Abs(Dif)-LSD	y	n
y	-5.51612	0.08326
n	0.08326	-3.10524

Positive values show pairs of means that are significantly different.

Figure 7.10.2: Analysis of Ravens (Year 2) and SHIP schools

That the differences increased in the second year further confirmed the higher scores overall on the RPM from students in the SHIP schools. There was no statistical difference between the groups on creativity (TTCT) measures in the first year. This was the factor however, on which the author expected to see positive gains by SHIP school attendees.

Alpha= 0.05

Comparisons for all pairs using Tukey-Kramer HSD

q *
1.96818

Abs(Dif)-LSD	y	n
y	-5.90693	-1.19135
n	-1.19135	-4.39339

Positive values show pairs of means that are significantly different.

Figure 7.10.3: Analysis of TTCT (Year 1) and SHIP schools

This difference in Year 2, as anticipated, was significant (at the 1% level), as Figure 7.10.4 attests.

Alpha= 0.01

Comparisons for all pairs using Tukey-Kramer HSD

q *
2.60279

Abs(Dif)-LSD	y	n
y	-11.2341	2.02612
n	2.02612	-6.23158

Positive values show pairs of means that are significantly different.

Figure 7.10.4: Analysis of TTCT (Year 2) and SHIP schools

The hypothesis that nomination grouping and SHIP school attendance or not were independent, was firmly rejected at the 5% level whether the *u*, or unclassified group are included, or not (see Figures 7.10.5–6).

Crosstabs

SHIP

nom: Count	n	y	
n	15	16	31
ng	16	3	19
r	92	68	160
	123	87	210

Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	2	3.60465	0.0243
Error	206	144.86218	
C Total	208	148.46683	
Total Count	210		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	7.209	0.0272
Pearson	6.548	0.0379

Figure 7.10.5: Analysis of Nomination and SHIP schools

Given the very small number of *ng* students from SHIP schools in the eventual research (caused by the non-participation of two of the five SHIP schools in this aspect of the research), nothing further could usefully be gained in this line of analysis.

Crosstabs

SHIP

Count (nom)	n	y	
n	15	16	31
ng	16	3	19
r	92	68	160
u	67	22	89
	190	109	299

Tests

Source	DF	-LogLikelihood	RSquare (U)
Model	3	7.51459	0.0227
Error	293	323.00365	
C Total	296	330.51824	
Total Count	299		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	15.029	0.0018
Pearson	14.393	0.0024

Figure 7.10.6: Analysis of Nomination (or not) and SHIP schools

Finally in this section, the author examined the possible differences between SHIP school attendance and change scores on each of the Ravens and Torrance tests. No differences on change scores (Figures 7.10.7–8) were observed.

Alpha= 0.05

Comparisons for each pair using Student's t

t
1.97289

Abs(Dif)-LSD	y	n
y	-1.53435	-0.75006
n	-0.75006	-0.86375

Positive values show pairs of means that are significantly different.

Figure 7.10.7: Analysis of Ravens Change scores and SHIP schools

Alpha= 0.05

Comparisons for each pair using Student's t

t
1.97303

Abs(Dif)-LSD	y	n
y	-9.37840	-3.28187
n	-3.28187	-5.16082

Positive values show pairs of means that are significantly different.

Figure 7.10.8: Analysis of Torrance Change scores and SHIP schools

The following chapter will discuss implications of all results reported.

Chapter 8: Discussion and Conclusions

Just as an explorer penetrates into new and unknown lands,
one makes discoveries in the everyday life,
and the erstwhile mute surroundings begin to speak
a language which becomes increasingly clear ...
(Kandinsky, 1947, in Edwards, 1986: 111)

[The purpose of this chapter is to discuss the key findings and observations highlighted previously. It addresses results, the consequent support of the hypotheses, summarises limitations of the study, indicates directions for future research and presents conclusions]

8.0. Introduction

This study has asserted that any view of intelligence needs to consider the three elements of *critical* thinking (including basic *g*), *creative* thinking, and the social and emotional components of intelligence, referred to by Lipman (1994) as *caring* thinking. In order to conceptualise intelligence, consideration needs to be given to the *degree* of these three essential components, and the *kinds* of their makeup. Gifted individuals have an advanced degree of one or all of the three components. Gifted students who are successful academically in the current school system often display high levels of the critical thinking skills, high *g*, and they tend to do well on IQ tests. The author has argued, based on the research, that gifted students who have advanced abilities in creative thinking or advanced levels of sensitivities and insights in caring thinking skills, are more 'at risk' of not developing these gifts in regular school systems. This thesis has argued that visual intelligence is an essential component of advanced thinking skills across all three constructs. The critical and creative aspects of intelligence were measured in this study using the figural forms of the RPM and the TTCT.

This study has proposed that the RPM is not a measure of *all* that constitutes 'intelligence', but results which are discussed in this chapter, do indicate that it is a good measure of *g*. Despite the cited limitations of the TTCT and all tests of creativity, the results of this study do suggest that it is a sound measure of figural creativity.

This chapter discusses the results obtained from both the qualitative and quantitative outcomes of this thesis. New questions are raised and included as directions for future research.

The results confirm that there are strong links between visual thinking, creativity and IQ, yet that at the highest level of IQ these links are more difficult to identify. The results also confirm the reliability of teacher nomination of students who do IQ tests well. The results further indicate that an enriched teaching intervention can be responsible for increased figural creativity scores. The correlations between scores on the visual thinking instrument (FoS) and the figural IQ test (RPM) suggest links with visual intelligence and IQ. The results are positive and statistically strong enough to justify further exploration in this area of research. In particular, the links between high levels of creative thinking and a high level of figural IQ, which the results of this study support, are significant enough to warrant further investigation.

From this study there is sufficient evidence to state, with more certainty than before, that there is a universal language or grammar of visual form, and that learning this language is efficacious for advanced thinking and creative problem solving.

In Chapter 1 of this thesis, the following hypotheses were put forward, that:

1. the RPM and TTCT are stable measures of figural IQ and figural creativity

2. the RPM and TTCT correlate significantly at the low to above average IQ/Creativity interface but *not* at the highest levels of performance

3. teacher nomination is a reliable indicator of giftedness as measured by IQ scores but not necessarily as measured by creativity or visual thinking tests

4. training in visual thinking can enhance visual intelligence

5. a universal language or grammar of visual intelligence exists and can be identified and measured

6. visual intelligence is a central component of advanced creativity and intellectual giftedness.

The quantitative findings in Chapter 7, as well as the research cited in previous chapters are discussed and integrated in Sections 8.1–8.6 as they relate to each hypothesis in turn.

8.1. The stability of the RPM and TTCT

This study has highlighted the limitations as well as the strengths, of most current tests of IQ and creativity. However the results reported in the previous chapter consistently confirm, as the literature review had predicted, that the RPM and the TTCT are reliable measures of figural IQ and figural creativity and that they yield stable scores and similar distribution of scores when measured on the same subjects, over the period of a year (see Sections 7.1 and 7.2).

The stability of the RPM over the period of one year, is supported and re-affirmed by the results reported in Section 7.1, namely that the correlation between R1 and R2 was very highly significant and the two distributions were correspondingly similar. The known practice effect was slightly higher than expected but well within the bounds of acceptability.

The change scores (R2–R1) were normally distributed which allowed for the ANOVA and parametric multiple comparisons. The data confirmed that there were no overall differences between male and female subjects on raw scores, or standardised scores on the RPM, and persisted, regardless of however the gender groups were levelled (e.g. IQ, area, nomination). This finding is in keeping with the Australian restandardisation of the RPM which confirmed "comparison of the mean scores of boys and girls indicated no differences according to sex on either the timed or untimed version of the test" (de Lemos, 1989: 21).

These data further confirm the stability of this test as a basic measure of *g*, with the consistency of such results over the year of testing.

The issue of degrees (or levels) of measured ability was reported and discussed in Section 7.1 (see Figures 7.1.19 – 24). A 'very coarse filter' three-way classification of intelligence, between high (top 4%), average and low (bottom 4%) revealed that for the high group there was a significant difference in the mean change scores, compared with the large average group (also see Table 7.1).

Further, when five IQ levels were used in the analysis, there was a highly significant difference (0.1% level $p < 0.0001$) between the five groups' average change scores. Follow-up paired comparisons emphasised the difference of the highest IQ groups' (top 4%) changes, which were significant (at the 5% level) from each of the other IQ levels, except the lowest (bottom 4%).

The major contributions to the variation between the levels was the difference between the highest level of IQ and each of the above average, average and below average levels. In other words, the changes in the scores at the 'top' are different from those in the middle.

The degree of change in these 'change scores' (i.e. their variances) also were significantly different at the 0.1% level (Figure 7.1.21), but the Welch ANOVA testing of the hypothesis of 'equal average change scores' across IQ levels was still rejected at the 0.1% level. These findings help support the *Differentiation Hypothesis* (that intellectual abilities as measured by IQ tests correlate more strongly at lower ability levels), which has been identified by other studies to date and referred to earlier in this thesis.

The findings further confirm that attempts to measure subject responses at the highest levels of intellectual abilities are still relatively unstable (Figure 7.1.16/17). The results from the data support the findings of previous studies cited in the Literature Review, that the 'middle ground' yields clearer insights into intellectual functioning than the extremes (Figure 7.1.19–21).

The subjects' total scores on the Torrance Tests of Creative Thinking showed significant correlations over the period of the study and reasonable stability in the change scores. There was a highly significant correlation between TTCT1 and TTCT2 at the 0.1% level, as the results in Section 7.2 indicate.

The separate components of the Torrance tests, i.e. fluency, originality and elaboration were also significantly correlated over the two administrations of the tests. This further indicated that these forms of the TTCT were stable measures of what they purport to measure.

Of particular interest in the results was the correlation ($p = 0.7339$ in Figure 7.2.25 which had a p-value <0.0001, which is highly significant) between originality and fluency. The observation that the production of many ideas (ideational fluency) is possibly related to better, or more novel ideas, is central to the inclusion of brainstorming techniques and flexibility training (e.g. the Brainstorming Keys and Reverse Keys) in differentiated curricula. This reflects the observation, (attributed to Edison) that "if you want to come up with a *good* idea then come up with *many*". Edison's sketchbooks contained thousands of 'failures and errors' which he claimed led him to *one* significant and original invention.

Much research is still needed on this issue, as the research in general is not conclusive. The support advanced in this thesis on the high correlation between scores of fluency and originality does not resolve this issue completely. Runco's original work (1986) found that encouraging children to be original increased their fluency (in Piirto, 1999: 169). Other studies have suggested that fluency can mitigate against reliable scores for originality:

> *Several researchers have noted that fluency can be a contaminating influence on originality scores – if fluency is controlled, reliability evidence for originality scores is often very poor ... while several suggestions have been made regarding techniques for removing the influence of fluency on originality ... few studies have evaluated and compared the various suggestions with respect to the reliability and validity evidence for resulting originality scores*
>
> *(Plucker & Runco, 1998: 36).*

When the substrates (originality, fluency and elaboration) of the TTCT were correlated over the two years (Figure 7.2.19), pairings were highly significant (all beyond the 1% level). The only pairing to show a modest correlation ($p = 0.1021$), was Fluency Year2 and Elaboration Year1. It was reasonable to predict that these two should correlate, as they did for Year 2 elaboration and fluency ($p = 0.0004$). This finding supports the belief that if many ideas are generated, then they should also be able to be built upon (elaborated).

The subjects' change scores between TTCT1 and TTCT2 overall and between the sub-tests, were all normally distributed, which allowed for parametric techniques such as ANOVA and *t-tests* to be used. When the TTCT group was divided according to the five levels of IQ there was a significant difference (at the 1% level) in the average change scores for each group.

The follow-up *t-tests* in Figure 7.2.31 show that subjects in the higher ability levels differ significantly from those in the average, below average and low IQ groups. The highest level only differed significantly from the low ability group, while the 'above average' (2avg++) differed significantly from all groups except the highest.

The mean of the TTCT test scores in Year 2 was slightly (although not statistically significantly) lower than Year 1. This result was unexpected as the scorer adhered to the scoring guidelines and testing protocols of the test and the reliability across the parallel forms of the TTCT has been well-researched. However, it highlighted a possible issue for debate: that lower scores in the second year reflect an extra year in a school system which may not necessarily encourage, train, nor reward divergent thinking. While this is not a criticism of the school system, it is an observation of education in general that, as students progress from late primary into the secondary years, 'training' in getting the right answer becomes an unintentional objective. It is plausible that where public examinations and other assessments require 'the right answer', practice and recall might be covertly valued, rather than an original views or divergent insights. In this way, creativity for the same population could be suppressed and correspondingly, creativity test scores slightly depressed. It is pertinent to note that when the TTCT scores were analysed in the second year according to teacher nomination, the *ng* group (who completed the *Turning World* program) posted very different scores from all the other groups. This is discussed in detail in Section 8.4.

8.2. Correlations between the RPM and the TTCT

There was a positive correlation between scores on the RPM and TTCT which is significant at the 5% level in Year 1 of the study (Figure 7.3.1). In other words the students' performance on the IQ test corresponded to their performance on the creativity test. In Year 2 the correlation between RPM and TTCT was even more significant, at the 0.1% level, (Figure 7.4.1).

This finding supported the central hypothesis which is that visual IQ and visual creativity are linked in some way.

In the first year with High and Above Average IQ groups combined as a single group, there was a significant correlation at the 1% level between the RPM and TTCT (Figure 7.3.5). Taken separately, each group's correlation was close to, but not quite significant at the 5% level (Figures 7.3.6/7).

Similarly, when the average, below and low groups were combined as one, a significant correlation at the 5% level was found (Figure 7.3.3), but not for the groups taken individually (Figures 7.3.8–10).

Interestingly, the asymptotic relationship raised previously in the Literature Review appeared to be evident in this data. In other words IQ and creativity do correlate (Figure 7.3.5) for high and above average IQ groups (the top 23%) but at the highest level (the top 4%) of IQ functioning the correlations are not evident (Figure 7.3.6).

For the lowest group, where the limited research suggests that low IQ scores should attend low creativity scores, significant correlations should be expected between RPM and TTCT, yet the opposite appeared to be true (Figure 7.3.10). This result can be interpreted as supporting the idea that some subjects in the low IQ group must have scored more highly on the TTCT, with respect to their ranking in the whole group on the TTCT.

It was of interest to note the higher scores on the RPM in both years for students in the SHIP schools (Figure 7.10.3), as it has been previously reported that high IQ was not a crierion of selection. As the nature of the SHIP program focusses on the teaching of creative thinking principles by teachers trained in gifted education, it was to be expected that higher scores on the TTCT would occur. In the second year of testing, this was clearly the case (Figure 7.10.4).

In the second year of testing, a highly significant correlation between RPM and TTCT was recorded for the whole group (Figure 7.4.1), with all substrates demonstrating similar strengths of association (Figure 7.4.2). However of the various groupings and mixes examined by the author, only the group formed using the Above Average and Average IQ levels achieved near significance ($p = 0.0566$, Figure 7.4.4). All other groupings or individual IQ levels were 'some distance' from a significant correlation (Figures 7.4.3 and 7.4.5–7.4.10).

Any statistical differences between the groups' mean performances, and the major contributors to such difference (Figure 7.4.11) were identified, showing the highest IQ group differed significantly from the Average and Below Average groups. Across the substrates of the TTCT, there were no differences on *fluency*, however, the High IQ group differed significantly from the large Average group on *originality* (Figure 7.4.12), and differed significantly from the three 'central' groups (Above Average, Average & Below Average, see Figure 7.4.13) on the *elaboration* substrate.

It could be argued from this that creativity seems to be a 'necessary but not sufficient' component and a key, but differential aspect of high intelligence, and one that can only be measured 'up to a point' for those who score in the middle range. Other results cited in this research strongly suggest that appropriate intervention can significantly enhance creativity scores.

The research to date indicates that creativity is an essential component of intelligence *in general* thus, from the results presented in this study, it appears that the instruments used to correlate such abilities are limited in sensitivity when it comes to identifying the different ability levels.

8.3. Teacher nomination as an indicator of IQ, creativity and visual thinking

Not all schools in this study participated in the nomination component of the data collection, as discussed in Chapter 6.1–6.2. The 'unclassified' or *u* group comprised 89 subjects from five different schools including one SHIP school. It is reasonable to assume that this heterogeneous *u* group was representative of the whole population from which the other subjects in the research were chosen, selectively (i.e. the *n* (and thus, *ng*) and *r* groups).

In general, as Figures 7.5.1 – 7.5.6, indicate, there was a high level of correlation between teacher nomination and actual RPM scores. In other words, the nominations as reported by the teachers were a reliable match to the actual scores obtained on the RPM in Year 1.

The mean IQ scores relative to the teacher-nominated groups were significantly different (at the 0.1% level) with both the *n* and *ng* groups being significantly different (at the 5% level) from the *r* and *u* groups in Year 1. However in the second year only, the *ng* group was significantly different from the *r* and *u* groups (Figure 7.5.1).

The TTCT1 and TTCT2 had a significant correlation subject to teacher nomination, especially when the unclassified *u* group was excluded from the data, a highly significant correlation at the 0.1% level was observed (Figure 7.6.1). It is important to note here that the nomination form given to the teachers did not ask them to nominate the students with the highest level of *creativity*. This is raised as a limitation of this study in the next section. However, given the correlations between RPM and TTCT scores, and the correlations between RPM and teacher nomination, it was to be expected that TTCT scores would also correlate with teacher nomination of students.

What *is* significant to note in the results, however, is the finding that when the groups were subgrouped and analysed by *ng*, *n* and *r* (remembering that the *u* group was excluded from this analysis) it was the *ng* group alone that had no correlation between teacher nomination and actual scores on TTCT (Figure 7.6.2). This is surprising yet understandable in this context because of the profound effect that the intervention program, the *Turning World* appears to have had on those (*ng*) students undertaking it. The group's mean score from Year 1 to Year 2 increased so significantly, that there was every possibility of a 'near zero' correlation (based on ranks, in each year), as the relative performance within the *ng* group changed, even if overall, for the better.

The respective lack of rank changes for '*ng*' subjects' scores in both the IQ and the creativity measures were reflected in a significant correlation (Figure 7.6.15), which was surprisingly mirrored in a significant correlation for females but not for the males (Figure 7.9.14–15).

The *n* sub-group, on the other hand did have a significant correlation between the two TTCT scores (Figure 7.6.12). Statistically, this means that the students in the *n* group more or less maintained their relative positions in both tests. Educationally, an explanation for this could be that, whilst on the one hand teachers are accurate at predicting high scores on a test of IQ for students who are already performing well academically, they may not be so accurate at predicting high levels of creative thinking abilities. This interesting finding could further support the proposal raised by this study that whilst creativity tests such as the TTCT are reliable measures, for most subgroups, at the very top of the intellectual ability range they are relatively unstable indicators of a wider intellectual functioning that includes divergent thinking skills. This is an area which clearly would benefit from more research.

By examining the changes in scores between the two applications of the TTCT test, relative to the nomination category, only the *ng* subgroup, which uniquely experienced the *Turning World* intervention program, came close to a statistically significant correlation (Figure 7.8.3).

8.4. Training in visual thinking and effects on visual intelligence

The higher scores on the Ravens Progressive Matrices obtained in the second year for the students who completed the *Turning World* program (see Figure 7.5.1), in addition to the significantly higher scores on the TTCT obtained in the second year, are probably the results most worthy of discussion. When the pairwise analysis of the groups (i.e. *ng* with *n, ng* with *u, ng* with *r*) was examined it was clear that the subjects in the *ng* nomination had scored significantly higher on the RPM in the second year.

These results supported the hypothesis that training in a higher-order visual thinking program can significantly increase scores on figural IQ and creativity tests.

It should be noted that scoring both the RPM and the FoS is an objective procedure. Neither instruments rely on the subjective analysis of the marker in terms of what constitutes good, logical thinking in the first instance (RPM) and advanced visual thinking (FoS) in the second. Although the weaknesses of each instrument have been identified in this thesis, the fact remains that the scoring is objective. This is unlike the scoring of the TTCT, wherein subjective interpretation of the responses is required. However, by adhering strictly to the guidelines in the TTCT manual, the marker obtained a high level of consistency of scores from Year 1 to Year 2 as the results indicate (Figures 7.2.19 and Figures 7.6.1).

8.5. A universal grammar of visual intelligence

This study sought to provide evidence for the existence of a universal language of visual thinking. The purpose of correlating IQ and creativity scores with the FoS was an attempt to identify clearer and more measurable evidence than that already reported in the research.

The total scores on the FoS ('FoS Tot8') had highly significant (beyond 0.1% level) and positive correlations with the RPM in both years (Section 7.7) but not with the TTCT (Section 7.8) in either year. Yet significant correlations between RPM and TTCT were reported in each year (Sections 7.3 & 7.4). These results raise many interesting issues. As Kandinsky's quote at the beginning of this chapter suggests, these findings might suggest that the 'mute surroundings' which have been a feature of this area of research are not necessarily those measured by the TTCT Figural forms.

The design and utilisation of the *Figures of Sound* instrument was an attempt to explore an alternative way of evaluating visual thinking skills, a possibility which the results cited here, support.

The near significant correlations of some specific questions on the FoS with RPM measures raises issues for further investigation, concerning refining the internal constructs in the FoS's Q2, Q3 and Q8 that link with the elements in the RPM.

It is interesting that the author initially subtitled the FoS as "an instrument designed to explore visual thinking ability and creativity" (see Appendix 5). In any future version the 'creativity' term would be removed as the author, at the conclusion of this study suggests that the concept of the FoS has no stronger link with creativity than with general intelligence. Indeed the results have shown stronger correlations between the RPM and the FoS than between the FoS and the TTCT.

The hypothesis that 'visual intelligence is a central component of advanced creativity and intellectual giftedness' was examined in this thesis through the Literature Review (Chapter 2) which consistently reported findings that advanced visual intelligence attends the highest levels of intellectual functioning and creative problem-solving.

The experimental results presented in Chapter 7 confirm that for the whole group which undertook the RPM testing in both years (with outliers removed, n=187), there were significant correlations (beyond the 1% level, see Figures 7.7.1 and 7.7.2) between total scores on the FoS and the RPM.

These highly significant correlations strongly suggest that there is a facility for interpreting the grammar of visual form, as defined by Kandinsky (and which formed the basis of the FoS), which is present in the visual logic ability required to score well on the RPM.

Interestingly, for the nominated group ($n + ng = 50$) there was no appreciable correlation between FoS and RPM in either year (Figures 7.7.6 & 7.7.7). This was also true for the *ng* and *n* groups separately (Figures 7.7.8 to 7.7.11). An explanation for this might be that those subjects who are expected to score highly on the RPM (i.e. those nominated) may not 'test' as well on the more 'artistic' or 'divergent' instrument which the FoS probably represented to them, or rank differently within their groups on the two tests.

A similar result was noted for those subjects (n = 88), who were not classified by their teachers (*u*, see Figure 7.7.12). It needs to be remembered that the unclassified, *u* group, would have included students with abilities across the whole range of intelligence, the higher scoring ones probably contributing to this alteration in performance, as measured by ranks.

The *r* group (Figure 7.7.13) showed significant correlations on FoS and IQ measures. Concomitantly, one could argue that those students who are perhaps not expected to score highly on the RPM (i.e. the 'regular' students) have a consistent and close association between their ability to perform on figural intelligence (RPM) and the FoS measure. This viewpoint is strongly supported by the very highly significant correlations (both at the 0.1% level) between both Year 1 and Year 2 of the RPM and the FoS for the 'regular' group (Figure 7.7.13). This is in line with the research cited.

These results add support to the previously documented *Differentiation Hypothesis* (i.e. that intellectual abilities as measured by IQ tests correlate more strongly at lower ability levels).

The results indicate that there is a significant difference in IQ scores (R2-R1) for the *ng* group (Figure 7.5.6) compared with *r* and *u* in both years of testing but for the *n* group, only in Year 1. This difference was significant at the 5% level for the *ng* group and significant at the 1% for the group not designated as *ng*.

To interpret this aspect of the data, it is proposed that the students in the whole *n* group (n=50), (which included the *ng* group, n=19 in year 1), were no doubt closer to the ceiling of the RPM in both years of testing. The *n* and *ng* groups had a smaller possible gain score (i.e. the *change* score) on the RPM than the other groups (*r* and *u*).

The change on the RPM from Year 1 to Year 2 in the highest ability group is statistically different from the change at the lower levels. For this reason the use of the Advanced Form of the RPM (the APM) test, suitable for the nominated group, is recommended for future studies of this kind as it provides a greater discrimination in IQ scores at the highest levels of ability.

However, the significant *overall* correlation between scores on the FoS and the RPM is a finding of great interest in this study. While this correlation does not establish conclusively that visual intelligence is a necessary component of advanced IQ, as the FoS is not a standardised instrument, it does support the central hypothesis of this thesis, that the two *are linked.*

Possibly one of the most significant results from the data is the increase in scores on the TTCT for the *ng* group (the class that attended the *Turning World* program) in the second year of testing, as compared with the first year.

In the first year (TTCT1), there was no significant difference overall between the four classified groups (regular, *r*; unclassified, *u*; nominated, *n*; nominated gifted, *ng*). Yet in the second year, the hypothesis of equal performance for the four groups is rejected at the 0.1% level. As these results are significant at this level it is reasonable to suggest that it is only the *Turning World* intervention which could explain such dramatic increase in figural creativity scores (Figure 7.6.6). It is relevant to remember here the integrity of the design of this study and its data collection. The *ng* group was drawn from five different schools, and the whole experimental sample from 15 schools. Any extraneous influences over the one year intervening period of the data collection randomly applied to all groups, including the *ng* group from the *Turning World* program, which appears to be the critical difference which led to this *ng* group outperforming other groups on the TTCT in Year 2.

8.6. Limitations of the study

This thesis was not a simple, linear exploration likely to yield clear and simple results. The study engaged a large number of subjects in testing across 15 different schools. It engaged the author in the planning and execution of a complex and higher-order teaching program which necessitated lengthy negotiations with students, parents, teachers and the DECS. As with any complex, multi-faceted exploration, this study did have limitations.

First, it would have been efficacious to have included a verbal/linguistic measure in this study as a point of comparison with the visual. The use of sub-tests on the WISC, or the linguistic component of the DAT – (Verbal) test might have given more strength to the central hypothesis that IQ and creativity do link specifically with visual thinking, if such a verbal component had been available for comparison.

However, it needs to be noted that the DECS was very generous in providing the author with so much testing time (approximately two hours for each testing session in addition to the initial, follow-up, and feedback sessions across all schools). In addition, the inclusion of an extra test would have necessitated separate testing sessions as four tests (i.e. one in addition to the RPM, TTCT and FoS) would have been too tiring for the subjects. Pragmatically, the inclusion of an extra test was not desirable. If an additional test were then to be introduced into the research design, testing fatigue, need for additional class time for student orientation and increased teacher awareness would all need to be addressed.

A second limitation of this study was possibly the restricted range of the Standard RPM. The advanced form of the RPM, the Advanced Progressive Matrices (APM), would have allowed for greater discrimination of IQ scores with subjects at the highest level of performance. The APM has been used since 1997 to select students for the secondary SHIP program and the test is only appropriate for this age group if the students have been nominated as giving evidence of advanced intellectual ability. The use of the APM in this study, while not appropriate for the whole group, would have provided some further useful data if it had been administered to the *n* (including the *ng)* sub-group. However the issue raised in the first limitation outlined above also applies here and the author wanted to avoid the 'over-testing' of subjects. Also, use of the APM for the *n* and *ng* group would have excluded the remaining groups from the analysis thus restricting the range and type of correlations.

A third limitation to this study could possibly be the reduced numbers in the second year and the decision of some schools to decline to nominate five students as those with high intellectual potential, also reduced the numbers in the general *n* category. The reduced number of subjects in Year 2 had been anticipated and could not be avoided. When an original target population of approximately 300 was planned as part of the design for this study, it was with the assumption that the numbers would be reduced in Year 2. The study was fortunate to have been allowed access to such a large beginning cohort and the extra data drawn from the 193 subjects in Year 2 is more than sufficient to sustain the statistical analyses conducted. Many studies have conducted such statistical explorations with much smaller samples.

It is important to note here that the nomination form given to the teachers did not ask them to nominate the students with the highest level of *creativity*. This issue is raised as a limitation of this study so that future studies might address it by including this extra aspect of nomination in initial data collection. The author believes that it would have been useful to have included a section in the teacher nomination form which asked the teachers to nominate students whom they would rank as having high levels of creativity.

In addition, the fact that some schools declined to nominate students might initially be seen as a limitation as it certainly reduced the number of subjects in the differently nominated categories. However, as the results in Chapter 7 and discussion in Section 8.3 have indicated, this 'new' category (e.g. totally unclassified or *u*) provided a useful sub-category for analysis as it was the only one with no pre-ordained or pre-conceived categories of ability.

A known limitation of the study was that the FoS is not a standardised instrument, hence correlations with visual IQ or figural creativity tests were exploratory.

8.7. Recommendations for future research

This study was not initially designed as a pre-test, intervention, post-test, type of study. However aspects of the results do raise questions which require further research. There are original and investigative outcomes sufficient to sustain further studies. The aspects of the results from the data analysis which warrant further discussion and investigation are:

• there were measurable changes in performance on the TTCT, for the subjects who completed the *Turning World* program. This indicates potential areas for further research as it appears that training in a visual enrichment program increases socres on the TTCT.

• the change on the RPM from Year 1 to Year 2 in the highest ability group is statistically different from the change at the lower levels. For this reason the use of the

Advanced Form of the RPM (the APM) test, suitable for the nominated group, is recommended for future studies of this kind as it provides a greater discrimination in IQ scores at the highest levels of ability.

• the students in the SHIP schools scored significantly higher on the RPM in both years and higher on the TTCT in the second year. The effects of an enriched learning environment on measures of *g* and creativity have been raised in this thesis and clearly more research is required to explore this interface further. While participation in the creativity training inherent in the SHIP school program might help explain the higher scores on the TTCT in Year 2, the advanced scores on the RPM warrant further investigation.

• there are areas for future research in a comparative study of verbal constructs of IQ and FoS performance. Pragmatically, this would require a smaller sample as there is not a verbal equivalent of the RPM, suitable for whole class or group administration, which also avoids the cultural bias which language-based tests generally exhibit. A study of verbal intelligence and links with visual thinking would provide an interesting comparative study.

• the mixed responses of the subjects in FoS Question 7 warrant a further comparative study between students trained in visual art form and those with no training. Question 7 was so firmly based on the principles of communication of the point and line within the basic frame that further exploration of links with a possible 'universal language' is justified.

• Question 8 on the FoS be modified to remove the square and reduce the number of distractors. It would then be interesting to examine correlations between Question 8 and Question 1, as both would be based more soundly on the Golden Ratio.

• a revised form of the FoS, modifying Questions 9 and 10 could provide further interesting insights, particularly if scores could be more clearly defined at the highest and lowest IQ levels.

• a future study would be useful to score TTCT data using the more recent norms. Such a study would allow for a comparison of scores obtained from the differing norms and provide further insight into the stability and reliability of the TTCT which this study has raised.

8.8. Conclusions

In addition to the insights into links between figural intelligence, figural creativity and visual intelligence that this study has provided, it has also contributed two original ideas to the field of Education in the forms of the design of the *Turning World* program and the *Figures of Sound* instrument. While neither is a perfect design, both constitute an original contribution to the discipline.

The *Turning World* program, with its original design and successful implementation, has been set out in structure and content for other teachers in South Australia to follow. It provides a unique crossing of a long-held barrier between the tertiary sector and schools. With its principles of differentiated curriculum, particularly novel and sophisticated content, it provides a much needed alternative to regular in-school enrichment for gifted students. Teachers who access the *Turning World* material, even without training in visual art teaching or gifted education, should be able to engage a class in visual thinking skills within an art gallery setting. Indeed, the guiding principles outlined in the *Turning World* could apply to artworks in any gallery.

The *Figures of Sound* instrument, even in current 'pilot' form, has shown itself to correlate with reliable figural IQ measures. It is anticipated that improved versions of this original idea will constitute deeper analyses of the central hypothesis which this thesis has addressed, namely, that visual thinking and intellectual giftedness are intrinsically linked.

This study was designed in such a way that whatever the outcomes of the qualitative or the quantitative explorations, there would be a new insight into this essential hypothesis, and a successful outcome for the students who participated, particularly the ones who attended the *Turning World* program.

The author designed the *Turning World* program as an advanced enrichment program, built upon years of similar, successful teaching, and so whatever the results of the testing, she knew that the students would have 'changed' in some way at the conclusion of the program. Whether this change was measurable or not, a successful outcome for the students was virtually assured.

A comparison could perhaps be drawn with the principles of *Pascal's Wager.*
H.G. Wells' variation on this wager is that we do not know whether the world will or will nor survive an atomic holocaust, but that we should live and behave as if sure it

will, because as he observed, "if at the end your cheerfulness is not justified, at any rate you will have been cheerful" (in Gardner, M. 1982).

This thesis began by highlighting one of the initial problems which prompted the investigations which is the documented negative attitude in Australian society to gifted students. It is the author's hope that studies such as this will shed more light on the paradox and the enigma of giftedness and, equally, highlight the need for specialised educational provision for such students. With clearer community understanding of the 'normal difference' which is giftedness might come a dispelling of the suspicion and even fear of bringing it to fruition. Nelson Mandella coming from his own 'darkness' to his Presidential Inaugural Speech, expressed it better:

Our deepest fear is not that we are inadequate.
Our deepest fear is that we are powerful beyond measure,
It is our light, not our darkness, that most frightens us.

Appendices

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APPENDIX ONE

Outline of The Palace of Wisdom program

THE FLINDERS UNIVERSITY
OF SOUTH AUSTRALIA

GPO Box 2100
Adelaide 5001
Australia

School of Special Education and Disability Studies
Faculty of Education Humanities Law & Theology

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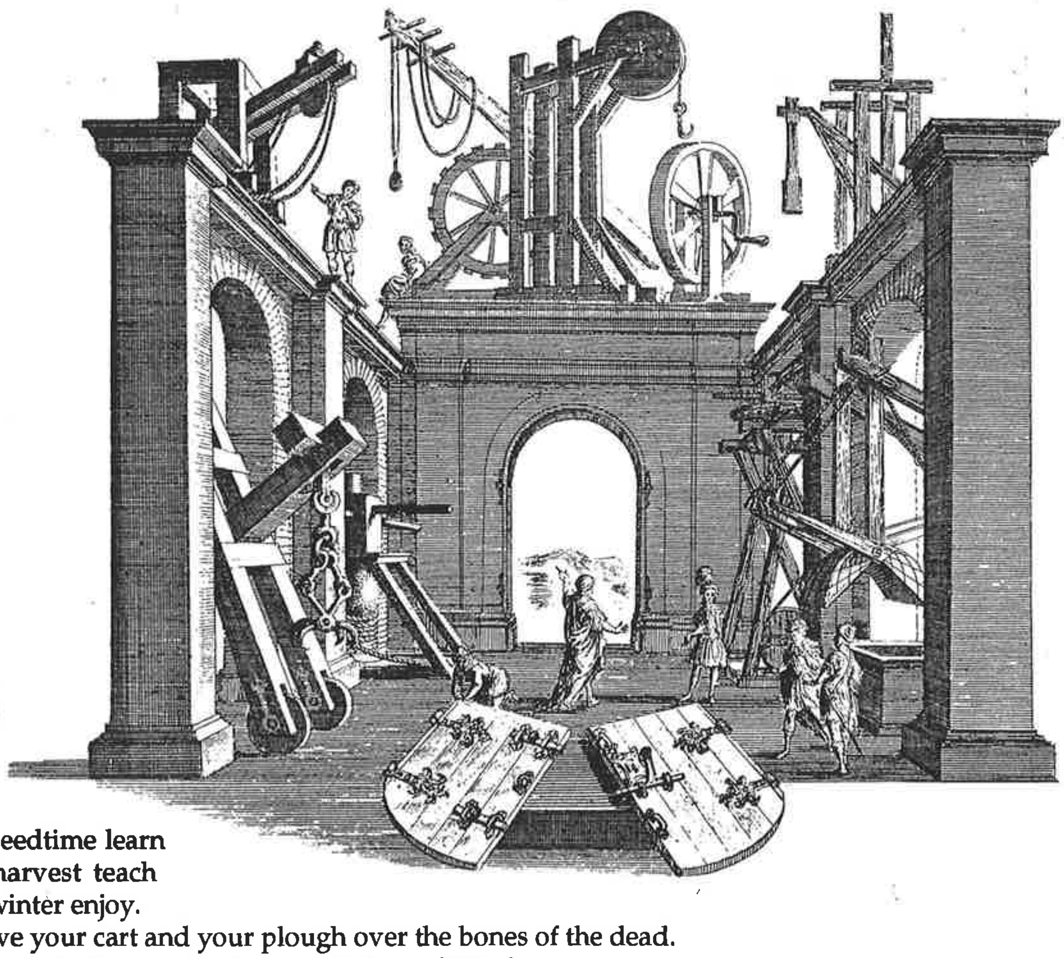
The Palace of Wisdom

A Course of Enrichment Studies for Talented Students

Staff at Flinders University are offering a specialised course of studies over traditional subject boundaries of Literature, Poetry, Science, Mathematics, Art, Music, Film and Drama.

Co-Ordinator: Maria McCann
Senior Lecturer in Gifted Education



In seedtime learn
in harvest teach
in winter enjoy.
Drive your cart and your plough over the bones of the dead.
The road of excess leads to the Palace of Wisdom.
Prudence is a rich, ugly old maid
courted by incapacity.
He who desires but acts not
breeds pestilence.

William Blake, from The Marriage of Heaven and Hell

The Programme

Date	Topic	Co-ordinators

The students embark upon a course of excessive scope and magnitude

18 August "Whan that Aprile..." A Journey to Perception — Maria McCann, Mem Fox

> In this session we will experience literature ranging in time and style from Geoffrey Chaucer to Peter Carey.
> Through our own perceptions of the written word we will brainstorm ideas and feelings leading to individual and group writing workshops.
> The power of imagery will lead us to the examination of synectics - a forging of erstwhile unlike relationships - in order to achieve even greater heights of power over the mere printed word.

25 August Writing & writhing! Harmonious Rhythms — Mem Fox, Maria McCann

> In this session we got rhythm! We'll move, rhythmically of course, from poetic rhythm to sung rhythm to rhythm in prose.
> We will also focus on 'focus'. Writing is like filming.
> This will be explained, explored and - exciting!
> From the muse to the musical; from the photographic to the phantastic - we'll create images in words. Truly a feat, this feast of focus - hocus - pocus!

1 September Sense and Sensibility... The Writer's Perception — Lyn Wilkinson, Maria McCann

> A sensible approach to writing? Not a bit of it!...In this session we will explore the puzzle, the paradox and illusion that our fickle senses are prone to. To trap this sensory response in writing requires sharpened perception. This in turn relies upon us identifying our own sensory response to the world: be it artistic or scientific.

8 September Seeing is not believing The Science of Perception — Rob Morrison, Nigel Murray-Harvey

How we think about the world depends entirely on how we perceive it - through sight, hearing, smelling, tasting and feeling.
In this session we examine practically how our sense organs work and how, by providing them with conflicting information, we can produce some very odd illusions.

15 September Making sense of it The Art of Perception — Nigel Murray-Harvey, Rob Morrison

This session explores the artist's perception of the rectangle, or why to put what, where! The special qualities of the rectangle that artists have traditionally made use of, such as the golden section, rabatment and the internalisation of the rectangle's basic proportion...

20 October Adding up to Sum-Think Perceiving the Abstract — Jeff Baxter, Peter Brinkworth

What makes forms, structures and designs 'pleasing' to the eye? How are aesthetic aspects built in to designs, be they architectural of archetypal? This session examines the underlying ideas of some of the essential artifices and techniques of artistic creation from 300 years ago to the modern day.

27 October Rhythm, Writing & 'Rithmetic with Pattern & Perception... — Jeff Baxter, Elizabeth Silsbury

From composition to campanology, elementary and advanced mathematics is part of the background to the creation and full understanding of harmony and rhythm.
The origins of the scales of (western) music is intricately tied up and, surprisingly, linked to the harmonies and proportions explored in the previous week's session.

3 November Play on...Active Perception

Elizabeth Silsbury
Maria McCann

Flow from formula to fantasy! See and hear how great composers from Josquin to Bach to Mozart to Steve Reich have used pattern and perception to create great music, and try your own hand at it!

10 November "The play's the thing...Visual Perceptions"

Rex Guthrie
Malcolm Fox

This session is an introduction to basic skills in video techniques and improvisational drama. Some introductory characterisation work will follow and the session will end with simple performance. This work will be developed in the final drama/video session.

17 November "...what nedeth wordes mo?"
Perceiving the Product

Malcolm Fox
Rex Guthrie

During this session, a play will be developed by the group, but will also be worked on within the discipline imposed by video techniques. The results will be a play for the small screen too!

About the Contributors :

Maria McCann : Coordinator of this course, Maria brings broad experience from her particular field of Special Education. She has published articles and spoken at international conferences on the topic of gifted and talented students, together with many years running short courses in language arts for gifted people. A gifted teacher herself, her professional development work with other teachers is a significant contribution to the teaching of the gifted in this state. Maria is a lecturer in special education at Sturt campus.

Mem Fox : A native born Australian, Mem's early years spent in South Africa and England were finally put into perspective by her domicile in South Australia. She has been a writer from birth, but in recent years has had her talents recognised with the advent of Possum Magic and the subsequent flood of children's books. She loves reading and writing to, for and with children - and also conjugating sentences like this! Mem's teaching ability and sense of humour are truly remarkable, all else is merely sensational. Mem is a senior lecturer in the language arts at Sturt campus.

Lyn Wilkinson : Lyn is a burgeoning talent in the professional writing field, with a wicked sense of humour to boot. Lyn manages to get kids writing, despite their unrelenting diet of after school TV soapies and mind deadening commercials! When it comes to new challenges Lyn is in her element; she lectures in language arts at Sturt campus.

Rob Morrison : Rob is Internationally and nationally known for his long-standing contribution to arousing the scientific curiosity of a generation through a host of public appearances and the famous and long running 'Curiosity Show'. These have resulted in a range of public and professional awards from <<le Grand Prix de Jeunesse>> for television, a Churchill fellowship for scientific work and his 16 books for children on scientific discovery. Although lesser known, his many high quality artisan, technical, bushcraft and teaching skills, as well as a joyful approach to life are brought to bear in his work with students. Rob is a senior lecturer in science at Sturt campus.

Nigel Murray-Harvey A quietly outrageous artist and art educator who has won recognition and success not only through painting , drawing and his published illustrations in a series of children's science books, also has skills in the allied artistic fields of silk screening, calligraphy, pottery and silversmithing. A true craftsman, he also has diverse hobbies and sports skills, being one of very few to have sailed solo (in a crew of three!) from England to Australia (he found it more of a challenge than paying £10 to migrate!). Nigel is a lecturer in art at Sturt campus.

About the Contributors :

Jeff Baxter : An national identity in mathematics education, with interests in learners of all ages from toddlers to adult. A well known enthusiast about mathematics and its value aesthetically, as well as societally, he is also absorbed by its engaging nature. He is a widely travelled speaker and highly regarded by his colleagues, recognised by elected office as President of the Australian Association of Mathematics Teachers, Australia's largest professional association of mathematics educators. Jeff is a lecturer in mathematics at Sturt campus.

Peter Brinkworth Whilst a quiet and reserved character on first meeting, Peter is a person capable of surprising even his closest colleagues and friends with the depth and breadth of his knowledge in many areas. Widely recognised as one of this state's most knowledgeable educators, particularly in the fields of mathematics and general curriculum, his many talents extend from award winning painting to acclaimed theatre performance. Known at the College as 'the Renaissance Man', he brings to the Palace the wisdom and wit of a true scholar. Peter is a senior lecturer in mathematics and curriculum at Sturt campus.

Elizabeth Silsbury : One of the best known music educators in Australia, is the Principal music critic at The Advertiser and is a Director of The Australian Opera. Elizabeth has been a driving force behind Adelaide's Festivals, choirs, eisteddfods and musical theatre for years, and her own musical activities include playing piano and harpsichord for concert and theatre performances and choral conducting. Making, teaching and talking about music have been the major passions of her life since she discovered B flat at the age of 3. Elizabeth is a senior lecturer in music at Sturt campus.

Malcolm Fox : An outstanding teacher of drama and theatre performance, he is well-known in the performing arts arena in this state. A love of travel, particularly when combined with fluency in the French language, keeps him alternately poor but well fed! Passionate about most things, his zest and creative insights ensures on-going appeal of his work with students of all ages. Malcolm is a lecturer in drama at Sturt campus.

Rex Guthrie : Committed to visual education, Rex brings expertly grounded technical skills to bear upon the intricacies of production. His work professionally.as a pioneer in aboriginal television at Ernabella, resulted in the first public broadcasting station to be set up in Australia. He has extensive experience in video production both at the SACAE and through training and organising the local Pitjantjatjara crews for productions such as 'Dreamtime stories' and 'Bush Medicine'. Rex is a technical Officer in charge of visual education at Sturt campus.

APPENDIX TWO

Turning World media coverage

Brain-storming sessions for gifted students

By Education Writer
NICOLE LLOYD

Gifted children as young as 10 could be plucked from classrooms to attend Flinders University "enrichment" programs next year.

And Flinders is also hoping to introduce formal guidelines to allow such students to undertake tertiary study while still at school.

The proposals, to be discussed at a national conference on gifted education opening in Adelaide today, are part of an ambitious push to stop exceptionally talented students from becoming quiet underachievers.

Flinders University special education lecturer Ms Maria McCann said highly gifted students often had needs as great as children with intellectual disabilities.

"We acknowledge that schools are doing a brilliant job — but students at the highest levels of ability have divergent thinking and creative abilities that are so advanced we don't have a (school) system that suits their ability levels," said Ms McCann, who is also president of the Australian Association for the Education of the Gifted and Talented.

"Encouragement is needed because if they don't learn to play the game they drop out.

"So much of what we call 'enrichment' is just extra work. Bright students don't necessarily need harder work but different work — otherwise we are training them to slow down."

Initially, Flinders is hoping to offer a series of 10-week courses each involving about 50 students from primary and high schools.

The course would be based on Ms McCann's three-month pilot program at the University of Adelaide last year in which 30 primary school students from five government primary schools attended a weekly session at the university.

Students taking part in the Flinders program would attend brain-storming sessions with senior lecturers, using visual art and poetry to stimulate their critical, visual and spatial thinking skills.

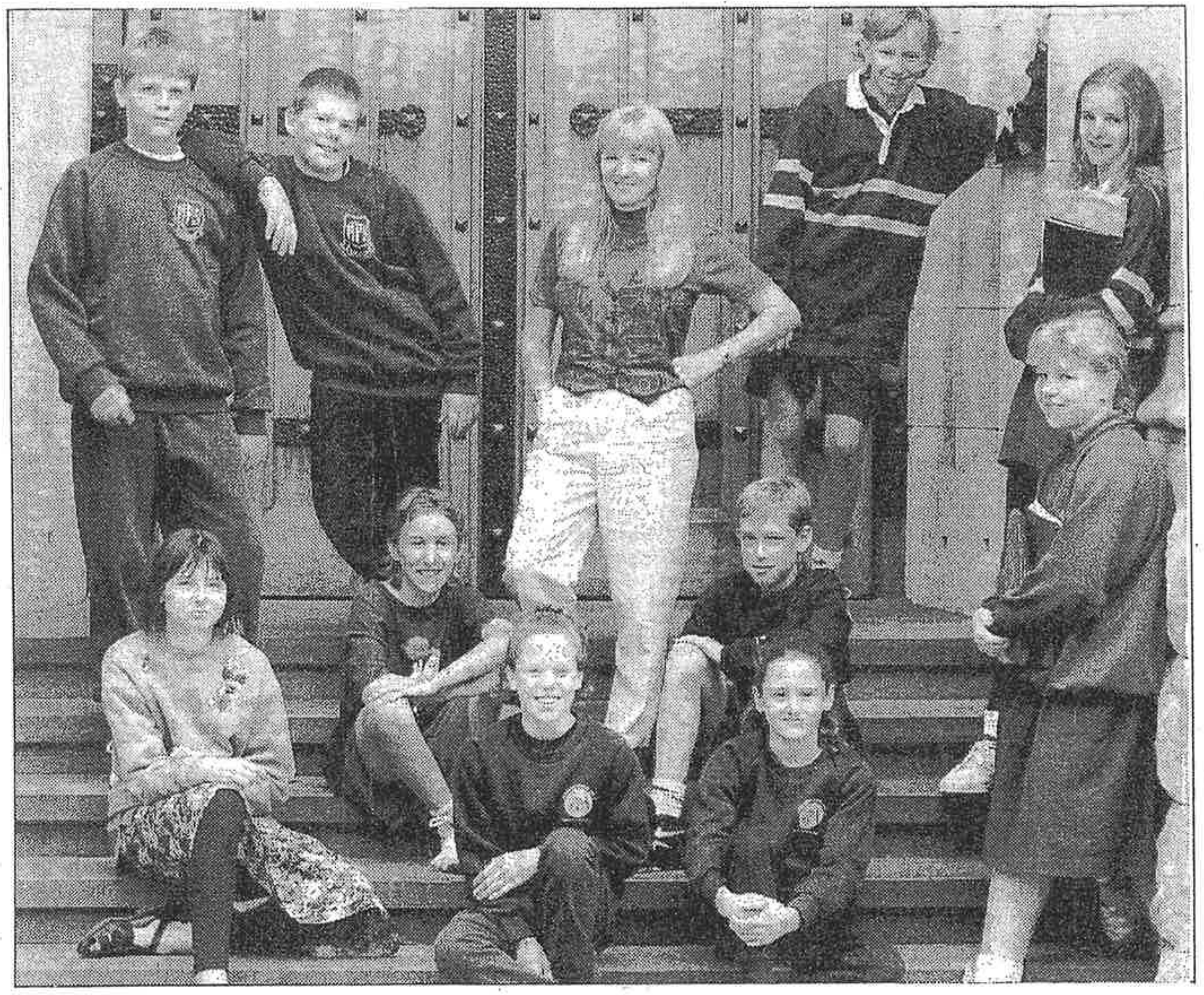
Students would also use interactive CD/Roms to boost mathematical problem-solving skills.

Meanwhile, Flinders also plans to formalise its approach to allow school students to gain access to university courses.

So far this has been done on an "ad hoc" basis with students such as Terry Tao, who gained first-class honors in pure mathematics from Flinders at 16 in 1992.

"We need to get over the headset that 16-year-olds need to be learning with other 16-year-olds and that school students who attend universities are some type of freaks," Ms McCann said.

The sixth *National Conference of Gifted Education* will be held in Adelaide from today until Saturday.



Seated front row (from left) Dayna Griffin, 12, Henry Martin, 11, Michelle Huish, 12, and Nicholas Parkin, 12, seated behind Carmen Griffin, 12. Back row: Tristan Williams, 11, Paul Britcher, 12, the program's founder Maria McCann, Bryan Carman, 12, and (standing right) Rebecca Boxall, 12, Danielle Peters, 12 (front). Picture: BARRY O'BRIEN

Taste of greater things for clever children

They may be up to seven years away from formally completing their schooling — but these students have already had a taste of university life.

The gifted students are among 30 from five State primary schools who took part in a pilot program at the University of Adelaide aimed at fostering their potential.

Their experiences could be used to build a full-scale program at Flinders University next year.

They were excused from normal lessons at Modbury, Magill, Goodwood, Henley Beach and Seacliff primary schools to take part.

Apart from special lectures, the program also was peppered with visits to the Art Gallery and the School of the Future at Technology Park (The Levels).

After the eight-week program, coordinator Ms Maria McCann, who is also president of the Australian Association for the Education of the Gifted and Talented, said she had noticed a difference in students' attitudes towards learning. "There was a level of scepticism when we started but, at the end of it, there was a high level of motivation," she said.

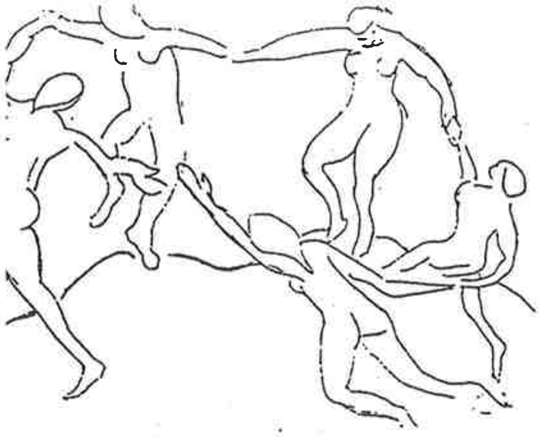
Magill primary student Rebecca Boxall, 12, said "I really enjoyed looking into different sides of poetry and stories." She also had enjoyed visiting the Art Gallery and "looking behind" her first impressions of paintings.

- Nicole Lloyd

The Adelaide Advertiser 18/4/96

APPENDIX THREE

Outline/worksheets from the Turning World program



The Turning World:

A Critical Thinking Program Using Visual Arts

"At the still point of the turning world ... there is only the dance ..."
T.S. Eliot

This enrichment program will be taught at The University of Adelaide, The South Australian Art Gallery, and The S.A. School of The Future every Friday.

In this program the students will learn the following skills:

- **critical thinking**
- **visual thinking**
- **creative writing**
- **mathematical/spatial thinking and problem solving**
- **artistic/spatial thinking and problem solving**

The content of the program will initially focus on poetry and visual art forms. These first classes will take place in the Department of Education at The University of Adelaide and the adjoining South Australian Art Gallery. Many of the lessons will be based on Dorothy Hamilton's program, *Picture Thoughts: Critical Thinking Through Visual Arts.*

Following this, the students will attend the School of The Future for two of the sessions where they will be introduced to Kevin Olssen's *Working Mathematically in Space* program. This program will involve mathematical problem solving using an interactive CD Rom/Computer program. No previous experience with either computers or CD Rom is required.

Interested teachers and parents are invited to be present during the classes.

The co-ordinator of this program is Maria McCann, who is a Senior Lecturer in Special Education at Flinders University.
The program is part of her PhD studies which she is undertaking at the University of Adelaide.
Maria is the National President of the Australian Association for the Education of the Gifted and Talented, and has a great deal of experience with teacher inservice courses in gifted education, as well as teaching enrichment programs for students with high intellectual potential. Her very successful *Palace of Wisdom* program, available to lower-secondary students, was taught at Flinders University for four years.

anger

joy

peacefulness

loneliness

feminine

masculine

powerlessness

energy

GUIDING THOUGHTS

Identification	Description

Boy with a Tire

Interpretation	Extrapolation

ce: PICTURE THOUGHTS, Hamilton Associates, Columbia, Maryland.

Ls

GUIDING THOUGHTS

Identification	Description

Poor Man's Cotton

Interpretation	Extrapolation

ce: PICTURE THOUGHTS, Hamilton Associates, Columbia, Maryland.

GUIDING THOUGHTS

Identification

Description

Picture with White Border

Interpretation

Extrapolation

:e: PICTURE THOUGHTS, Hamilton Associates, Columbia, Maryland.

GUIDING THOUGHTS

Identification

Description

Iris

Interpretation

Extrapolation

ce: PICTURE THOUGHTS, Hamilton Associates, Columbia, Maryland.

GUIDING THOUGHTS

Identification

Description

Voice of Space

Interpretation

Extrapolation

:e: PICTURE THOUGHTS, Hamilton Associates, Columbia, Maryland.

Boy With Tyre by Hughie Lee-Smith

Words which describe the mood of this painting:

Words which extrapolate a story from the painting:

Student name:

....

Voice of Space by Rene Magritte

Words which describe the mood of this painting:

Words which extrapolate a story from the painting:

Student name:

....

Write down all of the words which come to mind when you look at the painting:

Sketch for Painting With White Border by Wassily Kandinsky

After you have listed all of your words, draw a ring around the ones which describe or identify and a box around the words which interpret or extrapolate.

Using only point and line, represent the following work of art:

Iris by Vincent Van Gogh

Compare your point and line representation with the one you did for "Energy" and "Peacefulness". From these findings, what can you *extrapolate* about the artist's intention in painting this picture? How is this painting different from a still life painting of flowers, e.g. Fantin-Latour's *Zinnias* ?

Student name:

....

• Using only point and line (not colour), depict *freedom*: now find the artwork or the sculpture which best fits your sketch.

Title of painting: ______________________________

Artist: ____________________________________

Reason for choice:

- List things which you can lose.

Select a painting which represents something now lost.

Write down your reasons for choosing the painting and be prepared to talk to the class about your choice.

Things which I can lose:

Title of painting: ______________________

Artist: ______________________________

Reason for choice:

•Do a point and line representation of energy. Select a painting which represents *energy*:

Title of painting: ____________________________

Artist: ____

Reason for choice:

•Identify three of the art works in the gallery which sustain life.

1.Title of painting: ______________________

Artist: ______________________
Reason for choice:

2.Title of painting: ______________________

Artist: ______________________
Reason for choice:

3.Title of painting: ______________________

Artist: ______________________
Reason for choice:

• In the Aboriginal art section of the gallery, identify the traditional aboriginal symbols (e.g. ∪ for women, and ⅄ for kangaroo): invent some new ones to represent important things in your life.

Symbol	Reason for choice

•Find a painting where you think the painter was sad. Give a reason for your choice.

Title of painting: ______________________

Artist: ______________________________

Reason for choice:

• Find a painting in the gallery which answers or asks the question, *when*?

Title of painting: ______________________________

Artist: ____________________________________

Reason for choice:

• Find a painting in the gallery which answers or asks the question, *why*?

Title of painting: ______________________

Artist: ______________________________

Reason for choice:

THE CANTERBURY TALES

Fragment I (Group A)

GENERAL PROLOGUE

HERE BYGYNNETH THE BOOK OF THE TALES OF CAUNTERBURY

WHAN that Aprill with his shoures soote   *sweet*
The droghte of March hath perced to the roote,
And bathed every veyne in swich licour
Of which vertu engendred is the flour;
Whan Zephirus eek with his sweete breeth   *also*
Inspired hath in every holt and heeth   *quickened; wood*
The tendre croppes, and the yonge sonne   *shoots*
Hath in the Ram his halve cours yronne,
And smale foweles maken melodye,   *birds*
That slepen al the nyght with open ye
(So priketh hem nature in hir corages);   *incites; hearts*
Thanne longen folk to goon on pilgrimages,
And palmeres for to seken straunge strondes,
To ferne halwes, kowthe in sondry londes;
And specially from every shires ende
Of Engelond to Caunterbury they wende,   *go*
The hooly blisful martir for to seke,   *blessed; visit*
That hem hath holpen whan that they were seeke.   *helped* / *sick*
  Bifil that in that seson on a day,
In Southwerk at the Tabard as I lay   *stayed*
Redy to wenden on my pilgrymage
To Caunterbury with ful devout corage,

3–4 And bathed every sap-vessel in moisture, by virtue of which the flower is produced.
7–8 The young sun (i.e. the sun at the beginning of its annual journey) has completed the second half of its course in the Ram. (In other words the sun had left the zodiacal sign Aries, which it did in Chaucer's time on 11th April. We know from the *Introduction to the Man of Law's Tale*, II. 5, that the first or second day of the pilgrimage was 18th April.)
13 And palmers to visit foreign shores.
14 To distant shrines, well known in different lands.
17 i.e. St Thomas Becket.

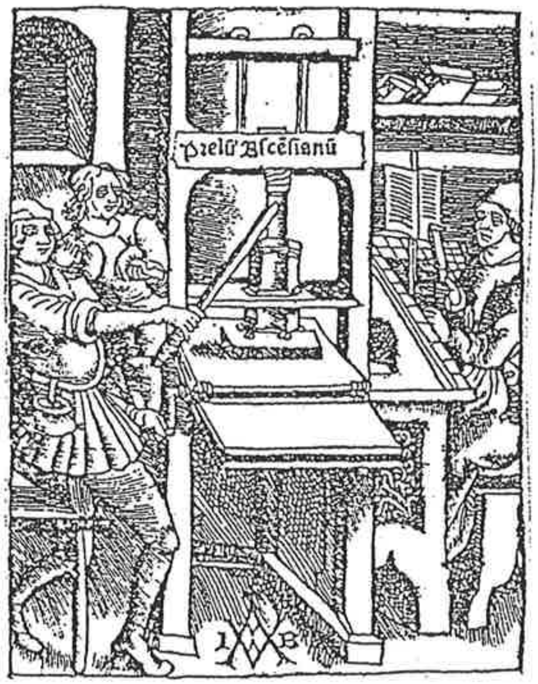
At nyght was come into that hostelrye
Wel nyne and twenty in a compaignye,   *at least*
Of sondry folk, by aventure yfalle
In felaweshipe, and pilgrimes were they alle,
That toward Caunterbury wolden ryde.   *intended to*
The chambres and the stables weren wyde,
And wel we weren esed atte beste.
And shortly, whan the sonne was to reste,   *(gone) to rest*
So hadde I spoken with hem everichon   *each one*
That I was of hir felaweshipe anon,
And made forward erly for to ryse,   *agreement*
To take oure wey ther as I yow devyse.
  But nathelees, whil I have tyme and space,   *nevertheless* / *opportunity*
Er that I ferther in this tale pace,   *before; proceed*
Me thynketh it acordaunt to resoun
To telle yow al the condicioun
Of ech of hem, so as it semed me,
And whiche they weren, and of what degree,
And eek in what array that they were inne;   *attire*
And at a knyght than wol I first bigynne.
  A KNYGHT ther was, and that a worthy man,
That fro the tyme that he first bigan
To riden out, he loved chivalrie,   *to go campaigning*
Trouthe and honour, fredom and curteisie.
Ful worthy was he in his lordes werre,   *war*
And therto hadde he riden, no man ferre,   *also; farther*
As wel in cristendom as in hethenesse,   *heathendom*
And evere honoured for his worthynesse.
At Alisaundre he was whan it was wonne.
Ful ofte tyme he hadde the bord bigonne
Aboven alle nacions in Pruce;   *Prussia*
In Lettow hadde he reysed and in Ruce,
No Cristen man so ofte of his degree.
In Gernade at the seege eek hadde he be
Of Algezir, and riden in Belmarye.

25 By chance met together.
29 And we were excellently entertained.
34 To where I tell you of.
37 It seems to me to be in order.
40 And what sort of men they were.
46 *Trouthe*, fidelity, loyalty; *fredom*, liberality; *curteisie*, gracious and considerate conduct.
51 The Saracen stronghold of Alexandria was taken by Pierre de Lusignan, King of Cyprus, in 1365.
52 He had very often sat in the seat of honour at table.
54 He had campaigned with the Teutonic knights against the barbarians of Lithuania and Russia.
56–7 He had taken part in the siege and capture of the Moorish citadel of Algezir in Granada (1344); *Belmarye*, Benmarin, a Moorish kingdom in North Africa.

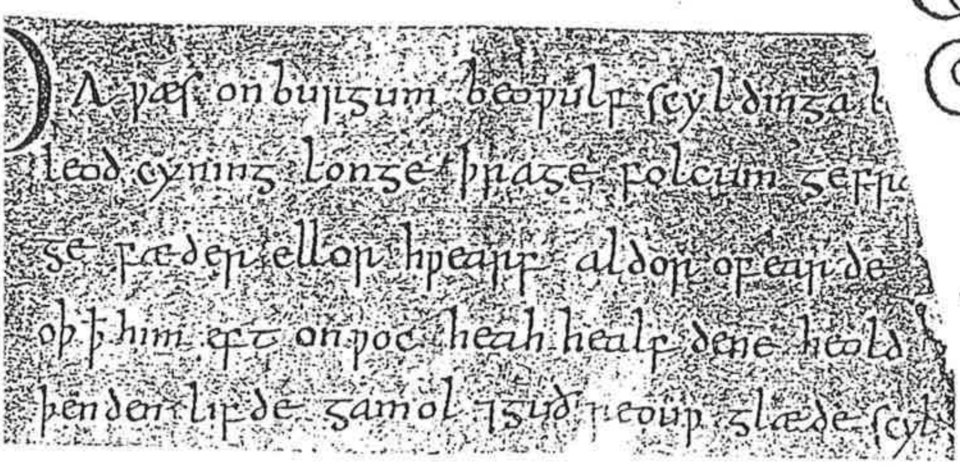
GENERAL PROLOGUE

HERE BEGINS THE BOOK OF THE TALES OF CANTERBURY: When April with its gentle showers has pierced the March drought to the root and bathed every plant in the moisture which will hasten the flowering; when Zephyrus with his sweet breath has stirred the new shoots in every wood and field, and the young sun has run its half-course in the Ram, and small birds sing melodiously, so touched in their hearts by Nature that they sleep all night with open eyes—then folks long to go on pilgrimages, and palmers to visit foreign shores and distant shrines, known in various lands; and especially from every shire's end of England they travel to Canterbury, to seek the holy blessed martyr who helped them when they were sick.

One day in that season when I stopped at the Tabard in Southwark, ready to go on my pilgrimage to Canterbury with a truly devout heart, it happened that a group of twenty-nine people came into that inn in the evening. They were people of various ranks who had come together by chance, and they were all pilgrims who planned to ride to Canterbury. The rooms and stables were large enough for each of us to be well lodged, and, shortly after the sun had gone down, I had talked with each of these pilgrims and had soon made myself one of their group. We made our plans to get up early in order to start our trip, which I am going to tell you about. But, nevertheless, while I have time and space, before I go farther in this account, it seems reasonable to tell you all about each of the pilgrims, as they appeared to me; who they were, and of what rank, and also what sort of clothes they wore. And I shall begin with a Knight.




In ẏ begyn
nynge God
created hea
uen ⁊ earth:
and ẏ earth
was voyde
and emptie,
and darck-
nes was v-
pon the de-
pe, ⁊ ẏ spie-
te of God
moued vpō
the water.
And God sayde: let there be light, ⁊ there
was light. And God sawe the light that it
was good. Then God deuyded ẏ light from
the darcknes, and called the light, Daye: and
the darcknes, Night. Then of the euenynge
and mornynge was made the first daye.


ða wæs on burgum beowulf scyldinga l
leod cyning longe þrage folcum gefr
ge fæder ellor hwearf aldor of ear de
oþ þ him eft on woc heah healfdene heold
þenden lifde gamol ⁊ guðreouw glæde scyl

– Dylan Thomas –

Fern Hill

Now as I was young and easy under the apple boughs
About the lilting house and happy as the grass was green,
The night above the dingle starry,
Time let me hail and climb
Golden in the heydays of his eyes,
And honoured among wagons I was prince of the apple towns
And once below a time I lordly had the trees and leaves
Trail with daisies and barley
Down the rivers of the windfall light.

And as I was green and carefree, famous among the barns
About the happy yard and singing as the farm was home,
In the sun that is young once only,
Time let me play and be
Golden in the mercy of his means,
And green and golden I was huntsman and herdsman, the calves
Sang to my horn, the foxes on the hills barked clear and cold,
And the sabbath rang slowly
In the pebbles of the holy streams.

All the sun long it was running, it was lovely, the hay
Fields high as the house, the tunes from the chimneys, it was air
And playing, lovely and watery
And fire green as grass.
And nightly under the simple stars
As I rode to sleep the owls were bearing the farm away,
All the moon long I heard, blessed among stables, the nightjars
Flying with the ricks, and the horses
Flashing into the dark.

And then to awake, and the farm, like a wanderer white
With the dew, come back, the cock on his shoulder; it was all
Shining, it was Adam and maiden,
The sky gathered again
And the sun grew round that very day.
So it must have been after the birth of the simple light
In the first, spinning place, the spellbound horses walking warm
Out of the whinnying green stable
On to the fields of praise.

And honoured among foxes and pheasants by the gay house
Under the new made clouds and happy as the heart was long,
In the sun born over and over,
I ran my heedless ways,
My wishes raced through the house high hay
And nothing I cared, at my sky blue trades, that time allows
In all his tuneful turning so few and such morning songs
Before the children green and golden
Follow him out of grace,

Nothing I cared, in the lamb white days, that time would take me
Up to the swallow thronged loft by the shadow of my hand,
In the moon that is always rising,
Nor that riding to sleep
I should hear him fly with the high fields
And wake to the farm forever fled from the childless land.
Oh as I was young and easy in the mercy of his means,
Time held me green and dying
Though I sang in my chains like the sea.

1945 1946

Loo-Wit, the Fire-Keeper (1988). In Caduto, M.J. and Bruchac, J. *Keepers of the Earth: Native American Stories and Environmental Activities for Children*. Golden, CO: Fulcrum Publishing.

NOTE: This publication is included in the print copy of the thesis held in the University of Adelaide Library.

Some ideas to try

Build a structure

Build a symmetrical structure in the 3D Constructor space. Paste different views of it in your journal and use those pictures to help you write about the symmetrical aspects of your structure.

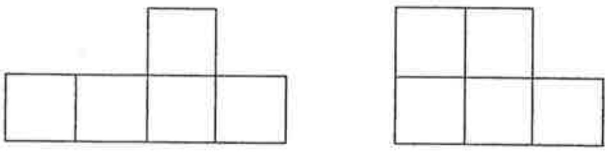
Design your own pattern

Design an interesting pattern of your own in the 3D Constructor building space. It could be a repeating pattern or a pattern that grows in a consistent way. Write about your pattern in your journal.

Explore orthographic views

Build a very simple structure in the 3D Constructor and then choose 'Orthographic display' from the 'View' menu. Try to work out what this shows. Record your ideas in your journal.

Here are two side views of a structure. What does it look like in 3D? Explore the possibilities. Write about your discoveries (you could include pictures of the structure from the 3D Constructor too).



side view 1   side view 2

Hiding cubes

Build a simple structure and then create a copy of it using 'Copy' from the 'Tools' menu. Change the colour of the second structure and then try to move it so that it is hidden behind the first one.

In your journal describe how you hid the structure. Include pictures from the 3D Constructor to help with your description. You could even try constructing an animation to show how you hid the structure.

Do you think there are any rules for hiding cubes in the 3D Constructor?

Tower pattern

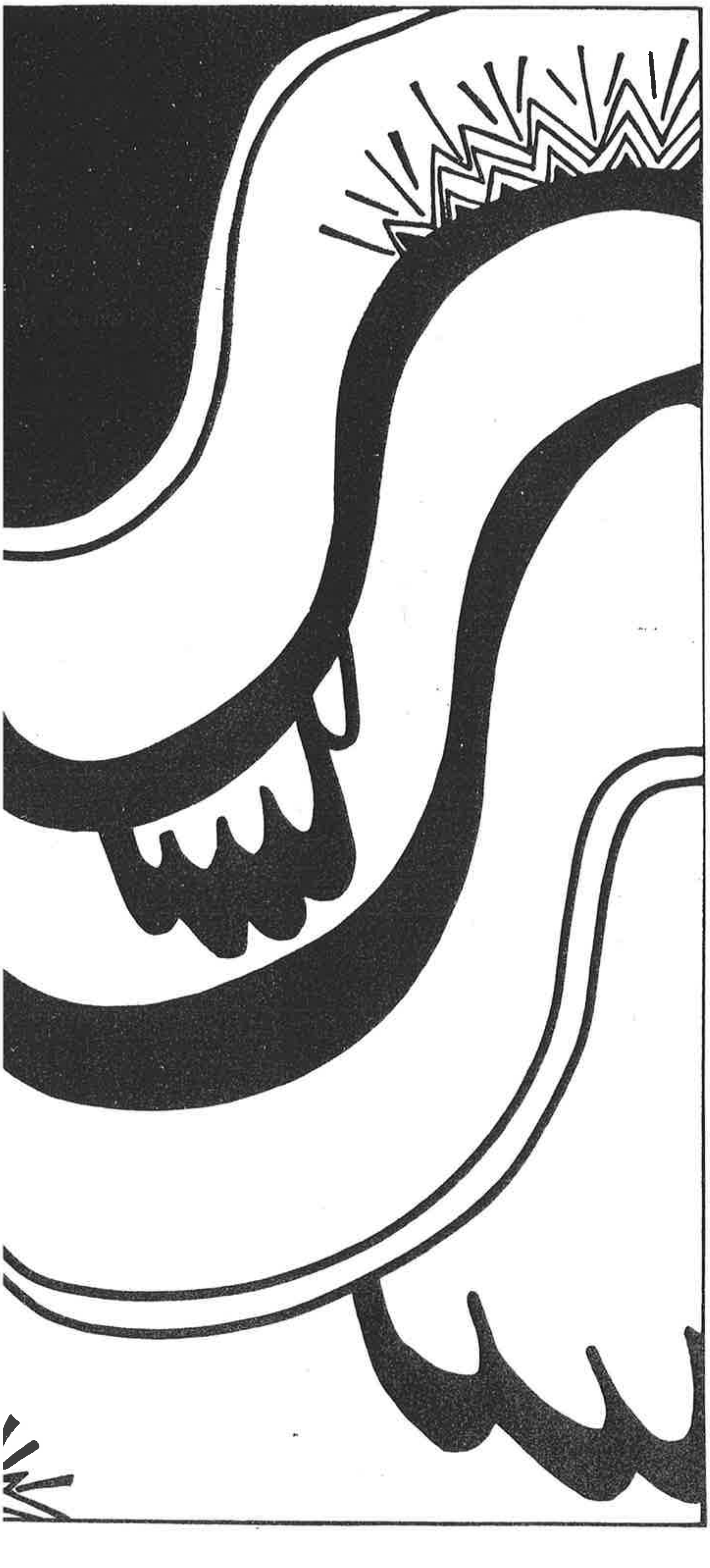
Design and construct a pattern of towers based on the number pattern below. This could be made up of separate structures or be presented as an animation.

stage	1	2	3	4	5	...
number of cubes	5	9	13	17	21	...

In your journal describe how to continue the tower pattern. Is there a rule?

APPENDIX FOUR

Torrance Tests of Creative Thinking (Figural Form A)



THINKING CREATIVELY WITH PICTURES

By E. Paul Torrance

FIGURAL BOOKLET A

NAME________________________

AGE______________SEX__________

SCHOOL______________________

GRADE_______________________

CITY_________________________

DATE_________________________

SCHOLASTIC TESTING SERVICE, INC.
480 Meyer Road, P.O. Box 1056
Bensenville, IL 60106-8056

Torrance, E.P. (1962). *Thinking Creatively with Pictures: Figural Booklet A*. Bensenville, IL.: Scholastic Testing Service.

APPENDIX FIVE

Figures of Sound instrument

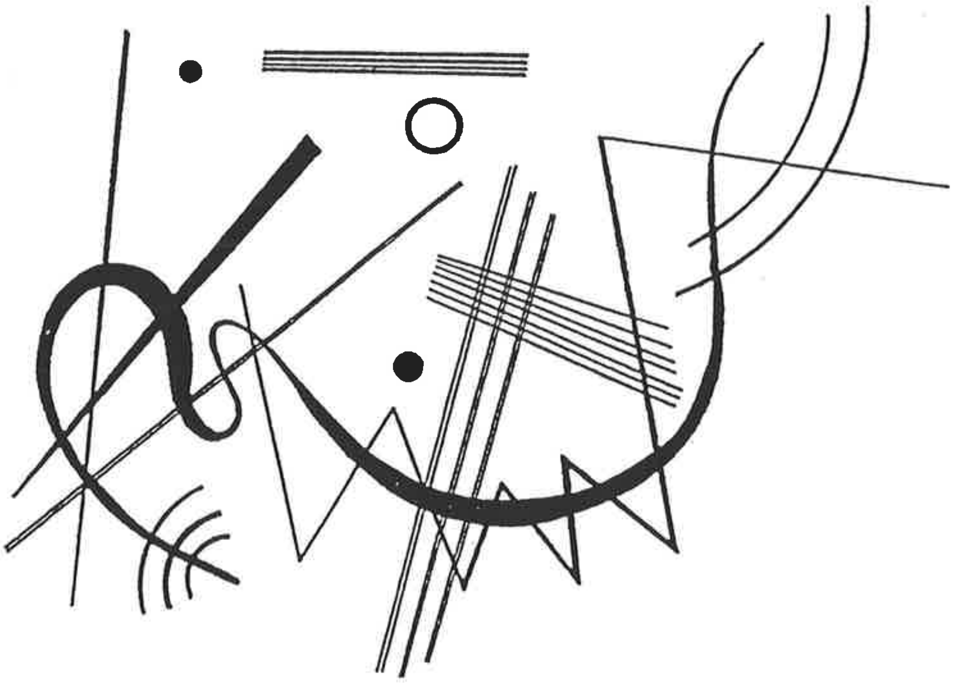
Figures of Sound

An instrument designed to explore visual thinking ability and creativity.

Concept and design: Maria McCann
Artwork (after Wassily Kandinsky): Nigel Murray-Harvey

Instructions - In this booklet there are drawings and questions about the drawings. You will be asked to look carefully at each drawing and then answer the question for it. There are no right or wrong answers. You are asked to just respond to each drawing and question and give the response or answer which you think fits best.

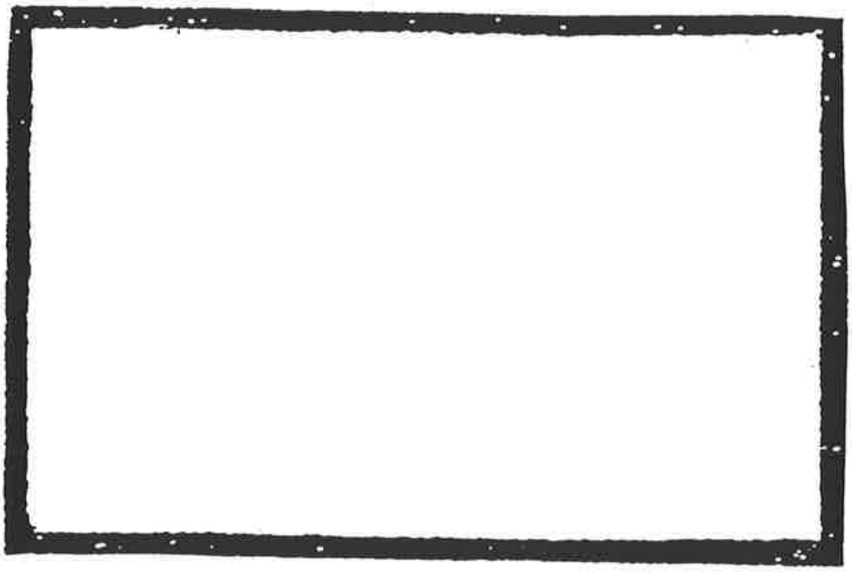
I will read through each question with you and tell you when to take up your pencil and when to turn the pages.



The designs for this instrument are based largely on the artwork and teachings of Wassily Kandinsky (1866 - 1944).

Question 1.

Here is a rectangle. There is nothing inside the rectangle.
Now imagine that I want you to put a dot inside this rectangle in a place where you think it looks best.
Look at the rectangle and imagine where the dot would look best.
Now take up your pencil and place a dot into the rectangle in a place where you think it looks best.
Place only one dot inside the rectangle.



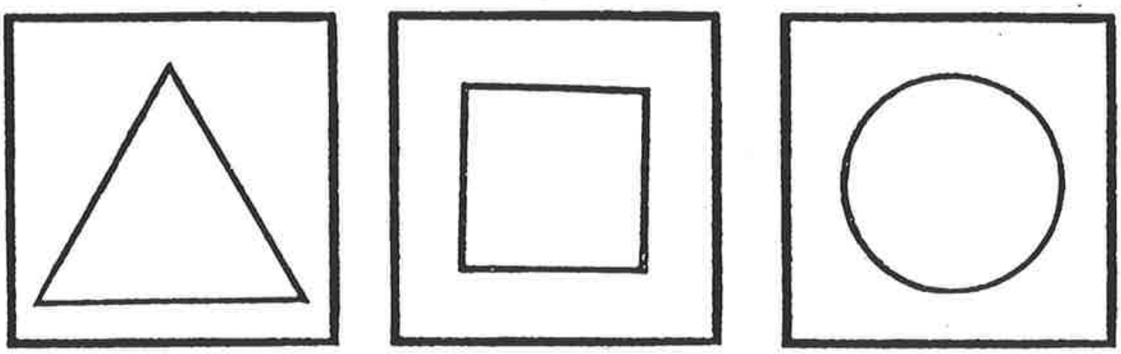
Question 2
Here are three shapes - a triangle, a square, and a circle.
Each shape is inside a frame.

Now imagine that you have three coloured pencils -

Red(R)
Blue(B)
Yellow(Y).

Look at each shape and imagine one colour to suit each shape.
Ask yourself: what colour will best suit each shape? Which shape looks best as Yellow? Which shape looks best as Blue? And which shape looks best as Red?

Now take up your pencil and write either Y, B, or R inside each shape to indicate which colour best suits each shape.
Use only one colour for each shape and give each shape a different colour.

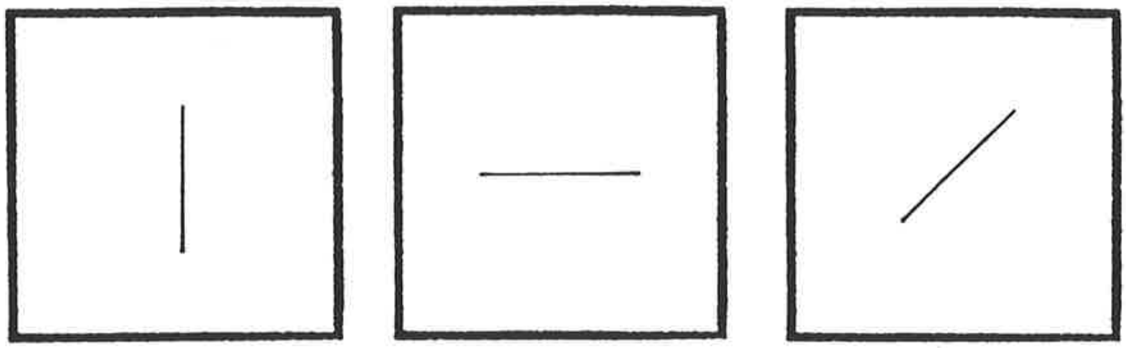


Question 3

Here are three lines.
Each line is inside a frame.
At the bottom of the page are three words: *cold, warm* and *hot*.
Give each line a separate name or title by writing *cold, warm* or *hot* on the line under it.

Look at the lines first and ask yourself: what line will be called, *cold;* what line will be called *warm;* and what line will be called *hot*?

Now take up your pencil and write one title on the line under each frame. Give each line a different name or title.



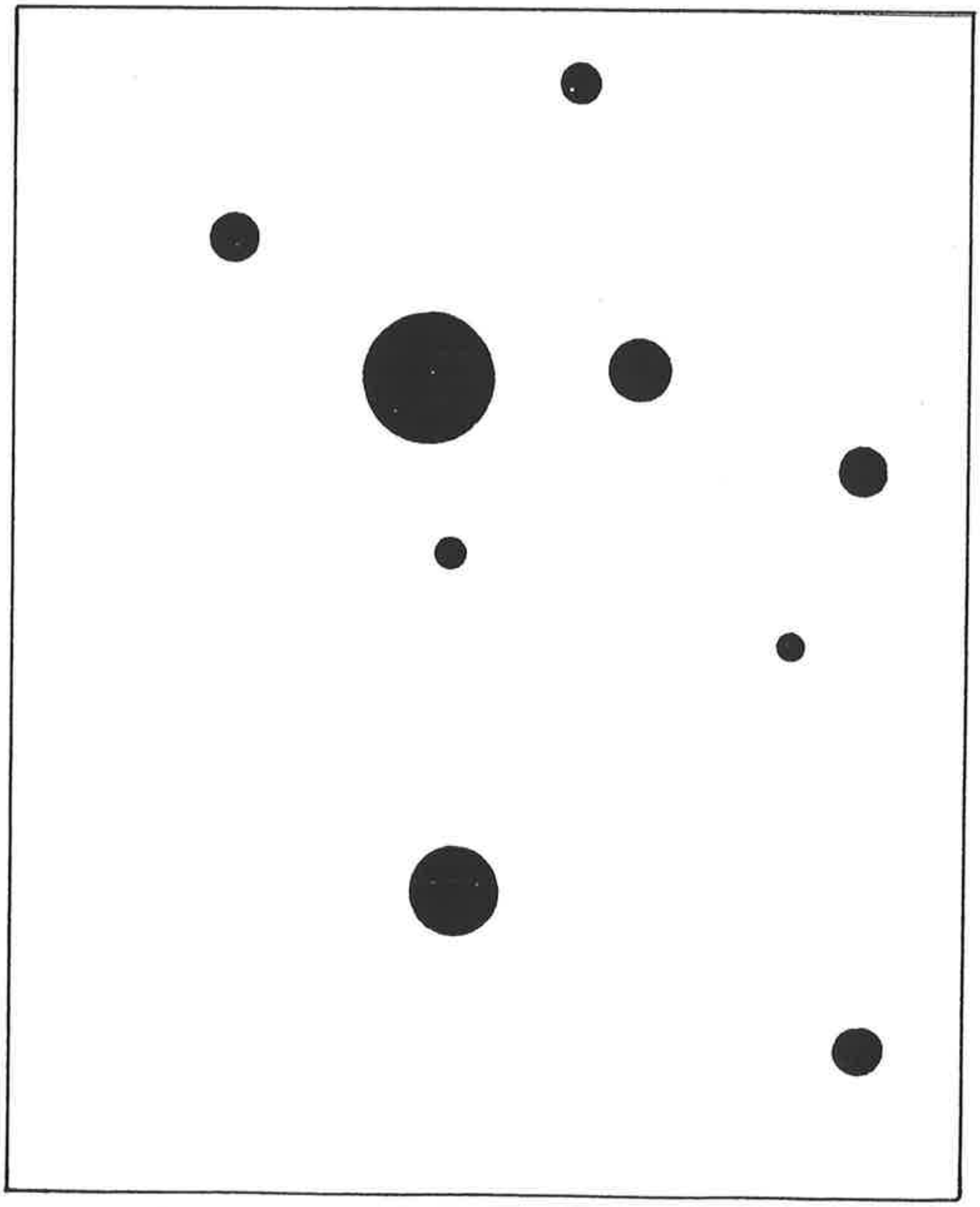
cold

warm

hot

Question 4
Here is a drawing of some points. They are in a frame.

Look at these points and ask yourself: are they rising up, are they falling down, or are they still?
Take some time to look at the points.
Now take up your pencil and tick one box for your answer.



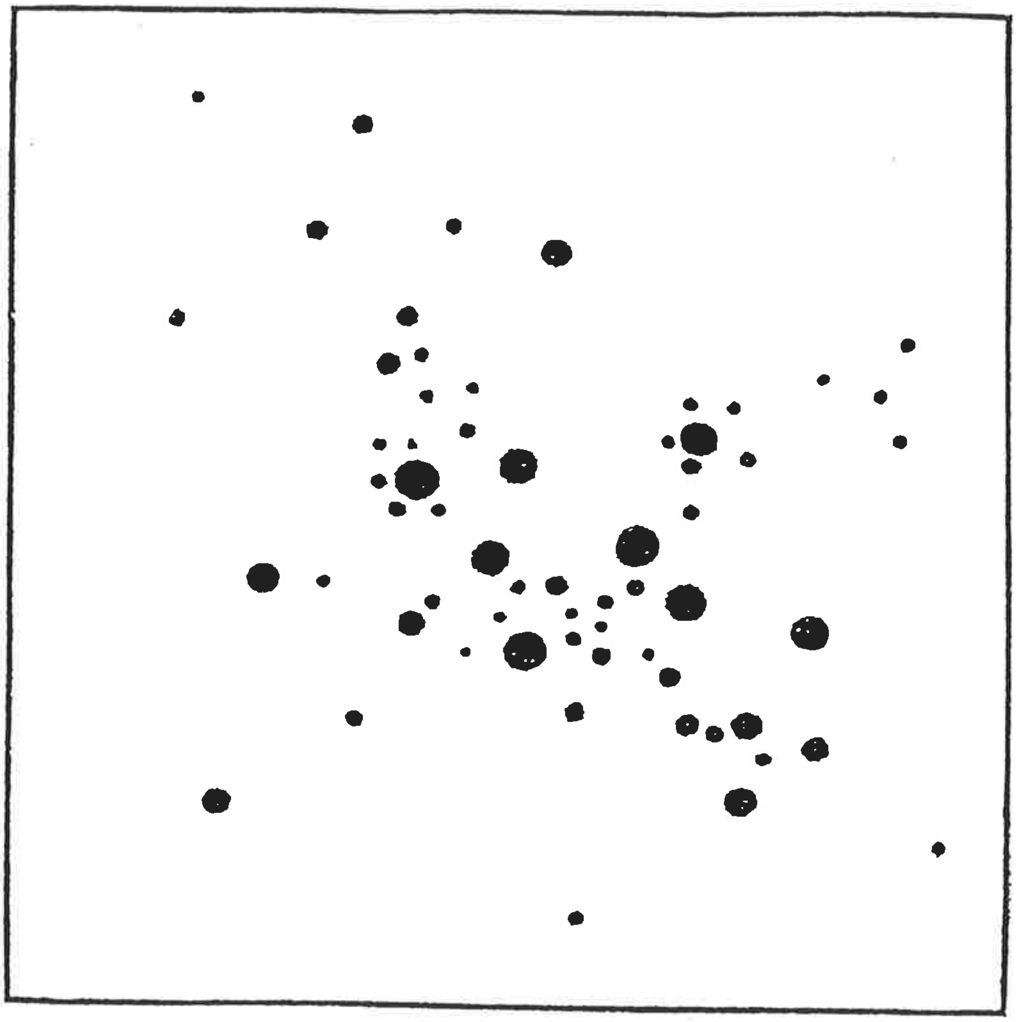
☐ the points are rising

☐ the points are falling

☐ the points are still

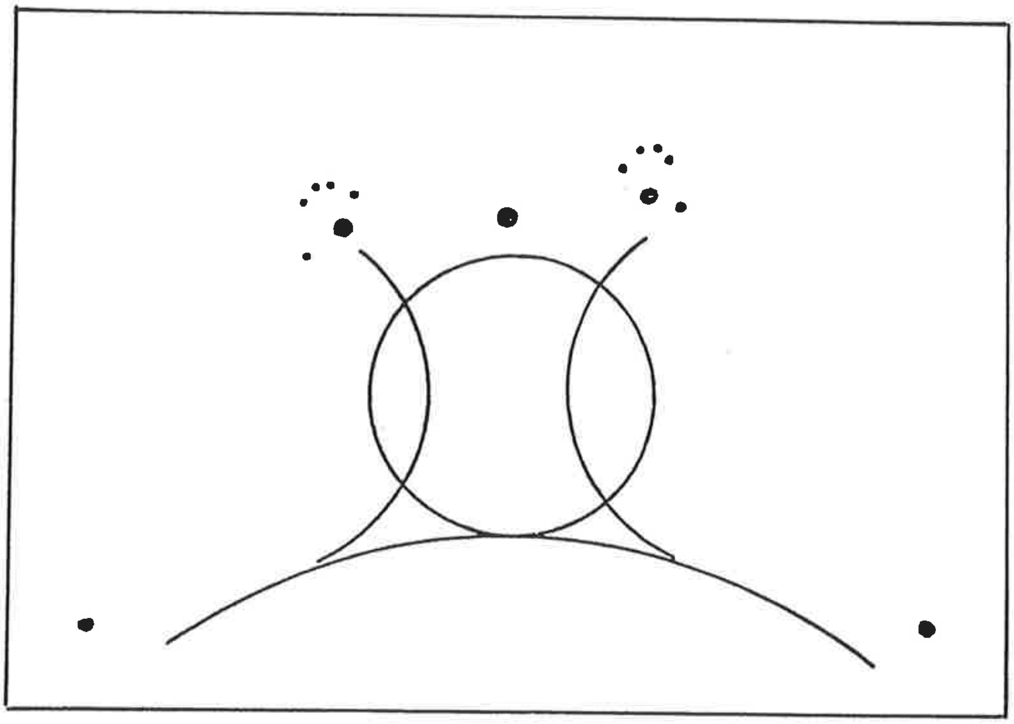
Question 5

Here is a drawing of some more points. They are also in a frame.
Look at these points and ask yourself:
Are these points still, or are they moving in towards the centre, or are they moving out towards the edges?
Take some time to look at these points.
Now take up your pencil and tick one box for your answer.



- ☐ still
- ☐ moving in towards the centre
- ☐ moving out towards the edges

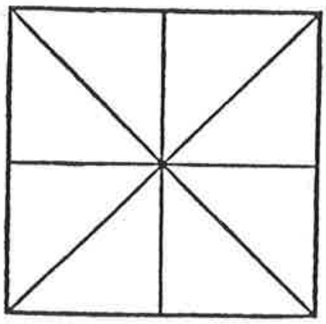
Question 6
Here is a drawing inside a frame.
Give this drawing a title by ticking one of the boxes below.
Look at the drawing and ask yourself: which name or title suits this drawing best - running, swimming or jumping? Choose only one of these names or titles for this drawing.
Now take up your pencil and tick the box which gives the best title or name for this drawing.

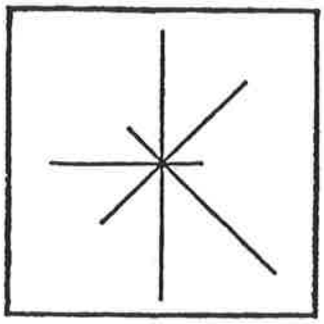


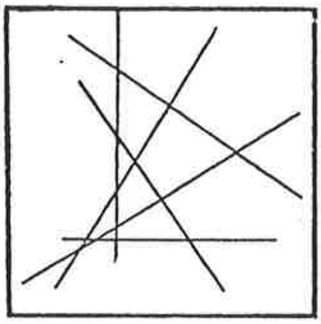
- ☐ running
- ☐ swimming
- ☐ jumping

Question 7
Here are three frames with different sets of lines inside them.
At the bottom of the page there are three names or titles: *laughter* (a), *silence* (b) and *scream* (c).
Look at the drawings and ask yourself, which one should have the title, *laughter*, which one should have the title, *silence* and which one should have the title, *scream*?

Now take up your pencil and provide a title for each drawing by placing either a, b, or c on the line under it:







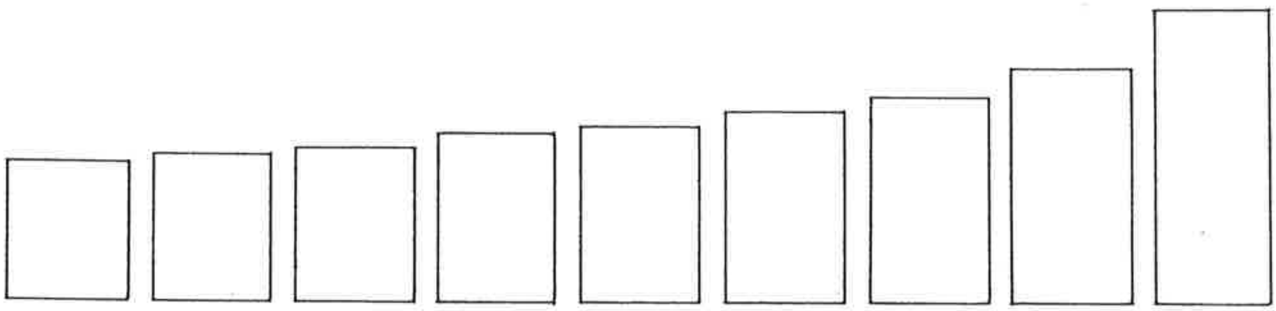
a. laughter

b. silence

c. scream

Question 8

Here are some boxes. They are different shapes and sizes.
Take a look at all of the boxes and put a cross inside the one which you think looks the best.
Which box appeals most to you?



Question 9

Here is an empty frame.
Now I want you to picture a scene in your mind.
Picture a sandy desert.
Think about this:

> A desert is a sea of sand.
> Each grain of sand is different.

Now take up your pencil and draw one grain of sand.

Question 10

Here is another empty frame.
Now take up your pencil and draw a desert.

APPENDIX SIX

Glossary of statistical terms

Appendix 6 – Glossary of statistical terms

Dist of Y: Test for Normality
The "Test Dist is Normal command" tests that the distribution is normal. If n ≤2000 a Shapiro–Wilk W test is given. If n > 2000 a KSL test is done. If the p–value reported is less than .05 (or some other alpha), then you conclude that the distribution is not normal.If you conclude from these tests that the distribution is not normal, it is useful to use the Normal Quantile command in the check border menu to help assess the lack of normality in the distribution.

Nonparametric Tests
JMP offers three nonparametric tests for testing whether distributions across factor levels are centered at the same location. All these tests are from the rank-score family.

- Wilcoxon rank scores are simply the ranks of the data. The Wilcoxon test is the most powerful rank test for errors with logistic distributions. (Also called Mann-Whitney U.; called Kruskal-Wallis if more than 2 groups).
- Median rank scores are either 1 or 0 depending on whether a rank is above or below the median rank. The Median test is the most powerful rank test for errors with doubly exponential distributions.
- Van der Waerden rank scores are the ranks of the data divided by one plus the number of observations transformed to a normal score by applying the inverse of the normal distribution function. The Van der Waerden test is the most powerful rank test for errors with normal distributions.

The report for each test is
(1) a summary of the rank scores for each level,
(2) if there are only two levels, a Normal or Student's t approximate test, and
(3) a Chi-square approximation appropriate for 2 or more levels.
If your sample size is not large, you should consult a table of critical values to help judge the significance.

Distribution of Y: Test Mean=Value
The Test Mean=Value command prompts you for a test value for statistical comparison to the mean. After you click OK, the Test Mean=value report is appended to the bottom of the reports for that variable.
t test is the Student's t test statistic and the p–values for the two–sided and one–sided alternatives. The Student's t test assumes the data is distributed normally.

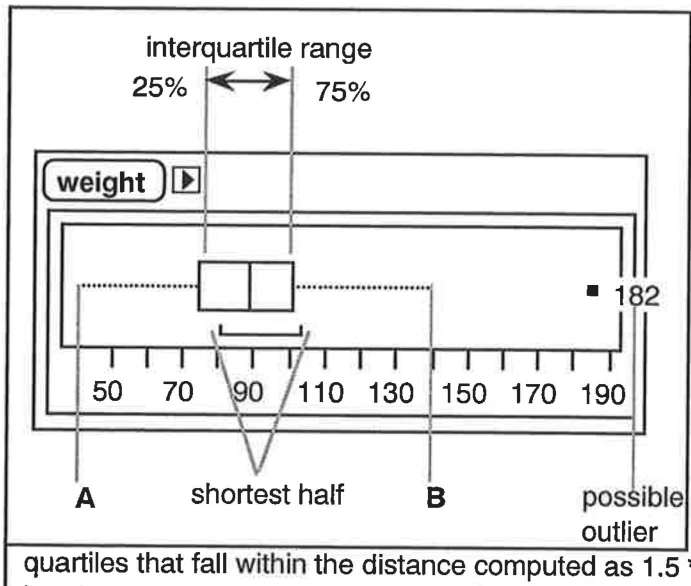
z test tests a sample mean against a value using known population mean and standard deviation.

Signed–Rank the Wilcoxon signed rank statistic followed by the p–values for the two–sided and one–sided alternatives. This test assumes only that the distribution is symmetric.This test uses average ranks for ties. The p–values are exact for n ≤ 20 where n is the number of values not equal to the hypothesized value. For n > 20 a Student's t approximation due to Iman and Conover is used.

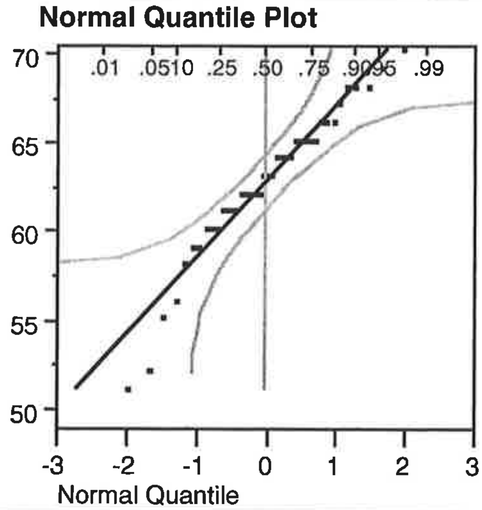
Prob > |t| is the probability of obtaining a greater absolute t value by chance alone when the sample mean is not different from the hypothesized value. This is the p–value for observed significance of the two–tailed t test.

Prob > t is the probability of obtaining a t value greater than the computed sample t ratio by chance alone when the sample mean is not the hypothesized value. This is the p–value for observed significance of a one–tailed t test. The value of this probability is half of Prob > |t|.

Prob < t is the probability of obtaining a t value less than the computed sample t ratio by chance alone when the sample mean is not the hypothesized value. This is the p–value for observed significance of a one–tailed t test. The value of this probability is 1–Prob > t.You can use the Test Mean=Value command repeatedly to test different values..



The **Outlier Box Plot** is a schematic that lets you see the sample distribution and identify points with extreme values, or outliers. The ends of the box are the 25th and 75th quantiles, also called the quartiles. The difference between the quartiles is the interquartile range. The line across the middle identifies the median sample value. The ends of the whiskers, denoted **A** and **B**, are the outer-most data points from their respective quartiles that fall within the distance computed as 1.5 *(interquartile range). The bracket along the edge of the box indentifies the shortest half, which is the most dense 50% of the observations.



The normal quantile plot is an additional graph for each interval variable which is useful for visualizing the extent to which the variable is normally distributed. If a variable is normal, the normal quantile plot is a diagonal straight line. The normal quantile plot has the Lillifors confidence bounds, which surround the area of normal distribution, and reference lines. This plot is also referred to as a theoretical quantile-quantile plot or Q-Q plot.

Nonparametric Correlations

The **Nonparametric Measures of Association** table lists Spearman's Rho (Spearman's rank–order correlations) and Kendall's tau–b statistics for each pair of variables. This report also shows significance probabilities for all measures and compares the correlations with bar charts.

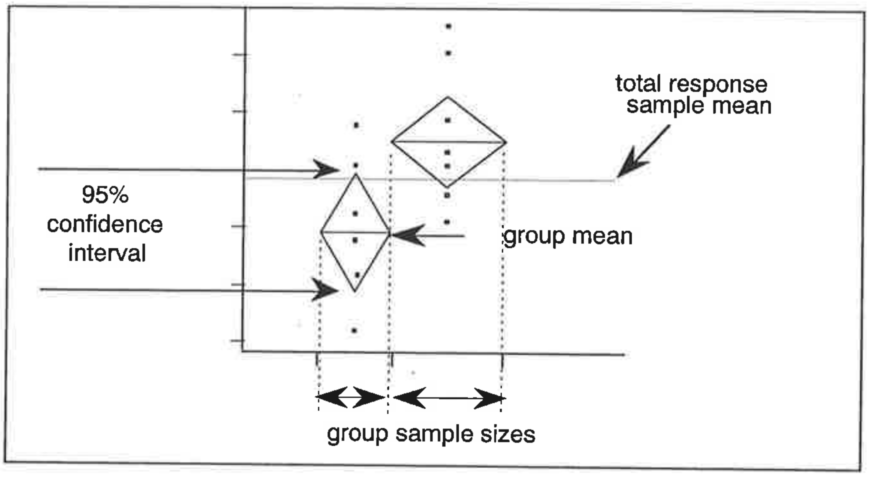
- **Spearman's Rho** is a correlation coefficient computed on the ranks of the data values instead of the values themselves.
- **Kendall Tau-b** coefficients are based on the number of concordant and discordant paris of observations, and uses a correction for tied pairs (pairs of observations that have equal value of x or equal values of y).
- **Hoeffding D** scales ranges from –.5 to 1, with only large positive values indicating dependence.

click on any measure for more info

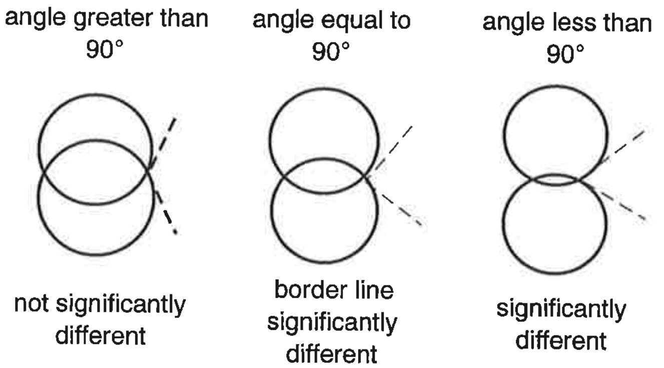
Spearman's Rho Coefficients

Spearman's Rho correlation coefficient is computed on the ranks of the data using the formula for the Pearson's correlation.

Means diamonds
are a schematic of the mean and standard error of the mean for each sample group. The line across each diamond represents the group mean. The height of each diamond represents the 95% confidence interval for each group, and the diamond width represents the group sample size.



Means Comparison Circles
When you click on a means circle, it highlights along with circles for all means that are not significantly different. The outside angle of intersection tells you whether or not group means are significantly different. Circles for means that are significantly different either do not intersect or intersect slightly so that the outside angle of intersection is less than 90 degrees. If the circles intersect by an angle of more than 90 degrees or if they are nested, the means are not significantly different.



Tests that the Variances are Equal

When the variances across groups are not equal, the usual analysis of variance assumptions are not satisfied and the Anova F test is not valid. JMP gives four tests for equality of group variances and an Anova that is valid when the group sample variances are unequal. The concept behind the first three tests of equal variances is to perform an analysis of variance on a new response variable constructed to measure the spread in each group. The fourth test is Bartlett's test which is similar to the likelihood ratio test under normal distributions.

click on a test for more help

- O'Brien's test
- Brown-Forsythe test
- Levene's test
- Bartlett's test

If the tests of equal variances reveal that the group variances are significantly different, the Welch Anova for the means should be used in place of the usual Anova in the Fit Means report. The Welch statistic is based on the usual Anova F test, however the means have been weighted by the reciprocal of the sample variances of the group means . If there are only two levels then the Welch Anova is equivalent to an unequal variance t-test (the t value is the square root of the F).

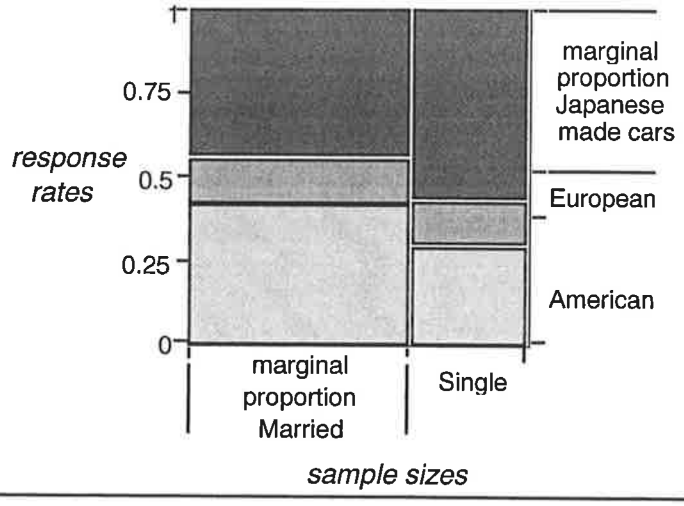
Multiple Comparisons

These commands offer different ways of comparing means statistically.
Compare Each Pair command computes individual pairwise comparisons using Student's t test. This test is sized for only an individual comparison. If you make a number of pairwise tests, there is no protection across the inferences, and thus the alpha–size (Type I) error rate across the hypothesis tests is much higher than that for each individual test.
Compare All Pairs command gives a test that is sized for all differences among the means. This is the Tukey or Tukey–Kramer HSD (honestly significant difference) test. (Tukey 1953, Kramer 1956). This test is an exact alpha–level test if the sample sizes are the same, and conservative if the sample sizes are different (Hayter 1984).
Compare with Best command tests whether means are less than the unknown maximum (or greater than the unknown minimum). This is the Hsu MCB test (Hsu 1981).
Compare with Control command tests whether means are different from the mean of a control group. This is Dunnett's test (Dunnett 1955).

click on a topic below for more help

- Multiple Comparison Reports
- Multiple Comparison Graphs

A **Mosaic Chart** consists of side-by-side divided bars for each level of the X variable, where each bar is divided into proportional segments that represent each discrete Y value. The width of each bar is proportional to the sample size. When the lines dividing the bars align, the response proportions are alike. When the lines are far apart the response rates of the samples may be statistically different.



Crosstabs Table

When both the response and the factor are nominal or ordinal, the data are summarized by frequency counts. These counts estimate the response rates of the Y levels for each level of the X factor.

The **Crosstabs** table first appears as a two–way frequency table. There is a row for each response level and a column for each factor (sample) level. The borders of the table display the row, column and grand totals. The pop-up menu next to the table name lets you request percents, and expected cell frequencies, cell deviations, and cell chi-square.

Click on the pop-up menu for more help

Crosstabs

sex

Count (age)	F	M	**Total**
12	5	3	8
13	3	4	7
14	5	7	12
15	2	5	7
16	2	1	3
17	1	2	3
	18	22	40

Count
Total%
Row%
Col%
Expected
Deviation
Cell ChiSq

Test names the chi–square statistical tests of the hypothesis that the response rates are the same in each sample category.

ChiSquare lists the Chi-square statistics computed from the sample.

- The Likelihood Ratio chi–square test is computed as twice the negative log likelihood for Model in the Tests table.
- Pearson is another chi–square test of the hypothesis that the response rates are the same in each sample category. This is calculated by summing the squares of the differences between observed and expected cell counts. The Pearson chi–square exploits the property of frequency counts to tend to a normal distribution in very large samples.
- If both variables have only 2 levels, Fisher's exact probabilitys for the one–tailed tests and the two–tailed test also show.

Fit Y by X: Regression and Curve Fitting

Regression analysis and curve fitting apply to continuous by continuous Y by X combinations. This platform's initial stage is a scatterplot of points for each X, Y pair. Using the Fitting pop-up menu commands, you can superimpose straignt line, polynomial, and spline fits on the points, which approximate or predict the Y variable as a function of the X variable.

Scatterplot *click on any topic for more help*

Fitting Commands	Each individual fit has its own options
• Fit Mean	• Show Points
• Fit Line	• Confid Curves (Fit)
• Fit Polynomial	• Confid Curves (Indiv)
• Fit Transformed...	• Color
• Fit Spline	• Save Predicted
• Density Ellipses	• Save Residuals
• Paired t-test	• Remove Fit
• Grouping Variable	
• Nonpar Density	

Window Options, titles and footnotes

APPENDIX SEVEN

Data spreadsheets

Yr1 Ravens	Yr2 Ravens	R2-R1	Yr1 Torrance	Yr2 Torrance	T2-T1	nom	sex	area	SHP	IQ 1	IQ1 level	IQ grp1	Extr IQ1	IQ1 rank	IQ 2	IQ2 level	Q 2-IQ 1	FoSq1	FoSq2	FoSq3	FoSq4	FoSq5	FoSq6	FoSq7	FoSq8	FoSTot8	FoSGrpd	fluency1	orig1	elab1	fluency2	orig2	elab2	flu2-flu1	ori2-ori1	elb2-elb1
25	25	0	131	91	-40	r	m	c	n	79	below	below	avg	low	74	below	-5	0	0	1	1	0	1	1	0	4	below	38	80	13	16	63	12	-22	-17	-1
43	47	4	61	65	4	r	m	c	n	115	2avg++	2avg++	avg	high	119	2avg++	4	0	0	0	0	0	0	1	2	3	avg	18	33	10	26	29	10	8	-4	0
38	44	6	63	68	5	r	f	c	n	103	3avg	3avg	avg	avg	110	3avg	7	2	3	3	0	0	1	1	0	10	above	24	24	15	19	36	13	-5	12	-2
29	38	9	85	67	-18	r	m	c	n	83	below	below	avg	low	93	3avg	10	0	1	3	0	1	0	1	0	6	avg	30	45	10	23	34	10	-7	-11	0
43	51	8	88	98	10	ng	f	c	n	115	2avg++	2avg++	avg	high	131	1high	16	0	3	3	1	1	1	1	0	10	above	25	50	13	32	55	11	7	5	-2
39	50	11	55	57	2	r	f	c	n	105	3avg	3avg	avg	avg	128	1high	23	0	0	3	1	1	1	1	0	7	avg	16	30	9	10	38	9	-6	8	0
30	•	•	78	•	•	r	f	c	n	86	below	below	avg	low	•	•	•	0	0	0	1	1	1	1	0	4	below	27	42	9	•	•	•	•	•	•
36	45	9	73	57	-16	r	m	c	n	99	3avg	3avg	avg	avg	113	2avg++	14	0	3	1	1	0	0	1	2	8	above	20	41	12	22	26	9	2	-15	-3
28	40	12	64	73	9	r	m	c	n	81	below	below	avg	low	98	3avg	17	0	0	0	0	1	1	1	0	3	below	16	37	11	12	50	11	-4	13	0
39	46	7	109	71	-38	r	m	c	n	105	3avg	3avg	avg	avg	116	2avg++	11	0	3	3	0	0	1	1	0	8	above	28	70	11	10	50	11	-18	-20	0
27	•	•	84	•	•	r	m	c	n	80	below	below	avg	low	•	•	•	0	0	1	0	0	0	0	0	1	avg	24	44	16	•	•	•	•	•	•
27	33	6	98	41	-57	r	m	c	n	80	below	below	avg	low	85	below	5	0	1	0	1	0	0	0	0	2	below	26	57	15	13	18	10	-13	-39	-5
11	15	4	44	27	-17	r	f	c	n	64	low	below	low	low	67	low	3	1	0	0	0	0	0	1	0	2	below	10	28	6	11	12	4	1	-16	-2
40	•	•	112	•	•	ng	f	c	n	108	3avg	3avg	avg	avg	•	•	•	0	1	3	0	1	0	1	0	6	avg	28	67	17	•	•	•	•	•	•
48	48	0	86	70	-16	ng	m	c	n	129	1high	1high	high	high	122	2avg++	-7	0	3	3	0	1	0	1	0	8	above	26	47	13	24	38	8	-2	-9	-5
38	42	4	67	62	-5	r	m	c	n	103	3avg	3avg	avg	avg	103	3avg	0	0	3	3	0	1	1	1	0	9	above	20	36	11	22	32	8	2	-4	-3
36	•	•	84	•	•	r	f	c	n	99	3avg	3avg	avg	avg	•	•	•	0	1	3	0	1	0	1	0	6	avg	25	46	13	•	•	•	•	•	•
36	38	2	64	32	-32	r	f	c	n	99	3avg	3avg	avg	avg	93	3avg	-6	0	0	0	0	1	0	1	0	2	below	22	35	7	13	14	5	-9	-21	-2
39	52	13	86	83	-3	ng	m	c	n	105	3avg	3avg	avg	avg	135	1high	30	0	0	0	0	1	0	3	0	4	below	22	53	11	23	53	7	1	0	-4
40	•	•	75	•	•	r	m	c	n	108	3avg	3avg	avg	avg	•	•	•	0	0	0	0	1	1	1	0	3	below	21	42	12	•	•	•	•	•	•
39	•	•	72	•	•	r	f	w	n	105	3avg	3avg	avg	avg	•	•	•	1	3	3	0	0	1	1	0	9	above	15	42	15	•	•	•	•	•	•
39	46	7	55	59	4	r	f	w	n	105	3avg	3avg	avg	avg	116	2avg++	11	1	3	3	0	1	0	1	0	9	above	14	26	15	16	35	8	2	9	-7
25	•	•	58	•	•	r	f	w	n	79	below	below	avg	low	•	•	•	1	3	3	0	0	0	1	0	8	above	15	29	14	•	•	•	•	•	•
40	47	7	55	41	-14	r	m	w	n	108	3avg	3avg	avg	avg	119	2avg++	11	0	1	1	1	0	1	1	2	7	avg	10	28	17	11	23	7	1	-5	-10
14	10	-4	78	31	-47	r	m	w	n	69	low	below	low	low	62	low	-7	0	0	3	1	0	0	1	0	5	avg	19	41	18	12	13	6	-7	-28	-12
18	26	8	140	98	-42	r	f	w	n	73	low	below	low	low	75	below	2	0	0	0	0	0	0	1	0	1	below	36	87	17	24	62	12	-12	-25	-5
40	42	2	111	70	-41	n	f	w	n	108	3avg	3avg	avg	avg	103	3avg	-5	0	1	3	1	0	1	1	0	7	avg	28	65	18	20	32	18	-8	-33	0
43	45	2	89	99	10	ng	f	w	n	115	2avg++	2avg++	avg	high	113	2avg++	-2	1	0	1	1	0	1	1	2	7	avg	25	50	14	34	54	11	9	4	-3
29	30	1	76	38	-38	r	m	w	n	83	below	below	avg	low	81	below	-2	0	1	0	1	0	1	1	2	6	avg	16	44	16	14	16	8	-2	-28	-8
36	39	3	70	64	-6	r	f	w	n	99	3avg	3avg	avg	avg	95	3avg	-4	0	3	1	0	0	0	1	1	6	avg	20	34	16	9	51	4	-11	17	-12
46	51	5	76	77	1	ng	f	w	n	123	2avg++	2avg++	avg	high	131	1high	8	0	1	1	0	1	0	1	0	4	below	22	39	15	27	41	9	5	2	-6
31	37	6	85	49	-36	n	m	w	n	88	below	below	avg	low	92	3avg	4	0	1	1	0	0	0	0	0	2	below	22	45	18	15	23	11	-7	-22	-7
34	44	10	47	41	-6	n	f	w	n	94	3avg	3avg	avg	avg	110	3avg	16	1	0	1	0	1	0	1	0	4	below	14	21	12	8	27	6	-6	6	-6
39	43	4	86	94	8	ng	m	w	n	105	3avg	3avg	avg	avg	107	3avg	2	1	1	3	0	1	1	1	1	9	above	26	45	15	32	49	13	6	4	-2
28	34	6	71	61	-10	r	m	w	n	81	below	below	avg	low	86	below	5	0	0	1	1	0	0	1	0	3	below	20	35	16	17	38	6	-3	3	-10
35	•	•	107	•	•	r	m	w	n	96	3avg	3avg	avg	avg	•	•	•	0	3	0	1	1	1	1	0	7	avg	35	63	9	•	•	•	•	•	•
42	•	•	107	•	•	r	m	w	n	113	2avg++	2avg++	avg	high	•	•	•	1	0	1	1	1	0	1	0	5	avg	40	57	10	•	•	•	•	•	•
42	•	•	59	•	•	r	m	w	n	113	2avg++	2avg++	avg	high	•	•	•	0	1	0	1	1	1	1	1	6	avg	20	30	9	•	•	•	•	•	•
34	•	•	83	•	•	r	m	w	n	94	3avg	3avg	avg	avg	•	•	•	1	1	0	1	0	1	1	0	5	avg	19	47	17	•	•	•	•	•	•
38	44	6	48	47	-1	r	m	w	n	103	3avg	3avg	avg	avg	110	3avg	7	0	1	1	1	0	1	1	0	5	avg	14	29	5	20	21	6	6	-8	1
37	47	10	69	68	-1	n	f	w	n	100	3avg	3avg	avg	avg	119	2avg++	19	0	0	0	1	1	0	1	0	3	below	19	39	11	26	34	8	7	-5	-3
40	•	•	107	76	-31	r	f	w	n	108	3avg	3avg	avg	avg	•	•	•	0	0	3	1	1	1	3	0	9	above	30	63	14	25	41	10	-5	-22	-4
36	•	•	88	•	•	n	m	w	n	99	3avg	3avg	avg	avg	•	•	•	0	1	1	0	0	1	0	0	3	below	27	53	8	•	•	•	•	•	•
40	45	5	92	92	0	r	m	w	n	108	3avg	3avg	avg	avg	113	2avg++	5	0	0	1	0	1	1	1	0	4	below	33	50	9	37	47	8	4	-3	-1
41	•	•	75	•	•	r	f	w	n	111	3avg	3avg	avg	avg	•	•	•	0	1	3	1	0	0	3	0	8	above	18	40	17	•	•	•	•	•	•
39	•	•	71	•	•	r	f	w	n	105	3avg	3avg	avg	avg	•	•	•	0	1	3	1	1	0	1	0	7	avg	19	36	16	•	•	•	•	•	•
47	•	•	108	•	•	n	f	w	n	126	2avg++	2avg++	avg	high	•	•	•	0	1	1	1	0	0	1	0	4	below	29	61	18	•	•	•	•	•	•
34	40	6	70	70	0	r	m	w	n	94	3avg	3avg	avg	avg	98	3avg	4	0	3	3	1	0	0	1	1	9	above	20	35	15	24	32	14	4	-3	-1
35	39	4	41	62	21	n	m	w	n	96	3avg	3avg	avg	avg	95	3avg	-1	0	1	1	1	1	1	1	0	6	avg	18	15	8	17	37	8	-1	22	0
43	•	•	50	•	•	r	m	w	n	115	2avg++	2avg++	avg	high	•	•	•	0	3	0	1	0	0	0	0	4	below	8	25	17	•	•	•	•	•	•
41	46	5	67	57	-10	r	m	w	n	111	3avg	3avg	avg	avg	116	2avg++	5	0	1	3	1	0	0	1	0	6	avg	16	36	15	17	28	12	1	-8	-3
47	50	3	118	102	-16	n	m	w	n	126	2avg++	2avg++	avg	high	128	1high	2	0	3	1	0	1	0	1	0	6	avg	31	71	16	30	54	18	-1	-17	2
16	23	7	124	70	-54	r	f	w	n	70	low	below	low	low	73	low	3	0	1	3	0	0	0	0	0	4	below	37	78	9	28	31	11	-9	-47	2
37	•	•	91	•	•	r	m	w	n	100	3avg	3avg	avg	avg	•	•	•	0	1	1	1	1	1	1	0	6	avg	28	45	18	•	•	•	•	•	•
29	33	4	60	48	-12	r	f	w	n	83	below	below	avg	low	85	below	2	0	0	1	1	1	1	0	0	4	below	22	31	7	19	17	12	-3	-14	5
32	42	10	46	62	16	r	m	w	n	90	3avg	3avg	avg	avg	103	3avg	13	0	3	1	0	1	1	1	2	9	above	9	28	9	21	32	9	12	4	0
25	31	6	71	48	-23	r	m	s	n	79	below	below	avg	low	82	below	3	0	1	3	1	1	0	1	0	7	avg	17	41	13	16	22	10	-1	-19	-3
39	44	5	86	56	-30	r	m	s	n	105	3avg	3avg	avg	avg	110	3avg	5	0	0	1	0	0	0	1	1	3	below	24	46	16	14	35	7	-10	-11	-9
42	44	2	55	56	3	r	m	s	n	113	2avg++	2avg++	avg	high	110	3avg	-3	0	3	3	1	1	1	1	1	11	above	13	26	16	25	22	11	12	-4	-5
41	43	2	80	85	5	r	f	s	n	111	3avg	3avg	avg	avg	107	3avg	-4	0	0	3	0	0	0	1	0	4	below	23	46	11	23	46	16	0	0	5
45	46	1	29	33	4	n	m	s	n	120	2avg++	2avg++	avg	high	116	2avg++	-4	0	3	3	0	1	0	1	0	8	above	8	19	2	16	12	5	8	-7	3
36	43	7	65	61	-4	n	f	s	n	99	3avg	3avg	avg	avg	107	3avg	8	0	3	3	0	1	0	1	0	8	above	15	42	8	19	32	10	4	-10	2
35	36	1	105	54	-51	n	f	s	n	96	3avg	3avg	avg	avg	90	3avg	-6	0	0	3	0	1	0	1	1	6	avg	28	60	17	18	24	12	-10	-36	-5
10	24	14	59	79	20	r	m	s	n	64	low	below	low	low	73	low	9	0	0	3	1	0	0	1	1	6	avg	21	28	10	24	44	11	3	16	1
42	47	5	59	53	-6	r	m	s	n	113	2avg++	2avg++	avg	high	119	2avg++	6	1	1	3	1	0	0	0	0	6	avg	17	26	16	13	30	10	-4	4	-6
44	•	•	70	•	•	r	f	s	n	118	2avg++	2avg++	avg	high	•	•	•	0	3	3	0	1	0	1	0	8	above	24	34	12	•	•	•	•	•	•
41	•	•	84	•	•	r	m	s	n	111	3avg	3avg	avg	avg	•	•	•	0	1	1	0	1	0	1	0	4	below	17	53	14	•	•	•	•	•	•
30	35	5	79	62	-17	r	f	s	n	86	below	below	avg	low	88	below	2	0	3	0	1	0	0	3	0	7	avg	31	37	11	21	34	7	-10	-3	-4
41	41	0	70	26	-44	r	m	s	n	111	3avg	3avg	avg	avg	100	3avg	-11	1	0	3	1	1	0	1	1	8	above	20	39	11	9	11	6	-11	-28	-5
46	49	3	81	49	-32	r	m	s	n	123	2avg++	2avg++	avg	high	124	2avg++	1	0	1	3	1	1	0	1	0	7	avg	23	45	13	19	23	7	-4	-22	-6
37	43	6	68	67	-1	r	f	s	n	100	3avg	3avg	avg	avg	107	3avg	7	0	1	3	0	0	0	1	0	5	avg	18	43	7	24	34	9	6	-9	2
42	43	1	59	54	-5	n	f	s	n	113	2avg++	2avg++	avg	high	107	3avg	-6	0	3	1	0	0	0	3	1	8	above	13	33	13	18	26	10	5	-7	-3
42	47	5	71	68	-3	n	f	e	y	113	2avg++	2avg++	avg	high	119	2avg++	6	1	0	3	0	1	0	1	0	6	avg	22	31	18	26	35	7	4	4	-11
49	•	•	55	•	•	n	f	e	y	131	1high	1high	avg	high	•	•	•	0	0	1	0	1	0	3	2	7	avg	13	28	14	•	•	•	•	•	•
46	49	3	84	59	-25	r	f	e	y	123	2avg++	2avg++	avg	high	124	2avg++	1	0	1	3	0	1	0	1	2	8	above	21	48	15	21	30	8	0	-18	-7
42	50	8	87	111	24	r	f	e	y	113	2avg++	2avg++	avg	high	128	1high	15	1	3	3	1	1	0	1	0	10	above	14	56	17	23	80	8	9	24	-9
46	49	3	66	77	11	r	f	e	y	123	2avg++	2avg++	avg	high	124	2avg++	1	1	1	3	1	1	0	1	2	10	above	8	44	14	26	45	6	18	1	-8

Yr1 Ravens	Yr2 Ravens	R2-R1	Yr1 Torrance	Yr2 Torrance	T2-T1	norm	sex	area	SHP	IQ 1	IQ1 level	IQ grp1	Extr IQ1	IQ1 rank	IQ 2	IQ2 level	Q 2-IQ 1	FoSq1	FoSq2	FoSq3	FoSq4	FoSq5	FoSq6	FoSq7	FoSq8	FoSTot8	FoSGrpd	fluency1	orig1	elab1	fluency2	orig2	elab2	flu2-flu1	ori2-ori1	elb2-elb1
50	54	4	65	69	4	n	m	e	y	132	1high	1high	high	high	143	1high	11	1	0	3	0	1	0	1	2	8	above	17	32	16	23	32	14	6	0	-2
42	.	.	138	.	.	r	m	e	y	113	2avg++	2avg++	avg	high	.	.	.	0	0	1	1	1	0	1	0	4	below	39	81	18	.	.	.	.	.	.
50	55	5	131	79	-52	r	m	e	y	132	1high	1high	high	high	143	1high	11	0	1	3	1	1	0	1	1	8	above	40	79	12	10	54	15	-30	-25	3
45	.	.	89	.	.	n	m	e	y	120	2avg++	2avg++	avg	high	.	.	.	0	1	3	1	0	0	3	1	9	above	19	52	18	.	.	.	.	.	.
39	45	6	94	71	-23	r	m	e	y	105	3avg	3avg	avg	avg	113	2avg++	8	0	0	3	0	1	0	1	0	5	avg	26	51	17	23	41	7	-3	-10	-10
14	.	.	65	.	.	r	f	e	y	69	low	below	low	low	.	.	.	0	1	3	0	0	0	1	0	5	avg	19	36	10	.	.	.	.	.	.
39	42	3	99	105	6	r	f	e	y	105	3avg	3avg	avg	avg	103	3avg	-2	0	1	3	0	0	0	1	0	5	avg	25	57	17	33	60	12	8	3	-5
42	46	4	58	97	39	r	m	e	y	113	2avg++	2avg++	avg	high	116	2avg++	3	1	0	3	1	1	1	1	1	9	above	16	32	10	24	66	7	8	34	-3
50	49	-1	51	73	22	r	m	e	y	132	1high	1high	high	high	124	2avg++	-8	0	0	0	1	1	1	0	0	3	below	18	25	8	19	45	9	1	20	1
42	48	6	112	110	-2	r	m	e	y	113	2avg++	2avg++	avg	high	122	2avg++	9	0	1	0	1	0	1	1	0	4	below	33	70	9	38	64	6	5	-6	-1
41	.	.	77	.	.	r	f	e	y	111	3avg	3avg	avg	avg	.	.	.	1	1	3	1	0	1	1	0	8	above	22	44	11	.	.	.	.	.	.
36	42	6	73	64	-9	r	f	e	y	99	3avg	3avg	avg	avg	103	3avg	4	0	0	0	0	0	1	3	0	4	below	20	43	10	30	27	7	10	-16	-3
44	49	5	112	116	4	r	m	e	y	118	2avg++	2avg++	avg	high	124	2avg++	6	0	3	0	0	0	0	0	2	5	avg	29	66	17	31	75	10	2	9	-7
38	50	12	135	118	-17	r	m	e	y	103	3avg	3avg	avg	avg	128	1high	25	0	3	1	0	0	0	1	0	5	avg	40	80	15	47	64	7	7	-16	-8
45	.	.	54	.	.	r	m	e	y	120	2avg++	2avg++	avg	high	.	.	.	0	0	1	0	1	1	1	0	4	below	15	21	18	.	.	.	.	.	.
35	45	10	88	100	12	r	m	e	y	96	3avg	3avg	avg	avg	113	2avg++	17	0	1	0	1	1	0	1	0	4	below	27	49	12	26	62	12	-1	13	0
41	40	-1	91	62	-29	r	m	e	y	111	3avg	3avg	avg	avg	98	3avg	-13	0	0	0	1	1	1	1	1	5	avg	23	50	18	15	37	10	-8	-13	-8
40	.	.	21	.	.	r	m	e	y	108	3avg	3avg	avg	avg	.	.	.	0	3	1	0	1	1	1	0	7	avg	6	12	3	.	.	.	.	.	.
40	44	4	105	82	-23	r	m	e	y	108	3avg	3avg	avg	avg	110	3avg	2	0	0	0	1	1	1	1	1	5	avg	27	65	13	23	52	7	-4	-13	-6
46	50	4	85	.	.	r	m	e	y	123	2avg++	2avg++	avg	high	128	1high	5	0	1	0	0	0	1	1	1	4	below	18	49	18	.	.	.	.	.	.
41	.	.	81	.	.	r	m	e	y	111	3avg	3avg	avg	avg	.	.	.	0	1	0	1	1	1	0	2	6	avg	22	50	9	.	.	.	.	.	.
50	50	0	52	70	18	n	f	e	y	132	1high	1high	high	high	128	1high	-4	0	1	0	0	1	1	1	0	4	below	6	34	12	22	35	13	16	1	1
43	.	.	77	.	.	r	m	e	y	115	2avg++	2avg++	avg	high	.	.	.	0	0	1	0	0	1	1	0	3	below	25	46	6	.	.	.	.	.	.
40	50	10	100	81	-19	r	m	e	y	108	3avg	3avg	avg	avg	128	1high	20	0	0	3	1	0	1	1	1	7	avg	25	57	18	33	39	9	8	-18	-9
37	.	.	77	.	.	u	m	n	n	100	3avg	3avg	avg	avg	.	.	.	0	0	1	1	1	1	1	0	5	avg	22	40	15	.	.	.	.	.	.
40	49	9	91	62	-29	u	m	n	n	108	3avg	3avg	avg	avg	124	2avg++	16	1	0	1	0	1	1	1	0	5	avg	26	56	9	28	28	6	2	-28	-3
36	43	7	94	64	-30	u	f	n	n	99	3avg	3avg	avg	avg	107	3avg	8	0	3	1	1	0	0	1	0	6	avg	30	48	16	25	27	12	-5	-21	-4
33	40	7	128	70	-58	u	f	n	n	92	3avg	3avg	avg	avg	98	3avg	6	0	0	3	1	1	1	1	0	7	avg	40	73	15	20	29	21	-20	-44	6
36	.	.	86	.	.	u	m	n	n	99	3avg	3avg	avg	avg	.	.	.	1	3	3	1	0	0	1	0	9	above	19	53	14	.	.	.	.	.	.
33	38	5	87	55	-32	u	f	n	n	92	3avg	3avg	avg	avg	93	3avg	1	0	3	3	0	1	1	3	0	11	above	27	46	14	19	24	12	-8	-22	-2
32	.	.	113	.	.	u	f	n	n	90	3avg	3avg	avg	avg	.	.	.	0	0	1	1	1	0	1	0	4	below	40	58	15	.	.	.	.	.	.
37	42	5	103	84	-19	u	f	n	n	100	3avg	3avg	avg	avg	103	3avg	3	0	1	0	1	1	0	0	1	4	below	32	56	15	20	50	14	-12	-6	-1
39	.	.	129	.	.	u	f	n	n	105	3avg	3avg	avg	avg	.	.	.	0	0	1	0	0	1	1	0	3	below	36	76	17	.	.	.	.	.	.
38	49	11	74	63	-11	u	f	n	n	103	3avg	3avg	avg	avg	124	2avg++	21	0	1	1	1	0	0	1	0	4	below	23	35	16	19	34	10	-4	-1	-6
34	36	2	72	69	-3	u	f	n	n	94	3avg	3avg	avg	avg	90	3avg	-4	1	1	1	1	0	0	1	1	6	avg	23	35	14	26	36	7	3	1	-7
43	.	.	75	.	.	u	m	n	n	115	2avg++	2avg++	avg	high	.	.	.	0	0	1	0	1	1	1	0	4	below	25	42	8	.	.	.	.	.	.
33	38	5	43	59	16	u	f	n	n	92	3avg	3avg	avg	avg	93	3avg	1	0	0	1	0	1	1	1	0	4	below	16	18	9	21	31	7	5	13	-2
31	39	8	.	66	.	u	f	n	n	88	below	below	avg	low	95	3avg	7	1	0	3	1	1	1	1	1	9	above	.	.	.	20	35	11	.	.	.
40	.	.	96	.	.	u	f	n	n	108	3avg	3avg	avg	avg	.	.	.	0	3	1	1	0	0	1	2	8	above	24	54	18	.	.	.	.	.	.
32	.	.	77	.	.	u	m	n	n	90	3avg	3avg	avg	avg	.	.	.	0	1	1	1	0	0	1	0	4	below	25	40	12	.	.	.	.	.	.
31	.	.	66	.	.	u	m	n	n	88	below	below	avg	low	.	.	.	0	3	0	1	1	1	3	0	9	above	18	32	16	.	.	.	.	.	.
41	.	.	110	.	.	u	m	n	n	111	3avg	3avg	avg	avg	.	.	.	0	0	1	0	1	1	1	0	4	below	33	61	16	.	.	.	.	.	.
45	.	.	82	.	.	r	f	n	n	120	2avg++	2avg++	avg	high	.	.	.	0	0	3	1	1	1	1	0	7	avg	20	44	18	.	.	.	.	.	.
35	44	9	65	63	-22	r	f	n	n	96	3avg	3avg	avg	avg	110	3avg	14	0	1	3	1	1	1	1	0	8	above	20	49	16	17	34	12	-3	-15	-4
42	43	1	77	67	-10	r	f	n	n	113	2avg++	2avg++	avg	high	107	3avg	-6	0	3	3	0	0	1	1	0	8	above	22	42	13	26	31	10	4	-11	-3
37	44	7	62	59	-3	r	m	n	n	100	3avg	3avg	avg	avg	110	3avg	10	0	1	3	0	1	0	1	0	6	avg	12	37	13	18	30	11	6	-7	-2
40	45	5	94	75	-19	r	f	n	n	108	3avg	3avg	avg	avg	113	2avg++	5	0	0	3	1	0	0	3	0	7	avg	22	61	11	28	37	10	6	-24	-1
49	48	-1	108	98	-10	r	m	n	n	131	1high	1high	high	high	122	2avg++	-9	1	3	1	1	0	1	1	0	8	above	24	72	12	33	54	11	9	-18	-1
47	.	.	84	.	.	n	f	n	n	126	2avg++	2avg++	avg	high	.	.	.	0	0	1	1	1	0	1	1	5	avg	17	50	17	.	.	.	.	.	.
41	45	4	58	54	-4	r	m	n	n	111	3avg	3avg	avg	avg	113	2avg++	2	1	3	1	0	0	0	0	0	5	avg	8	36	14	20	27	7	12	-9	-7
53	57	4	80	117	37	ng	m	n	n	143	1high	1high	high	high	144	1high	1	0	0	3	1	0	1	1	0	6	avg	18	48	14	18	89	10	0	41	-4
42	44	2	90	47	-43	n	f	n	n	113	2avg++	2avg++	avg	high	110	3avg	-3	0	1	3	0	1	1	3	0	9	above	20	53	17	19	15	13	-1	-38	-4
44	48	4	119	74	-45	r	f	n	n	118	2avg++	2avg++	avg	high	122	2avg++	4	0	0	1	1	1	1	1	1	6	avg	30	79	10	24	42	8	-6	-37	-2
40	48	8	43	34	-9	r	m	n	n	108	3avg	3avg	avg	avg	122	2avg++	14	0	1	3	0	0	0	3	0	7	avg	7	27	9	10	18	6	3	-9	-3
44	50	6	59	43	-16	r	f	n	n	118	2avg++	2avg++	avg	high	128	1high	10	0	0	1	1	1	0	1	2	6	avg	11	33	15	11	22	10	0	-11	-5
40	45	5	88	48	-40	r	m	n	n	108	3avg	3avg	avg	avg	113	2avg++	5	0	1	3	0	1	0	1	0	6	avg	23	52	13	13	25	10	-10	-27	-3
44	.	.	.	.	.	r	m	n	n	118	2avg++	2avg++	avg	high	.	.	.	1	0	3	1	1	0	1	0	7	avg	.	.	.	.	.	.	.	.	.
30	.	.	98	.	.	r	m	n	n	86	below	below	avg	low	.	.	.	0	3	0	0	1	0	1	0	5	avg	27	61	10	.	.	.	.	.	.
41	43	2	77	80	3	r	f	n	n	111	3avg	3avg	avg	avg	107	3avg	-4	1	0	0	0	0	1	1	2	5	avg	21	41	15	31	40	9	10	-1	-6
49	54	5	90	100	10	ng	f	n	n	131	1high	1high	high	high	143	1high	12	0	1	0	0	0	1	1	2	5	avg	22	52	16	38	50	12	16	-2	-4
35	35	0	59	64	5	r	f	n	n	96	3avg	3avg	avg	avg	88	below	-8	0	0	1	0	0	1	3	0	5	avg	20	29	10	26	30	8	6	1	-2
28	38	10	60	71	11	r	f	n	n	81	below	below	avg	low	93	3avg	12	0	0	0	0	1	1	1	0	3	below	16	29	15	25	38	8	9	9	-7
43	47	4	63	72	9	r	f	n	n	115	2avg++	2avg++	avg	high	119	2avg++	4	0	1	0	0	0	0	3	0	4	below	23	25	15	25	34	13	2	9	-2
38	42	4	63	72	9	r	f	n	n	103	3avg	3avg	avg	avg	103	3avg	0	0	1	0	0	0	0	1	0	2	below	17	33	13	30	34	8	13	1	-5
42	42	0	68	77	9	ng	f	n	n	113	2avg++	2avg++	avg	high	103	3avg	-10	1	1	3	1	1	0	0	0	7	avg	17	38	13	33	36	8	16	-2	-5
49	55	6	109	102	-7	ng	m	n	n	131	1high	1high	high	high	143	1high	12	0	1	1	1	1	1	1	1	7	avg	27	70	12	27	63	12	0	-7	0
31	39	8	81	64	-17	r	f	n	n	88	below	below	avg	low	95	3avg	7	0	0	1	0	1	1	1	1	5	avg	18	47	16	20	30	14	2	-17	-2
46	50	4	62	71	9	r	f	n	n	123	2avg++	2avg++	avg	high	128	1high	5	0	3	3	1	1	0	1	0	9	above	12	34	16	27	37	7	15	3	-9
29	38	9	77	85	8	r	f	n	n	83	below	below	avg	low	93	3avg	10	1	3	3	0	1	0	1	1	10	above	21	42	14	30	46	9	9	4	-5
42	46	4	72	75	3	r	f	n	n	113	2avg++	2avg++	avg	high	116	2avg++	3	0	1	0	1	0	0	1	0	3	below	22	33	17	25	41	9	3	8	-8
37	44	7	62	41	-21	u	m	c	n	100	3avg	3avg	avg	avg	110	3avg	10	1	1	0	0	1	0	3	0	6	avg	16	38	8	11	22	8	-5	-16	0
36	42	6	100	87	-13	u	m	c	n	99	3avg	3avg	avg	avg	103	3avg	4	0	0	3	1	1	1	1	0	7	avg	33	50	17	26	52	9	-7	2	-8
37	41	4	73	44	-29	u	f	c	n	100	3avg	3avg	avg	avg	100	3avg	0	0	0	1	1	1	1	1	0	5	avg	21	38	14	18	18	8	-3	-20	-6
38	48	10	58	34	-24	u	f	c	n	103	3avg	3avg	avg	avg	122	2avg++	19	0	3	3	1	1	0	3	0	11	above	12	33	13	8	20	6	-4	-13	-7
41	.	.	88	.	.	u	f	c	n	111	3avg	3avg	avg	avg	.	.	.	0	1	1	0	1	0	1	0	4	below	25	49	14	.	.	.	.	.	.
18	25	7	55	48	-7	u	f	c	n	73	low	below	low	low	74	below	1	0	3	1	1	1	1	0	0	7	avg	16	27	12	12	30	6	-4	3	-6
29	35	6	45	31	-14	u	m	c	n	83	below	below	avg	low	88	below	5	0	0	1	1	1	0	1	0	4	below	10	26	9	10	16	5	0	-10	-4

Yr1 Ravens	Yr2 Ravens	R2-R1	Yr1 Torrance	Yr2 Torrance	T2-T1	nom	sex	area	SHP	IQ 1	IQ1 level	IQ grp1	Extr IQ1	IQ1 rank	IQ 2	IQ2 level	Q 2-IQ 1	FoSq1	FoSq2	FoSq3	FoSq4	FoSq5	FoSq6	FoSq7	FoSq8	FoSTot8	FoSGrpd	fluency1	orig1	elab1	fluency2	orig2	elab2	flu2-flu1	ori2-ori1	elb2-elb1
43	48	5	86	67	-19	u	m	c	n	115	2avg++	2avg++	avg	high	122	2avg++	7	0	1	0	0	0	0	1	2	4	below	25	49	12	22	38	7	-3	-11	-5
42	47	5	41	38	-3	u	m	c	n	113	2avg++	2avg++	avg	high	119	2avg++	6	0	1	1	0	0	0	1	1	4	below	10	24	7	16	16	6	6	-8	-1
28	35	7	54	51	-3	u	m	c	n	81	below	below	avg	low	88	below	7	0	0	0	1	0	0	1	0	2	below	6	32	16	22	24	5	16	-8	-11
44	•	•	63	•	•	u	m	c	n	118	2avg++	2avg++	avg	high	•	•	•	0	1	0	0	1	0	1	0	3	below	18	31	14	•	•	•	•	•	•
35	•	•	63	•	•	u	m	c	n	96	3avg	3avg	avg	avg	•	•	•	0	3	1	1	0	1	1	0	7	avg	14	36	13	•	•	•	•	•	•
31	•	•	58	•	•	u	f	c	n	88	below	below	avg	low	•	•	•	0	1	0	0	1	1	0	0	3	below	17	30	11	•	•	•	•	•	•
42	•	•	87	•	•	u	m	c	n	113	2avg++	2avg++	avg	high	•	•	•	0	3	3	0	1	1	3	0	11	above	20	49	18	•	•	•	•	•	•
28	28	0	81	90	9	u	m	c	n	81	below	below	avg	low	79	below	-2	0	1	1	0	0	1	1	2	6	avg	22	44	15	22	56	12	0	12	-3
34	37	3	85	32	-53	u	f	c	n	94	3avg	3avg	avg	avg	92	3avg	-2	0	1	1	0	1	0	1	0	4	below	24	43	18	14	11	7	-10	-32	-11
50	50	0	86	54	-32	u	f	c	n	132	1high	1high	high	high	128	1high	-4	1	0	1	1	1	1	3	0	8	above	26	42	18	19	26	9	-7	-16	-9
39	45	6	86	41	-45	u	m	c	n	105	3avg	3avg	avg	avg	113	2avg++	8	0	1	1	0	1	1	1	0	5	avg	22	49	15	11	17	13	-11	-32	-2
42	•	•	68	•	•	u	f	c	n	113	2avg++	2avg++	avg	high	•	•	•	0	1	0	1	1	1	0	0	4	below	17	37	14	•	•	•	•	•	•
37	44	7	71	62	-9	u	f	c	n	100	3avg	3avg	avg	avg	110	3avg	10	0	1	1	1	1	1	1	0	6	avg	24	38	9	17	37	8	-7	-1	-1
48	55	7	57	58	1	r	f	e	y	129	1high	1high	high	high	143	1high	14	0	0	1	0	1	1	3	0	6	avg	12	32	13	19	30	9	7	-2	-4
44	•	•	112	•	•	r	f	e	y	118	2avg++	2avg++	avg	high	•	•	•	0	0	3	0	1	1	1	1	7	avg	24	72	16	•	•	•	•	•	•
48	52	4	91	74	-17	n	f	e	y	129	1high	1high	high	high	135	1high	6	0	0	3	1	1	0	1	0	6	avg	20	55	16	22	37	15	2	-18	-1
43	57	14	59	105	46	ng	m	e	y	115	2avg++	2avg++	avg	high	144	1high	29	0	3	3	1	1	0	3	0	11	above	10	32	17	29	60	16	19	28	-1
48	51	3	81	94	13	r	m	e	y	129	1high	1high	high	high	131	1high	2	2	1	3	0	0	1	1	1	9	above	20	44	17	34	46	14	14	2	-3
43	47	4	71	80	9	r	m	e	y	115	2avg++	2avg++	avg	high	119	2avg++	4	0	1	0	1	0	0	3	0	5	avg	21	33	17	18	50	12	-3	17	-5
51	54	3	90	57	-33	r	m	e	y	135	1high	1high	high	high	143	1high	8	1	1	3	1	0	1	1	2	10	above	25	51	14	11	32	14	-14	-19	0
52	53	1	108	62	-46	r	m	e	y	138	1high	1high	high	high	143	1high	5	0	3	3	0	0	1	3	1	11	above	32	61	15	17	35	10	-15	-26	-5
35	43	8	83	67	-16	r	m	e	y	96	3avg	3avg	avg	avg	107	3avg	11	0	1	1	0	1	1	1	0	5	avg	23	51	9	23	35	9	0	-16	0
43	•	•	76	•	•	r	m	e	y	115	2avg++	2avg++	avg	high	•	•	•	0	0	1	1	0	0	1	2	5	avg	33	30	13	•	•	•	•	•	•
43	54	11	58	67	9	r	m	e	y	115	2avg++	2avg++	avg	high	143	1high	28	0	1	0	1	0	1	1	1	5	avg	12	37	9	26	32	9	14	-5	0
48	53	5	60	53	-7	n	m	e	y	129	1high	1high	high	high	143	1high	14	0	3	1	1	0	0	1	0	6	avg	12	30	18	12	28	13	0	-2	-5
40	50	10	66	49	-17	r	f	e	y	108	3avg	3avg	avg	avg	128	1high	20	0	3	3	1	1	0	1	0	9	above	15	42	9	18	23	8	3	-19	-1
39	41	2	108	101	-7	ng	f	e	y	105	3avg	3avg	avg	avg	100	3avg	-5	0	1	1	1	0	0	3	0	6	avg	29	66	13	35	57	9	6	-9	-4
45	51	6	•	47	•	r	m	e	y	120	2avg++	2avg++	avg	high	131	1high	11	0	3	3	1	0	0	1	0	8	above	•	•	•	13	21	13	•	•	•
31	43	12	56	41	-15	r	f	e	y	88	below	below	avg	low	107	3avg	19	0	1	3	0	0	1	1	0	6	avg	14	28	14	14	18	9	0	-10	-5
39	51	12	62	101	39	ng	f	e	y	105	3avg	3avg	avg	avg	131	1high	26	0	3	1	0	1	0	1	0	6	avg	17	31	14	32	54	15	15	23	1
39	44	5	116	65	-51	r	f	n	y	105	3avg	3avg	avg	avg	110	3avg	5	0	0	1	0	0	1	1	1	4	below	33	65	18	22	36	7	-11	-29	-11
44	50	6	78	101	23	n	f	n	y	118	2avg++	2avg++	avg	high	128	1high	10	0	3	3	1	1	0	3	2	13	above	19	44	15	31	54	16	12	10	1
44	•	•	77	•	•	r	f	n	y	118	2avg++	2avg++	avg	high	•	•	•	0	3	3	1	1	1	1	0	10	above	20	45	12	•	•	•	•	•	•
40	50	10	48	67	19	r	f	n	y	108	3avg	3avg	avg	avg	128	1high	20	0	1	3	1	0	1	1	0	7	avg	14	22	12	23	33	11	9	11	-1
44	•	•	71	•	•	n	f	n	y	118	2avg++	2avg++	avg	high	•	•	•	1	1	0	0	1	1	3	1	8	above	19	36	16	•	•	•	•	•	•
46	53	7	53	42	-11	r	f	n	y	123	2avg++	2avg++	avg	high	143	1high	20	0	3	3	0	0	1	0	0	7	avg	18	31	4	13	19	10	-5	-12	6
36	•	•	89	•	•	r	f	n	y	99	3avg	3avg	avg	avg	•	•	•	0	0	1	1	0	1	1	0	4	below	25	49	15	•	•	•	•	•	•
35	•	•	62	•	•	r	f	n	y	96	3avg	3avg	avg	avg	•	•	•	0	1	3	0	1	0	1	0	6	avg	17	34	11	•	•	•	•	•	•
44	•	•	103	•	•	r	f	n	y	118	2avg++	2avg++	avg	high	•	•	•	0	1	3	1	0	1	1	0	7	avg	31	56	16	•	•	•	•	•	•
24	35	11	86	79	-7	r	m	n	y	79	below	below	avg	low	88	below	9	1	1	1	0	1	0	0	1	5	avg	23	49	14	21	49	9	-2	0	-5
33	43	10	102	67	-35	r	m	n	y	92	3avg	3avg	avg	avg	107	3avg	15	1	1	3	1	0	0	0	0	6	avg	28	56	18	19	42	6	-9	-14	-12
40	44	4	80	53	-27	r	m	n	y	108	3avg	3avg	avg	avg	110	3avg	2	0	1	1	1	0	0	0	1	4	below	21	47	12	20	27	6	-1	-20	-6
41	48	7	90	76	-14	r	f	n	y	111	3avg	3avg	avg	avg	122	2avg++	11	0	1	1	0	1	1	1	0	5	avg	22	50	16	27	39	10	5	-11	-8
12	10	-2	110	85	-25	r	m	n	y	65	low	below	low	low	62	low	-3	0	1	1	0	0	1	3	0	6	avg	21	71	18	24	47	14	3	-24	-4
53	•	•	101	•	•	n	m	n	y	143	1high	1high	high	high	•	•	•	0	0	3	1	0	0	1	0	5	avg	20	63	18	•	•	•	•	•	•
39	•	•	•	•	•	r	f	n	y	105	3avg	3avg	avg	avg	•	•	•	0	1	3	0	1	1	1	1	8	above	•	•	•	•	•	•	•	•	•
48	51	3	89	68	-21	n	m	n	y	129	1high	1high	high	high	131	1high	2	0	3	3	0	1	0	1	1	9	above	21	54	14	17	40	11	-4	-14	-3
38	•	•	68	•	•	r	f	n	y	103	3avg	3avg	avg	avg	•	•	•	1	1	3	1	1	0	1	2	10	above	17	37	14	•	•	•	•	•	•
47	55	8	108	63	-45	u	m	e	n	126	2avg++	2avg++	avg	high	143	1high	17	0	1	1	0	0	1	1	0	4	below	30	60	18	21	29	13	-9	-31	-5
41	52	11	81	54	-27	u	m	e	n	111	3avg	3avg	avg	avg	135	1high	24	0	3	1	0	0	1	1	0	6	avg	26	37	18	16	26	12	-10	-11	-6
43	51	8	74	52	-22	u	m	e	n	115	2avg++	2avg++	avg	high	131	1high	16	0	3	3	0	0	1	1	0	8	above	21	37	16	14	28	10	-7	-9	-6
38	47	9	61	34	-27	u	f	e	n	103	3avg	3avg	avg	avg	119	2avg++	16	1	1	1	1	1	1	1	1	8	above	20	31	10	13	14	7	-7	-17	-3
39	42	3	107	55	-52	u	m	e	n	105	3avg	3avg	avg	avg	103	3avg	-2	0	3	0	1	1	1	0	0	6	avg	33	65	9	17	30	8	-16	-35	-1
28	43	15	57	52	-5	u	m	e	n	81	below	below	avg	low	107	3avg	26	0	1	1	0	0	0	1	0	3	below	14	27	16	18	23	11	4	-4	-5
32	40	8	60	45	-15	u	f	e	n	90	3avg	3avg	avg	avg	98	3avg	8	0	0	0	1	0	1	1	1	4	below	21	29	10	16	21	8	-5	-8	-2
43	49	6	76	32	-44	u	m	e	n	115	2avg++	2avg++	avg	high	124	2avg++	9	0	0	1	1	1	0	1	0	4	below	26	44	6	14	12	6	-12	-32	0
15	13	-2	35	32	-3	u	f	e	n	70	low	below	low	low	66	low	-4	0	0	0	0	0	1	3	0	4	below	11	17	7	8	19	5	-3	2	-2
24	34	10	61	49	-12	u	m	e	n	79	below	below	avg	low	86	below	7	0	1	1	1	1	0	1	0	5	avg	17	30	14	14	29	6	-3	-1	-8
33	44	11	71	40	-31	u	m	e	n	92	3avg	3avg	avg	avg	110	3avg	18	0	3	3	0	0	1	3	1	11	above	21	38	12	11	22	7	-10	-16	-5
39	45	6	125	89	-36	u	f	e	n	105	3avg	3avg	avg	avg	113	2avg++	8	0	1	1	1	1	1	1	0	6	avg	37	79	9	26	52	11	-11	-27	2
38	39	1	103	62	-41	u	m	e	n	103	3avg	3avg	avg	avg	95	3avg	-8	0	3	3	1	1	1	1	0	10	above	24	62	17	13	38	11	-11	-24	-6
38	45	7	54	39	-15	u	f	e	n	103	3avg	3avg	avg	avg	113	2avg++	10	0	3	3	1	0	1	1	0	9	above	12	27	15	12	18	9	0	-9	-6
41	•	•	94	•	•	u	m	e	n	111	3avg	3avg	avg	avg	•	•	•	0	1	1	0	1	1	1	0	5	avg	40	37	17	•	•	•	•	•	•
44	•	•	67	•	•	u	m	c	n	118	2avg++	2avg++	avg	high	•	•	•	0	1	3	0	0	0	1	0	5	avg	13	38	16	•	•	•	•	•	•
51	54	3	65	68	3	u	m	c	n	135	1high	1high	high	high	143	1high	8	0	1	3	0	1	0	3	0	8	above	21	26	18	23	32	13	2	6	-5
38	48	10	82	83	1	u	m	c	n	103	3avg	3avg	avg	avg	122	2avg++	19	0	1	3	1	1	0	1	0	7	avg	24	45	13	18	50	15	-6	5	2
44	•	•	73	•	•	u	m	c	n	118	2avg++	2avg++	avg	high	•	•	•	0	1	1	1	1	0	1	0	5	avg	22	39	12	•	•	•	•	•	•
41	49	8	70	76	6	u	m	c	n	111	3avg	3avg	avg	avg	124	2avg++	13	0	0	3	0	1	0	1	0	5	avg	17	41	12	25	37	14	8	-4	2
37	45	8	73	77	4	u	m	c	n	100	3avg	3avg	avg	avg	113	2avg++	13	0	1	0	0	1	0	1	0	3	below	19	40	14	16	52	9	-3	12	-5
47	46	-1	61	57	-4	u	m	c	n	126	2avg++	2avg++	avg	high	116	2avg++	-10	0	•	•	•	•	•	•	0	•	•	14	32	15	19	29	9	5	-3	-6
43	51	8	65	72	7	u	f	c	n	115	2avg++	2avg++	avg	high	131	1high	16	0	1	3	1	1	1	1	0	8	above	15	32	18	17	45	10	2	13	-8
36	36	0	60	65	5	u	m	c	n	99	3avg	3avg	avg	avg	90	3avg	-9	0	0	3	0	0	1	1	0	5	avg	17	33	10	22	37	6	5	4	-4
44	47	3	64	72	8	u	m	c	n	118	2avg++	2avg++	avg	high	119	2avg++	1	1	1	3	0	1	0	0	1	7	avg	17	30	17	23	41	8	6	11	-9
42	45	3	86	69	-17	u	m	c	n	113	2avg++	2avg++	avg	high	113	2avg++	0	0	1	1	1	1	1	1	0	6	avg	26	42	18	13	43	13	-13	1	-5
33	42	9	105	75	-30	u	f	c	n	92	3avg	3avg	avg	avg	103	3avg	11	0	0	3	0	1	1	1	0	6	avg	32	56	17	27	35	13	-5	-21	-4
38	48	10	95	84	-11	u	m	c	n	103	3avg	3avg	avg	avg	122	2avg++	19	0	0	1	0	1	0	1	0	3	below	25	57	13	22	49	13	-3	-8	0
37	•	•	38	•	•	u	m	c	n	100	3avg	3avg	avg	avg	•	•	•	0	3	1	0	0	0	1	0	5	avg	17	13	8	•	•	•	•	•	•

Yr1 Ravens	Yr2 Ravens	R2-R1	Yr1 Torrance	Yr2 Torrance	T2-T1	nom	sex	area	SHP	IQ 1	IQ1 level	IQ grp1	Extr IQ1	IQ1 rank	IQ 2	IQ2 level	Q 2-IQ 1	FoSq1	FoSq2	FoSq3	FoSq4	FoSq5	FoSq6	FoSq7	FoSq8	FoSTot8	FoSGrpd	fluency1	orig1	elab1	fluency2	orig2	elab2	flu2-flu1	ori2-ori1	elb2-elb1
51	51	0	89	63	-26	ng	m	s	n	135	1high	1high	high	high	131	1high	-4	0	0	0	0	0	1	1	0	2	below	23	52	14	17	33	13	-6	-19	-1
48	49	1	76	92	16	ng	m	s	n	129	1high	1high	high	high	124	2avg++	-5	0	1	3	1	0	0	1	0	6	avg	19	39	18	30	46	16	11	7	-2
43	42	-1	86	78	-8	r	m	s	n	115	2avg++	2avg++	avg	high	103	3avg	-12	0	1	3	0	1	0	0	0	5	avg	23	52	11	25	46	7	2	-6	-4
41	41	0	66	92	26	r	m	s	n	111	3avg	3avg	avg	avg	100	3avg	-11	0	1	0	1	1	0	1	0	4	below	15	36	15	26	52	14	11	16	-1
47	•	•	85	•	•	ng	m	s	n	126	2avg++	2avg++	avg	high	•	•	•	0	1	0	1	1	1	1	0	5	avg	25	42	18	•	•	•	•	•	•
42	46	4	42	43	1	r	m	s	n	113	2avg++	2avg++	avg	high	116	2avg++	3	0	0	0	0	0	1	1	0	2	below	11	22	9	11	25	7	0	3	-2
42	51	9	46	93	47	r	m	s	n	113	2avg++	2avg++	avg	high	131	1high	18	1	0	3	1	0	0	3	0	8	above	7	23	16	25	54	14	18	31	-2
49	46	-3	69	115	46	r	m	s	n	131	1high	1high	high	high	116	2avg++	-15	1	1	3	1	1	1	1	0	9	above	16	35	18	37	66	12	21	31	-6
41	51	10	66	97	31	r	f	s	n	111	3avg	3avg	avg	avg	131	1high	20	0	1	3	0	0	1	3	1	9	above	16	43	7	30	56	11	14	13	4
42	47	5	65	90	25	r	m	s	n	113	2avg++	2avg++	avg	high	119	2avg++	6	0	3	3	1	0	0	1	1	9	above	13	38	14	20	61	9	7	23	-5
36	•	•	30	•	•	r	m	s	n	99	3avg	3avg	avg	avg	•	•	•	0	3	0	1	0	0	1	0	5	avg	7	13	10	•	•	•	•	•	•
33	•	•	60	•	•	r	f	s	n	92	3avg	3avg	avg	avg	•	•	•	1	0	3	1	1	1	1	0	8	above	19	26	15	•	•	•	•	•	•
44	56	12	69	48	-21	n	f	s	n	118	2avg++	2avg++	avg	high	144	1high	26	0	3	0	1	0	0	0	1	5	avg	19	32	18	14	19	15	-5	-13	-3
51	55	4	113	107	-6	r	f	s	n	135	1high	1high	high	high	143	1high	8	0	0	1	1	0	1	3	0	6	avg	36	61	16	36	57	14	0	-4	-2
39	•	•	34	•	•	r	m	s	n	105	3avg	3avg	avg	avg	•	•	•	0	0	0	0	1	0	0	2	3	below	9	17	8	•	•	•	•	•	•
42	46	4	76	78	2	r	f	s	n	113	2avg++	2avg++	avg	high	116	2avg++	3	1	1	0	1	0	0	3	1	7	avg	18	43	15	28	38	12	10	-5	-3
45	48	3	79	92	13	r	m	s	n	120	2avg++	2avg++	avg	high	122	2avg++	2	0	1	3	0	1	0	1	1	7	avg	19	43	17	30	48	14	11	5	-3
42	53	11	83	99	16	ng	f	s	n	113	2avg++	2avg++	avg	high	143	1high	30	0	1	0	0	0	1	1	2	5	avg	25	44	14	27	56	16	2	12	2
53	52	-1	83	99	16	ng	m	s	n	143	1high	1high	high	high	135	1high	-8	1	1	3	1	1	1	1	1	10	above	20	47	16	27	58	14	7	11	-2
33	42	9	90	80	-10	r	f	s	n	92	3avg	3avg	avg	avg	103	3avg	11	0	0	0	1	0	0	1	1	3	below	20	55	15	27	43	10	7	-12	-5
42	45	3	49	63	14	r	f	s	n	113	2avg++	2avg++	avg	high	113	2avg++	0	0	1	0	1	0	1	1	0	4	below	11	25	13	23	35	5	12	10	-6
43	46	3	56	95	39	r	f	s	n	115	2avg++	2avg++	avg	high	116	2avg++	1	0	0	1	1	1	1	1	1	6	avg	18	21	17	33	47	15	15	26	-2
40	•	•	46	•	•	r	f	s	n	108	3avg	3avg	avg	avg	•	•	•	1	3	0	1	0	0	1	1	7	avg	12	26	8	•	•	•	•	•	•
46	•	•	97	•	•	u	m	s	y	123	2avg++	2avg++	avg	high	•	•	•	0	1	0	0	1	1	0	1	4	below	25	54	18	•	•	•	•	•	•
39	•	•	145	•	•	u	m	s	y	105	3avg	3avg	avg	avg	•	•	•	1	3	3	1	1	0	1	2	12	above	40	89	16	•	•	•	•	•	•
45	•	•	103	•	•	u	f	s	y	120	2avg++	2avg++	avg	high	•	•	•	0	3	3	1	1	0	1	0	9	above	26	62	15	•	•	•	•	•	•
42	•	•	80	•	•	u	f	s	y	113	2avg++	2avg++	avg	high	•	•	•	0	1	1	1	1	0	3	0	7	avg	26	39	15	•	•	•	•	•	•
41	•	•	58	•	•	u	f	s	y	111	3avg	3avg	avg	avg	•	•	•	0	3	3	0	1	0	3	0	10	above	17	27	14	•	•	•	•	•	•
40	•	•	85	•	•	u	m	s	y	108	3avg	3avg	avg	avg	•	•	•	1	3	1	0	0	1	0	2	8	above	20	48	17	•	•	•	•	•	•
30	•	•	61	•	•	u	m	s	y	86	below	below	avg	low	•	•	•	0	1	3	0	0	1	0	0	5	avg	19	30	12	•	•	•	•	•	•
31	•	•	76	•	•	u	m	s	y	88	below	below	avg	low	•	•	•	0	1	1	0	1	1	3	0	7	avg	21	39	16	•	•	•	•	•	•
36	•	•	76	•	•	u	m	s	y	99	3avg	3avg	avg	avg	•	•	•	0	1	3	0	1	1	0	0	6	avg	26	37	13	•	•	•	•	•	•
45	•	•	94	•	•	u	m	s	y	120	2avg++	2avg++	avg	high	•	•	•	0	1	0	0	0	1	1	2	5	avg	29	48	17	•	•	•	•	•	•
44	•	•	61	•	•	u	m	s	y	118	2avg++	2avg++	avg	high	•	•	•	0	1	1	1	1	0	3	0	7	avg	13	30	18	•	•	•	•	•	•
42	•	•	89	•	•	u	f	s	y	113	2avg++	2avg++	avg	high	•	•	•	1	0	3	0	0	1	1	0	6	avg	25	51	13	•	•	•	•	•	•
31	•	•	56	•	•	u	f	s	y	88	below	below	avg	low	•	•	•	0	0	1	0	0	1	1	0	3	below	14	30	12	•	•	•	•	•	•
44	•	•	113	•	•	u	f	s	y	118	2avg++	2avg++	avg	high	•	•	•	0	3	1	0	1	1	1	0	7	avg	26	73	14	•	•	•	•	•	•
42	•	•	75	•	•	u	m	s	y	113	2avg++	2avg++	avg	high	•	•	•	0	1	1	0	0	1	1	1	5	avg	19	42	14	•	•	•	•	•	•
41	•	•	94	•	•	u	f	s	y	111	3avg	3avg	avg	avg	•	•	•	1	0	1	1	1	0	0	0	4	below	28	48	18	•	•	•	•	•	•
43	•	•	54	•	•	u	f	s	y	115	2avg++	2avg++	avg	high	•	•	•	1	3	1	1	0	0	1	1	8	above	14	26	14	•	•	•	•	•	•
44	•	•	89	•	•	u	m	s	y	118	2avg++	2avg++	avg	high	•	•	•	0	0	3	1	0	1	1	0	6	avg	28	44	17	•	•	•	•	•	•
41	•	•	69	•	•	u	m	s	y	111	3avg	3avg	avg	avg	•	•	•	0	0	3	1	1	1	1	0	7	avg	20	38	11	•	•	•	•	•	•
40	•	•	81	•	•	u	m	s	y	108	3avg	3avg	avg	avg	•	•	•	0	0	1	1	0	1	1	0	4	below	20	46	15	•	•	•	•	•	•
42	•	•	75	•	•	u	f	s	y	113	2avg++	2avg++	avg	high	•	•	•	1	1	1	0	1	0	0	0	4	below	19	44	12	•	•	•	•	•	•
51	•	•	120	•	•	u	m	s	y	135	1high	1high	high	high	•	•	•	1	1	0	0	1	1	0	0	4	below	35	68	17	•	•	•	•	•	•
40	•	•	101	•	•	r	f	w	y	108	3avg	3avg	avg	avg	•	•	•	1	1	1	0	0	0	1	2	6	avg	24	63	14	•	•	•	•	•	•
37	•	•	•	•	•	r	m	w	y	100	3avg	3avg	avg	avg	•	•	•	0	0	3	1	1	0	0	0	5	avg	•	•	•	•	•	•	•	•	•
43	•	•	68	•	•	r	m	w	y	115	2avg++	2avg++	avg	high	•	•	•	1	1	0	0	0	1	1	0	4	below	16	36	16	•	•	•	•	•	•
38	•	•	69	•	•	r	m	w	y	103	3avg	3avg	avg	avg	•	•	•	0	0	1	0	1	1	1	0	4	below	22	33	14	•	•	•	•	•	•
42	•	•	61	•	•	r	m	w	y	113	2avg++	2avg++	avg	high	•	•	•	0	3	1	1	0	0	1	0	6	avg	24	28	9	•	•	•	•	•	•
25	•	•	92	•	•	r	m	w	y	79	below	below	avg	low	•	•	•	0	1	1	1	1	0	1	1	6	avg	32	46	14	•	•	•	•	•	•
21	•	•	29	•	•	r	m	w	y	77	below	below	avg	low	•	•	•	0	1	1	0	0	0	0	0	2	below	10	12	7	•	•	•	•	•	•
51	•	•	118	•	•	n	m	w	y	135	1high	1high	high	high	•	•	•	0	1	1	1	1	0	1	1	6	avg	38	64	16	•	•	•	•	•	•
49	•	•	78	•	•	n	m	w	y	131	1high	1high	high	high	•	•	•	1	3	0	1	1	1	1	0	8	above	19	44	15	•	•	•	•	•	•
28	•	•	60	•	•	r	m	w	y	81	below	below	avg	low	•	•	•	0	0	3	1	0	1	1	0	6	avg	13	33	14	•	•	•	•	•	•
40	•	•	75	•	•	r	m	w	y	108	3avg	3avg	avg	avg	•	•	•	1	1	1	0	1	1	1	1	7	avg	29	38	8	•	•	•	•	•	•
37	•	•	77	•	•	n	f	w	y	100	3avg	3avg	avg	avg	•	•	•	1	1	1	1	0	1	1	0	6	avg	17	44	16	•	•	•	•	•	•
35	•	•	67	•	•	r	f	w	y	96	3avg	3avg	avg	avg	•	•	•	0	1	1	1	1	0	1	0	5	avg	19	35	13	•	•	•	•	•	•
22	•	•	93	•	•	r	f	w	y	77	below	below	avg	low	•	•	•	0	0	3	0	0	0	1	0	4	below	32	48	13	•	•	•	•	•	•
45	•	•	65	•	•	n	m	w	y	120	2avg++	2avg++	avg	high	•	•	•	0	1	3	1	0	1	0	1	7	avg	13	39	13	•	•	•	•	•	•
19	•	•	69	•	•	r	f	w	y	75	below	below	avg	low	•	•	•	0	1	0	1	0	0	0	0	2	below	21	42	6	•	•	•	•	•	•
48	•	•	61	•	•	r	m	w	y	129	1high	1high	high	high	•	•	•	1	3	1	0	1	1	1	1	9	above	14	31	16	•	•	•	•	•	•
48	•	•	79	•	•	n	f	w	y	129	1high	1high	high	high	•	•	•	0	0	3	0	0	0	1	0	4	below	25	39	15	•	•	•	•	•	•
25	•	•	71	•	•	r	f	w	y	79	below	below	avg	low	•	•	•	1	1	0	1	0	0	1	0	4	below	23	36	12	•	•	•	•	•	•
34	•	•	53	•	•	r	m	w	y	94	3avg	3avg	avg	avg	•	•	•	0	0	1	0	1	0	3	0	5	avg	14	31	8	•	•	•	•	•	•
35	•	•	39	•	•	r	m	w	y	96	3avg	3avg	avg	avg	•	•	•	1	1	3	0	1	0	1	0	7	avg	11	19	9	•	•	•	•	•	•
39	•	•	•	•	•	r	m	w	y	105	3avg	3avg	avg	avg	•	•	•	0	3	3	0	1	1	1	0	9	above	•	•	•	•	•	•	•	•	•
38	•	•	•	•	•	r	m	w	y	103	3avg	3avg	avg	avg	•	•	•	0	0	3	0	1	0	3	0	7	avg	•	•	•	•	•	•	•	•	•