



SOCIAL, PERSONALITY AND AROUSAL VARIABLES AFFECTING  
MEASURES OF PERFORMANCE IN HUMANS AND ANIMALS.

Thesis submitted in fulfilment of  
the requirements for the  
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Jacques Christoph Metzger  
B.Sc.(Hons) (Adel. 1972)

Department of Psychology  
University of Adelaide  
South Australia

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Author's Statement

This thesis contains no material which has been accepted for the award of any other degree or diploma at the University of Adelaide or any other University. To the best of my knowledge and belief, the thesis contains no material previously published or written by any other person except as due reference is made in the text of the thesis.

Signed:

Jacques C. Metzger.

## CONTENTS

|                                                                                          | Page |
|------------------------------------------------------------------------------------------|------|
| <u>FOREWORD</u>                                                                          |      |
| <u>SUMMARY</u>                                                                           |      |
| <u>CHAPTER I. LITERATURE REVIEW AND THEORETICAL DISCUSSION</u>                           | 1    |
| I.1. Overview of Social Facilitation in the Early Comparative and Ethological Literature | 1    |
| I.1.1. Terminology and Definitions in the Literature                                     | 1    |
| I.1.2. Proposed Mechanisms                                                               | 4    |
| I.1.3. Ontogenetic Factors                                                               | 11   |
| I.1.4. Evaluation                                                                        | 14   |
| I.2. The Drive Theory of Social Facilitation                                             | 17   |
| I.2.1. Coaction Effects                                                                  | 21   |
| I.2.2. Audience Effects                                                                  | 25   |
| I.3. General Arousal, Motivation and Audience Effects                                    | 28   |
| I.3.1. Independent Evidence for the Presence of Others as a Source of General Arousal    | 28   |
| I.3.2. Other Theoretical Predictions about Increases in Arousal                          | 32   |
| I.4. The Role of Individual Differences in Social Facilitation                           | 37   |
| I.4.1. Anxiety                                                                           | 39   |
| I.4.2. Neuroticism                                                                       | 44   |
| I.4.3. Extraversion                                                                      | 46   |
| I.4.4. Emotionality                                                                      | 47   |
| I.5. Characteristics of the Audience Stimulus                                            | 50   |
| I.6. The Use of Operant Behaviour in Studying Social Facilitation                        | 58   |
| I.7. Summary of Experimental Hypotheses                                                  | 65   |

|                         |                                                   |     |
|-------------------------|---------------------------------------------------|-----|
| <u>CHAPTER II.</u>      | <u>EXPERIMENT 1. SOCIAL AND SOLITARY</u>          |     |
|                         | <u>RESPONDING BY RATS ON A SIDMAN AVOIDANCE</u>   |     |
|                         | <u>SCHEDULE AS A FUNCTION OF VARYING</u>          |     |
|                         | <u>AROUSAL LEVELS</u>                             | 66  |
|                         | <u>Method</u>                                     |     |
|                         | Subjects                                          | 69  |
|                         | Apparatus                                         | 69  |
|                         | Experimental Design and Procedure                 | 71  |
|                         | <u>Results</u>                                    |     |
|                         | Phase 1                                           | 74  |
|                         | Phase 2                                           | 86  |
|                         | Discussion                                        | 90  |
|                         | Summary                                           | 97  |
| <br><u>CHAPTER III.</u> | <br><u>EXPERIMENT 2. COMPARISON OF SOCIAL AND</u> |     |
|                         | <u>SOLITARY RESPONDING BY HUMANS ON A</u>         |     |
|                         | <u>FREE-OPERANT AVOIDANCE SCHEDULE</u>            | 99  |
|                         | <u>Method</u>                                     |     |
|                         | Subjects                                          | 100 |
|                         | Apparatus                                         | 101 |
|                         | Procedure and Experimental Design                 | 102 |
|                         | <u>Results</u>                                    | 105 |
|                         | Discussion                                        | 109 |
|                         | Summary                                           | 111 |
| <br><u>CHAPTER IV.</u>  | <br><u>EXPERIMENT 3. THE ROLE OF EMOTIONALITY</u> |     |
|                         | <u>OF RATS IN SIDMAN AVOIDANCE RESPONDING</u>     |     |
|                         | <u>WITH AND WITHOUT AN AUDIENCE</u>               | 112 |
|                         | <u>Method</u>                                     |     |
|                         | Subjects                                          | 114 |
|                         | Apparatus                                         | 116 |
|                         | Procedure                                         | 116 |
|                         | <u>Results</u>                                    | 117 |
|                         | Phase 1                                           | 119 |
|                         | Phase 2                                           | 121 |
|                         | Discussion                                        | 128 |
|                         | Summary                                           | 134 |



|                                                                  |     |
|------------------------------------------------------------------|-----|
| <u>CHAPTER V. EXPERIMENT 4. THE ROLE OF NEUROTICISM IN</u>       |     |
| <u>DRL RESPONDING OF HUMANS WITH AND WITHOUT</u>                 |     |
| <u>AN AUDIENCE</u>                                               | 135 |
| <u>Method</u>                                                    |     |
| Subjects                                                         | 137 |
| Apparatus                                                        | 138 |
| Procedure                                                        | 138 |
| <u>Results</u>                                                   | 140 |
| Discussion                                                       | 144 |
| Summary                                                          | 146 |
| <br><u>CHAPTER VI. IMPLICATIONS OF EXPERIMENTS 1, 2, 3 AND 4</u> | 148 |
| VI.1. Theoretical Issues Arising from Attempts                   |     |
| to Summate Various Sources of Arousal                            | 148 |
| VI.2. Interactions between Appetitive and                        |     |
| Aversive Stimuli : Contrast Effects                              | 152 |
| <br><u>CHAPTER VII. EXPERIMENT 5. CONTRAST EFFECTS WITH</u>      |     |
| <u>HUMAN SUBJECTS ON A DRL SCHEDULE</u>                          | 159 |
| <u>Experiment 5A</u>                                             | 160 |
| Method                                                           |     |
| Subjects                                                         | 160 |
| Apparatus                                                        | 160 |
| Procedure and Design                                             | 161 |
| Results and Discussion                                           | 163 |
| <u>Experiment 5B</u>                                             |     |
| Method                                                           |     |
| Subjects                                                         | 170 |
| Apparatus                                                        | 170 |
| Procedure and Design                                             | 171 |
| Results and Discussion                                           | 171 |
| Summary and Conclusions                                          | 175 |

|                        |                                                                                                            |         |
|------------------------|------------------------------------------------------------------------------------------------------------|---------|
| <u>CHAPTER VIII.</u>   | <u>EXPERIMENT 6. A COMPARISON OF AUDIENCE<br/>AND RESPONSE COST ON HUMAN DRL<br/>PERFORMANCE</u>           | 176     |
|                        | <u>Method</u>                                                                                              |         |
|                        | Subjects                                                                                                   | 177     |
|                        | Apparatus                                                                                                  | 178     |
|                        | Procedure and Experimental Design                                                                          | 180     |
|                        | <u>Results</u>                                                                                             | 183     |
|                        | Discussion                                                                                                 | 193     |
|                        | Summary                                                                                                    | 199     |
| <br><u>CHAPTER IX.</u> | <br><u>THE EFFECT OF AN AUDIENCE CONTINGENCY<br/>ON DRL RESPONDING BY RATS.</u>                            | <br>201 |
|                        | <u>Method</u>                                                                                              |         |
|                        | Subjects                                                                                                   | 204     |
|                        | Apparatus                                                                                                  | 204     |
|                        | Experimental Design and Procedure                                                                          | 206     |
|                        | <u>Results</u>                                                                                             |         |
|                        | Phase 1                                                                                                    | 210     |
|                        | Phase 2                                                                                                    | 215     |
|                        | Discussion                                                                                                 | 216     |
|                        | Summary                                                                                                    | 222     |
| <br><u>CHAPTER X.</u>  | <br><u>GENERAL DISCUSSION</u>                                                                              | <br>224 |
| X.1.                   | Implications for the Drive/Arousal<br>Theory of Social Facilitation                                        | 224     |
| X.2.                   | Competing Social Responses and<br>Distraction as Possible Alternative<br>Explanations for Audience Effects | 225     |
| X.3.                   | The Role of Species Differences in<br>Audience Effects                                                     | 230     |
| X.4.                   | Implications for Future Theorisation<br>and Research                                                       | 240     |
| <br><u>REFERENCES.</u> |                                                                                                            | <br>244 |

# LIST OF ILLUSTRATIONS

|          |   |                                                                                                                                                                                    |      |
|----------|---|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| FIGURE 1 | : | Audience Skinner Box used in Experiments 1 and 3                                                                                                                                   | 70   |
| FIGURE 2 | : | Graphical display of the significant Response level x treatment interaction for reinforcement rate changes in Experiment 1                                                         | 84   |
| FIGURE 3 | : | Samples of cumulative records of two subjects from Baseline, Spectator and $I_2$ treatments in Experiment 1                                                                        | 93   |
| FIGURE 4 | : | (Simulated) Subject with apparatus and audience in Experiment 2                                                                                                                    | 101a |
| FIGURE 5 | : | Samples of cumulative records taken from the 2nd hour of Baseline and Spectator sessions of $R_{90}$ and $R_{69}$ in Experiment 3                                                  | 132  |
| FIGURE 6 | : | Cumulative records taken from Baseline and Experimental sessions of $S_6$ , $S_9$ and $S_{16}$ in Experiment 5A                                                                    | 168  |
| FIGURE 7 | : | (Simulated) Subject with apparatus and Novel Stimulus with curtain in "open" position                                                                                              | 182  |
| FIGURE 8 | : | (Simulated) Subject with apparatus and Professor 2 with curtain in "open" position. (N.B. Professor 2 wore spectacles during all Audience sessions, although not so depicted here) | 179  |

- FIGURE 9 : (Simulated) Subject with apparatus and Professor 1 with curtain in "open" position. (N.B. Photograph taken from videotape - hence brightness inconsistencies) 179
- FIGURE 10 : Samples from cumulative records of  $S_5$  during Baseline and Treatments. The 5 min. periods constitute the Non-stimulus component; the 10 min. periods constitute the Stimulus component. 194
- FIGURE 11 : Samples from cumulative records of  $S_8$  during Baseline and Treatments. The 5 min. periods constitute the Non-Stimulus component; the 10 min. periods constitute the Stimulus component. 194a
- FIGURE 12 : Audience Observation Skinner Box (Subject compartment in foreground; Spectator compartment behind Subject's head) in Experiment 7. 205
- FIGURE 13 : Samples of cumulative records of  $S_4$  during Baseline and the Treatments in Experiment 7. The marker line at bottom indicates 3 min. periods constituting component 1 (lower lines) and 12 min periods constituting component 2 (upper lines). 221

## LIST OF APPENDICES

### APPENDIX A. Experiment 1.

- A1 : Baseline Comparisons between 0.5mA and 2.0mA
- A2 : Summary of analysis of variance for response rate changes
- A3 : Summary of analysis of variance for shock rate changes
- A4 : Summary of analysis of variance for shock to response ratio changes
- A5 : Summary of analysis of variance for efficiency index changes

### APPENDIX B. Experiment 3.

- B1 : Mean defecation and mean latency measures
- B2 : Baseline and Audience treatment measures

### APPENDIX C. Baseline and Audience treatment measures in Experiment 4.

### APPENDIX D. Experiment 5.

- D1 : Subjects' answers to Question, "What strategies did you use to respond?" in Experiment 5A.
- D2 : Subjects' answers to Question, "What strategies did you use to respond?" in Experiment 5B.

### APPENDIX E. Experiment 6.

- E1 : Logic Diagrams of apparatus
  - E1.1 : General Circuit
  - E1.2 : Curtain Circuit
- E2 : Instructions to Audience
- E3 : Change scores between baseline and treatments on all dependent variables of all subjects
- E4 : Analyses of variance summaries for data
  - E4.1 : Response Rates
  - E4.2 : Reinforcement rates
  - E4.3 : Interresponse times
  - E4.4 : Efficiency DRL ratios

E5 : Subjects' Responses to Questions:

(1) "What strategies did you use to respond?"

(2) "What did you experience in this session?"

(Q2, Audience treatment only)

APPENDIX F. Experiment 7.

F1 : Vertical Door Circuitry for Audience Skinner  
Box

F2 : Mean Response and Reinforcement Rates for  
Subjects (Phase 1)

F3 : Comparisons between Components during baselines  
(Phase 1)

F4 : Mean Efficiency DRL ratios of Subjects (Phase 1)

F5 : Mean Response and Reinforcement Rates for  
Subjects (Phase 2)

## FOREWORD

Social facilitation research has undergone a radical theoretical re-organisation since Zajonc (1965), in an essay of great elegance, put forth an explanation unifying some of the varied effects of social facilitation found in the literature up to that time. This explanation was as all-embracing as it was forceful:

"the presence of others increases the individual's general arousal or drive level". (p.272).

The renewed enthusiasm and interest which were as a consequence regenerated in the all but abandoned area, must surely rank Zajonc's theory as one of the most influential in recent social research.

General reviews of the field have been given by various authors (e.g. Crawford, 1939; Heingartner, 1970; Zajonc, 1965, 1968) but in spite of the many concentrated research efforts to clarify the controlling variables, some puzzling features remain. Why is it, for example, that performance by some subjects seems to be consistently worsened in a social facilitation situation (i.e. a "decrement" in performance), and consistently bettered (i.e. an "increment" in performance) by other subjects under apparently identical experimental conditions (e.g. Metzger, 1971)? Similarly, the possibility that personality differences interact with social facilitation situations to produce differential performance has attracted only scant attention in the literature (e.g. Paivio, 1965).

The present program of research was intended to help clarify some of these puzzling features. To this end, various experimental situations within an operant conditioning framework were used; situations (or "paradigms") which either had produced controversial findings in the past, or which had never been used to test social facilitation.

Throughout the thesis the author has used various temporally based schedules of reinforcement and punishment from research based on operant techniques for investigating social facilitation effects. Temporally based schedules are convenient to test social facilitation as a great deal is known about performance on them, and motivation changes may be assessed by performance on these schedules (e.g. Teitelbaum, 1966).

All multifactorial designs (except those in Chapter 3) requiring analyses of variance in the present thesis were run with the aid of a computer package specially designed by Williams (1974) for local use on a CDC 6400 (The University of Adelaide's largest computer). The author is grateful for this statistical aid.

It is doubtful that the research undertaken would have drawn to a successful conclusion had Frank Dalziel, the author's supervisor, not freely and constructively given advice, generously interspersed with his unmistakable humour. With almost infinite patience did he see and encourage the author through the program and each of the writing-up stages which took somewhat longer than was intended.



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Jacques Christoph Metzger

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## SUMMARY

Audience effects within the area of social facilitation were investigated in a series of experiments utilising free-operant avoidance and DRL (differential reinforcement of low rates of responding) schedules of reinforcement. The theoretical context of these investigations was the drive/arousal theory of social facilitation. Following the curvilinear relation between arousal and performance which has been documented in the literature, it was hypothesised that various manipulated sources of arousal (one of which was an audience) would interact to produce facilitation or impairment of performance depending on whether optimal or overarousal respectively, was attained.

Experiment 1 attempted to vary arousal levels of rats on a schedule of free-operant avoidance by manipulation of the electric shock intensity and the presence or absence of a spectator rat. Subjects were divided on the basis of baseline response rates (indicating arousal levels) into three response level groups (Fast, Medium and Slow), each subject undergoing each of 4 treatments (a spectator at baseline shock intensity and 3 shock intensity levels ( $I_2$ ,  $I_3$ ,  $I_4$ ) without a spectator). Although there were no differences between the response level groups, there was an overall increment in responding in the spectator treatment compared with baseline. This increase seemed to be similar to the increment obtained in the  $I_2$  treatment. The presence of the spectator affected the temporal spacing of responses

so that shocks were taken in groups rather than singly as in baseline. When all subjects were rerun to a new baseline at a higher shock intensity and given a spectator treatment, a decrement in performance was obtained. These results seemed to support a joint competing response and arousal explanation, rather than follow an inverted-U relationship.

Experiment 3 attempted to test the hypothesis that on a stressful free-operant avoidance schedule, performance by high emotionality rats would be further impaired by the addition of a spectator rat, whereas the performance by low emotionality rats would be facilitated by the presence of a spectator rat. The subjects were selected on the basis of defecation scores and latency of movement in an open-field apparatus out of a colony of 200 rats. The hypothesis was not supported. There did seem to be a suppression effect, however, as predicted by the competing response theory, during extinction when a spectator was present compared with no spectator present.

Experiment 2 attempted to ascertain whether performance on a free-operant avoidance schedule by human subjects with money-loss as the aversive stimulus would be sensitive to the presence of a human spectator and changes in the size of the money loss as purported arousal variables. Because most subjects were relatively high rate responders and sustained very few losses, affirmative answers to the hypothesis could not be obtained and the schedule (for human subjects) was rejected as unsuitable for the required purposes.

Experiment 4 attempted to ascertain whether performance on a DRL schedule by human subjects with money-gain as

the reinforcer would be sensitive to the presence of an audience, and to test whether high and low neuroticism (measured by high and low N scores on the Eysenck Personality Inventory) would affect possible audience effects. Some motivational variables are known to affect DRL performance, usually by increasing the response rate, which paradoxically and frequently leads to a decrease of reinforcement. The theoretical question was whether the highly reactive high N subjects would become overaroused with consequent performance decrements in the presence of two high status spectators, and whether the weakly reactive low N subjects would tend towards better (optimal) performance under these same conditions. No differences were found between the two N groups either during baseline or the audience treatment, although there was some evidence for greater efficiency of performance during the audience treatment when the high and low N groups were combined. These results cast doubt on a central aspect of social facilitation theory which assumes that an audience is an aversive rather than appetitive stimulus. The remaining experiments were addressed to this problem.

Since arousal/drive theory has difficulty in accurately predicting basic motivation hypotheses involving the combination of several stressors or a combination of stressors and appetitive stimuli, a quite different analysis was used - the study of contrast effects.

Experiments 5A and 5B were attempts to produce contrast effects on a DRL schedule by human subjects, using response cost which is known to produce suppression of

responding (Weiner, 1963). After baseline training on DRL, subjects were exposed to one or three successive sessions where two components alternated with each other. One component (the "stimulus" component) involved DRL responding and response contingent money loss, while the other (the "nonstimulus" component) was a return to DRL responding. Both behavioural contrast (acceleration of responding during the nonstimulus component; no change during the stimulus component) as well as generalised suppression (suppression in both components) were obtained at various sizes of money gain and money loss. These parametric studies were used to determine a comparison treatment for an attempt to obtain contrast when a brief audience exposure was substituted for a money loss in Experiment 6. It was hypothesised in Experiment 6 that if an audience is predominantly aversive, response contingent exposure should produce suppression of responding on the DRL schedule, with possibly punishment contrast; whereas if an audience is predominantly appetitive, response contingent exposure should produce acceleration of responding. The results showed that (1) there was little difference between extraverts and introverts on any of the treatments, (2) behavioural contrast was shown by subjects who were exposed to one of the two audiences used; these subjects described their audience treatment experience in positive terms, (3) suppression was shown by subjects who were exposed to the other audience used; these subjects described their audience treatment experience in negative terms, (4) the response cost treatment produced mostly suppression, (5) a novel stimulus treatment

produced very little effect on responding. The differential audience effects were interpreted as being inconsistent with the drive theory of social facilitation assumption that audiences give rise to an aversive drive. Differential nonverbal mediators were suggested as being responsible for the human audience effects.

Experiment 7 attempted to test the same hypotheses as in Experiment 6, but with rat subjects responding on a DRL schedule. With these subjects, overall punishment contrast was obtained in a spectator treatment, an anaesthetized spectator treatment, but with neither a stuffed spectator nor a no spectator treatment. However, the punishment contrast effect was not consistent within some subjects. These data seemed to be more consistent with an aversive stimulus interpretation of an audience than those of Experiment 6, although they were suggested as ruling out a competing response hypothesis used as explanation in Experiments 1 and 3.

The results overall were discussed in relation to a distraction hypothesis of social facilitation, species differences in the audience effect, possible mediators in the audience effect, and generally paradigms for further testing the aversive/appetitive nature of the audience stimulus.



## CHAPTER I

### LITERATURE REVIEW AND THEORETICAL DISCUSSION

#### I.1. OVERVIEW OF SOCIAL FACILITATION IN THE EARLY COMPARATIVE AND ETHOLOGICAL LITERATURE

The early ethological literature (and to a lesser extent the later) contains numerous references to social facilitation, mostly in nonhuman species, but with some human studies included in the early work (e.g. Triplett, 1897; Meumann, 1904).

##### I.1.1. Terminology and Definitions in the Literature.

Crawford (1939) referred to social facilitation as:

" ... any increment of individual activity which results from the presence of another individual..." (p.412),

and again:

" ... increments in the frequency and intensity of responses already learned by an individual, shown in the presence of other individuals usually engaged in the same behavior" (p.411).

Allee et al. (1950), following Crawford's review, added to, but retained much of his definition:

" ... any increment or decrement in an individual's behavior resulting from the presence of another organism." (p.410).

It is to be noted that these are rather loose definitions, in the sense that they do not suggest anything about the nature of the social stimulus, or about the mechanism(s) which might underly the effect. On the other hand, more rigorous definitions have not been accepted widely.

For example, Armstrong (1951) in a "retranslation" of the term social facilitation as "mimesis", has suggested that it occurs when

" ... the species is so constituted that the perception of certain innate behavior-patterns performed by another animal is the releaser of the same, or closely similar, innate behaviour-patterns by the observing individual" (p.46).

As Tolman (1968) pointed out, although the definition contains precise features, i.e. (a) it is the behavior of the companion that is the relevant stimulus, and (b) this stimulus releases, or elicits, the relevant behavior from the subject animal, Armstrong said little about the ontogeny of the facilitative mechanism. Also, Hinde (1953) has criticised this definition for its ambiguity in spite of its precise features. Similarly, Thorpe (1966) described social facilitation as "contagious behaviour" to distinguish it from imitation to which he referred as "social learning" (p.133). Contagious behaviour is defined as

" ... the performance of a more or less instinctive pattern of behavior by one (animal which) will tend to act as a releaser for the same behavior in another or in others, and so initiate the same lines of action in the whole group" (p.133).

Yawning is given by Thorpe as a common example of contagious behavior in man: the effect is immediate.

Lorenz (1937) has also written of "contagious reactions" which he described as instinctive reactions which released like reactions in other animals in flocks or herds. These contagious reactions were seen by Lorenz as being both secondary and social in origin and function.

Thorpe (1960) also writes of "local enhancement" as



a special case of social facilitation. This is defined as "apparent imitation" resulting from the directing of the subject's attention to a particular part of the environment. An example is Lorenz's (1935) observation of ducks' behavior in a "hole-in-the-wall" escape problem. If a duck was close to or immediately behind an escaping duck, the first bird was more likely to solve the problem than if it were elsewhere, because its attention had been directed toward the hole. It is difficult to see, however, how local enhancement is to be separated from social learning, even if the bird only learns to direct its attention to the first bird's escape behaviour.

Ethologists have also described a form of behaviour closely allied to social facilitation: allelomimetic behaviour. The two terms have often been confused and used as synonyms in the ethological literature. One major reason for this confusion is the fact that different authors attach different meanings to the term social facilitation. For example Scott (1968), one of the major modern researchers into allelomimetic behaviour, defined allelomimetic behaviour as

" ... two or more individuals (doing) the same thing at the same time, with some degree of mutual stimulation" (p.55).

He considers contagious behaviour, infectious laughter in humans, flocking in birds and schooling in fish, etc. to be merely synonyms for allelomimetic behaviour applied to the appropriate species. He considers social facilitation

on the other hand, to follow Crawford's (1939) definition, i.e. any increment or change in activity resulting from the presence of another individual.

Therefore, allelomimetic behaviour exists as a separate entity, the result of which is to produce an increment or sometimes a decrement in performance.

Social facilitation can therefore exist, as it were, as a by-product of allelomimetic behaviour. Like Crawford's and Allee's definitions of social facilitation, Scott's definition of allelomimetic behaviour is descriptive, rather than explanatory, and implies nothing about underlying mechanisms. He does, however, propose an explanation regarding the ontogeny of allelomimetic behaviour in the dog, the species with which his research was mainly carried out (Scott, 1968).

#### I.1.2. Proposed Mechanisms.

There is little doubt that Lorenz (1937), Armstrong (1951) and Thorpe (1966) consider social facilitation as being innately determined, although these authors have not been explicit about the ontogeny of the facilitative mechanism. Typically, explanations by these authors postulate the operation of a triggering mechanism whereby the companion's behaviour acts as an eliciting stimulus for a reflex response in the subject. Tolman (1968), in classifying models of social facilitation, has grouped the above explanations under the reflex mechanism category. To account for the similarity between the stimulus behaviour

and the released behaviour, Thorpe also suggests (a) an apparent transference of mood (an emotional state), and (b) it is this mood state which mediates the facilitated response, not just the companion's behaviour itself.

Tolman (1968) has called this a motivational mechanism.

Bayer's (1929) observations of the recommencement of eating by satiated hens in the presence of other hens pecking at food were interpreted by him as "food envy" being the critical motive. Zajonc's (1965) theory considering the mere presence of the companion as the critical motive inducing stimulus also falls into this category.

A disinhibitory mechanism is implicit in Wheeler's (1966) model to account for social facilitation. Here, it is assumed that the response is normally inhibited by restraints, and the companion's behaviour inhibits these restraints. For example, Davitz & Mason (1955) found that the presence of a nonfearful rat had the effect of producing a fourfold increase in exploratory activity in rats made fearful by electric shock. The presence of a fearful rat also reduced the strength of the fear response (freezing), but just not significantly.

A perceptual mechanism proposes that the companion draws attention to the stimulus object. Recall Lorenz's (1935) example of the "hole-in-the-wall" problem, whereby one duck escaping seems to attract a nearby bird's attention to the hole. Sparrows and chaffinches attract each other to a food source (Turner, 1964).

The reflex, disinhibitory and perceptual mechanisms

all emphasise the role of stimulus properties, which are considered to be primarily determined by unlearned factors. Consequently, these three mechanisms have been the most popular in the ethological literature, but it has also meant that there has been only scant attention given to ontogenetic factors. Various forms of the motivation mechanism have generally not been invoked by ethologists, but instead by investigators from social and comparative psychology (e.g. Bovard, 1959; Cottrell, 1968; James, 1960; Zajonc, 1965), primarily because of their greater interests in learned or ontogenetic factors. Nevertheless, the gradual synthesis of ethology and comparative psychology, which according to some recent (optimistic!) authors (e.g. Mason & Lott, 1976) "is essentially complete" (p.150), has ensured that researchers are becoming more concerned with combining their overlapping interests. A good example is provided by Strobel's (1972) work in which he attempted to investigate the relative contributions or strengths of stimulus and motivational factors in the social facilitation of an operant response in rats. One of his treatments included a satiated rat and a hungry companion, where both animals could bar press. He found that the satiated animal's bar press was strengthened. To test the two mechanisms two alternatives were proposed. First, if the response is triggered by cues associated with bar pressing in a reflex-like fashion, then high temporal correlations of bar pressing between the two rats throughout the experimental condition would be predicted. A change in motivational state on the

other hand, would predict a slowly increasing function of bar presses, that is, the cues could act on the normal mechanisms underlying the motivational state. Strobel's results showed both effects, indicating that a composite model incorporating both progressive changes in the motivational state of the subject, and a set of stimuli triggering the bar press response, was necessary to explain the data. Tolman (1968) gives an excellent review of literature supporting his four hypothetical mechanisms. He concluded that these data were on the whole equivocal, some evidence supporting each model, and that none of them accounted exclusively for social facilitation effects.

In considering various experiments showing decremental and incremental effects resulting from social stimulation, Tolman (1968) puts forth some interesting generalisations. First, increments in a particular behaviour are associated with the occurrence of at least the same type of behaviour noticed in the companion. There are many examples of these in the literature involving feeding behaviour stimulating feeding (Bayer, 1929; Harlow, 1932; Turner, 1964), running stimulating running (Vogel, Scott & Marston, 1950), exploration stimulating exploration (Simmel, 1962), swimming stimulating swimming (Welty, 1934), copulation stimulating copulation (Larsson, 1956), etc. Some of these studies involved also learned responses, e.g. Welty's goldfish were required not only to swim, but to swim a maze for food reinforcement, that is, the direction of the swimming responses had to be learned. Grouped fish learned faster

and retained learning better than single fish. Welty's work has been confirmed by Greenberg (1947) using green sunfish. Second, decrements in behaviour are often found when the companion's behaviour is clearly different from the behaviour of the subject. Examples from the literature include play behaviour interfering with running (Vogel, Scott & Marston, 1950); aggressive behavior interfering with feeding by opossums (Platt, Sutker & James, 1967) and with feeding by ten-week-old cockerels (Tolman, 1965); aggressive behavior interfering with swimming of mazes by fish (Hole, 1956); social behaviours interfering with maze running by shell-parakeets (Allee & Masure, 1936) and with food discrimination learning by greenfinches (Klopfer, 1959). Both learned and unlearned responses are found to suffer decrements, but according to Tolman (1968), more learned behaviours are involved in decremental effects than in incremental effects.

Tolman explains these differential effects by appealing to Breland & Breland's (1961) concept of instinctive drift. Whenever there are strong innate behaviours in the animal's repertoire in the experimental situation, then conditioned responses, which tend to compete with the strong innate responses, will tend to be displaced by them after prolonged experimental running. Thus interference effects may be found in social situations whenever the learned response (which is the appropriate dependent variable) gives way to competing responses with strong innate components. Play behaviour with its strong

social impetus in dogs may therefore take over from running in the Vogel, Scott & Marston (1950) study. Aggressive behaviour may also interfere with the learning of mazes by fish in the Hale (1956) study, and the learning of a jump response by mudminnows in the Welty (1934) experiments. Decremental effects in social situations of this kind are therefore explained by postulating interference by strong competing responses. It follows that whenever it is the already existing or innate responses which are being measured for social facilitation effects, incremental effects are likely because summation of various response tendencies, rather than competition between them, tends to occur. For example, schooling responses may assist swimming mazes in the group conditions in Welty's goldfish.

It seems indeed that incremental effects are found wherever there is an absence of strong competing responses in social facilitation situations, but the situation is not so clear with decremental effects.

Decremental effects have been found in situations where there are no obvious strong responses competing with the response being measured (see later in the chapter for a review), but the point made by Tolman (1968) remains a good one:

"whether a socially induced increment or decrement is observed simply depends on what is measured. Surely the animals who eat more in groups were showing a decrement in something, if only "standing around". (p.47).

The primary effect of allelomimetic behaviour is to cause individuals to behave more alike (mutual mimicry) and,

according to Scott (1968), this may lead directly to social facilitation. Again, it is clear that either decrements or increments in performance can be the end result. What mechanisms tend to underly social facilitation effects as seen from the allelomimetic viewpoint?

As a starting point to this basic question it can firstly be noted that, since the behaviour of (say) two animals becomes more alike, the faster animal will run slower, and the slower animal will run faster, if speed is the dependent variable. Allelomimetic behaviour has a general facilitating effect only if at least one animal is additionally motivated. Experimentally, one additional form of motivation is often induced by producing a goal motivation of one sort or another (Scott, 1968). Competition has been used (Scott & McCray, 1967) to this end. It was postulated by these authors that, in accordance with general learning theory principles, the effect of competition would be to produce faster running by the winner and slower running by the loser of a pair of dogs running an alley for food reward. If allelomimetic tendencies existed, and competition had no effect, then the dogs would run just as fast whether rewarded or unrewarded. The latter effect was indeed found, supporting the allelomimetic motivation hypothesis. Generally, the dogs ran faster in pairs than singly, and there was no significant difference between the competitive and noncompetitive trials, both of which involved paired running. The authors concluded that allelomimetic motivation existed independently of competition and that social facilitation (increment in performance) resulted because one member of a pair may be more



highly motivated than another member toward an external goal. It is clear that any real predictive power of the occurrence of social facilitation effects must depend on separate and independent measures of each animal's goal motivation - a crucial omission on the part of Scott & McCray (1967), who simply assumed that differential goal motivation was induced in the two members of each pair as a result of the effects of competition.

#### I.1.3. Ontogenetic Factors.

It has generally been the investigation of learned factors in social facilitation research that has emphasised the role of the ontogeny of the hypothesised mechanisms. In general, not very much research has been involved with the development of social facilitation, but the few studies that have been carried out here seem to point towards social experience as one of the most crucial variables. Unfortunately, a clearcut picture as to how this variable operates has not emerged. In part, the reason for this may be attributed to the lack of agreement noted earlier (I.1.1.) as to the precise features of the term "social facilitation", and partly to the fact that many of the relevant studies have been involved with rather limited aspects of social facilitation. Let us now consider some of these latter aspects.

Turner (1964) and Tolman (1964) have both studied the facilitation of a pecking response by chicks using a "mechanical hen" and a tapping pencil as stimuli respectively. It was found that the chicks could be induced to peck at food near these mechanical devices, and also more food was ingested.

These authors seem to have followed Thorpe's (1966) definition of local enhancements as an apparent imitation resulting from directing the bird's attention to the relevant stimulus - hence the use of a controlled model rather than a live hen.

In Turner's (1964) experiments, chicks that were socially isolated from hatching to 21 days did respond to the mechanical hen's pecking, but socialised chicks pecked more than the isolated chicks at 30 hours of age. Curiously, this difference was reversed at 7 and 21 days. Tolman (1964), on the other hand, found no difference between isolated and socialised chicks, although this result was derived from measurement averaged over a 12-hour period and masked the initially better performance by the socialised chicks.

May & Dorr (1968) observed an increase in pecking by socialised chicks under group testing, and an increase in pecking by isolated chicks under isolating testing. This was explained by the authors using a learning dependent interpretation. The presence or absence of comparisons with socialised or socially isolated chicks respectively, has acquired discriminative stimulus properties ( $S_D$ ) for pecking. Any departure from these conditions can be construed as having negative discriminative stimulus properties ( $S_{\Delta}$ ): facilitation therefore depends on increasing the similarity between rearing and testing conditions.

Brown & Kiely's (1974) results showed the opposite effect to May & Dorr's (1968) data. Brown & Kiely found that isolated chicks pecked more than communally-reared birds under group testing, and suggested that emotionality might be

implicated to further confuse the total picture.

It seems reasonable to conclude from these studies that, although social experience is a variable influencing peck rates in chicks, there probably is a range of other variables which is also important in determining the development of social pecking and facilitation of feeding in birds. Further discussion of some of these variables can be found in later parts of this chapter.

Social experience has also been studied by James (1960) and James & Gilbert (1955) using dogs as subjects. Puppies fed in isolation for 90 days after weaning did not exhibit social facilitation, whereas puppies fed in groups during the same post-weaning period did show facilitation at 40 days, when testing began. The isolate-fed puppies, when tested for social facilitation for 40 subsequent days, gradually showed the effect. This gradual development of the effect was explained by the authors also along learning theory lines. Other animals acquire secondary (conditioned) reinforcer properties which are specific to the social feeding situation. Tolman (1968) points out that, it is not so much the other animal's presence in the feeding situation which controls the feeding behaviour (i.e. acts as a secondary reinforcer), as the feeding behaviour of the companion which takes on discriminative stimulus properties.

In general, the afore mentioned studies have considered feeding behaviour, or other unlearned behaviours, as the response to be studied in relation to the development of social facilitation and have tended to opt for an instrumentally or operantly learned response explanation of

the effect. One rather broad question that arises at this point is how this situation changes when clearly learned behaviours are being measure for social facilitation effects. The resulting rather complicated and multiple learning situations which would be expected to arise here have not, in general, been considered in the ethological and comparative literature, even though very little is known about ontogenetic factors of social facilitation.

The related allelomimetic behaviour is also given a learning theory interpretation (e.g. Scott, 1967), which is analogous to Moltz's (1960) explanation of imprinting in ducklings. Scott (1967, 1968) suggests that the underlying motivation mechanism involves an aversive, emotional state induced by unfamiliar surroundings in ducklings and by the absence of familiar animals in puppies. This emotional state is immediately relieved by a return to familiar places and contact with familiar animals in the case of puppies. Avoidance of the emotional state then becomes part of the behavioural repertoire, and this is maintained by doing what other animals do and by remaining in contact with them. Strengthening of the avoidance response occurs throughout the animal's life by the continued process of negative reinforcement.

#### I.1.4. Evaluation.

It is difficult to avoid the conclusion that the field of social facilitation, as seen from the early ethological and comparative (or in modern terminology, the animal behaviourist's) viewpoint, is disjointed and lacking in

conceptual clarity. The field is plagued by problems of lack of consensus with respect to definitions, terminology, and indeed, even with respect to the phenomenon itself. These may, in part, be attributed to the earlier "division" between ethology and the comparative approach. Classical ethologists were always more interested in the description, the classification and the evolutionary implications of behaviour, while classic comparative psychologists have been more interested in the immediate causation of behaviour, often expressed within learning theory frameworks. It is understandable that both ethologists and comparative psychologists have (independently) tackled the phenomenon of social facilitation: its ubiquity in nature and its high cross-species generality makes it difficult to avoid the phenomenon in relation to other behaviours. Ethological investigators (e.g. Lorenz, 1937, Thorpe, 1966) have been more concerned with the innate components of behaviour, while comparative investigators (e.g. Zajonc, 1969) have been more concerned with the learned and motivational components. Both these approaches have in the past emphasised their own contributions and neglected those of the other. It is now generally regarded as not profitable to classify behaviours as innate or learned (e.g. Beach, 1955; Hinde, 1970) as was the case in the old nature-nurture controversy. Both Mason & Lott (1976) and Hinde (1970) have shown how the two disciplines may be combined. For example, Mason & Lott, (1976) suggest that four principal questions about any biological phenomenon ought to be asked:

- (a) causation (what mechanism is involved)
- (b) function (how does it benefit the individual or contribute to survival of the genes)
- (c) ontogeny (development of the mechanism in the individual)
- (d) evolution (what course has it followed through time).

Social facilitation research has not yet reached the appropriate division of labour stage in such a synthesis of disciplines.

Another major problem is the meaning of the term social facilitation. Some authors (e.g. Hinde, 1970; Thorpe, 1966) understand the term to be categorised under "insight learning" or "perceptual learning", as a direct consequence of their definition of the term. Other authors (e.g. Tolman, 1964; Turner, 1964) have come much closer to the concept of imitation when attributing their experimental effects to social facilitation. Indeed, it seems as if the concepts of imitation and social facilitation are intricably interwoven by many animal behaviour researchers. The unfortunate consequence of this is to further confuse the issue of understanding the social facilitation phenomenon. The study of imitation must, in principle, be separable experimentally from that of social facilitation, if understanding of mechanisms, ontogeny, etc. is to be gained at the end. It may well be, as Milton (1968) suggests, that imitation, allelomimetic behaviour, contagious behaviour, and the other seemingly related concepts are all best regarded as subclasses of social facilitation, and hence the principles explaining social facilitation should apply to its subclasses also. But, in order to discover these broad principles, the

first necessary condition is to reach agreement with regard to terminology and the description of the effect itself.

One recent investigator who has done more than any other to work towards this end is Zajonc (e.g. 1965, 1969). It is on his work that the groundwork of the present thesis is based.

### I.2. The Drive Theory of Social Facilitation.

The drive theory of social facilitation assumes many constructs from Hull-Spence learning theory. This seems rather surprising as this theoretical orientation seems to be rather outdated (e.g. Hilgard & Bower, 1975). Nevertheless, theorising and elaboration in the drive theory of social facilitation has maintained this Hull-Spence orientation (e.g. Rajecki et al, 1975; Shaver & Liebling, 1976; Weiss & Miller, 1971), since Zajonc's (1965) original formulation of the theory. The basis of the theory ought therefore to be discussed in some detail.

Zajonc (e.g. 1965, 1969) noted several inconsistencies in the literature and revived a distinction earlier suggested by Allport (1924) between Audience and Coaction effects. Audience effects occur whenever a subject engaged in some task is passively observed by one or more spectators. Coaction effects occur whenever a subject engaged in some task is in the presence of other subjects engaged in the same task. The effects are generally measured in terms of "alone-audience" and "alone-together" designs for the audience and the coaction paradigms respectively. Any differences in the relevant dependent variable(s) between the conditions in the two paradigms are considered to be evidence of social

facilitation. Zajonc reviewed some of the earlier literature and was able to explain some of the more puzzling features which resulted in both incremental and decremental effects found in the two paradigms.

According to Zajonc, there is one strand of consistency running through all of the social facilitation studies. This strand becomes clear only if a distinction is made between studies which involve learning, and those which measure performance. This distinction has been, of course, very much in popular usage by learning theorists (e.g. Walker, 1966) and performance theorists (e.g. Fitts & Posner, 1966). Learning is generally regarded as the acquisition of new responses, and performance as the emission of previously learned or innate responses. (This apparent "learned-innate" distinction in no way retracts what was said earlier about the learning vs. innate issue).

The Zajonc thesis is that the mere presence of others of the same species is a source of non-specific drive or arousal. It follows that if all responses are so energised, then it is the dominant responses in any situation which will benefit most. Zajonc (1969) appeals to Hull (1952) and Spence (1956) for theoretical justification along the following lines of reasoning. Reaction potential ( $S^E_R$ ) is a function of both habit strength ( $S^H_R$ ) and generalised drive (D), that is,

$$S^E_R = f(D \times S^H_R) \dots\dots(1)$$

If there are several responses,  $R_1, R_2, \dots$ , etc. possible in the situation, the probability that any one of them will be emitted depends on the size of its associated reaction potential.



For example, if there are two responses,  $R_1$  and  $R_2$ , and  $S^H_{R_1}$   $S^H_{R_2}$ , then

$$\begin{aligned} S^E_{R_1} - S^E_{R_2} &= f \left[ (D \times S^H_{R_1}) - (D \times S^H_{R_2}) \right] \\ &= f \left[ D(S^H_{R_1} - S^H_{R_2}) \right] \dots\dots\dots (2) \end{aligned}$$

If, in the social situation,  $D$  is increased, the difference between reaction potentials is increased, which means that  $R_1$ , the dominant response, is more likely to be emitted. A response tends to be highly probable or dominant in a appropriate situation, if it is well-learned (i.e. high value of  $S^H_R$ ), or if it has strong innate components. In situations where the dominant response is also the correct response, (i.e. usually the dependent variable), facilitation effects are predicted. If the dominant response is incorrect, such as in the early learning stages, then these incorrect responses are facilitated, causing a longer time for the correct responses to be emitted. Hence learning rates are slower and impaired; but once learned, performance is facilitated by the presence of coactors and/or an audience. Spence-Hull theory can also explain the often found differences in performance under apparently constant values of  $D$  and  $S^H_R$  by introducing the concept of oscillatory inhibition,  $S^O_R$  (Spence, 1956). This variable is postulated to vary randomly from moment to moment, and to reduce the excitatory potential of any response. Hence, equation (1) becomes

$$S^E_R = f \left[ (D \times S^H_R) - S^O_R \right] \dots (3)$$

where  $s^E_R$  is the momentary reaction potential which fluctuates with time. Reaction potential,  $s^E_R$ , is thus considered to be the central tendency of a range of  $s^E_R$  values, any one of which might be effective at any particular moment. Cottrell (1972) conceives the variability of  $s^E_R$  as being distributed along a normal distribution, and illustrates the effect of varying  $D$  for two competing responses of different habit strengths to support theoretically the Zajonc hypothesis. The idea of an oscillating threshold has, of course, been applied to sensory detection thresholds for many years in both classical psychophysics and modern signal detection theory (e.g. Fitts & Posner, 1967). Incorporating an oscillatory function into general drive theory, then, allows for apparent behaviour variability when other variables ( $D$ ,  $s^H_R$ ) are kept constant. Two further factors from Hull's (1943) theory which affect the reaction potential are reactive inhibition,  $I_R$ , and conditioned inhibition,  $s^I_R$ , both of which have been adopted from Pavlovian theory (Pavlov, 1927).  $I_R$  is specific to a particular response, and has fatigue-like properties which dissipate over time once responding has ceased.  $s^I_R$  is specific to a particular stimulus and response, and builds up when reinforcement does not follow a response (note that  $s^H_R$  builds up whenever a response is reinforced). These two inhibitory factors are subtracted from equation (3) to give

$$\dot{s}^E_R = f \left[ (D \times s^H_R) - (s^O_R + I_R + s^I_R) \right] \dots (4)$$

where  $\dot{s}^E_R$  is the effective momentary reaction potential.

Hilgard & Bower (1975) list some of the rather damaging criticisms which followed Hull's (1943) theory. For example, it is generally accredited by neo-Hullians (e.g. Spence, 1956) that some general formulation of inhibition is more likely to be useful in a Hullian framework than the separate concepts of  $I_R$  and  $S^I_R$ . Similarly, Amsel (1958) suggests that "frustration" is the underlying basis for conditioned inhibitory factors in appetite conditioning. Lastly, the concept of oscillatory inhibition must be regarded as an attempt to explain data apparently contradictory to early Hullian theory. In doing so, of course, all data can be now "explained", but none predicted.

Let us now consider some of the experimental findings under the separate headings of coaction and audience, which may support Zajonc's theory.

#### I.2.1. Coaction Effects.

Notwithstanding that the varying behaviour of the companion in the coacting situation has dramatic effects upon learning rates and performance rates, Zajonc (1968) argues that this does not preclude the energising properties of the mere presence of others. There do, however, seem to be some difficulties in interpreting the findings of many coaction studies in terms of Zajonc's theory. Some of these are now considered.

Allport (1924) performed a series of elegant experiments in an effort to study the effects of the presence of others in groups on task performance. He administered various tests to subjects working either in separate cubicles or in groups sitting around a table. The tasks on which clear facilitation

was observed in the coacting situations were chain word association, vowel cancelation, multiplication and reversible perspective. The main dependent variable in these tasks was the speed of the response. The tasks on which impairment was observed in the coacting situation were problem-solving which involved abstract reasoning, and judgements of odours and weights. Zajonc (1965) cites Allport's results as evidence that coaction facilitates the emission of responses high in the habit hierarchy such as those measured in the former tasks, but impairs performance which is measured by responses which are low in the habit hierarchy such as novel responses required in abstract reasoning. It is difficult, however, to rule out completely the confounding effects of competition in these tasks, although Allport attempted to minimise this by avoiding score comparisons and any reference to rivalry. Competition is a form of behavioural interdependence which involves the use of cues which are generated by the competitor's behaviours. It is always possible that these "social cues" are attended to and utilised, even if subjects are instructed not to do this.

Competition does not seem a likely and meaningful incentive in all studies on coaction however. Chen (1937) of the National Tsing Hua University of Peiping observed ants digging nests in bottles half filled with soil. Ants working together showed shorter latencies in starting to dig and excavated more soil in a given period than ants working alone. If it is accepted that nest digging is a well-learned or innate skill in ants, Chen's work can be regarded as

furnishing further evidence for Zajonc's thesis. Unfortunately, another potentially confounding factor was possible in Chen's study; this factor is imitation. It is possible that some of the slower working ants improved their performance by imitating faster working ants. (See also comments in I.2.2. with respect to Zajonc et al.'s (1969) cockroach study).

Both imitation and/or competition seem possible in many of the studies on coaction. Larsson (1956), for example, found that male rats who copulated (with females!) in groups reached a higher number of ejaculations per hour and achieved ejaculations in shorter times than when copulating occurred in isolated pairs.

In fact, when one looks at the early social facilitation literature as reviewed in an earlier part of this chapter, it seems as if these studies generally fall within the coaction rather than the audience paradigm.

If the underlying mechanisms of social facilitation are of prime theoretical interest, then it seems as if the coaction paradigm is not a good one, in the sense that one or more of the contaminating factors of competition, imitation, modelling, social reinforcement, etc. are difficult to avoid. In fact, a major problem in the study of social facilitation through the coaction paradigm is to determine whether these other forms of social interaction are occurring or not. Even in controlled laboratory settings, subtle interactional cues between coacting subjects which are not intended by the experimenter may occur. A good example of this is a study by Burwitz & Newell (1972) in which coactors were required to learn a novel motor skill. Subjects in the

coacting parts of the experiment were prevented from observing each other's performance, although it appears that they were allowed to see each other's faces. Although imitation and modelling seem to be ruled out here, the possibility that other interactional effects affected the results still remains. The very fact that the subject is in a coactive situation may give him reason to believe that his results are going to be compared with other's at a later time. There is also the possibility of nonverbal communication cues such as eye contact, body posture and facial expression (Argyle, 1969). These types of cues may be utilised by the subject, for example, to assess the extent to which the coactor is progressing in the task, and the extent of the coactor's attention on task factors. Non-verbal communication cues may also give feedback to the subject with respect to the coactor's motivation (e.g. frustration or anxiety). Complete elimination of such cues may well only be possible if coactors are isolated visually and auditorily from each other. In that event, it would become almost inappropriate to label the situation as social. Foot (1973) suggests that the process of coaction may be split into (a) implicit coaction, and (b) explicit coaction. Implicit coaction refers to situations in which the interchange of cues is minimised by experimental control, while explicit coaction refers to situations in which there are social cues available for the subject to utilise if he chooses. According to Foot, the real difference between explicit coaction and social interaction is that in the former, utilisation of social cues is optional, whereas in the latter, utilisation of social cues is compulsory. It is clear

that if the study of social facilitation is to be separated from studying various forms of social interaction, explicit coaction has too many possible sources of contamination. Even implicit coaction (and most of the studies reviewed so far seem to be cases of implicit coaction) may have contamination of social interactional variables. Even if it is attempted to minimise these, one cannot be sure how well this has succeeded, except by rather unsatisfactory post-hoc methods, such as post experimental questionnaires.

In the face of these difficulties, it was decided here to abandon the paradigm of coaction in favour of the audience paradigm to study the social facilitation effect.

#### 1.2.2. Audience Effects.

The study of social facilitation through the audience paradigm offers distinct advantages over the coaction paradigm. Provided that a passive audience is used, the processes of modelling, imitation and competition disappear as possible contaminants, although those of distraction and disruption due to response competition may remain.

The studies in the literature which incorporate audience effects generally are consistent with the findings under (implicit) coaction. For example, Travis (1925) found that after baseline training on a pursuit rotor task, subjects showed a marked increment in performance when they were required to perform in front of a passive and quiet audience. Although this difference was on the average only about 3 per cent, the advent of statistical tests of significance enabled Cottrell (1972) to show that Travis'

results were highly significant.

The presence of passive spectators was also found by Dashiell (1930) to result in improving the performance on tasks which involved word association and simple multiplication.

In a more recent experiment by Zajonc, Heingartner & Herman (1969), the presence of an "audience" of cockroaches was found to have dramatic effects on both the running speed and maze learning of subject cockroaches. A special runway and a crossmaze for cockroaches were constructed. Subjects were released on one end of the runway, and on one arm of the crossmaze. The task was to escape from a bright light - an aversive stimulus for the nocturnal insects - into a darkened box. For the "audience" trials, conditions were identical except for the inclusion of plexiglass "grandstands" in which 40 "spectator" roaches were accommodated, around the full length of the runway and the arms of the crossmaze. The results again supported Zajonc's generalisation: the inclusion of the cockroach "audience" resulted in faster running times to escape from the light in the runway and increased the time taken to escape in the crossmaze. Hence the effect of the cockroach "audience" was to improve performance when the dominant response was correct (escape response in runway), but to impair learning of the correct response in the crossmaze (i.e. dominant responses were likely to be incorrect in the first stages of learning). It is questionable, however, how much meaning can be attributed to the term 'spectator' or 'audience' with insects such as cockroaches. Spectator implies visual



contact - there is no evidence that cockroaches can see each other through a plexiglass partition; social interaction may be mediated through other sensory systems instead. Furthermore, most behaviours in arthropods seem to be in accordance with stereotyped Fixed Action Patterns initiated by releasers in the environment (Hinde, 1970). These may be contrasted to the greater plasticity of behaviours observed in vertebrates (particularly mammalian species). In view of these dramatic differences between the two phyla, which are no doubt mediated by the vast differences in neuronal complexity, it would probably not be meaningful to postulate a similar behaviour mechanism accounting for "audience" effects.

Pessin (1933) had subjects learn lists of nonsense syllables alone and in front of a passive audience. When subjects worked alone they required 9.85 trials to learn the list, while during audience observation, they required 11.27 trials. Moreover, the mean number of errors during learning was greater in the audience condition than in the alone condition. When required to relearn the same list after a substantial interval, the subjects in the audience condition required fewer trials than subjects in the alone condition. Again, Zajonc's theory seems to be supported.

As will be discussed later in this chapter, it is to be noted that although these reviewed experiments seem to support the notion of a change in motivation to account for differences in performance and learning, it is not at all clear that the critical variable is the mere presence

of the audience, as Zajonc suggests. Before this is done, let us consider other types of predictions which can be derived to account for the effects of audience as a result of a change in motivation.

### I.3. General Arousal, Motivation and Audience Effects.

According to Zajonc's theory, the mere presence of an audience leads directly to an increase in general drive (D) level or the arousal level of the subject organism. For the purposes of his theory these two processes (arousal and drive) may be used interchangeably, even though for other purposes a distinction may be useful. It is this increase in arousal which is responsible for the impairment of learning and the facilitation of performance. Several questions arise at this point.

- (a) Is there any evidence independent of these behavioural effects for the contention that the presence of others is a source of general arousal?
- (b) Are predictions other than the facilitation of dominant responses as a result of an increase in general arousal possible on theoretical and empirical grounds?

This section of Chapter 1 is devoted to examining these two questions in some detail.

#### I.3.1. Independent Evidence for the Presence of Others as a Source of General Arousal.

Zajonc (1965) points out some indirectly supporting evidence from the literature. Mason & Brady (1965), for

example, found that Rhesus monkeys, on days when their cages were in the same room and placed so that the monkeys could be in visual and tactual contact, had elevated hydrocortisone levels in their plasma. These levels were reduced if the cages were moved to individual rooms.

Moreover, low urinary levels of hydrocortisone were associated with low weekend laboratory activity. Hydrocortisone (17-OH corticosterone) is the main component of adrenocortical output and the activity of the adrenal cortex has been known for some time to be a good indicator of physiological arousal.

Population density seems to be correlated also with adrenocortical activity as is shown in studies using mice (Christian, 1959; Thiessen, 1961) and chickens (Flickinger, 1961).

In all of these studies; this adrenocortical activity may of course be attributed to events other than the mere presence of others. There are many concomitants of crowding such as fighting and competing for available resources to explain the latter studies, while in Mason and Brady's (1965) experiments, there was little control over the directive components of behaviour in the presence of others. Unfortunately, there seems to be a dearth of studies using animals as subjects in the literature which could be cited as providing independent support for the mere presence hypothesis.

On the other hand, other experiment involving the use of human subjects has shown a more promising avenue for the suggestion that others' presence affects the arousal level.

On a simple guessing task, for example, electrodermal indices of arousal were found to be higher in subjects in groups than in isolation (Shapiro et al, 1964). Strangely enough, these differences were reversed when the task was a very difficult one (Kissel, 1965). Shapiro & Crider (1969) conclude on the basis of these studies that the presence of others leads to heightened arousal on easy tasks, but to a dampening of arousal on difficult tasks. One possible explanation of these divergent results is that the presence of others can, under certain conditions, decrease the level of arousal. This possibility has received some attention by researchers. The conditions under which an apparent decrease in arousal is observed generally seem to involve stressful situations for subjects. Many different stimulus situations can be envisaged as being stressful. In the above studies, the variable of task difficulty may be conceived of as constituting a stressful situation if task difficulty is high, but a low stress situation if the task is easy. In another study, the anticipated use of aversive stimuli such as electric shock was varied from very high (high fear condition) to very mild (low fear condition) (Schachter, 1959). Significantly more subjects in the high fear condition chose to wait together (66%) than in the low fear condition (33%). These data seem to suggest that subjects in a state of high arousal tend to have their arousal lowered in the presence of others.

There is also some evidence against the Zajonc arousal hypothesis from animal studies which have made use of stressful situations. For instance, Conger, Sawrey & Turrell (1957, 1958)

found that rats alone in a continuing approach-avoidance situation had a significantly greater number of gastric ulcers than rats which faced the same situation in groups. Similarly, Davitz & Mason (1955) found that either the presence of a fearful rat or a nonfearful rat reduced the strength of the (rat) subject's fear response.

On the other hand, contradictory data were obtained by Brady, Porter, Conrad & Mason (1958) in which social stimulation in an avoidance situation seemed to produce greater ulceration in the "social contact" monkeys than in animals performing alone.

It seems then, that the evidence for the increase in arousal, which Zajonc suggests is the basis for the effect of the presence of others, is equivocal in situations where stress is an important feature. In fact, one of Zajonc's students attempted to test the hypothesis that under conditions of stress (intermittent foot shock) rats performing on a variable interval schedule of reinforcement would behave as if their arousal was lowered by the presence of an audience rat. (Heingartner, 1970). Although this hypothesis seemed to be supported (thereby contradicting his committee chairman's theory!), Heingartner did not take a more direct measure of arousal than the animals' rate of response.

Similar indirect measures of arousal (response rates and shock rates) were taken by Metzger (1971) in a free-operant (Sidman) avoidance task in an attempt to test Zajonc's theory under stressful conditions. In one treatment, rats performing at baseline avoidance levels were presented with

an audience rat in a separate compartment in the Skinner Box. Three animals facilitated and three animals showed impaired avoidance behaviour. These data provide further evidence that under stressful conditions, Zajonc's theory may need to be revised.

A more recent study by Davidson & Kelley (1973) provided evidence in terms of GSR (galvanic skin response) and self reports of hospitalised psychiatric patients who watched a stressful film, either in the presence of a nurse or alone. The nurse present group showed more stress reduction as measured by both dependent variables when the same film was shown after a 5-min. interval than the nurse absent group.

In the light of these divergent results of previous studies, it was decided that Zajonc's theory needed further testing in stressful situations, since it is in these situations in which most disagreement between studies seems to occur. Chapters II and III involve attempts to systematically compare different arousal levels with the presence of an audience in stressful free operant avoidance situations.

### I.3.2. Other Theoretical Predictions about Increases in Arousal.

So far, it has been attempted to integrate findings within Zajonc's general theoretical framework. That is, the effect of audience is to increase the level of general arousal and it is this increase which is theorised to be responsible for the facilitation of performance. Although Zajonc used Hull-Spence learning theory to formulate this prediction, it is possible to derive predictions about the effects of increased

drive or arousal on performance which do not coincide necessarily with his interpretation.

The first area in which one can take issue with Zajonc is in the interpretation of the effect of increases in drive within the context of Hull-Spence learning theory. There seems to be little doubt that, on the whole, whenever drive levels are increased from relatively low to moderate levels, the predictions derived from Hull-Spence learning theory are correct. Dominant responses are facilitated more than non-dominant responses. However, when very strong drive conditions are attained, the effect often observed is a decrement in the dominant response. The overall picture then is of an inverted U relationship between performance of the dominant response and drive level. Evidence for this relationship comes from many sources and reviews of drive studies (e.g. Cofer, 1959; Courts, 1942; Duffy, 1957; Malmo, 1958; Kendler, 1959). Although both Munn (1951) and Hull (1952) attribute response decrements after prolonged deprivations (in order to attain high drive) to physical weakening, there are studies which rule out this factor (reviewed by Malmo, 1959). For example, Bélanger & Feldman (1962) found an inverted U relationship between the rate of a bar-pressing response for water and the number of hours of deprivation. Concomitant with this relation was a linear increase of heart-rate with hours of deprivation, thereby furnishing evidence against the physical weakening hypothesis. Similarly, Thomas & King (1959) provided evidence against weakening. They increased drive in a generalisation situation. Responses to the training stimulus increased to a point, then decreased, while

the total frequency of the same response to all stimuli continued to increase.

Broen & Storms (1961) have shown that it is possible to account for the inverted U relationship in terms of Hullian drive theory, if a reaction potential ceiling level considerably less than that indicated by Hull (1942) is accepted. (Hull suggested that the maximum reaction potential was equal to the produce of drive level ceiling and habit strength ceiling). There is no need to go into the fine details of Broen & Storm's (1961) expose' for our purposes, except to note that an increase in drive or arousal may lead to a decrement in the dominant response, provided high drive conditions are attained. To have overlooked this possibility seems a serious neglect on the part of Zajonc, since it would seem that high drive conditions are more readily attained in situations where stress plays an important part. It is precisely under stressful conditions where the accuracy of Zajonc's theory is questionable.

A number of other theorists have found the inverted U function between performance on a variety of different tasks and arousal, and have attempted to explain it along different theoretical lines.

For example, Berlyne (1960) and Hebb (1955) take a neuropsychological orientation linking sensory stimulation as a behaviour guide to arousal. At the lower end of the arousal continuum, deep sleep causes the organism to be unresponsive to stimulation, while at the upper end complete disorganisation is caused by over-arousal or extreme excitation. In the middle range of arousal, optimal performance levels are attained. Factors such as novelty,



conflict, sensory stimulation tend to raise the level of arousal, while high predictability of environmental events, monotonous uniformity and lack of conflict tend to lower it. According to Hebb (1955) a physiological mechanism underlies the notion of arousal - the arousal system in the brain stem (also known as the Reticular Formation, and the Ascending Reticular Activating System). Routtenberg (1968) elaborated on this mechanism by suggesting that a second arousal system (limbic system) operated in conjunction with the ARAS. The two arousal systems were mutually inhibitory so that each suppressed the activity of the other. The function of the ARAS was to maintain general cortical arousal, while the limbic system exerted control over responses through incentives.

Welford (1962) has put signal detection theory to work to explain the inverted U relation between performance and arousal. At low levels of arousal the system is inert and only the strongest incoming signals secure responses. At intermediate levels of arousal sensitivity and responsiveness are improved and hence the effective strength of signals is raised. At high levels of arousal, spontaneous firing of neurons causes the background of "neutral noise" to increase and the system's channel capacity is reduced. Hence at low and high arousal levels performance is reduced. This explanation was further refined and elaborated by Welford (1973)

At this point a second area in which Zajonc's theory may be criticised may have become apparent. Since there seems to be much evidence in favour of the inverted U relationship

between performance in a variety of different tasks and arousal (see e.g. Broadhurst, 1959) from a variety of theoretical viewpoints, some of the reported decrements of social stimulation may well be due to cases of over-arousal. If a subject is performing at an already relatively high level of arousal, further increases in arousal due to the effect of an audience may well push the subject's performance over the inverted U "hump", thereby causing performance to be impaired, rather than facilitated as Zajonc would suggest (assuming of course that summation of arousal occurs).

There is not very much direct evidence in favour of this hypothesis, but some previous work may be of interest.

In the Sidman avoidance situation referred to earlier in this section, Metzger (1971) found that it was possible to explain curious individual differences between subjects during an audience treatment (half the animals facilitated, and half impaired performance), by assuming that these individual differences arose out of arousal level differences. Those animals which facilitated their performance (as shown by elevated response rates and reduced shock rates) under the audience condition had lower baseline levels of response, indicative of lower arousal levels, than the animals which showed impaired performance with audience. The latter subjects had generally higher response rates. Further, Davis (1969) in a similar experiment, found that the animal with the most effective avoidance response (i.e. highest response rate) was most disrupted by the presence of an audience animal. If the assumptions of (a) summation of arousal levels due to different sources, and (b) audience inducing the same increase in arousal for all subjects, are

made, then the explanation in the previous paragraph can be supported.

The explanation for the effects of an audience that Zajonc suggests may therefore well be incomplete - especially in tasks where arousal may be high. Chapter 11 describes an experimental situation in which an attempt was made to test the suggestion that the arousal increase due to the task (avoidance of aversive stimulation) may combine additively with arousal increase due to audience. At high (summated) levels of arousal, performance should be impaired in the presence of an audience, whereas at low (summated) levels of arousal, performance should be facilitated in the presence of an audience.

#### I.4. The Role of Individual Differences in Social Facilitation.

In the Hullian framework of drive theory, the concession made by Hull (but not by Zajonc) that individual differences can be taken into account in formulating predictions, has already been discussed. Hull had suggested that there could well be some variation of a quantitative kind between individuals. These were reflected in the values of various coefficients in his equations. At the same time, the concept of oscillatory inhibition ( $S O_R$ ) allowed for differences not only between individuals, but also for differences within subjects at various testing times.

As has been suggested earlier, the concept of oscillatory inhibition does not go very far towards explaining differences between individual performance. Instead, the concept has been used to justify the normative approach where the variation by subjects (e.g. attributed to them being

at different points on  $S_{OR}$  at the time of testing) is taken to somehow "average out" when means are calculated at the end of the day. Similarly, the inclusion of coefficients within equations seems to give no more than post-hoc descriptions of individual differences.

Alternatively, the finding of individual differences is sometimes taken to be a failure to control all the variables which affect the criterion measure, so that individual differences when found, tend to be an embarrassment to the experimenter.

The situation of individual differences as a source of investigation has received considerably less attention whenever animal subjects rather than human subjects have been used. For the purposes of social facilitation research, this has been an unfortunate omission, especially if we are interested in testing, for example, the drive theory of social facilitation. Already a large number of studies involving the use of animals has been reported in reviewing the social facilitation literature, and it may be possible that some of the divergent findings have their basis in systematic individual differences. With respect to general human studies, personality theory and research has, of course, been one of the older and more traditional areas of psychological investigation (e.g. Hall & Lindzey, 1957). Very few investigators however have published work relating personality measures to social facilitation. A notable exception is Paivio (1965), who, before Zajonc (1965) had suggested the mere presence theory, reviewed and reported research involving

factors of "emotional arousal" with respect to audience influence. We shall return to his work shortly.

Assume for the moment that the drive theory of social facilitation is correct. What are some of the constructs from personality theory likely to affect general arousal? It is suggested here that likely candidates are anxiety, neuroticism, extraversion, and in animals, emotionality. The reason why these particular variables may well mediate in the social facilitation effect lies in their theoretical links with general arousal or drive. Each of the variables has been well researched in its own right, but only rarely (if at all) with respect to social facilitation. Possible implications of each of these individual difference variables for the effects of audience will now be discussed.

#### I.4.1. Anxiety.

Paivio (1965) has named the emotional state aroused by observers "audience anxiety". Overt effects of this state, he assumes, depend on the level to which anxiety is raised by "situational factors" such as the composition or reactions of the audience. Individual differences in audience effects are believed to be due to predispositions to be anxious before observers, and is termed "audience sensitivity". Audience anxiety should be measurable in terms of physiological indices, while audience sensitivity may be measured by self-report inventories. Such an inventory (Audience Sensitivity Inventory) has indeed been constructed by Paivio & Lambert (1959). Significant correlations (although low) were found between ASI

scores and palmar sweating, a projective measure of stage fright, and with the Manifest Anxiety Scale. Paivio's theoretical orientation involves the postulate the differences in audience anxiety and sensitivity may be traced to learning histories of individuals. If the individual is consistently reinforced or punished by various audience behaviours, low or high audience anxiety and sensitivity respectively will be the result. It is, however, evident from Paivio's writings that he has made little attempt to keep audience factors constant whilst studying individual differences. He acknowledges that audience factors are important in determining the traits of audience anxiety and sensitivity; in fact, these factors may be wholly responsible for the development of the traits. For this reason Paivio's theory will be further considered in a later section examining audience characteristics.

There are several other measures of anxiety which can be considered with respect to the drive theory of social facilitation. One of these is the Test Anxiety Scale (e.g. Sarason, 1958). Cox (1966, 1968) found that the presence of an audience facilitated the performance of low-anxious subjects and interfered with the performance of high-anxious subjects in a marble-dropping task. These results are against the unrevised version of Zajonc's (1965) theory, but in accordance with the inverted U relationship between performance and general arousal suggested in the last section as an addition to the original Zajonc theory. Cox's results can be explained rather nicely, it would seem, by suggesting the summation of arousal levels induced separately by both audience and anxiety,

if these are assumed to be independent sources of general drive. Unfortunately, the Test Anxiety Scale may not be measuring a source of general drive, but rather a specific drive level (Wine, 1971). If this is so, summation would not be expected (Berkey & Hoppe, 1972).

What seems to be required for a test of the summation of anxiety with audience hypothesis is a measure of anxiety which is indicative of a general level of drive. The MAS (Taylor, 1953) seems to lend itself to this end. Although this well-used test was originally designed to measure individual differences in general drive within Hull-Spence theory, it has received only scanty attention within social facilitation research.

Spence, Farber & McFann (1956) found that subjects who scored high on the MAS learned more slowly than low scorers on competition lists of paired associates. High anxiety subjects, on the other hand, tended to score better than low anxiety subjects on non-competition lists. The competition lists were so constructed to have many competing responses, whereas the non-competition lists had few. These data were taken as support for the hypothesis that high-scorers on the MAS were operating under high drive, and low scorers under low drive conditions.

Cottrell, Rittle & Wack (1967) used the same competition and noncompetition lists as Spence et al (1956) in an attempt to test Zajonc's hypothesis. Results were in accordance with predictions, i.e. subjects with an audience behaved like subjects high scoring on the MAS, and subjects alone behaved like subjects scoring low on the MAS.

Berkey & Hoppe (1972) combined the rationale of the above two studies in an attempt to test the hypothesis that summation of the two sources of drive (anxiety and audience) would occur. The same lists of paired associates as in the above two studies were used as well as the presence or absence of an audience with high and low scores on the MAS. Results partially supported the summation of drive sources hypothesis according to Hull-Spence learning theory. That is, the presence of an audience produced the best learning of the noncompetitive list and the poorest learning of the competitive list by highly anxious subjects. But the lack of significant differences in the learning of the noncompetitive list did not support summation of drive. The authors suggested that the noncompetitive list might have been too easy for the (college) subjects used, so that insufficient variation in performance was observed in order to test drive effects of audience and anxiety.

The suggestion by the Iowa group that the MAS measures drive has been attacked from several different theoretical viewpoints. At least one factor analysis of the MAS (O'Connor et al, 1956) found at least five factors, some of which appeared to be more like intelligence, clerical ability and anxiety specific to conditioning apparatus (Kamin, 1955). MAS scores have also failed to correlate with level of reactivity, or conditionability of the GSR (e.g. Bitterman & Holtzman, 1952). A recent study involving the children's form of the MAS found no interactive or summated effects of anxiety scores with the stress of threatened shock, although separate



curvilinear (inverted U) relationships of each of these independent variables was found with motor performance (Martens & Landers, 1970). Their failure to find a significant stress X anxiety interaction is equivocal with the findings of Shore (1958). He did find a significant interaction between three anxiety groups and four levels of muscular tension during a perceptual recognition task. High anxiety subjects increased their efficiency, while low anxiety scorers showed a decrease in efficiency as induced effort was increased. Moderate anxiety subjects first increased to an optimal level, then decreased in efficiency. Martens & Landers (1970) did not elaborate on their failure to find MAS scores interacting with stress in the face of Shore's (1958) findings, apart from suggesting (the usual!) differences in tasks and methods of creating arousal.

For the purposes of studying audience effects, these criticisms of the MAS make its use in testing for arousal differences rather equivocal. Spence and Taylor themselves admit that there are two possible interpretations of the characteristics underlying differences in MAS scores. High anxiety subjects may differ from low anxiety subjects in having (a) higher prevailing levels of anxiety drive most of the time, regardless of environmental conditions, or (b) larger increments in anxiety drive levels whenever they are exposed to stressful environmental conditions. It is important to emphasise these different interpretations because they will lead to different predictions regarding the outcome of arousal increments as a result of task factors and audience. The Iowa

group have found evidence for both (a) and (b) (e.g. Taylor, 1956). This weakness in the theoretical usefulness of the MAS has been attacked by authors such as Eysenck (1957, 1967), who prefers to use the personality variable (or "type", in Eysenck's terminology) of neuroticism.

#### I.4.2. Neuroticism (N).

The term "neuroticism" is an unfortunate choice by Eysenck, for being neurotic is not a prerequisite to score highly on this personality dimension. A more descriptive term, and one which is used more widely, is emotional reactivity. Neuroticism is described by Jones (1960) as

" .... low tolerance for stress, whether it be physical, as in painful situations, or psychological, as in conflict or "frustration" situations. In learning theory terms, an individual scoring high on the factor of neuroticism would be characterised by a high level of drive in avoidance situations. High appetitive drives are not necessary to the theory ...." (p.492).

Eysenck has been one of the most vehement of Spence and Taylor's critics. For example, Eysenck found MAS scores to be positively correlated with both neuroticism and introversion. Some of the early studies by the Iowa group on eyeblink conditioning had shown that high anxiety subjects established the conditioned response faster than low anxiety subjects (e.g. Spence & Taylor, 1951). Eysenck suggests that it is really the higher conditionability of introverts which is reflected in these studies and cites in support of this, the well-known Franks (1956) experiment showing dysthymic neurotics (high N and high Introversion) to be faster conditioners than normals, whereas hysteric neurotics (high N

and high Extraversion) conditioned slower. The finding of a positive correlation between MAS scores and N scores, on the other hand, is one which has been reliably found also by other researchers (e.g. Nettlebeck, 1973), so that whatever it is that neuroticism measures, MAS scores must measure a similar underlying dimension. But since the MAS seems to measure other factors also, it would seem to be not the most satisfactory instrument neither for the purpose to which it has been applied, nor for the purpose of clarifying arousal consequences of the presence of an audience.

Eysenck's variable of neuroticism seems to have had more success in staving off critics. Eysenck (1967) suggests that theory underlying the neuroticism dimension is that it is a process rather than a state of the organism. That is, high N subjects react much more strongly than low N subjects in stressful or emotion-provoking conditions. Remember that one of the criticisms of manifest anxiety is that it could be interpreted as either a process or a state (Section I.4.1.). This criticism cannot be leveled at neuroticism in its modern interpretation (Eysenck, 1967). Evidence has also been presented which attempts to link the postulate directly to physiological arousal (Eysenck, 1967; Welford, 1965). Recall also in Section I.3.2. of this chapter, Routtenberg's (1968) physiological model of the arousal mechanism. According to this model, there are two mutually inhibitory arousal systems. It is the second arousal system (limbic system) which Eysenck relates to the neuroticism dimension. According to Eysenck's and Welford's theories, cortical arousal can be produced via these two distinct systems:

"It can be produced by sensory stimulation or by problem-solving activity of the brain, without necessarily involving the visceral brain (limbic system) at all; in this case, we have not autonomic arousal, but possibly quite high cortical arousal ... Cortical arousal can also be produced by emotion, in which case the reticular formation is involved through the ascending and descending pathways connecting it with the hypothalamus. In this case, we have both autonomic arousal and cortical arousal". (Eysenck, 1967, p.232).

The implications for high N scoring subjects in stressful situations is that they will quickly become autonomically and cortically over-aroused. If the inverted U relationship between performance and (both) arousal(s) holds, then it would be expected that high N subjects would show a decrement in performance in stressful or emotion-provoking situations, whereas low N subjects would not. If we add to this situation the factor of audience with its postulated arousal increment, the prediction becomes: high N subjects with audience will perform worse than low N subjects with an audience under stressful conditions. This prediction can be modified even further if recent evidence regarding the underlying nature of an audience is taken into account (Weiss & Miller, 1971). If it is accepted that the effect of audience is not only arousing, but also aversive (Weiss & Miller, 1971), then we have the prediction that the presence of an audience per se (since it itself is stressful) should be sufficient to detrimentally affect high N subjects performance. Weiss & Miller's postulate will be further discussed in the next section.

#### I.4.3. Extraversion (E)

How does the personality dimension of extraversion fit into the drive theory of social facilitation? A great deal

of evidence exists that introverts are chronically more highly aroused (cortically) than extraverts (e.g. Eysenck, 1967; Gale et al, 1969; Gale 1973; Savage, 1964). Similarly, a body of behavioural evidence from the areas of motivation, learning, perception, vigilance and psychopharmacology seems to be consistent with this postulate (reviewed by e.g. Eysenck, 1967). The physiological basis differentiating extraverts and introverts is therefore considered to be the chronic level of arousal which is assumed to be a function of the rate of accrual and dissipation of cortical inhibition. In extraverts inhibitory processes occur quickly, strongly and persistently, while excitatory processes occur slowly, weakly and non-persistently. The reverse is applicable to introverts. While it is interesting to note how Eysenck has developed his position on extraversion from a neo-Pavlovian model espousing differences in cortical excitation-inhibition (1957) to the model involving arousal states and processes (1967), for the purposes of testing audience effects, it is the latter model which is likely to be most useful. If extraverts have a lower chronic level of arousal than introverts, then this should show up as differences in performance under audience conditions. Extraverts should facilitate more than introverts, and if the inverted U curve is postulated, introverts may even show a decrement in performance under an audience if overarousal is assumed.

#### 1.4.4. Emotionality.

An individual difference factor which has been of interest especially amongst animal researchers is emotionality

(summarised by e.g. Broadhurst, 1957, 1958). In fact, it seems as if the personality variables of neuroticism and anxiety in humans are very closely related concepts with emotionality. While the personality variables are often measured by the use of inventories or questionnaires, emotionality in rats has been allegedly measured by a variety of methods (Broadhurst, 1957, 1958). These include defecation, urination, "freezing", trembling, jumping, washing, rearing, latency, and activity in an "open-field" box. While defecation seems to be a generally used and valid measure of emotionality (Hall, 1934; Broadhurst, 1957, 1958), the appropriateness of some of the other measures mentioned has been questioned. Ivinskis (1966), for example, found that in the open-field situation with two types of stressful stimuli (noise and bright light), only defecation and urination scores correlated significantly, while washing and activity were poor measures of emotionality. In 1970 he added latency to the validated list.

There have been some attempts to link emotionality measures to arousal or general drive. For example, Ley (1975) took defecation measures of male hooded rats in an open field situation and during aversive classical avoidance conditioning which followed. Assuming that defecation during avoidance conditioning is an index of the strength of the CER (conditioned emotional response), Ley's finding of significant positive correlations between open-field defecation measures and defecation measures during conditioning support the hypothesis that emotionality can be construed as a dispositional

characteristic which contributes to general drive. Also, there seemed to be an inverted U relationship between open-field defecation and the speed of the (hurdle-jump) response, i.e. low speeds by low and high defecating subjects, and higher speeds by moderate defecating subjects. This finding fits in rather nicely with the predictions about (stressful) task performance by low and high neuroticism subjects discussed previously. Predictions regarding the outcome of adding an audience to stressful situations would also be similar when taking subjects scoring high and low on emotionality measure.

The apparent similarity between neuroticism measures in humans and emotionality measures in other animals has also been found in a quite different way by Chamove, Eysenck & Harlow (1972). They factor analysed (following Eysenckian techniques) social interaction data from 168 macaques. Within a stable group situation and in less stable dyadic and triadic situations, the authors performed three separate factor analyses on ten behavioural measures. Two of the independent factors which emerged were interpreted as affiliative and fearful. The authors argued that these factors were similar to extraversion and neuroticism in humans respectively. A similar analogy between neuroticism and emotionality has been drawn up elsewhere also (Eysenck & Broadhurst, 1964) in an attempt to increase cross-species generality of various theoretical constructs of individual differences of this kind. Experiments by these authors attempting to summate drives (hunger and air deprivation) of rats selectively bred for high and low defecation scores in the open-field situation, have met with mixed success.

Some evidence was obtained, however, of emotionality summing with air deprivation in one of the above studies (Broadhurst, 1964).

To the present author's knowledge, no attempt has been made to date to study the variable of emotionality in relation to the effects of audience, although some coaction studies have been carried out (e.g. Warren & Ivinskis, 1972). These have generally not gone beyond testing in the open-field situation of, for example, exploratory behaviour, early social experience and handling of rats.

#### I.5. Characteristics of the Audience Stimulus.

As has already been stated, the Zajonc position on social facilitation is that the mere presence of others is arousing. Several modifications have been suggested to this audience characteristic. The question as to whether the mere presence of others is a sufficient condition to produce social facilitation effects has received most attention.

Cottrell et al (1968) tested the mere presence hypothesis in a pseudorecognition task under three conditions: alone, two observing peer spectators, and two blindfolded peer spectators. In a pseudorecognition task, subjects first acquire a set of verbal habits of different strengths, by the experimenter manipulating the number of times which subjects had to pronounce a series of nonsense syllables. These same syllables have then to be "identified" when briefly presented on a screen. On most trials, the syllables are not presented at all so that subjects have to guess. Under these conditions subjects tend to guess more frequently syllables of higher



habit strength (dominant responses). In Cottrell et al's (1968) experiment, dominant responses were facilitated only in the observing peer spectator condition, and not in the mere presence condition which produced similar results as the alone condition.

From these results, Cottrell et al (1968) and Cottrell (1972) argue that it is not the mere presence of an audience, but the evaluation or the evaluative potential of the audience which is responsible for audience effects. The blindfolded spectator condition, although "merely present", could not evaluate the subject's performance, since visual stimuli were used in the task.

Cottrell's interpretation has received additional empirical support from several other studies. Henchy & Glass (1968), also with a pseudorecognition task, used an "expert" audience condition and a "non-expert" audience condition and compared subjects' performance in these with an alone condition. In the expert audience condition, subjects were told that their performance was being evaluated by two "experts" in perception and human learning", whereas the non-expert audience consisted of two "students from another college". Their results showed that the greatest facilitation of dominant responses occurred in the expert condition. Similarly, Paulus & Murdock (1971) varied the evaluative component by leading subjects to believe that their task performance would be evaluated either after or during the pseudorecognition task. The hypothesis that anticipated evaluation by subjects facilitated performance was supported. Interestingly, the presence or absence of an audience (without evaluative power) did not alter the emission

of dominant responses. In a quite different setting, Bergum & Lehr (1963) found that vigilance performance by National Guard trainees could be drastically improved by instructing one group that visits from a superior officer could be expected during the task. These visits took place four times during the 135 minutes of the monitoring task. It seems as if anticipated evaluation by a high status person was responsible for this group's better performance.

Both Paulus & Murdoch (1971) and Henchy & Glass (1968) suggest that evaluation or evaluation apprehension are necessary conditions for obtaining social facilitation effects. Cohen & Davis (1973) found that evaluation in the form of performance ratings by the audience increased the intensity of the social facilitation effect, although a "neutral" audience (passively observing undergraduates) produced a smaller, but still significant increment in performance. One wonders though, how closely similar this "neutral" audience was to Cottrell et al's (1968) blindfolded audience in terms of mere presence.

Although assigning an evaluative role to the audience seems to make a difference in the social facilitation effect in these studies which used human subjects, it clearly cannot be the whole explanation. How does one assign a concept with cognitive overtones such as "evaluation apprehension" to a variety of species other than human? Yet, the evidence clearly points to the high cross-species generality of the social facilitation effect. What seems to be required is a more general modification of Zajonc's theory which takes into

account audience factors such as evaluation, status, neutrality, etc. Such an extension of the theory has been suggested by Cottrell (1968, 1972).

Cottrell, whilst accepting the major tenets of Zajonc's theory, attempted to integrate findings that seem to both contradict and support the theory. He suggested that the drive or arousal increasing property of the presence of others is created through social learning, and is not innately present as Zajonc's theory implies. Cottrell suggests that the presence of others is a learned source of drive (Brown & Farber, 1968) and hence subject to secondary reinforcement. He argues that various forms of aversive and appetitive stimulation occurring throughout the organism's stimulus history are spatially and temporally paired with the presence of others. For example, others are often sources of frustration, praise or reward, and criticism or punishment. Through the usual processes of classical conditioning, the organism eventually responds to only the presence of others by anticipating positive or negative outcomes. It is these anticipations, elicited by the presence of others, that increase the organism's arousal level.

Cottrell (1972) claims that when anticipation of evaluation is removed (and hence praise or criticism anticipations are removed), such as in the aforementioned studies by Henchy & Glass, and Paulus & Murdoch, the presence of others is not arousing. In animal subjects, where the concept of evaluation is not applicable, previous social experience with other animals of the same species can

similarly serve as elicitors of anticipations of positive or negative outcomes to increase arousal. For example, within groups, the feeding behaviour of a single animal is often frustrated by other animals who may steal food and cause other interruptions to the behaviour sequence. The animal eventually (after sufficient pairings) comes to anticipate frustration in the presence of others, and hence its arousal level increases. It is possible to explain results from studies mentioned earlier (e.g. Harlow, 1932; Vogel, Scott & Marston, 1950) in this way. Similarly, the role of prior social experience in social facilitation of feeding (e.g. James, 1960; James & Gilbert, 1955) seems to fit in with Cottrell's theory.

Evidence against Cottrell's theory comes from a study by Clark & Fouts (1973) who experimentally associated an audience (the experimenter) with positive, neutral, or negative experiences of preschool children. There were no differences between the neutral and negative conditions, but a decrement in performance was found in the positive condition. In view of the mainly verbal manipulation of social experience with these very young subjects, however, one may well question whether this was an adequately manipulated independent variable.

Support in a less direct manner for Cottrell's revision of Zajonc's theory comes from studies by McClelland & Apicella (1945) and Schalon (1968). In these studies, aversive social stimulation delivered in the form of critical comments or reports of failure have led to marked changes in performance,

both positive and negative, suggesting that social experiences exert powerful control over performance and motivation.

Zajonc (1972a) has not fully agreed with Cottrell's learned drive interpretation and quotes a study in which subjects were required to perform a complex stylus maze task. Subjects were specifically instructed to work as carefully as possible so that errors would be minimised. If subjects perform so as to gain the maximum positive outcome in an evaluative situation, then the presence of an audience should increase this effect and subjects would perform more carefully, and hence more slowly. But if the presence of an audience increases arousal, it should speed up performance even if this results in a larger number of errors. The results of the experiment showed faster performances in the presence of an audience, hence supporting the mere presence theory.

It might well be argued that this is not a fair way of testing between Zajonc's and Cottrell's theories. Cottrell argues that a higher nonspecific arousal state is produced by evaluation and by anticipating aversive or rewarding consequences. Zajonc argues that an audience per se increases arousal. It is probably a much more difficult task to realistically separate these factors than has been attempted in the above experiments. Even if subjects are instructed to minimise errors and evaluation apprehension, there is no guarantee that they will do so; this is very much like Allport's (1924) attempt to minimise competition between subjects by simply instructing them. Criticisms of the latter can be found earlier in this chapter. The suggestion that the

factor of evaluation per se may be responsible (in studies where human subjects are used) for differential performance effects seems refuted also in an experiment by Innes & Young (1975). These authors found that, although the evaluation factor (high and low) was not significant in the learning of a mirror drawing task, the interaction of evaluation with audience (present or not) and a condition in which the subject was exposed to an image of himself (a mirror present or not) was significant. This suggests that evaluation as a separate factor takes on meaning only in conjunction with these other variables. The fact that the audience effect was also found in the low evaluation condition (with a "nonevaluative" observer) suggests that either evaluation is difficult to vary without an audience, or that the factor is not wholly responsible for the audience effect.

A few years ago, Weiss & Miller (1971) expanded on Cottrell's view that the drive induced by audience is learned (secondary). If the learned drive hypothesis is correct, then

"the drive induced by audience observation is not an appetitive drive like hunger or thirst, but an aversive one like frustration or anxiety. This point follows directly from Cottrell's learned drive interpretation, since the evidence is abundant that learned drives are based on noxious primary drives like pain (e.g. Miller, 1948) and frustration (e.g. Daly, 1969; Wagner, 1963) and cannot be based on appetitive drives like hunger and thirst (e.g. Cravens & Renner, 1969; Myers & Miller, 1954; Novin & Miller, 1962)."

(Weiss & Miller, 1971, p.44).

Weiss & Miller correctly note that most research within the context of the drive theory of social facilitation has made use of the irrelevant drive paradigm. Typically, the arousing effects of audience are assumed to have irrelevant drive

properties unrelated to reinforcement contingencies. But response energisation is only one of the possible effects in which a relevant drive paradigm is used. If audience could be used as a drive which is relevant to the reinforcement contingency, a host of other predictions can be derived.

It should perhaps be added at this point that it is not necessary to remain within the framework of Hull-Miller-Spence learning theory (as do Weiss & Miller) in order to derive predictions of this kind. What is necessary, however, is to assume that the audience stimulus is a stimulus of a particular type. Weiss & Miller suggest that audience has aversive properties. There is also evidence from outside the Hullian framework to suggest that this is the case. We have already discussed for example, Paivio's work on "audience-anxiety" and "stage-fright", suggesting that an audience is anxiety inducing.

One prediction which seems to be an intriguing possibility is that if an audience is an aversive stimulus, then by making it contingent upon an already learned response, suppression of this response ought to occur. This is, in fact, the classical punishment paradigm (e.g. Church, 1963). Although sometimes "paradoxical" effects of punishment (i.e. facilitation of the response) are observed (Whiteis, 1956; Appel, 1960; Ferster & Appel, 1961), the conditions under which these occur have been sufficiently mapped out (e.g. Appel & Peterson, 1965). Church (1963) has indeed argued that such effects occur in spite of, rather than because of, punishment. In most cases, however, where an aversive stimulus is made response contingent,

suppression has been the outcome. Although most work reported in the literature on aversive stimulation has involved shock stimuli, recently a variety of stimulus dimensions has been shown to produce contingent response suppression so that aversiveness may be assumed to be a common characteristic (e.g. noise (Azrin, 1958); blasts of air (Church, 1969)).

It is therefore reasonable to suppose that social suppression is a distinct possibility if the punishment paradigm is used with audience as the (presumed) aversive stimulus. An additional appealing feature of the punishment paradigm is that it is not specific in its interpretation to a Hullian learning theory framework, even though the original equating of an audience with an aversive stimulus may have been derived from it. Much work in the area of aversive stimulation has been done, for example, within the context of operant (and classical) conditioning (e.g. reviewed by Fantino (1973)), and this offers distinct advantages also in the study of social stimulation from audiences. These advantages do not solely stem from recent extensive criticisms of Hullian and neo-Hullian learning theory (e.g. Hilgard & Bower, 1975).

#### I.6. The Use of Operant Behaviour in Studying Social Facilitation.

It is surprising to find only little use of operant conditioning as an experimental situation for studying social facilitation effects, especially as this appears to be a



promising line of research. A number of reasons support this statement.

First, operant responses in a standardised experimental situation can be tightly controlled with respect to independent variables. Changes in stable response rates, for example, are believed to reflect the manipulation of one or more independent variables. Since there is usually little ambiguity that the dominant response is the conditioned response (once stable responding is attained), these situations should lend themselves well to testing Zajonc's theory. One of the few studies to have utilised operant behaviour to this end is Heingartner's (1970), which has been described already.

Second, there already is some evidence available which suggests that with stable response rates maintained on positive reinforcement schedules (Ferster & Skinner, 1957), the conditioned suppression procedure (Estes & Skinner, 1941) is sensitive to social facilitation effects. In a study by Hake & Laws (1967), stable response rates by pigeons pecking for food in Skinner boxes on a VI (variable interval) schedule were first attained. The conditioned suppression procedure was then instigated by occasionally presenting a 1.5 sec. warning stimulus followed by shock at irregular intervals. The resulting suppression during the warning stimulus periods was found to be susceptible to both coaction and audience. On alternate days, a second pigeon was introduced in an adjacent box separated from the first pigeon by a transparent partition. The second pigeon had been conditioned to key peck

only during the warning stimulus. The effect was to reduce the suppression of the first bird during the warning stimulus periods. In a follow up experiment, Hake, Powell and Olsen (1969), this decrease in suppression was found to be greater at higher shock intensities.

Third, studies already referred to have used operant behaviour to study social facilitation effects. There is, for example, the study by Metzger (1971), who found, in a Sidman avoidance schedule with shock as the aversive stimulus, both facilitation and disruption of the avoidance behaviour when a spectator rat was introduced in a special audience compartment in a Skinner box.

There is also the study by Ader & Tatum (1963) in which the learning rates of two human coactors were compared with learning alone of a free-operant avoidance response. Subjects were required to learn a button-press response to avoid electric shock through electrodes attached to each leg. No instructions were given to subjects, and once the experimenter left the room, shocks were delivered at a rate of one every 10 seconds. A button-press could delay the next shock by 10 sec., so that the shock-shock interval equalled the response-shock interval (both 10 sec.). Out of the 12 pairs of (yoked) coactors, 3 pairs "walked out", 7 pairs did not reach the learning criterion (less than 5 shocks in 5 mins.) and 2 pairs did reach criterion. Out of the 12 individual subjects alone, there were 2 walk-outs, 2 non-learners, and 8 learners. The paired learners, after reaching criterion, responded at considerably higher rates than the

individual learners' post-criterion rates. Zajonc (1965) quotes this experiment to support his theory.

Similarly pointing in the direction of greater stress and arousal in the presence of others in already stressful tasks is the experiment by Brady, Porter, Conrad & Mason (1958) in which rhesus monkeys restrained in a chair were required to learn and perform a free-operant avoidance schedule with electric shock as the negative reinforcer. After completion of the spectator condition, in which subjects were required to avoid shock both for themselves and one yoked spectator on a 6hr. on, 6hr. off schedule, all subjects showed extensive gastrointestinal lesions, whereas none of the yoked control subjects showed these. In the experiment it was observed that whenever a shock was delivered, one effect was the communication of distress and "anger" by the yoked spectator to the subject. The possibility that this social aversive stimulus might be responsible for the ulceration in subjects was in fact ruled out in a follow up experiment by Brady (1958). Isolating the subjects from the yoked spectators in sound-proofed "telephone-booths" did not change the results. As a result of further investigation into the time relationship between periods of on-avoidance and off-avoidance, Brady concluded that this was the crucial factor producing ulceration and not the social situation per se. He also found that most acid secretion into the stomach of subjects took place during the off-avoidance periods and not the on-avoidance periods. The analogous (hypothetical) situation in human terms might be to suggest that it is the

anticipation of aversive stimuli which is the significant variable and not the aversive stimuli themselves. However, social factors may still play a role in producing the altered physiological states which ultimately lead to ulceration. This conclusion was also reached by Conger, Sawrey and Turrell (1957, 1958) using grouped and solitary rats as subjects in a conflict situation.

The approach taken by Brady (1966) and his associates seems to be an important one for our purposes, because their findings relating physiological changes in operant behaviour, especially involving aversive stimulation, can relate rather well to the drive theory of social facilitation. As has already been mentioned, there is some indirectly supporting physiological data for Zajonc's arousal theory, in the form of elevated urinary and plasma levels of 17-hydroxycorticosterone as an index of pituitary adrenocortical activity in animals in the presence of others. These raised steroid levels are also reliably found in the performance of Sidman avoidance (Sidman, Mason, Brady & Thach, 1962), where shock serves as the primary negative reinforcer. On the other hand, this arousal response is neither found in positive reinforcement schedules (i.e. not involving aversive stimulation), nor in abrupt changes in FR (fixed ratio) schedules from low to high values, nor in extinction to positive reinforcement schedules. (Mason, Brady & Sidman, 1957). Although initially it was not clear whether the arousal response could be attributed to the response-shock interval, the shock frequency or the rate of avoidance responding, a series of ingenious follow up experiments demonstrated that the lever-press avoidance

response per se seemed to be the critical determining variable of the arousal changes, independently of the shocks. Similarly, covariation of lever-pressing and steroid levels was demonstrated while holding the response-shock interval constant (Brady, 1966).

The implication for experimentation within the context of the drive theory of social facilitation seems to be very clear from the above review. Response levels are indicators of arousal levels in Sidman avoidance situations, so that differential responders may be considered to be operating under differential arousal levels. Any social stimulation will have to superimpose on (e.g. combine additively with) these existing different arousal levels. It seems now possible to predict with some greater accuracy when different degrees of (overall) arousal will be attained in social facilitation experiments using Sidman avoidance. It is this rationale which underlies the experiments reported in chapters II, III, V.

The following salient points illustrate the importance of the use of operant behaviour in studying audience effects in social facilitation.

Operant behaviour can be measured with relatively well understood dependent variables, and controlled in standardised experimental situations. The operant literature is full of examples in which changes in the environment (or in the schedule requirements) are correlated with response rate, reinforcement rate, etc. changes.

The stability of response rates after extended periods of baseline running on many schedules makes this variable

especially useful as a dependent measure, particularly as there is usually little ambiguity that the operant response is the dominant response. Sidman (1960) suggests that the ideal choice of a baseline should possess three aspects: stability, sensitivity to the experimental manipulation, and control of extraneous processes. These, he suggests, can be obtained conveniently with the use of operant techniques.

Motivational variables have often been tested with the use of operant responses (on timebased schedules) as the dependent measure (e.g, Teitelbaum, 1966) so that hypothesised motivational effects in social facilitation may be usefully compared with these.

The reinforcing nature of stimuli is often conveniently demonstrated in operant paradigms. For example, overwhelming evidence shows that making appetitive (positively reinforcing) stimuli contingent upon an operant response will strengthen (i.e. often increase the frequency of) that response, whereas contingent aversive stimuli will usually suppress the response. It follows that precise and reliable response measures are necessary to determine these effects, particularly as they may apply to testing the nature of an audience stimulus (see I.5, last two paragraphs).

Lastly, there is some evidence available which suggests that responding in operant paradigms involving aversive stimuli is susceptible to social facilitation.

For all of these reasons, it is expected that the use of operant paradigms should prove fruitful in further investigating the nature of the audience effect.

### I.7. Summary of Experimental Hypotheses.

From the foregoing sections, the following hypotheses may be derived.

1. In stressful avoidance situations, differential arousal levels will combine additively with audience induced arousal so that at high levels of arousal, performance is impaired and at low levels of arousal, performance is facilitated by the presence of an audience, (see I.3.2).
2. If being observed by an audience is aversive, then performance by high N subjects will be impaired, whereas performance by low N subjects will be facilitated by the presence of an audience, (see I.4.2).
3. Performance by high emotionality rats will be impaired, whereas performance by low emotionality rats will be facilitated by the presence of an audience, (see I.4.4).
4. If an audience is an aversive stimulus, then responding maintained by positive reinforcement will be suppressed by a superimposed audience contingency, (see I.5, last two paragraphs).

CHAPTER 11EXPERIMENT 1. SOCIAL AND SOLITARY RESPONDING BY RATS ON A  
SIDMAN AVOIDANCE SCHEDULE AS A FUNCTION OF VARYING AROUSAL  
LEVELS

The purpose of this experiment was to ascertain whether varying arousal levels on a Sidman (free-operant) avoidance schedule would produce facilitation or impairment of performance in the presence of an audience. If the inverted U hypothesis linking performance with arousal is correct, and if the drive theory of social facilitation holds, it would be expected that:

- (a) at low levels of arousal, the introduction of an audience will facilitate performance;
- (b) at moderate levels of arousal, the introduction of an audience will produce little, if any, change in performance;
- (c) at high levels of arousal, the introduction of an audience will produce impairment of performance.

In Sidman avoidance, two timers regulate delivery of the aversive stimulus : (a) the Shock-Shock (S-S) timer, which is in operation in the time interval when no responses are emitted, and (b) the Response-Shock (R-S) timer, which is in operation in the time interval when responses are emitted. For example, when the S-S timer is set at 5 sec. and the R-S timer at 10 sec, the schedule begins with only the S-S timer in operation and shocks are delivered every 5 sec. When a response is emitted, the S-S timer is stopped and the R-S timer now operates. If another response occurs within 10 sec., the R-S timer is reset and a further 10 secs. are given until the next shock. If no further response is emitted the S-S timer restarts and shocks are delivered every 5 sec, and so on. Hence all shocks can be avoided by responding at least once in every 10 sec. period.



The Sidman avoidance schedule seems especially well suited to test the hypotheses (a), (b) and (c) for the following reasons.

First, performance on the schedule is known to be sensitive to audience effects (Metzger, 1971); Ader & Tatum, 1963).

Second, a steady rate of response can be achieved and maintained over long periods of time (Sidman, 1952), so that performance changes corresponding with immediate environmental changes may be compared with the animal's stable baseline performance.

Third, it is suggested here that an indication of arousal levels in Sidman avoidance situations is the response rate, so that for example, relatively high response rates are indicative of relatively high arousal levels. This suggestion is supported by the commonly held assumption that rate of responding increases with higher D (Kimble, 1961). It is also supported, though indirectly, by Sidman et al's (1962) results that the avoidance response per se can activate the pituitary-adrenocortical system, independently of the shocks delivered. (As has been described already, the activity of this system is a reasonable index of general arousal level.) The number of shocks delivered also affected the "arousal-system", although the relative contribution to the system's corticosteroid output was not clear. It has been shown, on the other hand, that in studies with shock duration held constant, response rates increase as a monotonic function of shock intensity (Powell, 1971; Riess, 1970), so that it is fair to assume that increasing shock intensity is associated also with higher arousal levels. At high shock intensities, however, there seems to be no further increase in response rates (Boren, Sidman & Herrnstein, 1959) and under high values of aversive drive, decreases in avoidance responding have even been reported (Kaplan,

1952; Denenberg & Bell, 1960). Also, under low aversive drive avoidance responding is sometimes facilitated (Brush, 1957).

For all of these reasons, it seems reasonable to conclude that of the baseline response levels obtained in Sidman avoidance tasks, relatively high response rates are indicative of high arousal levels, and relatively low response rates are indicative of low arousal levels. Introducing an audience to a low responder should facilitate performance; introducing an audience to a high responder should impair performance.

Similarly, increasing the shock intensity to a higher level should impair the performance of high responders and facilitate the performance of low responders in related to baselines. At these higher shock intensity levels, high responders with an audience should show even greater impairment compared with that expected by changing to a higher shock intensity alone. At these higher shock intensities, low responders should show facilitated performance, but if an audience is added, performance may facilitate further if the "hump" of the inverted U has not been reached, or performance with an audience may be impaired if performance at the higher shock intensity is already over the "hump".

Zajonc's theory, on the other hand, would predict that, regardless of the initial level of general arousal, the mere presence of an audience should show up in performance (response) facilitation.

An attempt was also made to determine whether changes in avoidance performance (due to the presence of an audience) could be produced also by systematically changing the shock intensity used in the Sidman avoidance schedule.

## METHOD

### Subjects:

Twelve hooded, Wistar-strain, male rats were used as subjects and another twelve were used as audience rats. At the beginning of the experiment, all animals were about 60-90 days old, and were experimentally naive. The animals had been bred at the University's rat colony. From the time at which they arrived at the Department's animal housing room, they were all housed singly and given ad lib food and water. Numerous other rats were also housed in the holding area. Prior to the experiment proper, all subjects were handled for about 10 mins. per day for 10 days, in order to reduce the possibility of emotional behaviour interfering with performance.

### Apparatus:

Four "audience Skinner boxes" were specially constructed (Fig.1), each 22cm x 22cm x 22cm with two aluminium walls and perspex back, front and roof, and completely enclosed in a sound-attenuating chamber with an airfan and darkened observation window. The grid floor was made of stainless steel rods 1.3cm apart. Each box was divided into two equal sized compartments by two vertical grids in which the rods had been spaced 1.3cm apart. The two vertical grids were 2cm apart. One compartment contained a bar placed 7cm above the floor; each bar press was accompanied by the presentation of a brief response feedback light situated above the bar and a loud click. This compartment contained only subjects, while the other contained only spectators.

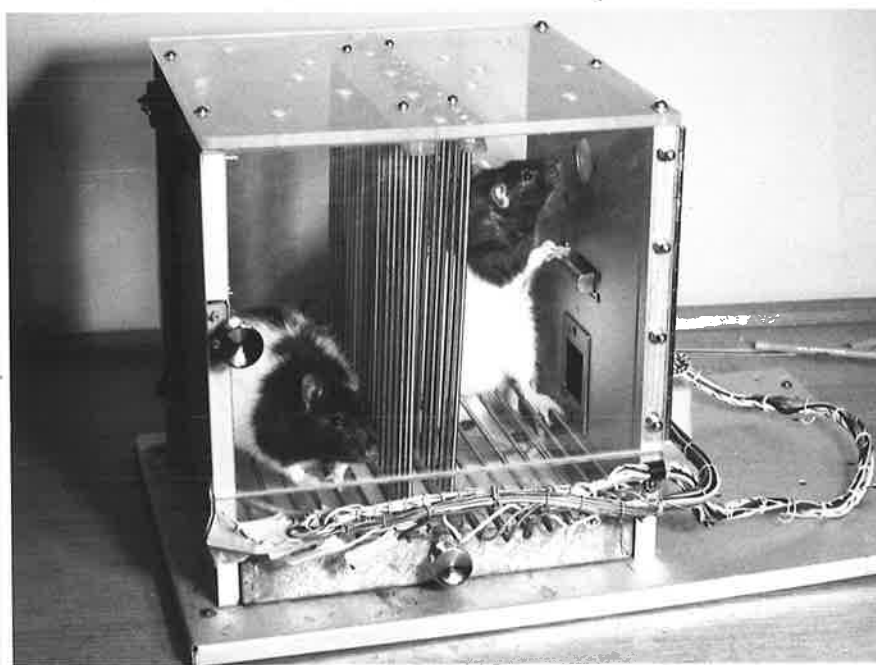


Fig. 1: Audience Skinner Box Used in Experiments  
1 and 3.

The grid floor and the vertical grid of the subject compartment were wired into a Grason-Stadler shock scrambler. The DC generator delivered shocks of 0.5sec. duration, while the intensity of shocks could be adjusted from 0.5 ma to 4 ma. Automatic timers regulated shock delivery. The shock-shock (S-S) interval was 5 sec. and the response-shock (R-S) interval was 30 sec., this particular schedule having been shown to maintain steady responding for several hours (Dalziel, 1970), and to have been sensitive to social facilitation in a similar apparatus (Metzger, 1971).

The vertical and floor grids of the spectator compartment were not connected to the generator, so that there was no possibility of the spectator receiving shocks. Two 5-watt houselights in the spectator compartment provided illumination within the Skinner Box.

The number of responses made by each subject, and the shocks delivered, were recorded on mechanical counters and cumulative records.

#### Experimental Design and Procedure:

Initially, all subjects were conditioned alone on the Sidman avoidance schedule with S-S=5 sec, R-S=30sec, shock duration = 0.5sec, intensity = 0.5mA. Although this is a relatively low intensity shock of a relatively short duration, with respect to usual Sidman avoidance stimulation, pilot studies carried out by the author showed that stable baseline response rates could be attained and maintained using these variable values. It was important to maintain baseline performance using this relatively mild aversive stimulus, so that overarousal would be unlikely to occur during baseline sessions.

All 12 subjects were given daily 2 hr. sessions throughout the experiment; these were conducted at approximately the same time each day. At the end of the 75th session all animals had attained the baseline criterion set at 3 successive sessions in which mean response rates did not vary more than  $\pm 10\%$ .

At this point the animals were divided into 3 groups of 4 on the basis of their ranked mean baseline response rates, so that the 4 fastest responders constituted the "Fast Responding Group", the next 4 constituted the "Medium Responding Group", and the 4 slowest responders formed the "Slow Responding Group".

Each animal underwent four experimental treatments:

- (a) Spectator observation (Sp), which involved the inclusion of a naive spectator rat in the audience compartment for the full length of one session. The subject was again required to avoid as in the baseline sessions, with shock intensity set at 0.5 mA.
- (b) Intensity level 2 ( $I_2$ ), during which no spectator was present, and the subject was required to avoid as in the baseline sessions, except that the shock intensity was changed to 1.0 mA (One session).
- (c) Intensity level 3 ( $I_3$ ), during which no spectator was present, and the subject was required to avoid as in the baseline sessions, except that the shock intensity was changed to 1.6 mA (One session).
- (d) Intensity level 4 ( $I_4$ ), during which no spectator was present, and the subject was required to avoid as in the baseline sessions, except that the shock intensity was changed to 2.0 mA (One session).

These treatments were given to the subjects according to the four different sequences of the balanced Latin Square Design (Winer, 1971):

| Sequences | Treatments |                |                |                |
|-----------|------------|----------------|----------------|----------------|
|           | 1          | Sp             | I <sub>3</sub> | I <sub>2</sub> |
|           | 2          | I <sub>3</sub> | I <sub>4</sub> | Sp             |
|           | 3          | I <sub>2</sub> | Sp             | I <sub>4</sub> |
|           | 4          | I <sub>4</sub> | I <sub>2</sub> | Sp             |

Animals were randomly assigned to these sequences with the proviso that of the 3 animals assigned to each of the 4 sequences, one was to be a Fast responder, one a Medium responder and one a Slow responder.

A treatment to control for possible effects of novelty was deemed unnecessary since a previous experiment using a closely resembling apparatus (Metzer, 1971) had shown novelty (a tennis ball) not to contribute to the spectator effect (although the baseline shock intensity was slightly higher than used here - 1.3 mA).

Each animal therefore underwent each of the treatments for one session and was returned to baseline in between treatments. If baseline could not be retrieved, sufficient sessions were given for a new baseline value to emerge, according to the same criterion (3 successive sessions to be within  $\pm 10\%$  of each other in mean response rates) as before.

In the audience sessions, a different spectator was used for each subject.

Since olfactory cues may be important in rat social behaviour, the Skinner boxes were thoroughly cleaned before each animal started its daily session.

A given animal was always placed in the same Skinner box, so that any slight differences in structures of the boxes such as the exact position of the bar, houselights, etc. would not interfere with each animal's performance.

In a second phase of the experiment, after all animals had completed their sequences of treatments, the shock intensity setting was changed from 0.5 mA to 2 mA and further training sessions were given to establish a new baseline measure according to the same criterion as before. When this new baseline criterion was reached, all animals were given an additional audience session.

The whole experiment lasted for 128 consecutive days, with the first animal finishing at 115 days, and the last animals finishing at 128 days. One animal died after 123 sessions during baseline training at 2 mA shock intensity, so that an audience session at 2 mA could not be given.

#### RESULTS:

The difference between the initial mean baseline response rates of the three groups Fast, Medium and Slow responders was significant, according to a one-way analysis of variance ( $F = 31.3$ ,  $df = 2/9$ ,  $p < 0.001$ ). These baseline response rates are given in Table 2.1.



|          |                | Groups |                     |                      |
|----------|----------------|--------|---------------------|----------------------|
|          |                | Fast   | Medium              | Slow                 |
| Subjects | S <sub>1</sub> | 7.53   | S <sub>5</sub> 4.15 | S <sub>9</sub> 3.50  |
|          | S <sub>2</sub> | 7.15   | S <sub>6</sub> 3.64 | S <sub>10</sub> 3.13 |
|          | S <sub>3</sub> | 6.65   | S <sub>7</sub> 3.56 | S <sub>11</sub> 2.67 |
|          | S <sub>4</sub> | 5.12   | S <sub>8</sub> 3.51 | S <sub>12</sub> 2.35 |
|          | Gp. mean       | 6.61   | Gp. mean 3.72       | Gp. mean 2.91        |

Table 2.1: Mean baseline response rates (no. of responses per minute) of all subjects in three response level groups: Fast, Medium, Slow.

Three other dependent measures were taken, and the initial baseline mean values of these concurrent with the mean baseline response rates are given in Table 2.2. The three variables were

- (a) shock rate (mean no. of shocks per minute)
- (b) shock to response ratio (total no. of shocks in the session divided by the total no. of responses in the session).
- (c) efficiency of avoidance index E, where

$$E = \frac{\text{No. of shocks}}{\text{No. of possible shocks}} \times \frac{\text{No. of responses + minimum no. of possible responses for total avoidance}}{\text{Minimum no. of possible responses for total avoidance}}$$

This efficiency index is taken from McIntire, Davis, Cohen & Franch (1968).

| Groups         |       |       |       |                |       |       |       |                 |       |       |       |
|----------------|-------|-------|-------|----------------|-------|-------|-------|-----------------|-------|-------|-------|
| Fast           |       |       |       | Medium         |       |       |       | Slow            |       |       |       |
|                | S.R.  | S/R   | E     |                | S.R.  | S/R   | E     |                 | S.R.  | S/R   | E     |
| S <sub>1</sub> | 0.178 | 0.024 | 0.071 | S <sub>5</sub> | 1.010 | 0.250 | 0.254 | S <sub>9</sub>  | 0.820 | 0.235 | 0.181 |
| S <sub>2</sub> | 0.244 | 0.034 | 0.095 | S <sub>6</sub> | 0.142 | 0.039 | 0.034 | S <sub>10</sub> | 4.010 | 1.270 | 0.861 |
| S <sub>3</sub> | 0.175 | 0.026 | 0.063 | S <sub>7</sub> | 0.633 | 0.180 | 0.146 | S <sub>11</sub> | 1.632 | 0.573 | 0.295 |
| S <sub>4</sub> | 0.175 | 0.034 | 0.052 | S <sub>8</sub> | 1.970 | 0.735 | 0.412 | S <sub>12</sub> | 2.680 | 1.143 | 0.456 |
| Gp.            | 0.193 | 0.030 | 0.070 |                | 0.938 | 0.301 | 0.212 |                 | 2.290 | 0.805 | 0.456 |
| Mns            |       |       |       |                |       |       |       |                 |       |       |       |

Table 2.2: Mean baseline values of shock rates (S.R.), shock to response ratios (S/R), and efficiency indices (E) of all subjects in three response level groups: Fast, Medium and Slow.

The differences between the 3 groups on these baseline measures were significant for shock rates ( $F=5.40$ ,  $df=2/9$ ,  $p<0.05$ ), for shock to response ratios ( $F=5.73$ ,  $df=2/9$ ,  $p<0.05$ ), but not for efficiency indices ( $F=3.98$ ,  $df=2/9$ ,  $p>0.05$ ).

The nature of these baseline measures needs some explanation. The measurement of performance in a Sidman avoidance situation is not always as straightforward as it often is on positive reinforcement schedules. For example, the commonly used measures of response rate and the number of shocks received in a session sometimes do not reflect important aspects of behaviour. The rate of response may remain constant, while the number of shocks may increase or decrease. Conversely, the number of shocks may be constant, even though variations occur in the response rate. For these reasons two measures were used which supplement the more

obvious measures of response rate and shock rate: the shock to response ratio and the efficiency index, both of which attempt to take into account the trade-off between responding and shock-taking during Sidman avoidance performance. The efficiency index takes into account (i) the number of responses in relation to the minimum number of responses which would have avoided all shocks, and (ii) the number of shocks in relation to the maximum number of shocks which could have occurred.

Lower values of E are thereby believed to indicate greater "efficiency" of performance. The much cruder shock to response ratio approaches lower values whenever (a) the number of responses increases while the number of shocks remains constant, or, (b) the number of shocks decreases while the number of responses remains constant.

While (b) seems to indicate greater "efficiency", (a) seems to indicate lower "efficiency", so that one needs to specify the response rate of the shock rate in conjunction with this measure.

Since the dependent measures were comparisons between the baselines and treatments, percent changes of scores in each treatment from baseline scores were calculated. This procedure reduces the variation in the treatment scores between subjects as a result of different baseline measures per se, since on three of these four baseline measures the groups were significantly different.

#### Phase 1.

Tables 2.3, 2.4, 2.5, and 2.6 indicate the data obtained for response rates, shock rates, shock to response

ratios and the efficiency index scores, calculated according to the above method.

These data were subjected to analyses of variance according to a three-factor design with repeated measures on one factor (treatments) (Winer, 1971, p.559). These three factors were (a) Response levels (Fast, Medium, Slow), (b) Sequence orders in the Latin Square (4 orders), and (c) Treatments (Spectator  $I_2$ ,  $I_3$ ,  $I_4$ ). Analyses of variance summaries for each of the four dependent variables can be found in Appendix A(2,3,4,5).

Where significance was found at the 0.05 level, individual comparisons were made of means using the "least significant difference" method (Winer, 1971, p.199). These are included in the following analyses summary:

(1) Response Rate Changes.

Only the treatments factor was significant and revealed a generally increasing trend from the Sp mean to the  $I_4$  mean. Table 2.3 shows this trend to be in a positive direction, all treatments having resulted in an increase in response rates with respect to baseline. Table 2.7 shows that the difference between Sp and  $I_2$  was not significant, but that the differences between Sp and  $I_3$ , and Sp and  $I_4$  were significant. Amongst the I comparisons, only  $I_4$  was significantly larger than  $I_2$ . A related samples t-test indicated the total increase of all Sp response rates over baseline response rates to be significant ( $t_{11} = 2.34$ ,  $p < 0.05$ ).

| Response Sequence Subject |            |    | Treatments |                |                |                |
|---------------------------|------------|----|------------|----------------|----------------|----------------|
| Level                     |            |    | Sp         | I <sub>2</sub> | I <sub>3</sub> | I <sub>4</sub> |
| Fast                      | 1          | 4  | +24.7      | -1.4           | +21.1          | +18.2          |
|                           | 2          | 1  | -3.3       | +4.2           | +46.8          | +26.8          |
|                           | 3          | 2  | +19.2      | +7.3           | +20.5          | +28.7          |
|                           | 4          | 3  | +10.9      | +27.2          | +13.0          | +21.5          |
|                           | Tmt. Means |    | +12.9      | +9.3           | +25.4          | +23.8          |
| Medium                    | 1          | 7  | -13.5      | +23.9          | +23.0          | +28.7          |
|                           | 2          | 8  | +68.7      | +43.0          | +87.0          | +104.0         |
|                           | 3          | 5  | +18.3      | +44.6          | +36.9          | +23.1          |
|                           | 4          | 6  | -15.9      | +7.1           | +13.7          | +35.2          |
|                           | Tmt. Means |    | +14.4      | +29.7          | +40.2          | +47.8          |
| Slow                      | 1          | 9  | +30.0      | +5.7           | +55.0          | +49.0          |
|                           | 2          | 12 | -3.8       | +9.8           | +33.6          | +35.3          |
|                           | 3          | 11 | +33.3      | +51.6          | +55.8          | +125.0         |
|                           | 4          | 10 | +9.0       | +91.0          | +133.2         | +176.5         |
|                           | Tmt. Means |    | +17.1      | +39.5          | +69.4          | +96.5          |
| Overall Tmt. Means        |            |    | +14.8      | +26.2          | +45.0          | +56.0          |

Table 2.3: Percent changes from baseline response rates of subjects in the treatments as a function of response levels (+ indicates increased response rate, - indicates decreased response rate).

| Response Sequence Subject |            |    | Treatments |                |                |                |
|---------------------------|------------|----|------------|----------------|----------------|----------------|
| Level                     |            |    | Sp         | I <sub>2</sub> | I <sub>3</sub> | I <sub>4</sub> |
| Fast                      | 1          | 4  | -47.4      | 0              | +45.9          | +49.0          |
|                           | 2          | 1  | -21.7      | -16.9          | +48.3          | +50.0          |
|                           | 3          | 2  | +4.6       | +45.5          | +76.3          | +79.1          |
|                           | 4          | 3  | -13.4      | -56.5          | +15.1          | -37.4          |
|                           | Tmt. Means |    | -19.5      | +7.0           | +46.4          | +35.2          |
| Medium                    | 1          | 7  | -110.6     | +56.6          | +6.2           | +57.5          |
|                           | 2          | 8  | -25.9      | +70.0          | +90.3          | +89.4          |
|                           | 3          | 5  | +7.1       | +73.6          | +53.0          | +71.9          |
|                           | 4          | 6  | -52.9      | +25.0          | +14.3          | +17.6          |
|                           | Tmt. Means |    | -45.6      | +56.3          | +41.0          | +59.2          |
| Slow                      | 1          | 9  | +9.5       | +66.4          | +71.8          | +82.2          |
|                           | 2          | 12 | -66.5      | +13.2          | +43.3          | +42.9          |
|                           | 3          | 11 | +49.0      | +74.5          | +65.1          | +78.6          |
|                           | 4          | 10 | -40.5      | +35.9          | +25.3          | +38.2          |
|                           | Tmt. Means |    | -12.1      | +47.5          | +51.4          | +60.5          |
| Overall Tmt. Means        |            |    | -25.7      | +32.3          | +46.3          | +51.6          |

Table 2.4: Percent changes from baseline shock rates of subjects in the treatments as a function of response levels (+ indicates decreased shock rate, - indicates increased shock rate).

| Response Sequence Subject |            |    | Treatments |                |                |                |
|---------------------------|------------|----|------------|----------------|----------------|----------------|
| Level                     |            |    | Sp         | I <sub>2</sub> | I <sub>3</sub> | I <sub>4</sub> |
| Fast                      | 1          | 4  | -11.8      | -4.2           | +62.2          | +48.1          |
|                           | 2          | 1  | -2.4       | -27.4          | +65.4          | +63.6          |
|                           | 3          | 2  | +10.0      | +50.0          | +82.4          | +86.9          |
|                           | 4          | 3  | -1.0       | -3.6           | +30.1          | -23.1          |
|                           | Tmt. Means |    | -1.3       | +3.7           | +60.0          | +43.9          |
| Medium                    | 1          | 7  | -140.0     | +64.4          | +17.6          | +69.5          |
|                           | 2          | 8  | +45.8      | +79.0          | +96.1          | +94.8          |
|                           | 3          | 5  | +17.4      | +82.4          | +59.9          | +70.1          |
|                           | 4          | 6  | -53.2      | +31.8          | +30.8          | +38.5          |
|                           | Tmt. Means |    | -32.5      | +64.4          | +51.1          | +68.2          |
| Slow                      | 1          | 9  | +30.6      | +65.3          | +85.3          | +88.3          |
|                           | 2          | 12 | -38.2      | +27.2          | +57.6          | +55.5          |
|                           | 3          | 11 | +60.9      | +83.8          | +76.7          | +89.4          |
|                           | 4          | 10 | -39.9      | +63.0          | +70.6          | +77.4          |
|                           | Tmt. Means |    | +3.4       | +59.8          | +72.6          | +77.7          |
| Overall Tmt. Means        |            |    | -10.1      | +42.6          | +61.2          | +63.3          |

Table 2.5: Percent changes from baseline shock to response ratios of subjects in the treatments as a function of response levels (+ indicates smaller, - indicates larger ratio).

| Response Sequence Subject |            |    | Treatments |                |                |                |
|---------------------------|------------|----|------------|----------------|----------------|----------------|
| Level                     |            |    | Sp         | I <sub>2</sub> | I <sub>3</sub> | I <sub>4</sub> |
| Fast                      | 1          | 4  | -80.8      | 0              | +36.2          | +33.3          |
|                           | 2          | 1  | -40.5      | -21.1          | +29.1          | +34.9          |
|                           | 3          | 2  | 0          | +44.2          | +70.9          | +70.6          |
|                           | 4          | 3  | +17.2      | -62.3          | +14.1          | -82.5          |
|                           | Tmt. Means |    | -26.0      | -9.8           | +37.6          | +14.1          |
| Medium                    | 1          | 7  | -93.8      | +50.3          | -2.2           | +48.8          |
|                           | 2          | 8  | +8.0       | +61.2          | +81.1          | +79.2          |
|                           | 3          | 5  | -0.8       | +65.0          | +63.8          | +68.3          |
|                           | 4          | 6  | -51.2      | +8.3           | +2.6           | 0              |
|                           | Tmt. Means |    | -34.5      | +46.2          | +36.3          | +49.1          |
| Slow                      | 1          | 9  | +22.1      | +67.1          | +68.7          | +76.5          |
|                           | 2          | 12 | -53.1      | +4.8           | +32.7          | +43.6          |
|                           | 3          | 11 | +40.1      | +67.8          | +55.7          | +66.9          |
|                           | 4          | 10 | -40.7      | +3.7           | -28.7          | +87.2          |
|                           | Tmt. Means |    | -7.9       | +37.2          | +32.1          | +68.6          |
| Overall Tmt. Means        |            |    | -22.8      | +24.5          | +35.3          | +43.9          |

Table 2.6: Percent changes from baseline efficiency index scores of subjects in the treatments as a fraction of response levels (+ indicates increased efficiency, - decreased efficiency).



| Comparison                      | Resp. Rates             | Shock Rates             | S/R                     | E                       |
|---------------------------------|-------------------------|-------------------------|-------------------------|-------------------------|
| Sp - I <sub>2</sub>             | t <sub>18</sub> =1.02   | t <sub>18</sub> =5.42** | t <sub>18</sub> =3.19** | t <sub>18</sub> =2.65*  |
| Sp - I <sub>3</sub>             | t <sub>18</sub> =2.42*  | t <sub>18</sub> =6.73** | t <sub>18</sub> =4.32** | t <sub>18</sub> =3.25** |
| Sp - I <sub>4</sub>             | t <sub>18</sub> =3.30** | t <sub>18</sub> =7.22** | t <sub>18</sub> =4.45** | t <sub>18</sub> =3.73** |
| I <sub>2</sub> - I <sub>3</sub> | t <sub>18</sub> =1.51   | t <sub>18</sub> =1.31   | t <sub>18</sub> =1.13   | t <sub>18</sub> <1      |
| I <sub>2</sub> - I <sub>4</sub> | t <sub>18</sub> =2.40*  | t <sub>18</sub> =1.80   | t <sub>18</sub> =1.23   | t <sub>18</sub> =1.08   |
| I <sub>3</sub> - I <sub>4</sub> | t <sub>18</sub> <1      | t <sub>18</sub> <1      | t <sub>18</sub> <1      | t <sub>18</sub> <1      |

\*p&lt;0.05

\*\*p&lt;0.01

Table 2.7: Summary of comparisons between all treatment means in terms of the four dependent variables, using the least significant difference method.

|             | Sp                      | I <sub>2</sub>          | I <sub>3</sub>     | I <sub>4</sub>          |
|-------------|-------------------------|-------------------------|--------------------|-------------------------|
| Fast - Med  | t <sub>18</sub> =2.38*  | t <sub>18</sub> =5.78** | t <sub>18</sub> <1 | t <sub>18</sub> =2.19*  |
| Med - Slow  | t <sub>18</sub> =3.06** | t <sub>18</sub> <1      | t <sub>18</sub> <1 | t <sub>18</sub> <1      |
| Slow - Fast | t <sub>18</sub> <1      | t <sub>18</sub> =4.98** | t <sub>18</sub> <1 | t <sub>18</sub> =2.31** |

\*p&lt;0.05

\*\*p&lt;0.01

Table 2.8: Summary of comparisons between response level means within each treatment (Response Levels X Tmts. interaction) for Mean Shock Rate changes, using the least significant difference method (see Fig. 2).

|                                 | Fast                    | Med                     | Slow                    |
|---------------------------------|-------------------------|-------------------------|-------------------------|
| Sp - I <sub>2</sub>             | t <sub>18</sub> =1.17   | t <sub>18</sub> =9.52** | t <sub>18</sub> =5.42** |
| Sp - I <sub>3</sub>             | t <sub>18</sub> =6.16** | t <sub>18</sub> =8.09** | t <sub>18</sub> >5.42** |
| Sp - I <sub>4</sub>             | t <sub>18</sub> =5.11** | t <sub>18</sub> =9.79** | t <sub>18</sub> >5.42** |
| I <sub>2</sub> - I <sub>3</sub> | t <sub>18</sub> =4.99** | t <sub>18</sub> =1.43** | t <sub>18</sub> =1.31   |
| I <sub>2</sub> - I <sub>4</sub> | t <sub>18</sub> =3.94** | t <sub>18</sub> <1      | t <sub>18</sub> =1.80   |
| I <sub>3</sub> - I <sub>4</sub> | t <sub>18</sub> =1.05   | t <sub>18</sub> =1.70   | t <sub>18</sub> <1      |

\*\*p&lt;0.01

Table 2.9: Summary of comparisons between treatment means within each response level (Response levels X Tmts. interaction) for mean Shock Rate changes (See Fig. 2), using the lsd method.

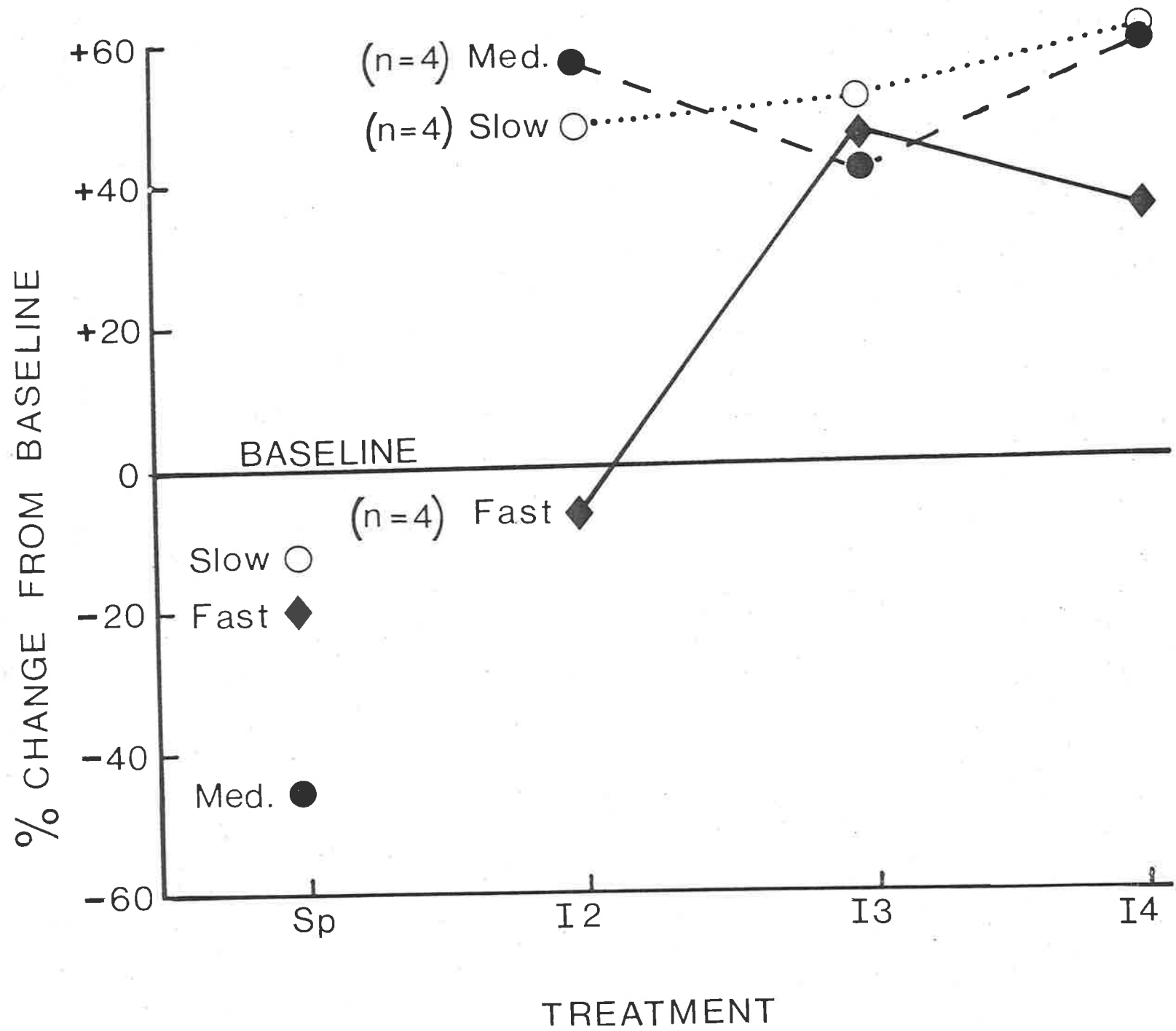


Fig. 2: Graphical display of the significant Response Level x treatment interaction for reinforcement rate changes in Experiment 1.

(2) Shock Rate Changes.

The treatments factor was significant, Table 2.4 showing the increasing trend from Sp to I<sub>4</sub>, the Sp treatment having resulted in an increased shock rate while the other 3 treatments showed decreased shock rates with respect to baseline. The A X C (Response level X treatments) interaction was also significant. This interaction is graphically represented in Fig 2. while Table 2.8 indicates within each treatment differences between the response levels; differences within each response level and between treatments are summarised in Table 2.9. Note the inverted U tendency by the Fast responders, but not by the Medium and Slow responders. The Sp treatment means for all 3 response levels indicate increased shock rates (i.e. a worsening in performance compared with baseline) most marked in the Medium group, although if baseline shock rates are compared with Sp shock rates for all subjects combined, a related samples t-test indicates this increase to be nonsignificant (Baseline Mean = 0.19, Sp Mean = 0.25,  $t_{11} = 1.34$ ).

(3) Shock to Response Ratio Changes.

Only the treatments factor was significant (Appendix A4), Table 2.5 showing a decreasing ratio trend from Sp to I<sub>4</sub>. Table 2.7 shows that the Sp treatment showed a significantly larger ratio than each of the I treatments. The I treatments did not differ significantly from each other. A related

t-test showed that the difference between baseline ratios and all Sp ratios was not significant ( $t_{11} = 0.90$ ).

(4) Efficiency of Avoidance Index Changes.

Again only the treatments factor was significant. (Appendix A5). Table 2.6 showing an increasing efficiency trend from Sp to I<sub>4</sub>. Table 2.7 shows that the Sp treatment showed a significantly smaller index than each of the I treatments. The I treatments again did not differ significantly from each other. A related t-test showed that the difference between baseline and all Sp Efficiency Indices was not significant ( $t_{11} = 1.34$ ).

Phase 2.

The change from 0.5 mA to 2.0 mA baseline effected changes in the dependent variables as follows. Appendix A1 gives the raw data for each of the 4 variables. Table 2.11 presents the percent changes in the 4 dependent variables as a function of the (initial) response level groups. One way analysis of variance demonstrated no significant difference between the Fast, Medium and Slow groups on response rate changes ( $F=1.57$ ,  $df=2/8$ ), shock rate changes ( $F=2.31$ ,  $df=2/8$ ), shock to response ratio changes ( $F<1$ ,  $df=2/8$ ), and efficiency index changes ( $F=1.72$ ,  $df=2/8$ ).

The three response level groups were therefore combined and treated as one group. Related samples t-tests were then carried out on the raw data (response rates, shock rates, shock to response ratios, efficiency indices) to determine whether the 0.5mA and 2 mA baselines differed in terms of these 4 dependent variables.

# Groups

| Fast           |         |        |       |        | Med            |       |       |        |       | Slow            |        |       |        |       |
|----------------|---------|--------|-------|--------|----------------|-------|-------|--------|-------|-----------------|--------|-------|--------|-------|
|                | RR      | SR     | S/R   | E      |                | RR    | SR    | S/R    | E     |                 | RR     | SR    | S/R    | E     |
| S <sub>1</sub> | -8.2    | +18.5  | +9.7  | +23.4  | S <sub>5</sub> | +27.4 | +44.9 | -106.8 | +35.2 | S <sub>9</sub>  | -8.4   | +58.1 | -235.0 | +71.0 |
| S <sub>2</sub> | -----1. |        |       |        | S <sub>6</sub> | -17.0 | -45.0 | +4.2   | -41.5 | S <sub>10</sub> | +111.8 | +28.4 | +74.3  | -9.3  |
| S <sub>3</sub> | +21.4   | -141.9 | -85.1 | -187.9 | S <sub>7</sub> | -23.0 | +55.4 | -78.5  | +60.6 | S <sub>11</sub> | +83.8  | +54.7 | -122.4 | +35.5 |
| S <sub>4</sub> | 0       | +10.3  | +14.3 | +7.5   | S <sub>8</sub> | +81.3 | +75.6 | +5.4   | +61.7 | S <sub>12</sub> | +50.6  | +69.8 | +57.6  | +60.4 |
| Gp.            | +4.4    | -37.7  | -20.4 | -52.3  |                | +17.2 | +32.7 | -43.9  | +29.0 |                 | +59.5  | +52.8 | -56.4  | +39.4 |
| Means          |         |        |       |        |                |       |       |        |       |                 |        |       |        |       |

Table 2.11: Percent changes of four dependent variables from 0.5 mA to 2.0 mA baselines for all subjects in three response level groups (From data in Appendix A1).  
(+ indicates "better" performance).

(Footnote) 1. S<sub>2</sub> deceased before a 2.0 mA baseline could be determined.

|        | RR   | SR   | S/R  | E    |
|--------|------|------|------|------|
| 0.5 mA | 3.98 | 1.00 | 0.25 | 0.22 |
| 2.0 mA | 4.90 | 0.59 | 0.12 | 0.18 |

Table 2.10: Baseline (0.5 mA and 2.0 mA) means of all subjects combined in terms of response rates, shock rates, shock to response ratios and efficiency indices.

Differences between 0.5mA and 2.0mA baselines were significant on response rates ( $t_{10}=1.94$ ,  $p<0.05$ ) and shock rates ( $t_{10}=2.11$ ,  $p<0.05$ ), but not on the other two measures. Overall, an improvement in performance on the 2mA baselines compared with the 0.5mA baseline may be inferred from these results.

Performance changes of the Spectator treatment at 2mA compared with 2mA baseline are summarised in Table 2.12.

One way analyses of variance indicated that there were no significant differences between the groups on any of the dependent variables (for all measures :  $F<1$ ,  $df = 2/8$ ). The three response level groups were therefore combined and treated as one group. Comparing the performance on 2.0mA + Sp (Table 2.13) indicated significant differences (1-tailed related t-tests) on shock rates ( $t_{10}=1.95$ ,  $p<0.05$ ); shock to response ratios ( $t_{10}=1.94$ ,  $p<0.05$ ) and efficiency indices ( $t_{10}=2.05$ ,  $p<0.05$ ), but surprisingly, not on response rates ( $t_{10}=0.89$ ).

|             | RR   | SR   | S/R  | E    |
|-------------|------|------|------|------|
| 2.0 mA      | 4.90 | 0.59 | 0.12 | 0.18 |
| 2.0 mA + Sp | 5.04 | 0.92 | 0.19 | 0.27 |

Table 2.13: Comparisons of 2.0 mA baselines means with 2.0mA + Sp means of all subjects on 4 dependent measures.

| Groups         |       |        |        |        |                |       |        |       |       |                 |      |        |        |        |
|----------------|-------|--------|--------|--------|----------------|-------|--------|-------|-------|-----------------|------|--------|--------|--------|
| Fast           |       |        |        |        | Med            |       |        |       |       | Slow            |      |        |        |        |
|                | RR    | SR     | S/R    | E      |                | RR    | SR     | S/R   | E     |                 | RR   | SR     | S/R    | E      |
| S <sub>1</sub> | -12.3 | -598.1 | -675.0 | -537.0 | S <sub>5</sub> | +13.1 | -114.8 | -88.8 | -80.3 | S <sub>9</sub>  | -3.1 | +17.5  | -16.7  | -9.4   |
| S <sub>2</sub> | ----- |        |        |        | S <sub>6</sub> | -2.8  | -11.2  | +15.4 | -6.9  | S <sub>10</sub> | +2.9 | -1.0   | +4.0   | -7.6   |
| S <sub>3</sub> | +7.7  | -2.0   | +0.5   | -3.3   | S <sub>7</sub> | +16.4 | -57.7  | -35.3 | -69.8 | S <sub>11</sub> | +2.4 | -106.8 | -101.2 | -111.0 |
| S <sub>4</sub> | +20.7 | -38.5  | +50.0  | +29.7  | S <sub>8</sub> | -7.2  | -36.6  | -45.8 | -28.0 | S <sub>12</sub> | +1.2 | -68.8  | -67.5  | -45.9  |
| Gp.            | +5.4  | -187.2 | -208.2 | -170.2 |                | +4.9  | -55.1  | -38.6 | -46.3 |                 | +0.9 | -39.8  | -45.4  | -43.5  |
| Means          |       |        |        |        |                |       |        |       |       |                 |      |        |        |        |

Table 2.12: Percent changes of four dependent variables from 2.0 mA baseline to 2.0 ma + Sp for all subjects in three response level groups (+ indicates "better" performance).

DISCUSSION.

In Phase 1 of this experiment, the inverted U hypothesis linking performance with arousal does not seem to be supported by the changes in response rates due to treatments. The different treatments did not differentially affect the three response level groups, although overall, subjects increased responding in the audience treatment with respect to baseline, supporting Zajonc's theory. This increase seems to be most similar to a mild increase in arousal, a conclusion implied by the nonsignificant differences between audience response rates and  $I_2$  response rates, and the significant differences of audience response rates with  $I_3$  and  $I_4$  response rates. This conclusion must be tempered however, by the similarity between  $I_2$  and  $I_3$  response rates, but dissimilarity between Sp and  $I_3$  response rates (Table 2.7).

The shock rate changes reveal a somewhat different picture of performance changes. From Tables 2.4 and 2.7, it appears that the Sp mean for all subjects is not similar to any of the I means. However, an examination of the significant A X C interaction (Fig.2) reveals that only for the Fast responders was there any similarity between the Sp mean and one of the I means (again the  $I_2$  treatment); all other comparisons between Sp and I means were significantly different (Table 2.9). (Table 2.8 indicates that the increase in shock rates in the Sp treatment with respect to baselines was larger for the Medium responders than for either the Fast or Slow responders, a rather surprising finding. One explanation of



this might be to suggest that the Fast and Medium response groups were much closer together in terms of initial baseline shock rates than Medium and Slow groups (Table 2.2), and hence the Medium group behaved as if it were a Fast group. This explanation does not seem very tenable because of the significant difference between the Fast and Medium group).

Fig. 2 indicates the improvement and impairment of performance in terms of shock rate changes. There is a slight tendency towards an inverted U curve by the Fast group. The overall picture presented by Fig. 2 is that the Sp treatment resulted in a slight tendency towards impaired performance and this was matched only by the Fast group on  $I_2$ . The improved performance by the rest on the I treatments seems to fit in with the postulated increment in arousal, although the Medium and Slow groups do not show an inverted U trend. Although the A X C interaction was not significant for both the S/R ratio and efficiency index changes, the significant treatments factor shows a similar trend to the shock rate changes: a (nonsignificant) drop in performance in Sp, with progressively improving performance from  $I_2$  to  $I_4$ .

How can these data be explained? First, there is the question of suitability of attempting to match "relevant" with "irrelevant" drive. During the I treatments, the source of relevant drive was increased, whereas during the Sp treatment the source of relevant drive remained constant and irrelevant drive was increased (by audience). Avoidance performance clearly improved progressively during the (increasing) I treatments, a finding already well-documented in the literature

(e.g. Boren, Sidman, Herrnstein, 1959), consistent with the shock intensity and duration range used in this experiment. Although response rates increased during the Sp treatment, shock rates increased (although for the latter not significantly over all the subjects), a finding suggesting that increasing irrelevant drive led to impaired performance under the experimental conditions. Some additional evidence for this comes from the examination of some typical comparisons of cumulative records of baselines and the Sp treatment (Fig.3). Although interresponse time distributions could not be measured with the available apparatus, it appears as if the presence of the spectator affected the temporal spacing of responses so that although more responses were emitted (arrows on Fig.3), more shocks were taken. Groups of shock (i.e. shocks taken without responses between them) seemed to be more prevalent in the Sp treatment than at baseline or in the I<sub>2</sub> treatment. While a change in stimulation of a social kind may produce increasing general arousal, it may also produce competing social responses which interfere with the avoidance response. Increasing the intensity of shock may produce increasing general arousal, but it would be less likely to be subject to interfering competing responses than the social situation. Casual observation seemed to support this view. In the Sp treatment, rats were attending (so far as this was possible through the grid partitions) to each other at least some of the time, including times when groups of shocks were taken by the subject. In the I treatments the onset of shock was

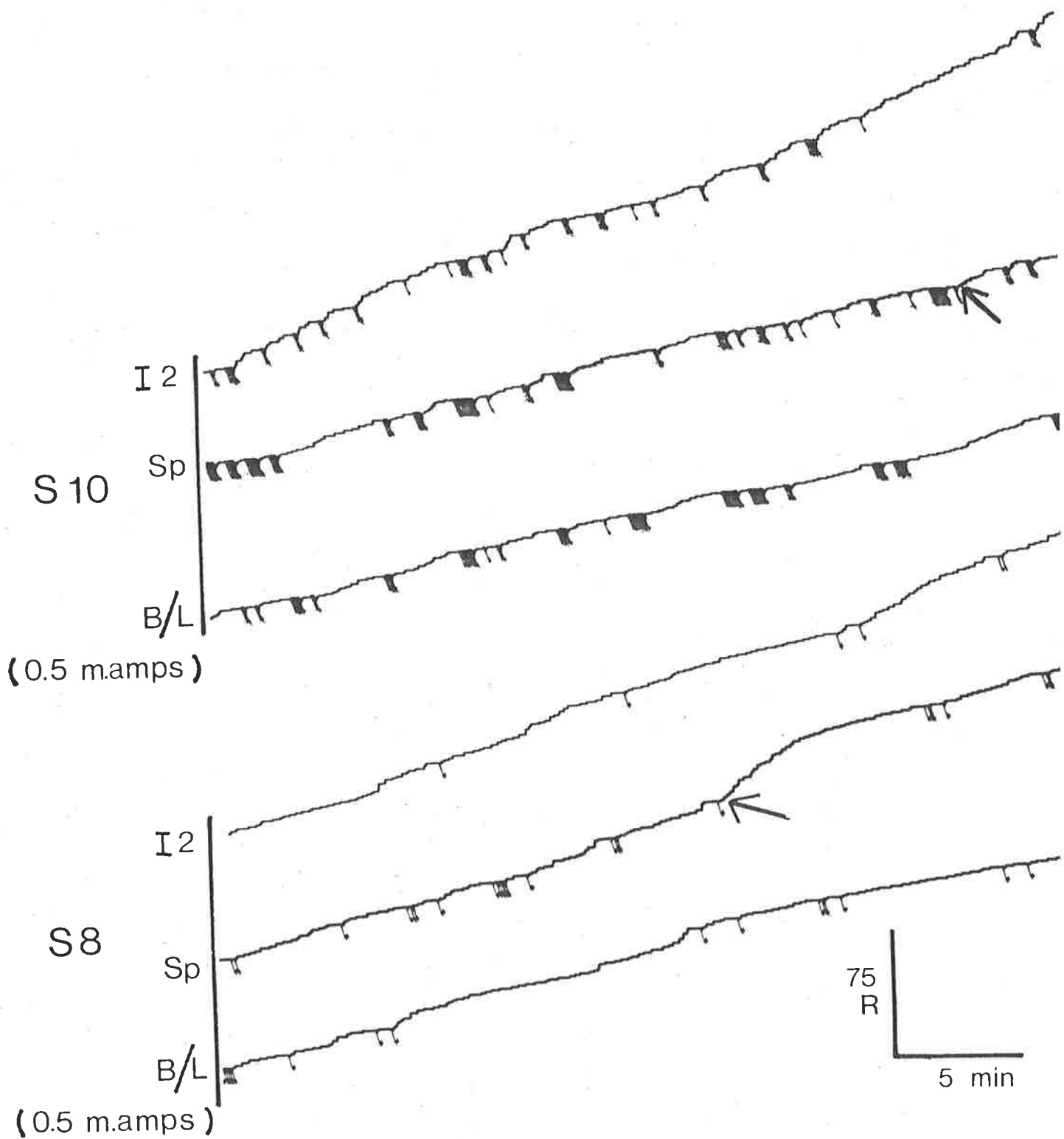


Fig. 3: Samples of cumulative records of two subjects (S<sub>10</sub> and S<sub>8</sub>) from baseline, Spectator and I<sub>2</sub> treatments in Experiment 1.

more likely to indicate to the subject that an avoidance response was required, as well as creating an immediate increase in arousal (relevant drive in this case).

It appears that, while increases in response rates in the spectator treatment are consistent with Zajonc's theory, rather than the inverted U hypothesis, there may yet be another explanation which has little to do with the social situation per se. If the effect of the spectator was to make more likely interfering social responses with as a consequence greater shock taking, the arousal increase may have resulted not only from the spectator presence, but also from the greater shock rate. It is impossible from the present design to extract these two factors.

In Phase 2 of the experiment, the performance changes from 0.5 mA to 2.0 mA baselines were not significantly different between the response level groups. This is rather surprising and may indicate that the three groups were no longer sufficiently separated from each other in terms of arousal as a result of (presumably) the Phase I treatments. A one-way analysis of variance did not confirm this when the groups were compared on their "new" baseline (0.5 ma) response rates (Appendix A1) ( $F = 7.46$ ,  $df = 2/8$ ,  $p < 0.05$ ).

However, the groups were not significantly different on the 2.0 mA baseline response rates ( $F = 1$ ,  $df = 2/8$ ), indicating that arousal levels were similar at the higher shock intensity. It is possible that under these high arousal conditions, all groups were now very similar and that the addition of a spectator added only a small increment of

arousal which was swamped by the already over arousing conditions. This is confirmed by the lack of no significant difference between the 2.0 mA baseline and Sp treatments on response rates. The fact that on the other three performance measures, a decrement was obtained indicates that even under high arousal conditions, the presence of a spectator may still impair performance. Whether this is due to the arousal interpretation or the competing response interpretation is not clear.

What are some implications of the competing response interpretation for the effects of audience within a Sidman avoidance situation? As has already been suggested, the effect of introducing an audience is not only to increase the likelihood of emitting the well-learned bar-press response, but also to change the overall stimulus situation so that other responses (e.g. attending to the social stimulus, etc.) can become more probable.

The former effect is due to an increase in arousal, the latter to a change in the nature of the stimulus situation itself. What can be expected from these effects with respect to the avoidance response?

First, as the audience is introduced, other responses such as attending to the other animal and its behaviour, and other responses which ordinarily are very low in the animal's habit hierarchy under the alone treatment, become immediately more probable under the audience treatment. Hence the overall structure of the habit hierarchy changes in the audience situation in such a way so as to make the avoidance

response not as likely as it was before the audience's introduction.

Second, Zajonc's theory predicts that general arousal increases with an audience, thereby increasing the likelihood of the dominant response. This assumes however, that the dominant response does not change before and after the introduction of an audience.

The implication of the first point is that the animal will reduce its response rate initially, and hence increase its shock rate. The implication of the second point is that whenever avoidance responding occurs, it is with more vigour and with greater frequency. There is some evidence for the latter from Fig. 3 (see arrows).

From the first implication (reduction in response rate and increase in shock rate) comes the already suggested implication that by increasing the shock rate, the arousal level is likely to increase. This in turn is likely to (eventually) raise the response rate again. It is possible that both of these effects operate in the Sidman avoidance schedule under the audience treatment. It would require a rather different experiment to test this two-process hypothesis, however. For example, if shock rates were kept constant, arousal changes due to the social factor could be investigated independently. This would however, seem to be an impossibility in a free-operant avoidance paradigm, because the animal determines (within the schedule limitations) its own shock rate. Hence any attempt at matching shock rates

between different animals would need to take into account e.g. groups of shock taken, pseudo-avoidance, etc. It might be more convenient to use the classical escape paradigm, where the experimenter determines the shock delivery, as this would avoid some of these problems.

#### SUMMARY

An experiment is reported which attempted to vary arousal levels on a Sidman avoidance schedule in which electric shock served as the reinforcer, by (a) introduction of a spectator and (b) varying the intensity of the shock at 3 different intensities. In Phase 1, all subjects underwent these 4 experimental treatments in a balanced Latin Square Design. Although on three baseline comparison measures (response rates, shock rates, shock to response ratios) the three groups of subjects (Fast, Medium and Slow Responders) were different at the beginning and at the end of Phase 1, they showed significant differences only on shock rates in a Response level X treatment interaction, in which only the Fast responding group showed an inverted U trend. Overall, increased responding occurred in the audience treatment when compared with baselines; this increase seemed to have some similarity with the increase in responding observed under the  $I_2$  treatment. It appeared as if the presence of the audience affected the temporal spacing of responses so that although more responses were emitted, there was also a trend towards taking more shocks in groups. Although these results seemed to support Zajonc's theory rather than the

inverted U theory, results were also discussed in relation to a competing social response hypothesis interacting with the various sources of arousal used. Under the overarousing conditions in Phase 2 of the experiment the three response level groups no longer showed different response rates, while addition of an audience showed no effect on response rates. A decrement in performance with the audience was indicated however, on shock rates, shock-to-response ratios and avoidance efficiency indices.



CHAPTER 111EXPERIMENT 2. COMPARISON OF SOCIAL AND SOLITARY RESPONDING  
BY HUMANS ON A FREE-OPERANT AVOIDANCE SCHEDULE

The objectives of this experiment were to:

- (a) ascertain whether the Sidman avoidance schedule used in Experiment 1 was suitable for establishing a reliable response rate in human subjects, when money loss was substituted for shock as the negative reinforcer, and whether,
- (b) once established, performance on the schedule would be sensitive to changes in arousal as was the aim of Experiment 1.

A variety of aversive stimuli have been used successfully in a Sidman avoidance schedule with humans as subjects, apart from electric shock. (Baer, 1960; Stone, 1961), including "point-loss periods" (Weiner, 1963), and "time-out" from monetary reinforcement (Baron & Kaufman, 1966). Loss of money has also been used by Kaufman & Baron (1969) as an effective aversive stimulus in Sidman avoidance. In this last study, the presence of a green light signalled payment at the continuous rate of US \$1.80 per session. Appearance of a 1 sec. red light signalled a loss of 5¢ from total earnings in the particular session. When the subject did not respond the loss stimulus occurred once every 5 sec. (i.e. the loss-loss interval = 5 sec). Each response when the loss signal was not present postponed the next loss by 5 sec (i.e. the response - loss interval = 5 sec). Baseline training

lasted until each subject received 5 or fewer losses during a given session or until a "stable" day to day loss rate was maintained (no criterion given in the article). All 7 subjects conditioned readily and maintained steady response rates varying from about 12 resp/min to about 200 resp/min, indicating the large between subject variation.

Accordingly, in the present experiment it was attempted to use money loss as an aversive stimulus in a Sidman avoidance task, and to investigate whether by varying the size of this money loss a similar effect could be obtained as the situation in which an audience was added to baseline responding with the original size money loss.

Concurrently with the behavioural measures, a physiological indicator of arousal (heart rate) was also taken, as there is some evidence that an increase in incentive is correlated with an increase in tonic heart rate (Elliot, 1969; Elliott, Bankart & Light, 1970; Evans, 1971). Autonomic measures of arousal in social facilitation situations have generally been confined to GSR (or similar sweat measures) and heart rate measures (e.g. Cottrell, 1968; Cohen & Davis, 1973; Henchy & Glass, 1968), but have not always produced results parallel to behavioural measures of arousal. Since GSR measures (and related techniques) do not seem appropriate in situations where manual manipulation is required, this study took heart rate measures.

## METHOD

### Subjects.

Twelve male undergraduate University of Adelaide Psychology

students served as subjects. Their ages ranged from 17 to 21 years. In view of the well known link between arousal and smoking, subjects were required to be non-smokers. Apart from this proviso, subjects were randomly selected from the Psychology 1 male population and invited to participate - no invited person refused, when it was explain that money could be earned.

#### Apparatus.

Subjects were seated alone in one corner of an experimental room facing a sloping panel box which displayed a 4-digit mechanical counter, a response manipulandum, a 1 sec. white response feedback light and a 1 sec. red money-loss light. (See Fig.4). At the beginning of each session the counter was set at 0150 which, the subject was told, represented \$1.50. The counter was set to subtract from this total units of 5 (representing 5¢) according to the following free-operant schedule. The (money) Loss-Loss time interval (corresponding to a Shock-Shock interval in Sidman avoidance) was set at 5 sec. while the Response-Loss interval (corresponding to a Response-Shock interval) was set at 30 sec. by means of two mechanical timers.

Responding was effected by pulling a 300mm long handle through a distance of 250mm with a force of 1000 gms (see Fig. 4). Each response reset the Loss-Loss timer.

The subject was attached to a "Both" portable ECG recorder by means of an electrode on each leg and one electrode on the non-preferred arm; it was explained to the subject that



Fig. 4: (Simulated) Subject with apparatus and audience  
in Experiment 2.

some autonomic activity would be measured during the session.

The number of responses and stimuli were recorded on counters and a cumulative recorder. All programming and recording equipment were situated out of the subject's sight, behind a large room dividing screen in the same experimental room. A 75dB white noise generator masked sounds made by the recording equipment and movements made by the experimenter in leaving and entering the experimental room for the purpose of taking ECG samples.

#### Procedure and Experimental Design.

At the start of each session all subjects were attached to the ECG recorder, seated facing the apparatus box and instructed:

"You are here to earn money, which is registered on the meter. Whatever amount is showing on the meter at the end of the session is yours - but you will be paid only after all sessions have been completed".

Subjects were relieved of books, pens, watches, etc., but given no further information as to the nature of the experiment, the reinforcement schedule or the response required. Sessions lasted for 60 mins. and during each session four 30 sec. ECG samples were obtained at approximately 15 min. intervals, beginning at 15 min. from the start of the session. Subjects generally took the first scheduled loss and then started responding at varying rates. All subjects were given 5 training sessions, at the end of which all but 2 subjects had attained the baseline criterion set at 2 successive sessions in which the mean response rates did not vary more

than  $\pm 10\%$ . For the 2 subjects who did not satisfy this criterion, their learning curves were extrapolated and a hypothetical "baseline" response rate determined for the 6th (experimental) session.

At this point, the subjects were divided into 3 groups of 4 on the basis of their ranked mean baseline response rates, so that the 4 fastest responders formed the "Fast Responding Group", the next 4 formed the "Medium Responding Group", and the next 4 constituted the "Slow Responding Group".

Each subject in each group was randomly assigned to one of these four experimental treatments during the 6th session:

- (a) Spectator observation (Sp), which involved the addition of an audience of 1 male academic member of the staff of the Psychology Department for the full length of the session. When the subject entered the experimental room, he was introduced to the audience who was waiting there:

"This is Dr. X. who will be observing your performance during this session; you are asked not to talk to him."

The audience was then seated approximately 200cm. from the subject (see Fig. 4) in a chair which had been present also during the training sessions. Subjects were not acquainted with the audience as the staff member was not involved in the first year course. The subject was then given the same instructions as before each baseline training session. The audience had been instructed to passively observe the subject at his task and not to respond if the

subject attempted to communicate verbally, smiled, etc. Apart from the addition of the audience, conditions were identical to those in the training sessions.

- (b) Money Loss = 10¢ ( $I_2$ ). The subject was instructed as in the training sessions, and conditions were identical to those in the training sessions except for the replacement of 5¢ losses by 10¢ losses.
- (c) Money Loss = 15¢ ( $I_3$ ). The subject was instructed as in the training sessions, and conditions were identical to those in the training sessions, except for the replacement of 5¢ losses by 15¢ losses.
- (d) Money Loss = 20¢ ( $I_4$ ). The subject was instructed as in the training sessions, and conditions were identical to those in the training sessions, except for the replacement of 5¢ losses by 20¢ losses.

Because it was noticed that from the second session onwards some subjects started responding before the first loss of the session was scheduled, one "free loss" was given to all subjects 10 sec. into each session after the second session. This procedure ensured that all subjects took at least one money loss; failure to have undertaken this amendment to the reinforcement schedule would have made ineffective the three experimental treatments  $I_2$ ,  $I_3$  and  $I_4$  for some subjects. At the completion of each session except the first, subjects were asked to rate on a scale of -10 to +10 whether they had experienced a change in anxiety in the just completed session in comparison with the previous session.

## RESULTS

The difference between the initial mean baseline response rates of the three groups Fast, Medium and Slow responders were significant, according to a one-way analysis of variance ( $F = 4.67$ ,  $df = 2/9$ ,  $p < 0.05$ ) after a square-root transformation was carried out on the data. These baseline response rates are given in Table 3.1.

| Groups        |            |               |
|---------------|------------|---------------|
| Fast          | Medium     | Slow          |
| $S_1$ 34.23   | $S_5$ 6.50 | $S_9$ 3.15    |
| $S_2$ 8.83    | $S_6$ 4.38 | $S_{10}$ 2.75 |
| $S_3$ 7.00    | $S_7$ 3.85 | $S_{11}$ 2.29 |
| $S_4$ 6.93    | $S_8$ 3.35 | $S_{12}$ 2.23 |
| Gp.mean 14.25 | 4.52       | 2.61          |

Table 3.1: Mean baseline response rates (no. of responses per minute) of all subjects in three response level groups.

The mean no. of losses taken during baseline are given in Table 3.2. These were significantly different ( $F = 4.17$ ,  $df = 2/9$ ,  $p < 0.05$ ) between the groups, after a square root transformation of the data.

| Groups    |         |              |
|-----------|---------|--------------|
| Fast      | Medium  | Slow         |
| $S_1$ 1   | $S_5$ 2 | $S_9$ 3      |
| $S_2$ 1   | $S_6$ 3 | $S_{10}$ 1.3 |
| $S_3$ 1   | $S_7$ 4 | $S_{11}$ 9   |
| $S_4$ 1   | $S_8$ 4 | $S_{12}$ 13  |
| Gp.mean 1 | 3.25    | 6.58         |

Table 3.2 Mean number of losses taken during baseline by all subjects.



From the electrocardiogram samples during the baseline sessions, a mean beats per minute (bpm) rate was determined for each subject in the baseline sessions; these are given in Table 3.3. There was no significant difference between the groups ( $F = 1.52$ ,  $df = 2/9$ ,  $p > 0.05$ ).

| Groups              |                     |                      |
|---------------------|---------------------|----------------------|
| Fast                | Medium              | Slow                 |
| S <sub>1</sub> 84.8 | S <sub>5</sub> 67.7 | S <sub>9</sub> 70.2  |
| S <sub>2</sub> 64.9 | S <sub>6</sub> 83.2 | S <sub>10</sub> 75.1 |
| S <sub>3</sub> 81.4 | S <sub>7</sub> 65.9 | S <sub>11</sub> 55.8 |
| S <sub>4</sub> 87.6 | S <sub>8</sub> 74.2 | S <sub>12</sub> 73.7 |
| Gp.mean 80.0        | 72.8                | 68.7                 |

Table 3.3: Mean bpm of all subjects during baseline.

Two-way analyses of variance (Hays, 1972, p.440) were conducted on percent changes from baselines in the four treatments as measured by the three dependent variables response rates, loss rates and heart rates. The two independent variables were response levels (3 levels) and treatments (4 levels). These data are summarised in Table 3.4 to Table 3.8. Because only one subject had been assigned to each combination of the two independent variables, no within subjects error terms could be determined and the response level X treatment interactions were used as the error terms in the analyses. None of the factors on any of the dependent measures was significant.

During the last baseline session all subjects indicated that they had experienced either no change in or less anxiety in comparison with the previous session. Anxiety changes

during the experimental treatments are given in Table 3.9. A two-way analysis of variance showed that neither the treatments nor the response level factors was significant ( $F = 1.45$ ,  $F = 1.31$  respectively).

| Response  |                      | Treatments            |                      |                       |  |
|-----------|----------------------|-----------------------|----------------------|-----------------------|--|
| Levels    | Sp                   | I <sub>2</sub>        | I <sub>3</sub>       | I <sub>4</sub>        |  |
| Fast      | S <sub>4</sub> -29.0 | S <sub>2</sub> +116.0 | S <sub>1</sub> -9.8  | S <sub>3</sub> +167.0 |  |
| Medium    | S <sub>7</sub> -21.3 | S <sub>5</sub> +104.0 | S <sub>8</sub> +43.3 | S <sub>6</sub> +57.9  |  |
| Slow      | S <sub>9</sub> +0.6  | S <sub>11</sub> +14.4 | S <sub>12</sub> +4.5 | S <sub>10</sub> +9.8  |  |
| Gp. Means | -16.6                | +78.1                 | +12.7                | +78.2                 |  |

Table 3.4: Percent changes from mean baseline response rates of all subjects during the treatments as a function of response levels (+ indicates increased, - decreased response rates).

| Source             | df | MS     | F    |
|--------------------|----|--------|------|
| Between Subjects   |    |        |      |
| Response Level (A) | 2  | 3070.3 | 1.23 |
| Treatments (B)     | 3  | 6848.8 | 2.74 |
| Error (AB)         | 6  | 2497.0 |      |

Table 3.5: Summary of analysis of variance for data in Table 3.4

| Response  |                      | Treatments            |                       |                        |  |
|-----------|----------------------|-----------------------|-----------------------|------------------------|--|
| Level     | Sp                   | I <sub>2</sub>        | I <sub>3</sub>        | I <sub>4</sub>         |  |
| Fast      | S <sub>4</sub> 0     | S <sub>2</sub> 0      | S <sub>1</sub> 0      | S <sub>3</sub> 0       |  |
| Medium    | S <sub>7</sub> -33.3 | S <sub>5</sub> -50.0  | S <sub>8</sub> -25.0  | S <sub>6</sub> +66.7   |  |
| Slow      | S <sub>9</sub> 0     | S <sub>11</sub> +55.6 | S <sub>12</sub> +38.5 | S <sub>10</sub> -207.7 |  |
| Gp. Means | -11.1                | +1.9                  | +4.5                  | -47.0                  |  |

Table 3.6: Percent changes from mean baseline no. of losses of all subjects during the treatments as a function of response levels (+ indicates improvement in performance, - impairment).

| Source             | df | MS   | F  |
|--------------------|----|------|----|
| Between Subjects   |    |      |    |
| Response Level (A) | 2  | 826  | <1 |
| Treatments (B)     | 3  | 1687 | <1 |
| Error (AB)         | 6  | 7946 |    |

Table 3.7: Summary of analysis of variance for data in Table 3.6.

Response

| Level     | Sp                   | I <sub>2</sub>       | I <sub>3</sub>        | I <sub>4</sub>        |
|-----------|----------------------|----------------------|-----------------------|-----------------------|
| Fast      | S <sub>4</sub> +13.1 | S <sub>2</sub> -5.2  | S <sub>1</sub> +7.4   | S <sub>3</sub> -14.3  |
| Medium    | S <sub>7</sub> +8.4  | S <sub>5</sub> +0.9  | S <sub>8</sub> +3.4   | S <sub>6</sub> -4.6   |
| Slow      | S <sub>9</sub> +10.1 | S <sub>11</sub> -3.2 | S <sub>12</sub> +17.0 | S <sub>10</sub> +23.6 |
| Gp. Means | +10.5                | -2.5                 | +9.3                  | +1.6                  |

Table 3.8: Percent changes from mean baseline Heart Rate data (bpm) of all subjects during the treatments as a function of response levels (+ indicates acceleration, - indicates deceleration).

| Source             | df | MS    | F    |
|--------------------|----|-------|------|
| Between Subjects   |    |       |      |
| Response Level (A) | 2  | 156.9 | 1.60 |
| Treatments (B)     | 3  | 116.6 | 1.19 |
| Error (AB)         | 6  | 98.3  |      |

Table 3.9: Summary of analysis of variance for data in Table 3.8.

## Response

| Level     | Sp                | I <sub>2</sub>    | I <sub>3</sub>    | I <sub>4</sub>     |
|-----------|-------------------|-------------------|-------------------|--------------------|
| Fast      | S <sub>4</sub> +2 | S <sub>2</sub> 0  | S <sub>1</sub> +2 | S <sub>3</sub> +2  |
| Medium    | S <sub>7</sub> +2 | S <sub>5</sub> 0  | S <sub>8</sub> 0  | S <sub>6</sub> +2  |
| Slow      | S <sub>9</sub> -3 | S <sub>11</sub> 0 | S <sub>12</sub> 0 | S <sub>10</sub> +2 |
| Gp. Means | +0.33             | 0                 | +0.67             | +2                 |

Table 3.10: Rated anxiety changes (on scale of -10 to +10) of all subjects during treatments (comparison with last baseline sessions), as a function of response levels (+ indicates more anxiety).

DISCUSSION

It was necessary to establish the feasibility of using a money-loss free operant avoidance task in conjunction with an audience. Because of budget limitations, the author was forced to use a relatively small number of subjects and sessions; this makes strong conclusions about obtained effects difficult. Nevertheless, the study was successful in the sense of showing that it was possible to establish a reliable response rate with money loss as the aversive event (negative reinforcer). The sensitivity of this procedure with respect to altering possible sources of arousal however, must be questioned. In this experiment most subjects learned the avoidance task quickly (within 1 or 2 sessions) and responded at relatively high rates while taking few (if any) losses, so that a preliminary unavoidable loss had to be given at the beginning of the session. It is known that when the aversive event is rarely encountered in avoidance conditioning,

(a) responding comes under the control of stimuli whose distinguishing characteristic is the absence of the aversive event, and (b) a high degree of resistance to extinction is developed (Kaufman & Baron, 1969). It follows that either omitting or changing the intensity of the aversive event does not produce any change in the stimulus conditions controlling the response. In other words, it appears that attempting to manipulate arousal by changing the intensity of the aversive event in this experiment was not successful. This is to some degree supported by the small changes in heart rates produced by the I treatments (Table 3.8), and similarly by the small changes in the subjective estimates of anxiety (Table 3.10). Although response rate changes in the treatments stopped short of significance, judging by the size of the changes it is possible that a better designed experiment may demonstrate a significant effect here (Table 3.4).

The spectator treatment can be regarded in this experiment as being dissimilar from the other treatments in respect of stimulus conditions and the manipulation of arousal, because it clearly was not subject to the difficulties of the I treatments. Because of the small number of subjects (3) who underwent the spectator treatment, it is not useful to attempt to demonstrate statistical significance with respect to baselines. There seems to be a slight trend, however, towards impaired performance under the Sp treatment when compared with baselines, concomitant with slight increases in heart rates consistent with the inverted U hypothesis between performance and arousal. Clearly this inference is

not very powerful, and hence only suggestive.

Because of these difficulties encountered with the high efficiency of performance by many of the subjects in the free-operant avoidance paradigm, it was decided to investigate a positive reinforcement schedule with humans which might be sensitive to the effect of audience, yet not present the difficulties encountered in this experiment. This is further examined in Chapter V.

#### SUMMARY

An attempt was made to determine whether responding by humans on a free-operant avoidance schedule with money loss as the aversive stimulus would be sensitive to (a) changes in the size of aversive stimulus and (b) the presence of a spectator. Subjects were run to baseline and then divided into three groups of Fast, Medium and Slow responders. One subject from each group was randomly assigned to one of four treatments ( $I_2 = 10\phi$  loss,  $I_3 = 15\phi$  loss,  $I_4 = 20\phi$  loss, Sp with baseline  $5\phi$  loss). It was found that there were no significant differences between the groups or between the treatments on all of the dependent variables used. It was concluded that the schedule was not a useful one to test (a) and (b) above as many subjects were very efficient responders and took few losses so that changes in the size of the money loss were difficult to administer to subjects.

CHAPTER 1VEXPERIMENT 3. THE ROLE OF EMOTIONALITY OF RATS IN SIDMAN  
AVOIDANCE RESPONDING WITH AND WITHOUT AN AUDIENCE.

The object of this experiment was to test the hypothesis that performance on a aversively motivated task by high emotionality rats will be impaired by the presence of an audience and performance will be facilitated by addition of an audience to low emotionality rats.

The role of emotionality as an index of arousal has already been discussed in Chapter I (I.4.4). One study (Ley, 1975) strongly supported the hypothesis that emotionality is a dispositional characteristic which contributes to general drive, by showing positive correlations between open-field defecation and defecation during avoidance conditioning. Other studies however, have suggested that the concept of emotionality is a complex one. For example, Paré (1964) has shown that the various measures by which it has been assessed are not always highly correlated. Similarly, Ivinskis (1966) using an open-field situation, found defecation and urination to be valid measures, but not activity and washing. Whimbey & Denenberg (1967) using factor analysis of a number of these measures, have shown that defecation in the open-field loaded on one factor (called "emotionality") while activity loaded on both the "emotionality" and the "exploration" factors. Also activity on the first day in the open-field correlated positively with defecation, whereas on subsequent days the correlation was negative.

It seems then, that the most reliable (Ivinskis, 1968) and most validated measure of emotionality from the literature is defecation. Latency of movement from the central position in the open-field has also been validated as an emotionality measure by Ivinskis (1970), although its reliability was found to be low (Ivinskis, 1968). Activity in the open-field is a much more dubious measure of emotionality and hence was not used in the present experiment.

Furthermore, Denenberg (1964) suggests that during avoidance conditioning (a stressful learning task) an inverted U relationship exists between adult performance and emotionality, such that optimal performance is attained by animals with moderate emotionality and poorer performance is attained by animals who are high and low in emotionality.

Can the addition of an audience with its postulated arousal increment summate with the emotionality factor? Since the concept of emotionality is often used interchangeably with the concept of arousal (Denenberg, 1964), this may indeed be hypothesised. Hence it would be expected that the addition of an audience to low emotionality rats will improve their performance and adding an audience to high emotionality rats will impair their performance, provided that the inverted U relationship between performance and arousal is assumed, and an avoidance situation is used.

An additional phase was added to the experiment to test the effects of emotionality and audience on the resistance to extinction of the avoidance response. In giving separate blocks of extinction sessions with retrieval of baselines in between, the normally observed phenomenon is of a gradual



decreasing resistance to extinction, so that for example, in the first extinction block the greatest resistance to extinction is observed, in the second block, a somewhat lesser resistance is observed and so on (e.g. Boren & Sidman, 1957). The usual explanation given for this phenomenon is that the animal eventually learns that once it goes beyond the R-S interval without receiving a shock, it will not be shocked again during that session, so that no more avoidance responses are required.

Since an increasing level of arousal would be expected to facilitate the learning of this temporal discrimination provided overarousal does not occur, the low emotionality group should benefit from an audience's presence during extinction, but the high emotionality group may show impaired extinction performance with an audience if overarousal is assumed.

#### METHOD

##### Subjects.

Sixteen brown hooded, Wistar-strain, male rats were used as subjects and another sixteen were used as audience rats. At the beginning of the experiment, all animals were about 90 - 120 days old and were selected from a colony of 200 rats, all of which had been subjects in a class exercise involving continuous reinforcement (crf), extinction to crf and fixed ratio reinforcement. All animals had learned a bar press response, but the time spent in the Skinner box for each animal amounted to less than 14 hours. At the completion of the class exercise, all 200 animals were tested

individually for scores on two emotionality indices - the number of boluses excreted (D) and the latency of movement from the central square (L) in an open-field apparatus during a single 3 minute period. The thirteen animals which scored highest and the thirteen which scored lowest on the D and L measures were further tested for 3 minute periods on three successive days and from these the final selection of the eight highest and the eight lowest scorers was made. The basis for choosing the highest and lowest scorers was by calculating a mean D and a mean L score for the three testing days. The final eight highest D and L scorers and final eight lowest D and L scorers were selected on the basis of their mean D and mean L scores. (See Appendix B1).

The D and L measures were obtained by the following technique. Subjects were transported from the animal holding area to the experimental room in a bucket, one subject at a time. Care was taken to handle subjects gently in order to avoid producing unnecessary stress. Subjects were placed in the centre square of an open-field apparatus which consisted of a square enclosure constructed of hard-board painted black on the inside walls and floor. The box measured 90cms along each side and 30 cms. high. The floor was marked into 25 equal size squares. Subjects were placed on the centre square facing away from the experimenter who moved away a distance of 3m behind a rack of empty cages to make observations. Normal room illumination was provided by fluorescent lights. At the end of the three minute period (measured by stopwatch), the subject was taken out, the floor of the open-field apparatus cleaned with an 80-20 mixture of water and methylated spirits, and the next subject run. Each animal was tested at

approximately the same time each day.

At all stages during the experiment the animals were housed singly and given ad lib food and water.

#### Apparatus.

For the experiment proper the same four audience Skinner boxes as in Experiment 1 (Chapter II) were used, along with the same shock apparatus. Shocks were of 0.5 sec. duration, with the intensity of shocks set at 1.3 ma (a moderate level of shock under Sidman avoidance conditions). The S-S interval was again set at 5 sec, with the R-S interval at 30 sec. Responses and shocks were recorded on mechanical counters and continuously monitored on cumulative recorders.

#### Procedure.

All subjects were given daily 2 hour sessions at approximately the same time every day. At the end of 65 sessions all animals had attained the baseline criterion again set at 3 successive sessions in which mean response rates did not vary more than  $\pm 10\%$ .

In Experiment 1, subjects were given one session of the audience treatment and then returned to baseline. It is possible that by giving more than one session any effect due to the treatment might be more pronounced or be easier to differentiate from baseline. Hence in this experiment three successive sessions of the audience treatment were given to all subjects. After these three treatment sessions, baselines were retrieved.

In the second phase of the experiment, all animals were given two sessions of Shock-off solitary extinction, then baselines were retrieved. Two sessions of social extinction

followed during which the spectator rat was present. Baselines were again retrieved and this was followed by another two sessions of solitary extinction.

The first of the two sessions of the three extinction blocks involved 20 mins. of normal avoidance as before; then for the remaining 100 mins. of the session, the shock was turned off. In the second of the two sessions of the three extinction blocks, no shock was given at the beginning of the session, so that these second sessions lasted for 100mins. each.

During the experiment all subjects were always given the same spectator rat during the social sessions. Skinner boxes were again cleaned before each animal commenced its daily session. The last animal finished at the end of the 81st session.

At the completion of running, all animals were tested on the emotionality indices D and L for three consecutive days as before, to give a reliability check of the indices.

## RESULTS

The differences between the two groups of subjects were significant on both the  $D_1$  measure ( $t_{14} = 9.54, p < 0.001$ ) and the  $L_1$  measure ( $t_{14} = 3.21, p < 0.01$ ) in the predicted direction (See Appendix B).

The difference between the two groups on the initial mean baseline response rates (Table 4.1) was significant ( $t_{14} = 2.57, p < 0.05$ ).

|          |                  | Groups            |                       |
|----------|------------------|-------------------|-----------------------|
|          |                  | High Emotionality | Low Emotionality      |
| Subjects | S <sub>21</sub>  | 5.32              | S <sub>39</sub> 7.63  |
|          | S <sub>42</sub>  | 2.86              | S <sub>69</sub> 4.30  |
|          | S <sub>46</sub>  | 3.26              | S <sub>102</sub> 6.22 |
|          | S <sub>47</sub>  | 3.79              | S <sub>146</sub> 7.30 |
|          | S <sub>54</sub>  | 4.73              | S <sub>158</sub> 3.95 |
|          | S <sub>90</sub>  | 4.49              | S <sub>163</sub> 5.59 |
|          | S <sub>93</sub>  | 5.05              | S <sub>173</sub> 4.03 |
|          | S <sub>180</sub> | 3.89              | S <sub>199</sub> 7.77 |
|          | Means            | 4.17              | 5.85                  |

Table 4.1: Mean baseline response rates (no. resp. per min.) of high and low emotionality subjects.

Differences between the two groups on the other three dependent measures are shown by their means and standard deviations in Table 4.2. Only on the efficiency of avoidance index was the high emotionality group significantly better (0.05 level) than the low emotionality group (low E scores indicate greater "efficiency" - see Chapter II). On shock rates, there was only a tendency towards the conventional 0.05 level of significance.

|                                    |      | Dependent Variable |             |             |
|------------------------------------|------|--------------------|-------------|-------------|
|                                    |      | S.R.               | S/R         | E           |
| Emotionality                       | High | 0.914(0.34)        | 0.235(0.13) | 0.232(0.08) |
| Groups                             | Low  | 1.28 (0.35)        | 0.240(0.09) | 0.411(0.14) |
| Comparisons of High and Low Groups |      | t = 1.98*          | t = 0.08    | t = 2.84**  |

\*\*  $p < 0.05$  (2-tailed)

\*  $p < 0.10$  (2-tailed)

Table 4.2: Comparisons of Means of the mean shock rates (S.R.), show to response ratios (S/R) and efficiency of avoidance indices (E) of the high and low emotionality groups (standard deviations in brackets).

Phase 1.

Table 4.3 summarises the mean percent changes (for High and Low Emotionality groups) obtained in the four dependent variables during the 3 audience sessions. Two factor analyses of variance with repeated measures on the audience session factor (Winer, 1971) were carried out on individual percent change scores for the four dependent measures. These four analyses indicated that neither the audience session factor nor the emotionality factor nor the interaction between these was significant (see summary of these analyses in Table 4.4). Planned comparisons were carried out on the percent change scores for each subject averaged over the 3 audience sessions, between the High and Low Emotionality groups. These scores and the planned comparison analyses are given in Table 4.5.

|                                     |                  | Dependent Variable |       |       |       |
|-------------------------------------|------------------|--------------------|-------|-------|-------|
|                                     | Audience Session |                    |       |       |       |
|                                     |                  | RR                 | SR    | S/R   | E     |
| High<br>Emotion-<br>ality<br>Groups | 1                | +4.0               | -12.8 | -13.6 | -14.4 |
|                                     | 2                | +2.1               | -8.3  | -8.3  | -11.2 |
|                                     | 3                | +4.0               | -4.8  | -2.2  | -7.5  |
|                                     | 1                | -7.7               | -17.3 | -38.1 | -1.9  |
|                                     | 2                | +2.5               | -9.1  | -21.7 | -5.6  |
|                                     | 3                | -3.4               | -18.8 | -42.2 | -9.8  |
| Low                                 |                  |                    |       |       |       |

Table 4.3: Mean percent changes from baseline measures of the four dependent variables response rates (RR), shock rates (SR), shock to response ratios (S/R) and efficiency of avoidance indices (E), during the 3 audience treatment sessions as a function of High (n=8) and Low (n=8) Emotionality groups. (+ indicates "better" performance, - indicates "worse" performance).

| Source           | df | Dependent Variables F ratios |      |      |      |
|------------------|----|------------------------------|------|------|------|
|                  |    | RR                           | SR   | S/R  | E    |
| Between Subjects |    |                              |      |      |      |
| Emotionality     | 1  | 0.66                         | 0.09 | 1.83 | 0.19 |
| Groups (A)       |    |                              |      |      |      |
| Error (Subjects) | 14 |                              |      |      |      |
| Within Subjects  |    |                              |      |      |      |
| Audience         |    |                              |      |      |      |
| Sessions (B)     | 2  | 0.10                         | 0.22 | 1.25 | 0.02 |
| A X B            | 2  | 1.00                         | 0.22 | 0.84 | 0.33 |
| Error (B X S)    | 28 |                              |      |      |      |

Table 4.4: Summaries of results of analyses of variance for data from which Table 4.3 is derived.

|              |             | Dependent Variable |        |        |        |
|--------------|-------------|--------------------|--------|--------|--------|
| Subjects     |             | RR                 | SR     | S/R    | E      |
| High         | 21          | +4.8               | -24.6  | -20.5  | -27.7  |
|              | 42          | -0.1               | -9.4   | -15.3  | -7.9   |
|              | 46          | -9.2               | +2.9   | -7.3   | +7.7   |
|              | 47          | -6.8               | -63.8  | -74.5  | -65.4  |
|              | 54          | +3.1               | +2.6   | +5.3   | -1.4   |
|              | 90          | +19.4              | +38.8  | +46.8  | +31.9  |
|              | 93          | +13.3              | -8.7   | +4.1   | -18.7  |
|              | 180         | +2.6               | -5.5   | +2.7   | -6.8   |
| Emotionality | Group Means | +3.4               | -8.5   | -7.4   | -11.0  |
| Low          | 39          | -18.3              | -50.1  | -89.5  | -28.1  |
|              | 69          | -5.4               | +2.0   | -5.8   | +4.9   |
|              | 102         | -7.1               | -25.3  | -35.7  | -7.9   |
|              | 146         | -37.8              | -41.0  | -125.7 | +1.1   |
|              | 158         | +14.0              | +18.2  | +27.6  | +9.2   |
|              | 163         | -12.9              | -56.8  | -82.6  | -41.0  |
|              | 173         | -1.3               | -4.9   | -6.9   | -4.7   |
|              | 199         | +45.2              | +37.8  | +46.5  | +20.0  |
| Planned      | Group Means | -3.0               | -15.0  | -34.0  | -5.8   |
| Comparisons  |             |                    |        |        |        |
| Between      |             | t+0.68             | t=0.42 | t=1.09 | t=0.43 |
| High and Low |             |                    |        |        |        |
| Emotionality |             |                    |        |        |        |

Table 4.5: Percent change scores for each subject averaged over the 3 audience sessions for all 4 dependent variables as a function of Emotionality. Planned comparisons between High and Low Emotionality groups were not significant at 0.05 level.

When the Emotionality groups were combined and the differences between baseline measures and mean audience measures examined (Appendix B2), it was found that none of the comparisons for RR, SR, S/R and E were significant at the 0.05 level. This represents a failure to replicate the audience effects found in Chapter II when all subjects were combined.

#### Phase 2 : Extinction.

Table 4.6 shows the percent changes from baseline response rates in the three extinction periods. A repeated measures analysis of variance design (Winer, 1971, p.518) with repeated measures on Extinction Periods (Solitary 1, Audience, Solitary 2) was carried out on the data in Table 4.6. That is, two separate analyses were carried out on the Session 1 scores and the Session 2 scores. It was decided to treat these sets of scores separately since the procedure of extinction varied between them : immediately before Session 1 periods, 20 mins. of normal shock avoidance was given, whereas no shock avoidance was in effect immediately before the Session 2 periods. Tables 4.7 and 4.8 show the analyses of variance summaries for the data in Table 4.6. The only significant F ratio was obtained for differences between the 3 Extinction Periods on the Session 2 scores. The greatest suppression of responding during these Sessions 2 was during the Audience treatment, the next during Solitary 2 treatment while least suppression occurred during the Solitary 1 period, suggesting that the effect of the Audience was to inhibit responses during the second extinction sessions. Table 4.9 confirms this effect but only significantly for the Low



Emotionality group.

If an arbitrary criterion to extinction during each session of a 10 minute block with the emitting of 1 response or less is set, the data in Table 4.11 are derived. If subjects had not reached the criterion a score of 100 minutes was given. Analyses of variance summaries of Session 1 and Session 2 scores are presented in Tables 4.12 and 4.13. It can be seen from these tables that again only in the Session 2 scores did differences between the 3 extinction periods become significant. There were also significant differences between the Emotionality groups. Planned comparisons of Session 1 and Session 2 extinction times with Audience extinction times were made (Table 4.10).

Retesting all subjects at the completion of the experiment on D and L measures gave data ( $D_2$  and  $L_2$  scores) reported in Appendix B1. The high reliability of the D measures was evident ( $r = 0.89$ ,  $df = 14$ ,  $p < 0.01$ ), but the L measures could not be reproduced reliably. ( $r = 0.13$ ,  $df = 14$ ,  $p > 0.10$ ).

| Extinction Periods |            |          |          |          |            |          |
|--------------------|------------|----------|----------|----------|------------|----------|
| Subjects           | Solitary 1 |          | Audience |          | Solitary 2 |          |
|                    | Session1   | Session2 | Session1 | Session2 | Session1   | Session2 |
| 21                 | 67.5       | 98.3     | 54.7     | 99.8     | 74.5       | 99.4     |
| 42                 | 95.5       | 96.2     | 99.7     | 99.0     | 97.2       | 99.0     |
| 46                 | 85.9       | 96.9     | 63.2     | 99.4     | 90.5       | 99.1     |
| High 47            | 88.9       | 98.4     | 92.6     | 99.7     | 98.9       | 93.4     |
| 54                 | 95.3       | 99.8     | 94.5     | 99.6     | 97.7       | 100      |
| 90                 | 23.8       | 65.3     | 46.5     | 86.2     | 50.3       | 85.1     |
| 93                 | 83.4       | 97.8     | 84.5     | 99.3     | 82.3       | 99.8     |
| Emo- 180           | 65.6       | 98.7     | 46.3     | 94.3     | 61.4       | 97.9     |
| tion               |            |          |          |          |            |          |
| al- Group          | 75.7       | 93.9     | 72.8     | 97.2     | 81.6       | 96.7     |
| ity Means          |            |          |          |          |            |          |
| Groups             |            |          |          |          |            |          |
| 39                 | 59.9       | 70.0     | 82.0     | 99.6     | 56.0       | 77.9     |
| 69                 | 74.2       | 90.0     | 87.7     | 98.9     | 94.0       | 99.3     |
| 102                | 20.9       | 86.5     | 83.9     | 98.4     | 79.7       | 99.2     |
| Low 146            | 48.4       | 92.5     | 48.4     | 96.6     | 25.5       | 96.6     |
| 158                | 73.7       | 85.6     | 60.0     | 98.5     | 92.7       | 90.4     |
| 163                | 85.0       | 98.2     | 92.8     | 95.7     | 93.9       | 95.2     |
| 173                | 50.1       | 89.3     | 34.8     | 97.3     | 37.7       | 80.4     |
| 199                | 65.5       | 96.0     | 73.8     | 98.3     | 83.5       | 94.2     |
| Group              |            |          |          |          |            |          |
| Means              | 59.7       | 88.5     | 70.4     | 97.9     | 70.4       | 91.7     |
| Overall            |            |          |          |          |            |          |
| Means              | 67.7       | 91.2     | 71.6     | 97.5     | 76.0       | 94.2     |
| Planned            |            |          |          |          |            |          |
| Comparisons        |            |          |          |          |            |          |
| Between            | t=1.33     | t<1      | t<1      | t<1      | t<1        | t<1      |
| High and           |            |          |          |          |            |          |
| Low Emot.          |            |          |          |          |            |          |

Table 4.6 : Percent changes from baseline response rates in  
3 Extinction periods as a function of Emotional-  
ity (all scores are negative).

| Source                 | df | MS     | F    |
|------------------------|----|--------|------|
| Between Subjects       |    |        |      |
| Emotionality (A)       | 1  | 1166.2 | 1.01 |
| Error (S)              | 14 | 1149.7 |      |
| Within Subjects        |    |        |      |
| Extinction Periods (B) | 2  | 273.5  | 1.63 |
| A X B                  | 2  | 193.3  | 1.15 |
| Error (B X S)          | 28 | 167.5  |      |

Table 4.7: Analysis of variance summary of  
Session 1 scores in Table 4.6.

| Source                 | df | MS     | F     |
|------------------------|----|--------|-------|
| Between Subjects       |    |        |       |
| Emotionality (A)       | 1  | 126.10 | 1.16  |
| Error (S)              | 14 | 108.39 |       |
| Within Subjects        |    |        |       |
| Extinction Periods (B) | 2  | 159.91 | 5.70* |
| A X B                  | 2  | 47.92  | 1.71  |
| Error (BS)             | 28 | 28.05  |       |

\*  $p < 0.01$

Table 4.8: Analysis of variance summary of  
Session 2 scores in Table 4.6.

|      | Sol 1 - Aud |              | Sol 2 - Aud  |              |
|------|-------------|--------------|--------------|--------------|
|      | Session 1   | Session 2    | Session 1    | Session 2    |
| High | ns          | ns           | $t_7=2.32^*$ | ns           |
| Low  | ns          | $t_7=2.76^*$ | ns           | $t_7=2.04^*$ |

\*  $p < 0.05$

ns  $p > 0.05$

Table 4.9: Planned comparisons of Solitary 1 and Solitary 3 Extinction (with Audience) changes in response rates (data from Table 4.6) carried out separately for High and Low Emotionality groups.

|      | Sol 1 - Aud |              | Sol 2 - Aud  |           |
|------|-------------|--------------|--------------|-----------|
|      | Session 1   | Session 2    | Session 1    | Session 2 |
| High | ns          | $t_7=2.89^*$ | $t_7=3.01^*$ | ns        |
| Low  | ns          | ns           | ns           | ns        |

\*  $p < 0.01$

ns  $p > 0.05$

Table 4.10: Planned comparisons of Solitary 1 and Solitary 2 Extinction with Audience Extinction times to reach criterion (data from Table 4.11) carried out separately for High and Low Emotionality groups.

| Extinction Periods         |          |                 |          |          |            |                 |
|----------------------------|----------|-----------------|----------|----------|------------|-----------------|
| Solitary 1                 |          |                 | Audience |          | Solitary 2 |                 |
| Subjects                   | Session1 | Session2        | Session1 | Session2 | Session1   | Session2        |
| 21                         | 87.0     | 16.5            | 85.0     | 10.0     | 55.0       | 10.0            |
| 42                         | 10.0     | 16.0            | 10.0     | 10.0     | 10.0       | 10.0            |
| 46                         | 10.0     | 18.5            | 79.0     | 10.0     | 29.0       | 16.0            |
| High 47                    | 10.0     | 10.0            | 34.5     | 10.0     | 10.0       | 10.0            |
| Emo- 54                    | 10.0     | 10.0            | 30.5     | 10.0     | 10.0       | 10.0            |
| tion-90                    | 100.0    | 57.0            | 100.0    | 46.5     | 100.0      | 26.0            |
| ality93                    | 71.0     | 25.0            | 54.5     | 10.0     | 50.0       | 10.0            |
| 180                        | 89.0     | 14.5            | 100.0    | 15.0     | 84.0       | 10.0            |
| Group Means                | 48.4     | 20.9            | 61.7     | 15.2     | 43.5       | 12.7            |
| 39                         | 10.0     | 86.0            | 51.5     | 16.0     | 10.0       | 49.0            |
| 69                         | 10.0     | 45.0            | 10.0     | 32.5     | 10.0       | 28.0            |
| 102                        | 100.0    | 35.0            | 53.5     | 15.5     | 60.0       | 13.5            |
| Low 146                    | 91.0     | 36.0            | 100.0    | 19.0     | 100.0      | 26.0            |
| Emo-158                    | 10.0     | 35.0            | 98.0     | 10.0     | 32.5       | 10.0            |
| tion163                    | 58.5     | 13.5            | 21.0     | 34.5     | 32.5       | 26.0            |
| al- 173                    | 85.0     | 31.0            | 100.0    | 42.5     | 90.5       | 40.0            |
| ity.199                    | 85.0     | 23.5            | 41.0     | 10.0     | 47.0       | 10.0            |
| Group Means                | 56.2     | 38.1            | 59.4     | 22.5     | 47.8       | 25.3            |
| Overall Means              | 52.3     | 29.5            | 60.6     | 18.9     | 45.7       | 19.0            |
| Planned Comparisons        |          |                 |          |          |            |                 |
| Between High and Low Emot. | ns       | $t_{14}=1.84^*$ | ns       | ns       | ns         | $t_{14}=2.33^*$ |

\*  $p < 0.05$ ns  $p > 0.05$ 

Table 4.11: Time taken (minutes) to reach the criterion to extinction during Sessions 1 and 2 in 3 Extinction periods as a function of Emotionality.

| Source                 | df | MS     | F     |
|------------------------|----|--------|-------|
| Between Subjects       |    |        |       |
| Emotionality (A)       | 1  | 128.38 | $< 1$ |
| Error (S)              | 14 | 3319.3 |       |
| Within Subjects        |    |        |       |
| Extinction Periods (B) | 2  | 888.58 | 2.28  |
| A X B                  | 2  | 105.77 | $< 1$ |
| Error (B X S)          | 28 | 389.14 |       |

Table 4.12: Analysis of variance summary of  
Session 1 scores in Table 4.11.

| Source                 | df | MS     | F     |
|------------------------|----|--------|-------|
| Between Subjects       |    |        |       |
| Emotionality (A)       | 1  | 1831.5 | 4.68* |
| Error (S)              | 14 | 391.32 |       |
| Within Subjects        |    |        |       |
| Extinction Periods (B) | 2  | 598.69 | 5.19* |
| A X B                  | 2  | 97.65  | $< 1$ |
| Error (B X S)          | 28 | 115.37 |       |

\*  $p < 0.05$

Table 4.13: Analysis of variance summary of  
Session 2 in Table 4.11.

## DISCUSSION

Phase 1 of the experiment showed that there were no differences between the High and Low emotionality groups with respect to the presence of an audience, although baseline response rates and efficiency of avoidance index scores did differ between the two groups. This indicates that separating the subjects according to D and L measures did have an effect upon responding in a Sidman avoidance situation. The High emotionality group showed lower baseline response rates, but higher baseline "efficiency" of avoidance than the Low emotionality group (see Tables 4.1 and 4.2). This is a rather surprising result, since it would be expected that High emotionality is related to high arousal under avoidance conditions (Denenberg, 1964). The baseline response rates obtained in this experiment clearly do not fit in with this prediction - in fact they show the reverse of the Denenberg theory. It is difficult to explain these data, but the following might serve as suggestions.

It is possible that the emotionality groups were not separate enough from each other in spite of the significant D and L differences, as the rats were selected from one population which had been treated similarly (housing conditions etc.). It might be possible to breed subjects for high and low emotionality over several generations. In fact, strain differences in emotionality have been shown to affect open-field and conditioned avoidance behaviour (Wilcock & Broadhurst, 1967). Also housing conditions (isolated vs. small groups) of hooded rats are known to affect emotionality measures

(Warren & Ivinskis, 1973), but the direction of these differences is in question as some studies have shown reverse tendencies (e.g. Latané, Cappell & Joy, 1970). The point is that groups high and low on emotionality may be separated further than was done in the present experiment by manipulation of strain and housing conditions.

Another possibility explaining the above data concerns the nature of the avoidance task. Denenberg (1964) suggests that animals high on emotionality should perform similarly to animals low on emotionality, while moderately emotional animals should perform best. It may be that the High emotionality group is closer to "moderate" emotionality than the Low emotionality group, and hence showed greater efficiency of avoidance. This explanation is offset however, by the High emotionality group's lower response rates, which should have been higher than the Low emotionality group, if the arousal-response rate link holds (Kimble, 1961).

Why was there a failure to significantly reproduce the audience effect shown in Experiment 1? Again this is a rather puzzling feature of the present experiment when the audience effect in Sidman avoidance under very similar conditions has been shown to occur under at least two separate occasions. There is one fundamental difference between this experiment and these previous occasions however : subjects were randomly selected in the latter, but were selected on the basis of emotionality scores in the former. However, if emotionality is not a determiner of audience effects in Sidman avoidance, replication of Experiment 1 results should still have occurred



when the subjects were combined, since random subject selection would have been satisfied (because emotionality can be considered an irrelevant variable). Yet no facilitation or impairment effect was shown when the subjects were combined, or when the two groups were considered separately. This may be explained by considering another variation between Experiment 1 and this experiment, which was the shock intensity. Significant audience effects with response rate changes were found in Experiment 1 when the shock intensity was 0.5 mA, but not when it was 2.0 mA. The present experiment's 1.3 mA tends to fit in with the 2.0 mA data for which an overarousal swamping effect was suggested, (see Chapter II - Discussion), which masked the arousal increment due to audience. However, there was a difference between baseline response rates between the emotionality groups, while this was not the case for the three groups in Experiment 1.

Similar trends appeared on cumulative records during the audience sessions as were observed in Experiment 1. Both emotionality groups seemed to take groups of shocks rather than occasional shocks during baseline sessions, and bursts of responses seemed to be more frequent (see Fig. 5). The implications of these in terms of competing social responses have already been discussed (Discussion, Chapter II).

Phase 2 of the experiment indicated that differences in shock-off extinction with and without an audience were apparent between the emotionality groups, but only with respect to the Session 2 scores (response rates and times to reach the extinction criterion). With the response rate

variable, both the High and Low Emotionality groups showed the smallest response rates in the audience extinction period with respect to both the solitary extinction periods, but only for the Low Emotionality group was this "benefit" significant (see Tables 4.6 and 4.9). This finding supports the hypothesis that the Low Emotionality group should benefit from an audience's presence during extinction, although the High emotionality group did not suffer impaired extinction performance with the audience as was hypothesised.

With the time to criterion variable (Tables 4.11 and 4.10) the above trend did not follow through consistently, although differences between the Emotionality groups were significant for the Solitary 1 and Solitary 2 Session 2 times with the High Emotionality group extinguishing faster. Extinction times on the audience periods were not different between the groups. With the time to criterion variable then, neither of the two groups "benefited" from the presence of audience during extinction. Nevertheless, partial support of the audience extinction hypothesis was provided by the analyses of the response rate variable. Why did only the Low Emotionality group benefit from the presence of the audience?

It seems again to indicate partial support for the Zajonc theory rather than the Inverted U hypothesis. Nevertheless, Zajonc's theory cannot explain why the High Emotionality group did not also benefit from the audience during extinction. The Inverted U theory could claim that, as has also been suggested earlier in this chapter section, the High group was not sufficiently removed from the Low Emotionality

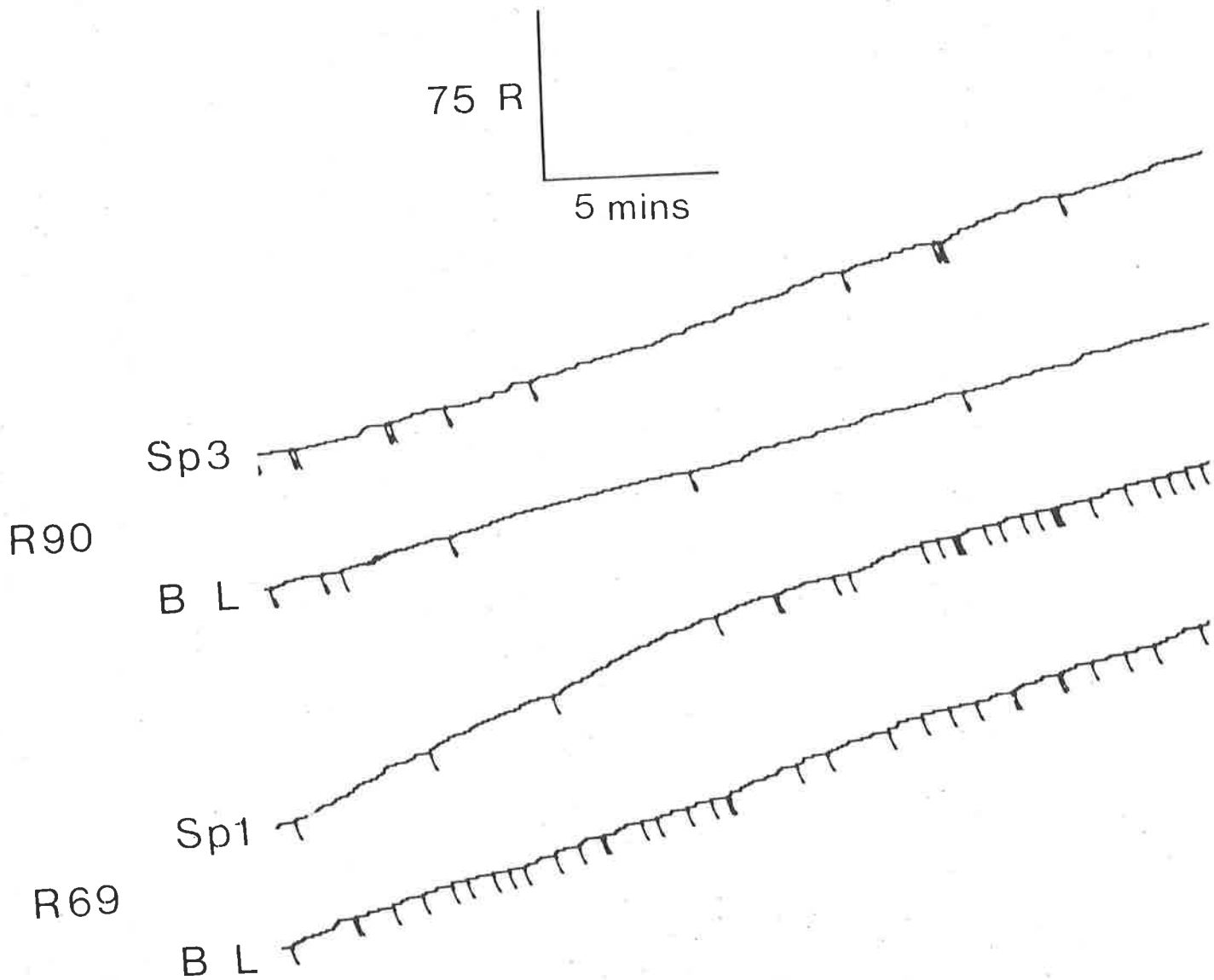


Fig. 5: Samples of cumulative records taken from the 2nd hour of Baseline and Spectator sessions of  $R_{90}$  and  $R_{69}$  in Experiment 3.

group, and had in fact not reached a large degree of over-arousal. It seems difficult to accept this reasoning, however, because of the reversed from expected order of baseline response rates between the Emotionality groups.

How would the competing response theory explain the extinction data?

First, the presence of an audience during extinction would be expected to suppress or inhibit avoidance responding because of the alteration of the probabilities of responses in the habit hierarchy, making social responses more probable at the expense of nonsocial (including the avoidance) responses. However, when the social stimulation is removed, responses in the habit hierarchy tend to revert to their original (i.e. pre-audience) probability levels. This return is incomplete however, because the animal has had experience in the Skinner box which involved no shock as well as social stimulation, so that there are elements of permanent change in the animal's habit hierarchy. However, animals which are high on emotionality should have shown this effect as well as those low on emotionality because a change in the habit hierarchy is effected and not only in arousal.

One important distinction is to be made between the competing response theory and Zajonc's theory with respect to these extinction results. Whereas Zajonc's theory predicts that the acquisition (i.e. learning) of the new no-shock - response contingency should be impaired by the presence of an audience, the competing response theory would predict that the effects of an audience during extinction should be to suppress temporarily the avoidance response. Hence the latter explanation should be favoured.

SUMMARY

The hypothesis that high emotionality rats would show impaired performance and low emotionality rats would show facilitated performance with an audience in a Sidman avoidance task was not supported. There did seem to be a suppression effect during shock-off extinction when an audience of one spectator rat was added, however. This effect was most marked for the Low emotionality group. It was concluded that although Zajonc's theory was not refuted by these data, an explanation involving competing social responses interfering with the avoidance response seemed more likely.

CHAPTER VEXPERIMENT 4 : THE ROLE OF NEUROTICISM IN DRL RESPONDING  
OF HUMANS WITH AND WITHOUT AN AUDIENCE.

The object of this experiment was to test:

- (a) the suitability of the DRL (differential reinforcement of low rates of responding) schedule to the audience effect with humans as subjects, and
- (b) to test the effect of high and low degrees of neuroticism interacting with this possible effect.

The outcome of the experiment in Chapter III was used to reject the paradigm of free-operant avoidance of money loss in conjunction with studying arousal effects of an audience. To maintain some continuity between that study and the present one, however, it was decided to investigate the usefulness of another schedule which also required temporal discrimination, but which was more difficult for humans than a free-operant schedule. One such schedule which seems to present itself for this purpose is DRL (differential reinforcement of low rates of responding). (Ferster & Skinner, 1957, p.33). In this positive reinforcement schedule, reinforcement is contingent upon the occurrence of a response separated from the preceding response by at least some specified time interval. For example, on a DRL30 schedule, only responses preceded by a 30 sec. pause or greater are reinforced; if the subject emits a second response within 30 sec. of the first, the timer is reset and he must now wait 30 sec. from the second response.

One of the problems in measuring performance in Experiment 2 was the extremely high rate of response exhibited by a number of subjects; this made performance measures and the delivery of aversive stimuli difficult. The DRL schedule however, required a low rate of response and forces the subject to postpone responding for at least a given period of time if reinforcers are to be delivered. In all positive reinforcement schedules, unlike Sidman avoidance, responding which does not meet the reinforcement contingency extinguishes, so that the delivery of stimuli assumes much more control over the behaviour. Using a positive reinforcement schedule therefore would seem to overcome some of the problems encountered in Experiment 2. Whereas in Sidman avoidance rapid responding is only a waste of effort, in the DRL schedule rapid responding is both a waste of effort and actually postpones the delivery of the reinforcement.

Human subjects perform reasonably well on DRL schedules regardless of whether they are given instructions (Bruner & Revusky, 1961; Carter & MacGrady, 1966). For example, Dews & Morse (1958) found that from 80% to 90% of the responses of subjects were reinforced on a DRL25 schedule.

It might be expected that performance on a DRL schedule, especially if the contingency requires relatively long <sup>s</sup>IRT's (i.e. large values for the DRL schedule), will be affected by the presence of an audience. There is some evidence for example, that motivational variables such as the amount of deprivation and magnitude of reinforcement affect performance by increasing the rate of response

(reviewed by Kramer & Rilling, 1970). This is a paradoxical effect since increasing the rate of response frequently leads to a decrease of reinforcement on a DRL schedule. Consequently, arousal increases, such as those postulated to be associated with the presence of an audience, would be expected to increase the response rate.

With the easily aroused high N scoring subjects, performance on the DRL schedule in the presence of an audience should be disrupted more than with the stable low N scoring subjects if it is assumed that the former become overaroused very quickly (see Chapter I, I.4.2). Low N scoring subjects on the other hand, may be expected to facilitate their performance if it is assumed that low reactivity to stimulation leads towards optimum arousal rather than overarousal, and that subjects are working at less than optimum arousal during baseline sessions. By using relatively large DRL values it seems possible to ensure that subjects are not overstimulated and hence not overaroused.

#### METHOD

##### Subjects.

Sixteen male and female undergraduate University of Adelaide first-year psychology students participated in the experiment. Eight subjects were randomly selected from the extreme upper end ( $N \geq 19$ ) and eight subjects from the extreme lower end ( $N \leq 5$ ) of the N scores of the Psychology I student population who had earlier completed Form A of the Eysenck Personality Inventory (Eysenck & Eysenck, 1964).



The range of the scores possible on the neuroticism dimension was 0-24. As in Experiment 2, all subjects were required to be non-smokers; their ages ranged from 17-24 years.

#### Apparatus.

A modified version of the apparatus in Experiment 2 was used. The modifications were as follows. The response manipulandum was removed and a 20mm long finger key was added. The key could be fully depressed by applying a force of 250 gms. through a distance of approximately 10mm - this represented a response. As well as the 1 sec. white response feedback light, a 1 sec. green reinforcement light was installed. The mechanical counter was replaced by a row of 4 neon-tube digital display units. The tube second from the lefthand side had a \$ marked immediately above it, while the third and fourth from the lefthand side had the symbol  $\phi$  marked immediately above them. Programming of stimuli and recording of data was effected in an adjoining room by means of cabling through a small hole in the wall between the experimental box and the equipment. Subjects were seated alone in one corner of the experimental room facing the box on a small table placed against the wall. About 150cm. to the left of the subject were placed two chairs. These were present during all sessions and accomodated the two-member audience during the audience sessions.

#### Procedure.

At the start of each session, the subject was seated

facing the experimental box and instructed:

"You are here to earn money, which is registered on the display in front of you. By manipulation of the response key you have to discover how the money is registered. Whatever amount is showing on the display at the end of the session is yours - but you will be paid only after all sessions have been completed."

Subjects were relieved of books, pens, watches, etc., but given no further information as to the nature of the experiment. Sessions lasted for 60 mins. and subjects took between 3 and 5 sessions to reach the criterion baseline which was set at 2 successive sessions in which the mean response rates did not vary more than 10%. After criterion had been attained, one experimental audience session was given to each subject. This consisted of introducing to the subject the audience of two spectators (one male and one female) as he/she entered the experimental room:

"These are Dr. X and Dr. Y, two members of the Psychology Department, who will be observing your performance during this session; you are asked not to talk to them".

Previously, the audience had been given the following instructions:

- "(1) Try to observe the subject for most of the time of the session.
- (2) Do not talk or communicate in other ways with each other or the subject.
- (3) Try not to distract the subject from his/her work by your behaviour such as shifting your chair, etc.
- (4) Do not let the subject see your watch.
- (5) It is intended that the subject perceive the audience as "evaluative" but passive. This is hopefully accomplished by you making some notes on the writing pads provided at approximately 10 min. intervals.
- (6) Do not go to sleep in the experimental chamber."

At the completion of each session except the first, subjects were asked to rate on a scale of -10 to +10 whether they had experienced a change in anxiety in the just completed session in comparison with the previous session. Subjects were also encouraged to write down any comments at all about each session.

All subjects were shaped to the DRL100 schedule in the first session by reinforcing responses which followed progressively longer and longer periods until at the end of the first session, all subjects were satisfactorily responding on the schedule.

### RESULTS

The difference between mean baseline response rates of the High and Low N groups was not significant according to an unrelated t-test ( $t=0.26$ ,  $df=14$ ,  $p>0.05$ ). The difference between mean baseline reinforcement rates was not significant ( $t=0.05$ ,  $df=14$ ,  $p>0.05$ ). These data are given in Table 5.1.

| High N         |       |       | Low N           |       |       |
|----------------|-------|-------|-----------------|-------|-------|
| Subject        | RR    | RftR  | Subject         | RR    | RftR  |
| S <sub>1</sub> | 0.556 | 0.428 | S <sub>9</sub>  | 0.457 | 0.368 |
| S <sub>2</sub> | 0.559 | 0.363 | S <sub>10</sub> | 0.570 | 0.451 |
| S <sub>3</sub> | 1.375 | 0.309 | S <sub>11</sub> | 0.595 | 0.457 |
| S <sub>4</sub> | 0.659 | 0.348 | S <sub>12</sub> | 0.500 | 0.437 |
| S <sub>5</sub> | 0.487 | 0.426 | S <sub>13</sub> | 0.416 | 0.337 |
| S <sub>6</sub> | 0.439 | 0.417 | S <sub>14</sub> | 0.604 | 0.426 |
| S <sub>7</sub> | 0.398 | 0.478 | S <sub>15</sub> | 0.391 | 0.305 |
| S <sub>8</sub> | 0.517 | 0.433 | S <sub>16</sub> | 1.893 | 0.410 |
| Means          | 0.624 | 0.400 |                 | 0.678 | 0.399 |

Table 5.1: Mean baseline response and reinforcement rates of all subjects in two N groups.

Interresponse times (IRT) were measured from the cumulative records and used as a dependent variable. Two categories of IRT were measured : IRT's which were reinforced (i.e.  $\geq 100$ sec.) and IRT's which were not reinforced (i.e.  $< 100$  sec). Table 5.2 shows the means of these categories for each subject.

| High N         |       |       | Low N           |       |       |
|----------------|-------|-------|-----------------|-------|-------|
| Subject        | Rfd   | Unrfd | Subject         | Rfd   | Unrfd |
| S <sub>1</sub> | 120.5 | 45.0  | S <sub>9</sub>  | 150.6 | 79.0  |
| S <sub>2</sub> | 152.5 | 43.5  | S <sub>10</sub> | 112.2 | 92.5  |
| S <sub>3</sub> | 120.8 | 15.8  | S <sub>11</sub> | 118.7 | 56.2  |
| S <sub>4</sub> | 128.7 | 22.8  | S <sub>12</sub> | 121.2 | 92.0  |
| S <sub>5</sub> | 126.6 | 78.0  | S <sub>13</sub> | 160.1 | 75.8  |
| S <sub>6</sub> | 140.3 | 28.5  | S <sub>14</sub> | 109.7 | 75.0  |
| S <sub>7</sub> | 156.4 | 93.4  | S <sub>15</sub> | 146.5 | 43.5  |
| S <sub>8</sub> | 112.3 | 93.0  | S <sub>16</sub> | 143.2 | 7.1   |
| Means          | 132.3 | 52.5  |                 | 132.8 | 65.1  |

Table 5.2: Mean baseline IRT's (sec) for reinforced and unreinforced responses of all subjects in two N groups.

The differences between the N groups were not significant for either the reinforced IRT's ( $t=0.06$ ) or the unreinforced IRT's ( $t=0.84$ ). Efficiency of DRL ratios were also calculated (Efficiency =  $\frac{\text{Number of Reinforcements}}{\text{Number of Responses}}$ , from Kramer & Rilling, 1970). Mean baseline efficiency ratios shown in Table 5.3 did not differ between the N groups ( $t=0.05$ ).

| High N         |              | Low N           |              |
|----------------|--------------|-----------------|--------------|
| Subject        | Effic. ratio | Subject         | Effic. ratio |
| S <sub>1</sub> | 0.770        | S <sub>9</sub>  | 0.816        |
| S <sub>2</sub> | 0.683        | S <sub>10</sub> | 0.796        |
| S <sub>3</sub> | 0.226        | S <sub>11</sub> | 0.772        |
| S <sub>4</sub> | 0.546        | S <sub>12</sub> | 0.874        |
| S <sub>5</sub> | 0.875        | S <sub>13</sub> | 0.809        |
| S <sub>6</sub> | 0.962        | S <sub>14</sub> | 0.710        |
| S <sub>7</sub> | 0.820        | S <sub>15</sub> | 0.765        |
| S <sub>8</sub> | 0.836        | S <sub>16</sub> | 0.221        |
| Means          | 0.715        |                 | 0.720        |

Table 5.3: Mean baseline efficiency ratios of all subjects.

Percentage difference scores were calculated between the baseline measures and the experimental audience treatment measures. These are presented in Table 5.4. There were no significant differences between the N groups on any of these measures (RR :  $t=0.31$ , RftR :  $t=1.23$ , IRT - Rfd :  $t=0.57$ , IRT - Unrfd :  $t=1.12$ , E :  $t=1.19$ . Similarly there was no significant difference in the anxiety ratings between the two N groups ( $t=1.01$ ). The two N groups were therefore combined and baselines compared with the audience treatment on each of these dependent measures. The raw data for these are given in Appendix C. Although the differences between the baseline and audience means were in the direction indicating better performance in the audience treatment for all but the RfdIRT variable, only the Efficiency of DRL measures gave significance (Baseline Mean = 0.718, Aud Mean = 0.805,  $t = 4.48$ ,  $df = 15$ ,  $p < 0.001$ ).

| High N         |       |       |       |        |       |      | Low N           |       |       |       |       |       |      |
|----------------|-------|-------|-------|--------|-------|------|-----------------|-------|-------|-------|-------|-------|------|
| Subject        | RR    | RftR  | IRT   |        | E     | Anx  | Subject         | RR    | RftR  | IRT   |       | E     | Anx  |
|                |       |       | Rfd   | Unrfd  |       |      |                 |       |       | Rfd   | Unrfd |       |      |
| S <sub>1</sub> | -16.2 | +1.2  | -4.9  | +74.4  | +20.5 | -1   | S <sub>9</sub>  | -12.5 | -9.5  | +8.0  | +10.1 | +2.1  | 0    |
| S <sub>2</sub> | -34.3 | -8.3  | +0.9  | +103.4 | +33.1 | +6   | S <sub>10</sub> | -3.5  | 0     | +8.6  | -53.0 | +2.8  | 0    |
| S <sub>3</sub> | +7.9  | +2.6  | -2.0  | +3.8   | -5.8  | +3   | S <sub>11</sub> | -13.1 | -9.0  | +11.3 | -12.8 | +4.5  | 0    |
| S <sub>4</sub> | +36.7 | -8.9  | +37.5 | +63.2  | +39.2 | +3   | S <sub>12</sub> | -0.8  | +13.5 | -0.2  | 0     | +12.6 | 0    |
| S <sub>5</sub> | +9.4  | +13.4 | -11.5 | -20.1  | +3.5  | +2   | S <sub>13</sub> | +10.7 | +38.3 | -20.4 | 0     | +19.2 | 0    |
| S <sub>6</sub> | -5.0  | 0     | +1.8  | 0      | +3.8  | -1   | S <sub>14</sub> | -3.5  | +5.6  | +2.6  | +4.4  | +8.6  | -2   |
| S <sub>7</sub> | -5.9  | +0.5  | -11.1 | -34.7  | +8.4  | 0    | S <sub>15</sub> | +27.9 | +42.0 | -9.1  | +74.7 | +13.3 | +5   |
| S <sub>8</sub> | -9.1  | +7.9  | +7.6  | -1.1   | +15.6 | 0    | S <sub>16</sub> | +0.2  | +1.5  | -13.7 | -32.4 | -2.3  | 0    |
| Means          | -2.1  | +1.1  | +2.3  | +23.6  | +14.8 | +1.5 |                 | +2.7  | +10.3 | -1.6  | -1.1  | +7.6  | +0.4 |

Table 5.4: Percentage difference scores between baselines and the audience treatment for 4 dependent measures (Response Rates, Reinforcement Rates, Interresponse times and Efficiency) and Anxiety rating changes from last baseline to the audience session.

## DISCUSSION

The two N groups were not different on any of the baseline measures, an apparently surprising finding. Several possible explanations may be considered. First, the nature of the DRL100 schedule required that subject to postpone responding for at least 100 secs. Since the last response for a reinforcement to be delivered. These long IRT's may not have been associated with overarousal in either of the two N groups - underarousal seems to have been a more likely result. The latter possibility is supported by postexperimental statements from subjects indicated boredom in baseline sessions. A second explanation is that the hypothesised differences in the N groups do not occur in baseline sessions because a positively reinforcing task is used rather than an aversively motivating task. Thus the conditions for overarousal in the high N group did not exist in the baseline sessions. Both of these explanations seem reasonable.

The addition of an audience of two high-status spectators did not produce differential effects between the N groups. This is even more surprising than the baseline situation, especially if the two explanations above are accepted. The presence of the audience according to Zajonc's and Cottrell's theories should under these conditions have produced an increment in arousal. According to Weiss & Miller' (1971) explanation of the drive theory of social facilitation, this arousal increment is through an aversively-motivated process (see Chapter I, I.5). It is under these conditions

that we would have expected the high N subjects to react strongly and have their performance detrimentally affected. However, no differences were found between the two N groups on any of the performance change measures, a finding which casts doubt on the usefulness of (a) N scores as predictors of performance in the presence of an audience on a DRL task and/or (b) the stressfulness of a high status audience. Both of these possibilities should be considered further in the present context, as an important implication arises from them.

It is generally accepted for example, that N scores are only a very crude measure of the (presumably) genotypic reactivity of the autonomic (and emotional) make-up of a subject (Eysenck & Eysenck, 1977), even though subjects on retesting of N scores (Eysenck Personality Inventory, Form B) immediately after the experiment showed high reliability ( $r = +0.86$ ,  $p < 0.005$ ). Because these scores may only be crude measures of arousal reactivity, a clear margin of error exists in assessing the performance measures in the above respects. It is also possible that the experimental conditions were not conducive to overarousal. It is expected that behavioural performance deficiencies would occur with high N scoring subjects under conditions of stress. (cf. the behavioural formula : Neurosis = Neuroticism X Stress, Eysenck & Eysenck, 1977, p.60). The (supposed) stress factor used in this experiment (i.e. being observed by a high status audience) was not quantified, so that its supposed effect was not independently assessed. The results



from Experiments 1, 2 and 3 suggest that the arousal increments as a result of audience observation may be only of small magnitude. It is therefore a possibility that the stressful effects of audience are of small magnitude also. In the latter case, performance decrements would not be expected to occur necessarily. The results from this experiment showed some evidence for greater efficiency of performance during the audience sessions for all subjects combined, so that the above argument may have some merit.

The following experiments attempt to investigate the question raised here : can the nature of the audience stimulus be regarded as stressful or aversive? The choice of the DRL schedule may prove to be a good one to test this question, as there have already been reported in the literature several studies in which aversive stimulation is used in conjunction with DRL schedules (Azrin & Holz, 1966; Holz et al, 1963).

#### SUMMARY

It was hypothesised that highly reactive high N scoring subjects' performance on a DRL schedule with money gain as the reinforcer would be impaired by the presence of two high status spectators, whereas the stable N scoring subjects were hypothesised to facilitate their performance under these conditions. No differences were found between the N groups during baseline or the audience treatment, although when the groups were combined there was some evidence of greater efficiency during the audience treatment. To explain the disconfirmation of the hypothesis it was suggested that differences in performance between the N groups

would be expected particularly under stressful conditions. These data therefore cast some doubt on a central tenet of the drive theory of social facilitation which asserts that the nature of the audience is aversive and hence stressful.

## CHAPTER VI

### IMPLICATIONS OF EXPERIMENTS 1, 2, 3 AND 4.

#### VI. 1. THEORETICAL ISSUES ARISING FROM ATTEMPTS TO SUMMATE VARIOUS SOURCES OF AROUSAL.

The experiments carried out so far have attempted to summate various postulated sources of arousal in order to test the revised drive theory of social facilitation with respect to the audience paradigm in conjunction with the inverted U hypothesis linking arousal with performance.

Although many studies (already reviewed in Chapter I) have shown the inverted U relationship between performance efficiency measures and arousal, most of them employ a single stimulus dimension (Yerkes & Dodson, 1908; Broadhurst, 1959). Some studies, however, report attempts to summate various sources of arousal (Broadhurst, 1964; Lind, 1976). In the latter study, an attempt was made to determine whether arousal can be considered unidimensional. It is argued that stimuli which induce an increase in arousal ought to be additive in their effects on behavioural efficiency. If increases in two stimuli administered separately produce an inverted U function with behavioural efficiency, then increases in the two stimuli administered at the same time should produce changes in behavioural efficiency. At low levels of stimulation, the two stimuli together should produce more arousal and improve performance, whereas at moderate and high levels of stimulation, the two stimuli together should produce progressively more arousal thereby impairing performance if overarousal is assumed. Using the two stimuli of white noise

and shock at various intensity levels, a classically conditioned avoidance response (shuttle-box) served as the dependent measure. The results showed that the predicted summation effects did not occur. Although inverted U curves were obtained for both stimuli separately, the stimuli "combined" also produced an inverted U function with the individual data points at all combined intensity levels not differing from the mean data points at all separate intensity levels. However, the linear and curvilinear coefficients of the combined function were significantly different from those of the separate functions, indicating that an interaction effect had occurred. No convincing explanation for this was given by Lind (1976), although several were considered - these shall be considered also at a later stage in this chapter.

In the older Hull-Spence framework, drive summation was used as an experimental method to test the theory, especially the big D construct. Several recent authors have argued persuasively against the validity of the generalised drive theory (Bolles, 1967; Hinde, 1970; Mackintosh, 1974). Particularly when appetitive stimuli are used in attempts to summate specific drives (e.g. hunger and thirst) which have produced results apparently supportive of generalised drive theory (e.g. Webb, 1949; Brandauer, 1953), these attempts have ultimately met with severe methodological problems (Mackintosh, 1974) making a drive summation hypothesis untenable.

Evidence slightly more favourable to drive summation comes from the interaction of appetitive with aversive drives

(reviewed by McFarland, 1966). This evidence need not be considered in detail here, except to note that a reasonable degree of consistency in findings is also lacking (Bolles, 1967, p.277). Only sometimes may combinations of appetitive and aversive stimuli produce facilitation of behaviour. Most of this evidence however, comes from studies which involve the transition of one stimulus to the other rather than the concurrent presentation of both stimuli (see Mackintosh, 1974). Facilitation of performance obtained under these conditions can be explained also by a "rebound" hypothesis (Mackintosh, 1974, p.352) which has some useful implications for testing the possible aversive nature of the audience stimulus. These will be considered shortly.

We have seen so far that the evidence for arousal or drive summation from the literature is controversial. The results of the experiments carried out so far seem to fit in with this general trend. It is possible that some or all of the occasional failures of the experiments to obtain predicted summation effects are reflections of the inadequacies of general drive and arousal theories, rather than refutations of Zajonc's basic postulate that an audience stimulus is arousal inducing.

Lind (1976) suggests several alternative interpretations which warrant some attention. It has been suggested, for example, that physical systems do not operate in a linear fashion throughout the range of an impressed stimulus (Patton, 1970). Ceiling effects might be predicted whenever stimuli are combined according to this interpretation. The stimuli used in Experiments 1, 2 and 3 were the audience and the

scheduled aversive stimulus (shock or money loss). If these two hypothesised stressors interact nonlinearly, predictions regarding the effect on performance can range from under to overarousal. Evaluation of this explanation must await either more knowledge with respect to the operation of physical systems, or until arousal is measured more directly than in these experiments.

Another explanation suggested by Lind is based on an attention mechanism and in some respects is similar to the competing response theory put forth to explain the data from Experiment 1. The attention explanation suggests that subjects at any one moment selectively attend to one stimulus and not at all to the other. These hypotheses both seem plausible in accounting for some of the results in Experiments 1 and 3. A difficulty however occurs when it is considered that at higher levels of stimulation with the proposed build-up of arousal by repeated shocking at the rate of every 5 seconds (when subject ceases responding in the Sidman avoidance schedule), such a selective attention mechanism tends to be unadaptive. Another difficulty with the attention hypothesis is that recent developments by attention theorists allow the existence of a mechanism by which the organism can simultaneously process two stimuli (Mackintosh & Turner, 1971).

It is difficult to avoid the conclusion at this stage, that Zajonc's postulate regarding the general drive increasing or arousing effects of an audience has come at a belated period in the zeitgeist of learning and motivation theory. Generalised drive theory has seemingly been irreparably

discredited (Bolles, 1967; Mackintosh, 1974): arousal theory finds difficulty in predicting accurately basic motivation hypotheses involving the addition of several stressors or a combination of stressors and appetitive stimuli.

At this point it was decided to pursue the possibility of using this manipulation of interacting appetitive and aversive stimuli with respect to testing the contention made in Chapter I (I.5) that an audience is basically aversive.

## VI. 2. INTERACTIONS BETWEEN APPETITIVE AND AVERSIVE STIMULI : CONTRAST EFFECTS.

A quite different analysis of interacting schedules involving appetitive and aversive stimuli is offered by the study of contrast effects. This study is concerned with transitions between different reinforcing events and the effects on responding on one schedule with changes occurring in another schedule. For example, the transition from a schedule or situation involving aversive stimulation (or the omission of appetitive stimuli) to a schedule or situation involving appetitive stimulation is often accompanied by an increase in responding in the appetitive schedule. Pavlov (1927) attributed a similar phenomenon within classical conditioning to a rebound effect and called it positive induction. He found that the presentation of a CS- immediately before a trial with CS+ was sometimes associated with a magnitude increase of the CR elicited by the CS+.

The term "contrast effect" was coined by Skinner (1938) for the effects observed when exposure to more than one condition of reinforcement accentuates or increases the difference between the conditions when administered independently. Two broad effects may be observed: (a) positive contrast, which occurs when exposure to a less favourable condition of reinforcement enhances performance to a more favourable condition of reinforcement, and (b) negative contrast, which occurs when exposure to a more favourable condition of reinforcement suppresses performance to a less favourable condition of reinforcement.

Mackintosh (1974) distinguishes between several varieties of contrast effects, all of which can be either positive or negative. The first category is called transient contrast. For example, negative transient contrast is defined as suppression of responding to  $S_1$  (stimulus signalling the less favourable reinforcement condition) by immediately preceding exposure to  $S_2$  (stimulus signalling the more favourable reinforcement condition). The effect is called transient contrast because it seems to be present only while the discrimination between  $S_1$  and  $S_2$  is being learned, and because performance to  $S_1$  is facilitated or suppressed only if it immediately follows exposure to  $S_2$ . Transient contrast effects have been well-reported in the literature in free-operant studies using pigeons (e.g. Nevin & Shuttleworth, 1966), and using rats (e.g. Williams, 1965; Bernheim & Williams, 1967). These studies rule out a fatigue-like process and fluctuations in motivation as possible explanations for the particular performance changes observed.



A second category, more commonly observed, is called behavioural contrast. This effect can be defined as a negative correlation between response rates in the presence of different stimuli following a change in value of one of the stimuli. For example, the rate of response to  $S_1$  signalling a variable interval (VI) schedule increases if a schedule signalled by  $S_2$  changes from VI to extinction. Similarly, during the formation of a successive discrimination between a red key correlated with reinforcement and a green key correlated with extinction, a pigeon's rate of pecking the red key increases while its rate of pecking the green key decreases (Reynolds, 1961). Behavioural contrast is considerably more permanent than transient contrast, as is suggested by a considerable body of evidence. For example, Nevin & Shuttleworth (1966) found that response rates to  $S_1$  in a multiple schedule were maintained above control levels long after the transient elevation of responding at the beginning of each  $S_1$  period had disappeared. Similarly, Rilling et al (1969) and also Hearst (1971) observed a positive contrast effect over 60 sessions of running.

Generally, the procedure used to obtain behavioural contrast has been to use a multiple (VI, VI) changing to a multiple (VI, extinction) schedule with pigeons responding with a key peck. Evidence of behavioural contrast has also been observed in other species such as rats (Pear & Wilkie, 1971; Mackintosh, 1974), although the effect is sometimes not as pronounced. It has been suggested that the behavioural contrast effect occurs because a decrease of

reinforcement occurs in  $S_2$  and this results in the decrease in responding during  $S_2$ . Many reported experiments have subsequently attempted to investigate the question whether increases during  $S_1$  are caused by a decrease in responding or by a decrease in reinforcement during  $S_2$ . Mackintosh (1974) suggests that this is the wrong question to ask, since positive contrast has been found during  $S_1$  in both the absence of reduction in reinforcement and in the absence of reduction in responding in  $S_2$ . It also has failed to occur when one or other has been reduced, suggesting that neither condition is sufficient, and neither is necessary, for the appearance of positive behavioural contrast.

Behavioural contrast has also been observed with the use of aversive stimuli. One of the early studies in this area (Azrin, 1960) found for example, that punishment of positively reinforced responses with electric shock during  $S_1$  but not during  $S_2$ , in a multiple schedule, results in transient decreases in responding during  $S_1$ . Brethower & Reynolds (1962) subsequently showed using similar conditions that not only did responding decrease during the punished  $S_1$  component, but also that responding increased during the non punished  $S_2$  component. This contrast effect is known as punishment contrast. The punishment contrast effect has been reported by a number of other authors (Holz, Azrin & Ulrich, 1963; Lattal, 1969; Rachlin, 1966) using positive reinforcement maintaining schedules. Punishment contrast has also been reported during Sidman avoidance with rhesus monkeys, thus considerably increasing the generality of the phenomenon. (Lattal & Griffin, 1972).

Azrin & Holz (1966) found that after several sessions of punishing positively reinforced responses, removal of punishment resulted in transient increases in response rates which exceeded baseline response rates. This effect (also called punishment contrast by the authors) seems to be similar to and different only in degree from schedules in which alternating periods of punishment and no-punishment occur within individual sessions. The latter design was used by Holz et al (1963) using a maintaining DRL 30 sec. schedule with pigeons key pecking. Subjects typically responded with low efficiency during baseline training, with frequent short bursts of responses and infrequent longer IRTs (leading to an increase in the probability of reinforcement in the DRL schedule). In experimental sessions, periods of shock punishment superimposed on the DRL schedule were alternated with no-punishment periods. The effect was to produce punishment contrast. In the punished periods, burst of responses decreased with corresponding increases of longer IRTs and the probability of reinforcement. In the non-punished periods, response rates increased to above baseline levels, which (paradoxically) led to a decreased probability of reinforcement. Thus the effect of punishment during the punishment contingency was to increase the efficiency of performance. The increases in responding during the non-punished periods proved to be transient, however, because with extended experimental sessions (4), response rates during the non-punished component returned to baseline rates.

These transient effects were similar to those found by Lattal & Griffin (1972) in shock punishment of periods of Sidman avoidance behaviour which alternated with periods of non-punished Sidman avoidance. Response rates increased in the non-punished component while response rates decreased in the punished component.

Both of these studies support Wertheim's (1965) suggestion that contrast may be a relatively general phenomenon observed during the formation of discriminations involving aversive stimulation. Species generality may similarly be inferred from these studies since contrast effects have now been reported in rats, pigeons and rhesus monkeys. A suitable question at this point would be to ask whether human operant behaviour can also show contrast effects of this nature. The next chapter reports such an attempt.

How may all of this be related to the effect of an audience? It may be recalled that the nature of the audience stimulus has been postulated as aversive (see Chapter I, I.5). Punishment contrast effects have not been reported in the literature with aversive stimuli other than electric shock, although the suppressive effects of a variety of aversive stimuli has been well reported (e.g. noise, Campbell & Bloom, 1965; bar slap, Skinner, 1938; etc). Church (1963) has summarised the available evidence at that time regarding the effects of punishment. Although sometimes the effect of punishment is to facilitate responding, Church argues that these effects tend to occur in spite of, rather than because of punishment. In most cases, however, the response-

contingent presentation of an aversive stimulus at mild or moderate intensities induces suppression of responding.

The remaining experiments reported here investigate the possibility that the contingent presentation of an audience on a positive reinforcement schedule can (a) suppress responding and (b) produce a punishment contrast effect under similar conditions as has been found with electric shock.

## CHAPTER VII

### EXPERIMENT 5 : CONTRAST EFFECTS WITH HUMAN SUBJECTS ON A DRL SCHEDULE.

As suggested by the literature review in the last chapter, one of the first problems which needed clarification was the question whether humans would show a contrast effect on an operant schedule when money gain and loss served as the controlling stimuli. Would the effect as observed with rats, pigeons and monkeys generalise to humans with a secondary reinforcer (money) rather than primary reinforcers (food, shock, etc.)? Holz et al (1963) found that their contrast effect was optimised if the shock intensity was relatively mild, but sufficient to cause suppression in the punished component. Paradoxically, this led to an increased frequency of reinforcement in the punished component because of the nature of the schedule requirements (DRL 30sec.) and because the baseline response rates were not conducive to optimal reinforcement. Alternating periods of non-punishment within the same sessions produced a disproportionate increase in responding above baseline levels. These were invariably associated with a decreased reinforcement rate as response bursts (i.e. short IRTs) became more frequent.

Could such a contrast effect be obtained on a DRL schedule which used money gain to maintain responding, but which used money loss as the aversive stimulus? If so, what would be the relative intensity or size of the money gains and money losses which produced the effect? It was decided to undertake an investigation to attempt to answer these questions. In the experiments to be reported in this chapter,

the sizes of the money gains and money losses were varied in order to produce a contrast effect with humans as subjects.

Since Weiner (1963) has already obtained suppressive effects of punishment in the form of response cost (point-loss per response) with human subjects in avoidance and escape conditioning, it seems possible that suppression of responding may be obtained under the conditions outlined above.

#### EXPERIMENT 5A

##### METHOD

##### Subjects.

18 subjects, males and females, all first-year psychology undergraduates volunteered for the experiment in reply to a general invitation to participate on a departmental notice board. It was explained to subjects that they could earn several dollars in the experiment provided that they attended all sessions required by the experimenter. All subjects were experimentally naive.

##### Apparatus.

The apparatus used in Experiment 4 was used with several modifications.

First, a 75 dB, 1 sec. tone source was situated at the top right hand side of the box display. This was activated only when a loss was programmed, and always occurred simultaneously with a 1 sec. red light presentation. The tone was added to facilitate signalling of a money loss.

Second, all programming of the experimental contingencies and the recording of response data was by means of cabling to and from a PDP8E computer located in an area well removed from the experimental room. A cumulative recorder was hooked up to the computer to record reinforcements and responses.

Reinforcements (up-counts on the neon-display units) were registered within 1 sec. of a response. Punishments (down-counts on the display) were registered approximately  $1\frac{1}{2}$ -2 sec. after the occurrence of a response so that both reinforcement and punishment (or "response cost" could be made two discernible events when one response was emitted.

#### Procedure and Design.

It was decided to increase the opportunities for reinforcement compared with Experiment 4 as some subjects had reported boredom during the long IRTs required on the DRL100 sec. schedule. The minimum IRT for reinforcement was henceforth reduced to 60 sec. and all subjects in the present and following experiments operated on a DRL60 schedule. All daily sessions lasted for 45 mins. and were scheduled for approximately the same time each day.

During the preliminary baseline sessions all subjects were required to learn and perform the DRL60 schedule to a criterion mean response rate which did not vary more than 10% between two successive sessions, or to 70% of the number of maximum possible reinforcements for any one session.

Before each session began, subjects were seated in the chair facing the display box and the following instructions were read.



"Give watches, books, pens, etc. to the experimenter for safekeeping. Do not move from your chair for the 45 mins. of the session. Do not smoke or eat and concentrate on the task which is for you to make as much money as possible appear on the display. You have to discover how the money is registered on the display, by manipulating the lever. Whatever amount is showing at the end of the session is yours; each session's earnings will be added together and you will be paid the lump sum at the end of the experiment, but you must complete all sessions before you get the money. Please do not talk to any other student about this experiment."

The starting position of the neon-display units at the beginning of each session was 500 (\$5.00). It was initially explained to subjects that this was an arbitrary zero point so that money could be gained or lost in each session and money gained in one session could be lost in another. No further explanations or instructions were given to subjects until debriefing at the end of the experiment.

After baseline criterion had been obtained, each subject was given one experimental 45 min. session which involved the alternation of two stimulus components lasting for 5 minutes and 10 minutes each, so that the session contained three 5 minute components and three 10 minute components. The session started with a 5 minute component - all of these components were identical to baseline training i.e. DRL60 sec. was in effect. The 10 minute components involved the DRL60 sec. schedule in addition to response cost (punishment), so that all responses were followed by a downcount and all responses which reached or exceeded the minimum IRT requirement for reinforcement (60 sec.) were followed also by an upcount.

Subjects were assigned randomly to one of the following six groups, so that each group contained 3 subjects:

|                            | <u>Upcount (<math>\phi</math>)</u> | <u>Downcount (<math>\phi</math>)</u> |
|----------------------------|------------------------------------|--------------------------------------|
| Gp 1 ( $S_1 - S_3$ )       | 3                                  | 3                                    |
| Gp 2 ( $S_4 - S_6$ )       | 3                                  | 4                                    |
| Gp 3 ( $S_7 - S_9$ )       | 3                                  | 5                                    |
| Gp 4 ( $S_{10} - S_{12}$ ) | 4                                  | 4                                    |
| Gp 5 ( $S_{13} - S_{15}$ ) | 4                                  | 5                                    |
| Gp 6 ( $S_{16} - S_{18}$ ) | 4                                  | 6                                    |

#### RESULTS AND DISCUSSION

All subjects reached baseline criterion either at 3 or 4 sessions of DRL60 training. Baseline mean response rates, mean reinforcement rates and mean IRTs are presented in Table 7.1. Differences between the groups on all measures yielded F ratios of less than 1, indicating that all groups performed similarly under the respective baseline conditions.

Means were computed for these 3 dependent measures from the 2 components of the single experimental session. Component 1 (3 periods of normal DRL60) and Component 2 (3 periods of DRL60 + response cost) are represented in terms of these 3 measures in Table 7.2.

Two way analyses of variance were carried out between the groups and also between the components and baselines on each of the 3 dependent variables. (Winer, 1971). Summaries of the analyses are presented in Table 7.3. These indicate that there were no differences between the 6 groups, but that differences between baselines and components were significantly different on all three dependent measures.

|       | Subject         | RR   | RftR | IRT   |
|-------|-----------------|------|------|-------|
| Gp 1  | S <sub>1</sub>  | 0.89 | 0.80 | 65.8  |
|       | S <sub>2</sub>  | 0.82 | 0.71 | 71.7  |
|       | S <sub>3</sub>  | 0.87 | 0.80 | 68.3  |
| Gp 2  | S <sub>4</sub>  | 0.53 | 0.53 | 107.4 |
|       | S <sub>5</sub>  | 0.91 | 0.76 | 65.7  |
|       | S <sub>6</sub>  | 1.38 | 0.58 | 41.9  |
| Gp 3  | S <sub>7</sub>  | 0.98 | 0.64 | 60.7  |
|       | S <sub>8</sub>  | 0.96 | 0.62 | 61.3  |
|       | S <sub>9</sub>  | 0.93 | 0.71 | 63.0  |
| Gp 4  | S <sub>10</sub> | 0.82 | 0.76 | 71.0  |
|       | S <sub>11</sub> | 0.73 | 0.73 | 80.7  |
|       | S <sub>12</sub> | 0.87 | 0.78 | 68.3  |
| Gp 5  | S <sub>13</sub> | 0.87 | 0.71 | 68.0  |
|       | S <sub>14</sub> | 1.02 | 0.69 | 57.6  |
|       | S <sub>15</sub> | 0.73 | 0.69 | 80.4  |
| Gp 6  | S <sub>16</sub> | 1.16 | 0.53 | 46.9  |
|       | S <sub>17</sub> | 0.87 | 0.80 | 67.4  |
|       | S <sub>18</sub> | 1.47 | 0.69 | 40.4  |
| Means |                 | 0.94 | 0.70 | 65.9  |

Table 7.1: Baseline dependent measures in Experiment 5A.

|       |                 | RR     |        | RftR   |        | IRT    |        |
|-------|-----------------|--------|--------|--------|--------|--------|--------|
|       | Subject         | Comp 1 | Comp 2 | Comp 1 | Comp 2 | Comp 1 | Comp 2 |
| Gp 1  | S <sub>1</sub>  | 0.73   | 0.87   | 0.67   | 0.80   | 73.3   | 72.8   |
|       | S <sub>2</sub>  | 0.80   | 0.77   | 0.27   | 0.63   | 67.2   | 81.6   |
|       | S <sub>3</sub>  | 0.80   | 0.77   | 0.67   | 0.70   | 71.3   | 79.9   |
| Gp 2  | S <sub>4</sub>  | 0.27   | 0.53   | 0.27   | 0.47   | 182.0  | 174.9  |
|       | S <sub>5</sub>  | 0.60   | 0.70   | 0.53   | 0.47   | 102.3  | 83.7   |
|       | S <sub>6</sub>  | 0.67   | 0.50   | 0.53   | 0.67   | 104.0  | 112.6  |
| Gp 3  | S <sub>7</sub>  | 0.60   | 0.57   | 0.27   | 0.33   | 81.6   | 101.8  |
|       | S <sub>8</sub>  | 0.73   | 0.63   | 0.60   | 0.50   | 98.4   | 84.3   |
|       | S <sub>9</sub>  | 1.13   | 0.77   | 0.53   | 0.57   | 55.9   | 70.7   |
| Gp 4  | S <sub>10</sub> | 0.60   | 0.80   | 0.53   | 0.57   | 88.9   | 76.3   |
|       | S <sub>11</sub> | 0.47   | 0.53   | 0.47   | 0.43   | 132.4  | 110.6  |
|       | S <sub>12</sub> | 0.67   | 0.57   | 0.53   | 0.53   | 87.8   | 102.0  |
| Gp 5  | S <sub>13</sub> | 0.67   | 0.70   | 0.47   | 0.53   | 95.6   | 154.8  |
|       | S <sub>14</sub> | 0.73   | 0.53   | 0.47   | 0.43   | 80.2   | 106.9  |
|       | S <sub>15</sub> | 1.27   | 1.03   | 0.47   | 0.37   | 51.6   | 54.0   |
| Gp 6  | S <sub>16</sub> | 0.67   | 1.73   | 0.33   | 0.43   | 68.3   | 33.1   |
|       | S <sub>17</sub> | 0.47   | 0.80   | 0.47   | 0.40   | 120.0  | 72.0   |
|       | S <sub>18</sub> | 0.80   | 0.30   | 0.40   | 0.20   | 126.7  | 102.8  |
| Means |                 | 0.70   | 0.73   | 0.47   | 0.50   | 93.7   | 93.0   |

Table 7.2: Means of 3 dependent measures in the two components (Component 1 = DRL60, Component 2 = DRL60 + response cost) for all subjects in Experiment 5A.

|                                    | Dependent variable F-ratios |       |         |         |
|------------------------------------|-----------------------------|-------|---------|---------|
| Source                             | df                          | RR    | RftR    | IRT     |
| Between Subjects                   |                             |       |         |         |
| Groups (A)                         | 5                           | 1.14  | 2.00    | 1.12    |
| Error (S)                          | 12                          |       |         |         |
| Within Subjects                    |                             |       |         |         |
| Baseline<br>with<br>Components (B) | 2                           | 4.48* | 36.29** | 14.19** |
| A X B                              | 10                          | 0.65  | 1.32    | 1.95    |
| Error (B X S)                      | 24                          |       |         |         |

\*  $p < 0.05$       \*\*  $p < 0.0001$

Table 7.3: Summaries of results of analyses of variance  
for data in Tables 7.1 and 7.2.

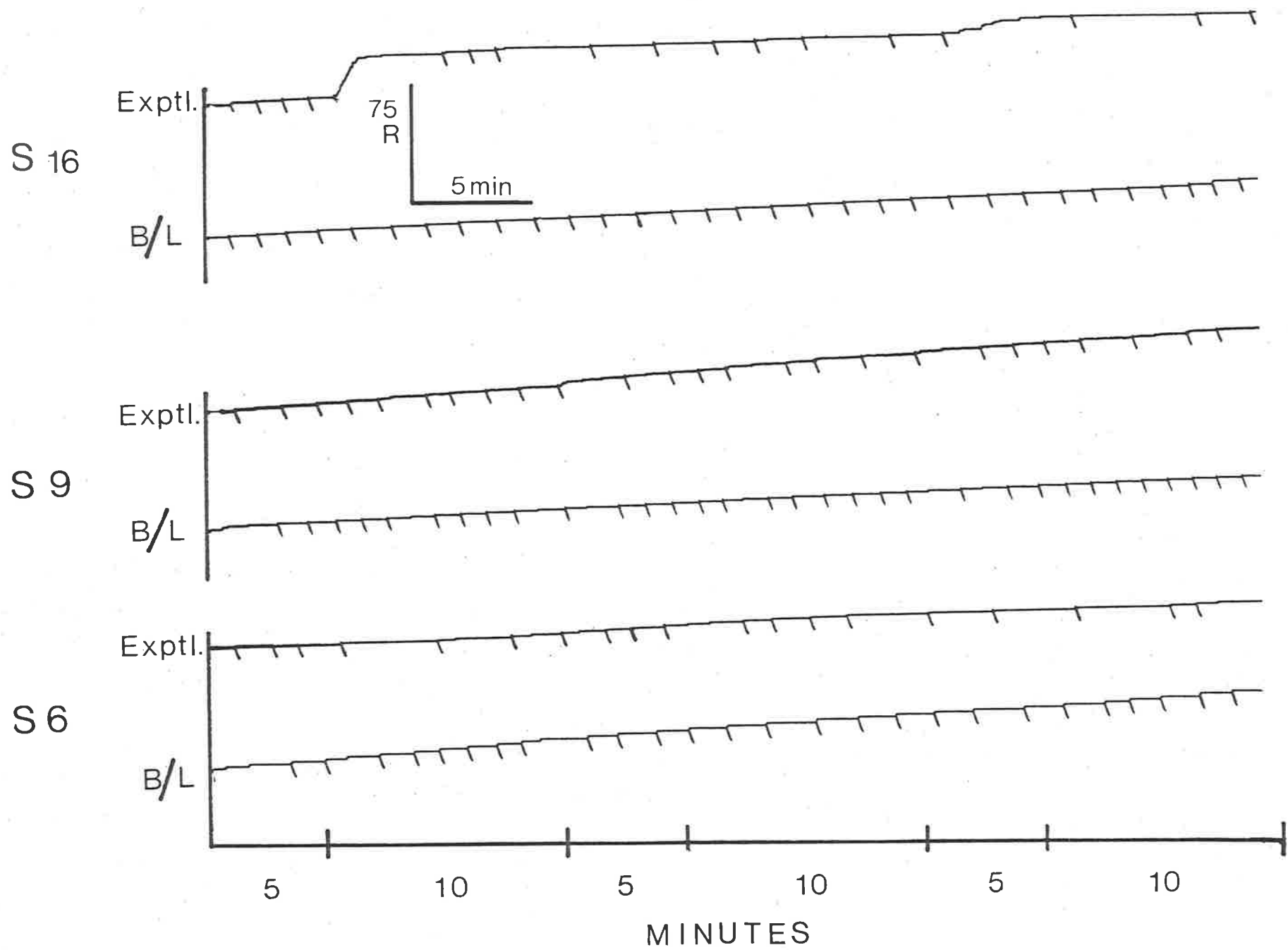
Inspection of the overall means of baselines and components indicate that most of the variance can be accounted for by the differences of baselines from both components. Generalised suppression in both components is indicated by these overall means.

Comparison by inspection of individual subject data in Table 7.2 with those in Table 7.1 (baselines) suggests that only  $S_9$  exhibited a punishment contrast effect;  $S_{15}$  showed a behavioural contrast effect (no suppression), and most other subjects (e.g.  $S_6$ ) showed generalised suppression in both components. Some subjects (e.g.  $S_{16}$ ) showed a contrast effect, but with suppression occurring during the non-punished component and acceleration of responding during the punished component! Cumulative records of the experimental sessions of the three subjects  $S_6$ ,  $S_9$  and  $S_{16}$  are

given in Fig. 6.

The effectiveness of suppression of the response cost variable has been demonstrated in this experiment, although contrast effects seem to be much less reliably obtained. It is not immediately clear what caused this intersubject variability. Subjects were asked to write down their responding strategies immediately after the last baseline and experimental sessions. Reference to Appendix D (Experiment 5A) shows answers given by subjects. Although all subjects could describe that during baseline the DRL contingency required a constant time interval between response, the majority of subjects during the experimental session said that they attempted different or varying time intervals in order to avoid the losses. The subjects who showed contrast effects could verbalise (roughly) that alternating periods of loss of money and gain of money were in operation and seemed to have adjusted their responding accordingly. These results may be interpreted via two hypotheses. The first of these may be described as a "cognitive" hypothesis which examines a subject's strategy for responding which would maximise his reinforcement. By changing the requirements of the schedule, a subject would necessarily be required to alter his response strategy. Under these conditions it would be reasonable to expect a subject to "experiment" or "test different hypotheses" as to which response strategy might optimise reinforcements. Since the DRL schedule requires the subject to not respond for a given time interval, a seemingly obvious change which

Fig. 6: Cumulative records taken from Baseline and Experimental sessions of S<sub>6</sub>, S<sub>9</sub>, S<sub>16</sub> in Expt. 5A.



could occur is a change in the time interval. This was indeed believed by most subjects (see Appendix D - Experiment 5A).

The second hypothesis may be described as an "information-content" (of the reinforcement contingency) hypothesis. Informative predictors of reinforcement would be expected to acquire greater reinforcing power than redundant stimuli or unreliable stimuli. In the present experiment the conditioned stimuli ( $S_D$ s) signalling the loss and no-loss components were temporal ones and required to be estimated by subjects. Since these temporal conditioned stimuli were both lengthy (5 to 10 mins), and competing with the response  $S_D$  (itself temporal - 60 sec.), they may have been unreliable for many subjects, and exert less control over responding than was intended.

Both of the above hypotheses seem plausible and they both imply that by giving subjects more information with respect to which component was in operation (whether this occurs through more efficient "hypothesis testing" by subjects or through a more reliable  $S_D$  with greater information content) may be a useful method to obtain contrast more reliably.

#### EXPERIMENT 5B

Following the last suggestion, a slight alteration was made to the computer program used in Experiment 5A, so that during the response cost component the red light on the display box would be continuously on for the duration



of the component, rather than come on for 1 sec. associated with a money loss. Hence the red light's function was to become a discriminative stimulus for the response cost component.

Similarly, it may be argued that subjects in Experiment 5A had little chance to accommodate to the experimental session, and that by giving subjects more experimental sessions of the alternating components may produce a more reliable contrast effect. Hence, some subjects were run under identical conditions as in Experiment 5A (i.e. no discriminative stimulus for the response cost component), except that they underwent three experimental sessions instead of one.

#### METHOD

##### Subjects.

Six male and female, all first-year psychology undergraduates who were experimentally naive (i.e. had not participated in any previous psychological experiment) volunteered for the experiment in reply to a general invitation to participate on a departmental notice board. It was again explained to subjects that they needed to attend every session required by the experimenter in order to receive the money at the end of the running.

##### Apparatus.

This was the same as in Experiment 5A with the modification mentioned above.

### Procedure and Design.

The procedure of schedule requirements, session length, instructions to subjects, etc. was the same as in Experiment 5A.

Since contrast effects had been obtained in Experiment 5A only with subjects on response costs of 5¢, this was retained as a constant here, so that all six subjects had downcounts of 5¢ during the response cost component. Reinforcement size (upcounts) was kept as 4¢ rather than 3¢ to maintain (it was assumed) a slightly higher motivation level in subjects.

All subjects were trained to baseline levels according to the same criteria as before. At this point, 3 subjects were given one experimental session which was identical to baseline conditions (DRL60, upcounts = 4¢) during the 5 min. component, but which also included downcounts of 5¢ contingent on each response and a red light showing continuously during the 10 min response cost component. These components alternated as before, each session beginning with a 5 min. component and finishing with a 10 min. component.

The other 3 subjects were given exactly the same experimental session as Group 5 in Experiment 5A, except that they were given three successive experimental sessions instead of one.

### RESULTS AND DISCUSSION

Subjects 2, 4 and 6 comprised Group 1 which had one experimental session involving the continuous red light during the response cost component. Baseline and component data are presented in Table 7.4.

|                                      |      | Subjects       |                |                |
|--------------------------------------|------|----------------|----------------|----------------|
|                                      |      | S <sub>2</sub> | S <sub>4</sub> | S <sub>6</sub> |
| Baseline                             | RR   | 0.87           | 1.00           | 0.87           |
|                                      | RftR | 0.73           | 0.62           | 0.76           |
|                                      | IRT  | 69.0           | 59.8           | 67.9           |
| Component<br>1                       | RR   | 0.80           | 1.27           | 0.87           |
|                                      | RftR | 0.60           | 0.67           | 0.73           |
|                                      | IRT  | 133.2          | 82.0           | 135.8          |
| Component<br>2<br>(Response<br>cost) | RR   | 0.33           | 0.57           | 0.40           |
|                                      | RftR | 0.25           | 0.17           | 0.10           |
|                                      | IRT  | 112.2          | 37.9           | 22.9           |

Table 7.4: Comparisons of Baseline with components mean dependent measures of subjects with response cost discriminative stimulus in Experiment 5B.

Inspection of these figures indicates that:

- (a) suppression of responding occurred during the response cost component for all three subjects, and
- (b) a slight tendency towards acceleration during the non-response cost component occurred for one subject only (S<sub>4</sub>), but this was not very pronounced - the other two subjects showed little change in response and reinforcement rates during this component compared with baseline. (N.B. Mean IRTs are not very sensitive measures, unless IRT distributions are also given).

Subjects 1, 3 and 5 comprised Group 2 which had three successive experimental sessions identical to that given to Group 5 in Experiment 5A. Baseline and component data are presented in Table 7.5. Subject 1 showed little consistent suppression or contrast over the three experimental sessions.

At the post experimental enquiry this subject could not correctly verbalise the experimental contingencies. Subject 3 showed generalised suppression (induction) to both components, which was fairly consistent over the three experimental sessions. Subject 5 showed consistent suppression in the response cost components over the three sessions, although behaviour in component 1 (non-response cost) seemed to be around baseline level (it might be possible to interpret responding in the third experimental session as slight acceleration).

Subjects' answers to the post-baseline and post-last-experimental session's questions indicated that all subjects (except  $S_3$ ) could verbalise that alternate gain and loss periods were in operation, (Appendix D, Experiment 5B), so that giving subjects more information with respect to this part of the contingency does not seem important in producing a more consistent contrast effect.

|          |       | Subjects |      |      |       |      |       |       |      |       |
|----------|-------|----------|------|------|-------|------|-------|-------|------|-------|
|          |       | $S_1$    |      |      | $S_2$ |      |       | $S_3$ |      |       |
|          |       | RR       | RftR | IRT  | RR    | RftR | IRT   | RR    | RftR | IRT   |
| Baseline |       | 0.90     | 0.80 | 59.2 | 0.91  | 0.76 | 65.6  | 0.89  | 0.82 | 66.4  |
| Comp 1   | $E_1$ | 0.70     | 0.65 | 81.1 | 0.33  | 0.33 | 177.1 | 0.73  | 0.67 | 77.6  |
|          | $E_2$ | 0.75     | 0.70 | 75.1 | 0.73  | 0.67 | 87.3  | 0.87  | 0.67 | 74.2  |
|          | $E_3$ | 0.80     | 0.65 | 70.9 | 0.60  | 0.47 | 115.2 | 1.00  | 0.73 | 60.0  |
| Comp 2   | $E_1$ | 0.93     | 0.50 | 55.8 | 0.40  | 0.30 | 147.2 | 0.67  | 0.60 | 89.2  |
|          | $E_2$ | 0.65     | 0.65 | 74.5 | 0.47  | 0.47 | 117.1 | 0.43  | 0.43 | 122.5 |
|          | $E_3$ | 0.87     | 0.80 | 70.1 | 0.37  | 0.37 | 148.4 | 0.17  | 0.17 | 234.9 |

Table 7.5: Mean Baseline and mean component dependent measures of 3 experimental sessions of all subjects in Experiment 5B.

A feature of the two experiments reported in this Chapter need a little further discussion. This is the nature of the reinforcement and punishment used, both involving the same stimulus dimension (money upcounts and downcounts). Contrast effects in the literature have generally been reported when different stimulus dimensions are used for reinforcement and punishment (e.g. food and shock respectively). This raises the possibility that the effects observed in the present experiments are qualitatively different from those using different stimulus dimensions. Not only would the same sense modalities be activated and similar types of motivation states be required in the former case, but also the effects could be qualitatively different from those where dimensionally different stimuli interact. Several arguments may counteract this possibility however. For example, punishment contrast has been reliably obtained where shock has served as both reinforcement and punishment (Lattal & Griffin, 1972). This study has already been referred to in Chapter VI (VI,2.). Also, an aggressive response in rats can be effectively elicited and punished by the same shock stimulus (Roberts & Blase, 1971). Lastly, the work of Weiner (1963) with human subjects has shown that the suppressive effects of response cost (punishment) using the same stimulus dimension as the reinforcer (points having monetary value) are similar to those which have been observed with shock punishment in animal subjects under analogous interval schedules. The fact that quantitatively similar data are obtained does not necessarily discount qualitative differences, although it may make them less likely.

### SUMMARY AND CONCLUSIONS

Overall, the two experiments reported in this chapter seem to bear out the following conclusions:

- (a) Introducing response cost by downcounts of 5¢ when responding was reinforced by upcounts of 4¢ on a DRL60 sec. schedule generally produced suppression of responding by human subjects, although a few subjects accelerated their responding.
- (b) When a response cost component was alternated with a non-response cost component, a variety of behaviours was observed during the latter component : suppression (induction), a return to baseline level responding, or acceleration (contrast).
- (c) Providing subjects with further information when responding is to be costed (punished) and when it is not, in the form of a discriminative stimulus, did not seem a more reliable method of obtaining a consistent contrast or induction effect.
- (d) Giving subjects several successive experimental sessions in which these alternating components are presented did not seem to give a more consistent contrast or induction effect.

Generally, it has been demonstrated that contrast (behavioural and punishment) can be produced by using the response cost variable, but the method so far has not proved to be very reliable. The effect of suppression during the response cost component, however, seemed to be more reliable.

## CHAPTER VIII

### EXPERIMENT 6 : A COMPARISON OF AUDIENCE AND RESPONSE COST ON HUMAN DRL PERFORMANCE.

It was decided at this stage to continue the testing of the audience factor in conjunction with a punishment schedule superimposed on a maintaining DRL60 schedule. Since it was established in the previous chapter that response cost in most cases would lead to suppression of responding when upcounts are used as reinforcers, downcounts contingent upon responding may be used as a suitable comparison treatment for an investigation of possible suppressive effects on performance of an audience (for theoretical justification, see Chapter I, I.5, last two paragraphs).

Recall the postulate also put forward in Chapter I (I.5.) that the usual effect of punishment is to produce suppression of responding (Church, 1963) and that a variety of stimulus dimensions (such as shock, noise, blasts of air, etc.) produce contingent response suppression. The common feature of these stimulus dimensions appears to be aversiveness. Since an audience is presumed to be an aversive stimulus also, contingent response suppression may be predicted. Can punishment contrast also occur when exposure to an audience is made response contingent?

This hypothesis was tested also in the present experiment.

An additional factor which attempted to take into account personality differences in the dimension of

extraversion was included also. This dimension's role has already been briefly discussed (Chapter I.4.3) but needs further clarification in the present context.

Eysenck (1957, 1967) has argued at length that although extraverts are traditionally the more sociable group, introverts are more socialised because they form socially conditioned responses faster and more readily than the (more sociable) extraverts. The possible aversive nature of audience should therefore have greater effects on introverts' performance, producing a greater decrement in responding during suppression.

A similar prediction may be derived for the performance under response cost; that is, introverts will be more affected (i.e. greater suppression) than extraverts since, according to Eysenck, extraverts will form conditioned responses less readily. Jones (1973) has already shown that in an operant conditioning task (continuous reinforcement) introverts condition better than extraverts when monetary reinforcers are used. This prediction from Eysenck's theory is also supported by Gray (1971) who argues and presents evidence for the contention that extraverts perform worse than introverts on tasks involving aversive stimulation.

#### METHOD

##### Subjects.

Twelve members of the first-year class in psychology at the University of Adelaide participated. None of the subjects had experience in operant conditioning tasks.



(Evidence that reinforcement history affects the mediation of human subjects on DRL schedules has recently been published (Stein, 1977). Six subjects were classed as extraverts and six as introverts from their scores on the E.P.I. (Form A). Extraverts' scores ranged from 3-4 and introverts' scores ranges from 18-20 (the possible range is 0-24).

#### Apparatus.

The apparatus used was the same as in Experiment 5 with the following additions. Immediately above the sloping panel, 100cm. from the floor, was a clear, double perspex screen 60 cm x 40cm, which contained an air layer of 4cm. between the two perspex sheets. The screen could give the subject visual access to an adjoining experimental room by means of two curtains travelling on a track and driven by a small electric motor within this room. Normally, the curtains were closed. During the times when an audience stimulus was scheduled, the subject's response was followed between 1 and 2 secs. by a 1 sec. red light and by the curtains opening and revealing an audience watching passively the subject for 15 secs., after which the curtains closed. The audience, who sat in a slightly higher position than the subject in order to observe him at his task, was physically removed from him by a distance of approximately 100cm. as measured "through" the screen (See Figs. 8 and 9). Normal room lighting was used for both experimental rooms. Efforts were made to sound attenuate both experimental rooms from each other by the use of carpet and seals around the common door.



Fig. 8: (Simulated) Subject with apparatus and Professor 2 with curtain in the "open" position. (N.B. Professor 2 wore spectacles during all Audience sessions although not so depicted here).



Fig. 9: (Simulated) Subject with apparatus and Professor 1 with curtain in the "open" position. (N.B. Photograph taken from video-tape, hence brightness inconsistencies).

Responding was effected by pressing a finger lever placed near the foot of the display box with a force of 250gms. through a distance of 1 cm. Continuous depression of the lever had no effect on the programmed contingencies. If a response was emitted when the curtain was still in the open position, a further 15 sec. open period was programmed from the time of the last response.

All programming of the experimental contingencies, and the recording of response data was by means of cabling to and from a digital PDP8 computer located in an area well removed from the two adjoining experimental rooms. A logic diagram of the apparatus is given in Appendix E1.

#### Procedure and Experimental Design

In the preliminary baseline sessions subjects were required to learn and perform the DRL60 sec. schedule to a criterion mean response rate which did not vary more than 10% between two successive sessions, or to 70% of the number of maximum possible reinforcements for any one session.

Instructions to subjects at the beginning of each 45 min. session were identical to those in Experiment 5, as were the arbitrary zero point, and the basic design of the experimental sessions. Each experimental session again began with a 5 min. component which alternated with a 10 min. component. All of the 5 min. ("non-stimulus" component) components were again identical to baseline conditions. The 10 min. components ("stimulus" components) involved the DRL60 schedule in addition to a superimposed contingency which was response contingent exposure to:

(a) an audience of one of two professors from the Psychology

Department. Both professors had earlier given class lectures to subjects and wore name tags in a prominent position so as to ensure recognition by subjects. It was decided to use the professors as audiences in an attempt to maximise the magnitude of any audience effects in accordance with the known effects of audience status and potential evaluation (e.g. Henchy & Glass, 1968). Professors in Australian Universities are at the top of the academic ladder; they hold "Chairs" in Departments and are the most senior academic positions available - these are generally held by internationally recognised authorities in particular fields. The audiences were instructed to observe passively the subject at his task, and to make in view of the subject a pencil mark on a pad during the open-curtain periods. Appendix E2 gives the actual audience instructions.

- (b) a response cost treatment in which a downcount of 5¢ with a 1 sec. red light 1 to 2 sec. after a response was administered.
- (c) a novel, "non-social" stimulus (a full size bust of Augustus Caesar placed on a classical pillar - see Fig.7) which replaced the professor. The bust faced the subject from approximately the same distance and height as the professor in the audience treatment.

All subjects underwent each of these three treatments in three separate sessions. Random assignment of subjects to different treatment sequence orders was according to a balanced Latin square design in which extraverts/introverts and the two professors were counterbalanced (Winer, 1971).



Fig. 7: (Simulated) Subject with apparatus  
and Novel Stimulus with curtain in  
"open" position.

At the end of the sequences it was attempted to return subjects to baseline in order to demonstrate stimulus control over their DRL60 performance; this was successful for 10 out of the 12 subjects ( $S_7$  and  $S_{12}$  could not be returned).

At the end of each session, subjects were asked on a scale of -10 to +10 to rate their anxiety change with respect to the last session. After completion of their second and third experimental sessions, subjects were asked also to indicate their anxiety change with respect to the last baseline session. They were again asked to write down what strategies they used for responding.

### RESULTS

The data in Tables 8.1, 8.2, 8.3 and 8.4 are presented as mean percentage changes from baseline levels of response rates, reinforcement rates, interresponse times and efficiency of DRL ratios, respectively, versus the mean of the nonstimulus and the mean of the stimulus components (see Appendix E3 for subject scores).

The data were subjected to a 3 factor analysis of variance with repeated measures on 2 factors (treatments and components) (Winer, 1971, p.539). These are presented in Appendix E4. The extraversion X treatments interaction was the only significant factor for response rates ( $F_{2,30}=3.55$ ,  $p<0.05$ ). When this is followed up by the lsd method of comparisons between means, only the difference between extraverts ( $\bar{X} = -35.1$ ,  $s = 31.5$ ) and introverts ( $\bar{X} = +17.8$ ,  $s = 66.3$ ) on the response cost treatment was significant ( $t_{30} = 2.14$ ,  $p<0.05$ ), (See Table 6.1).

| Task Component                | Extraverts  |              |              | Introverts   |              |            |
|-------------------------------|-------------|--------------|--------------|--------------|--------------|------------|
|                               | Aud         | R.C.         | N.S.         | Aud          | R.C.         | N.S.       |
| Non Stimulus                  | +5.7 (12.3) | -34.2 (26.0) | +16.6 (23.8) | +33.7 (87.1) | +18.7 (66.3) | -4.9 (9.0) |
| Stimulus                      | -5.1 (13.4) | -35.9 (36.1) | -2.4 ( 8.9)  | -0.2 (27.4)  | +16.9 (66.3) | +0.3(13.9) |
| Mean of Non<br>Stim.and Stim. | +0.3 (14.2) | -35.1 (31.5) | +7.1 (19.5)  | +16.7 (66.8) | +17.8 (66.3) | -2.3(12.0) |
| Overall Mean                  |             | -9.2 (29.4)  |              |              | +10.9 (55.6) |            |

Table 8.1: Mean percentage changes in response rates (resp/min) from base-lines (standard deviations in brackets) for extraverts and introverts during 3 experimental treatments each separated into two task components.

| Task Component | Extraverts  |              |             | Introverts  |              |              |
|----------------|-------------|--------------|-------------|-------------|--------------|--------------|
|                | Aud         | R.C.         | N.S.        | Aud         | R.C.         | N.S.         |
| Non Stimulus   | +2.4 (16.8) | -32.1 (25.2) | +6.9 (18.2) | +9.6 ( 8.9) | -5.5 (15.8)  | +22.6 (20.3) |
| Stimulus       | +3.8 (13.2) | -37.2 (16.8) | -3.5 ( 3.8) | +4.6 (28.1) | -19.9 (20.1) | +8.9 (11.9)  |
| Mean           | +3.3 (15.1) | -34.4 (21.5) | +1.7 (14.1) | +7.1 (21.0) | -12.7 (19.5) | +15.7 (18.0) |
| Overall Mean   |             | -10.0 (24.5) |             |             | +3.4 (22.9)  |              |

Table 8.2: Mean percentage changes in reinforcement rates (rfts/min) from base-lines (standard deviations in brackets).



| Task Component | Extraverts  |              |             | Introverts  |             |             |
|----------------|-------------|--------------|-------------|-------------|-------------|-------------|
|                | Aud         | R.C.         | N.S.        | Aud         | R.C.        | N.S.        |
| Non Stimulus   | -5.8 (14.4) | +48.7 (40.9) | -6.9 (11.2) | -5.6 (30.2) | +2.2 (36.5) | +2.0 (7.7)  |
| Stimulus       | +4.3 (12.0) | +69.4 (76.5) | -1.5 (5.0)  | +1.0 (16.8) | +5.9 (54.9) | +1.4 (12.1) |
| Mean           | -0.8        | +59.1        | -4.2        | -2.3        | +4.1        | +1.7        |

Table 8.3: Mean percentage changes in Interresponse Times from baselines  
(S.D. in brackets).

| Task Component | Extraverts  |             |             | Introverts  |              |              |
|----------------|-------------|-------------|-------------|-------------|--------------|--------------|
|                | Aud         | R.C.        | N.S.        | Aud         | R.C.         | N.S.         |
| Non Stimulus   | -0.4 (17.1) | +7.8 (15.1) | -9.4 (20.7) | -4.6 (24.1) | -9.1 (33.6)  | +19.0 (25.8) |
| Stimulus       | +2.8 (10.3) | -8.9 (13.9) | -0.1 (7.2)  | +0.1 (14.9) | -21.3 (18.7) | +6.7 ( 7.2)  |
| Mean           | +1.2 (14.2) | +1.8 (16.7) | -4.1 (16.2) | -0.8 (20.4) | -15.2 (27.9) | +12.9 (19.9) |
| Overall Mean   |             | -2.1 (15.5) |             |             | -1.0 (25.7)  |              |

Table 8.4: Mean Percentage changes in Efficiency Ratios ( $E = \frac{\text{No. rfts/min}}{\text{No. resp/min}}$ ) from baselines (S.D. in brackets).

For reinforcement rates (See Table 8.2), the treatments factor was significant ( $F_{2,30} = 22.61$ ,  $p < 0.001$ ), although the components factor also approached conventional significance levels ( $F_{1,30} = 3.34$ ,  $p < 0.10$ ). Table 8.5 presents a summary of the means under these two factors. By inspection of the treatment factor means it is apparent that the response cost treatment mean was smaller than both the audience and novel stimulus treatment means.

|                           | Aud  | R.C.  | N.S.  |
|---------------------------|------|-------|-------|
| Non Stim                  | +6.0 | -18.8 | +14.7 |
| Stim                      | +4.2 | -28.6 | +2.7  |
| Mean of Non-Stim and Stim | +5.1 | -23.7 | +8.7  |

Table 8.5: Reinforcement Rates (mean percentage changes from baseline) in the 3 treatments as a function of the 2 components.

For interresponse times (see Table 8.3), only the treatments factor was again significant ( $F_{2,20} = 4.41$ ,  $p < 0.05$ ), although the extraversion X treatments interaction also approached significance ( $F_{2,20} = 3.35$ ,  $p < 0.10$ ). Inspection of the means indicates that the response cost treatment, particularly for extraverts, gave rise to very much longer IRTs in both components than any of the other treatments, all of which had component means close to baseline values.

For efficiency of DRL ratios (see Table 8.4) none of the factors or interactions was significant, although the

extraversion x treatments interaction again approached significance ( $F_{2,20}=3.26$ ,  $p=0.06$ ), as well as the treatments x components interaction ( $F_{2,20}=2.95$ ,  $p<0.10$ ).

The data analysis presented so far seems to indicate that the response cost treatment in both components produced reliable suppression of responding with concomitant decreases of reinforcement (presumably because most subjects were responding at relatively efficient baseline levels) and increases in IRTs. The suppression of responding was confined, however, to the extraverted group. The audience and novel stimulus treatments, however, seem to have had little overall effect on performance.

The mean anxiety change scores (Table 8.6) were neither significant between introverts and extraverts nor between the 3 treatments.

The mean money scores were significantly different between the treatments only ( $F_{2,20}=191.3$ ,  $p<0.001$ ) and inspection of Table 8.6 reveals that this difference can be accounted for by the response cost treatment money losses when compared with money gains which are similar for the audience and novel stimulus treatments.

A planned comparison was carried out on the response rate variable to determine if contrast effects appeared within each treatment. Table 8.7 presents summaries of these. Only in the audience treatment was there a slight tendency towards contrast in the predicted direction.

|         | <u>Extraverts</u> |            |            |            | <u>Introverts</u> |            |            |            |
|---------|-------------------|------------|------------|------------|-------------------|------------|------------|------------|
|         | Baseline          | Aud        | R.C.       | N.S.       | Baseline          | Aud        | R.C.       | N.S.       |
| Anxiety | 0                 | -1.3 (2.3) | +4.8 (1.1) | -0.2 (0.4) | 0                 | +2.5 (2.4) | +0.5 (0.8) | -0.8 (1.2) |
| Money   | 126 (28)          | 125 (24)   | -15 (29)   | 126 (30)   | 121 (16)          | 121 (15)   | -11 (23)   | 135 (6)    |

Table 8.6: Mean changes in anxiety ratings from baselines and mean amount of money earned or lost (cents). (S.D. in brackets).

|          | Aud          | R.C.        | N.S.        |
|----------|--------------|-------------|-------------|
| Non Stim | +19.7 (63.8) | -7.7 (56.9) | +5.8 (20.9) |
| Stim     | -2.6 (21.7)  | -9.5 (59.6) | -1.0 (10.1) |
| t(df=30) | 1.34*        | $\leq 1$    | $\leq 1$    |

\*  $p < 0.10$  (1-tailed)

Table 8.7: Summary of contrast effects between components in the 3 treatments with mean percentage changes in response rates as the dependent measure (N.B. the pooled error term from Appendix E4.1 was used).

As a follow up to the significant (at least at 0.05 levels) F ratios obtained in the previous analyses of variance in the treatments factor (or interactions involving treatments), differences between the two professors within the audience treatment were investigated with the lsd method, as it seemed from individual subject data that some of the variance might be accounted for by professor differences. These data are summarised in Table 8.8.

|      |          | Prof 1      | Prof 2       | Comparison         |
|------|----------|-------------|--------------|--------------------|
| RR   | Non Stim | +0.8 (3.7)  | +38.6 (86.1) | $t_{30}=2.28^{**}$ |
|      | Stim     | -9.1 (15.9) | +3.9 (24.6)  | $t_{30} < 1$       |
| RftR | Non Stim | -2.9 (13.6) | +14.8 (14.8) | $t_{30}=2.36^{**}$ |
|      | Stim     | -3.8 (16.3) | +12.1 (23.9) | $t_{30}=2.13^{**}$ |
| IRT  | Non Stim | -5.7 (14.4) | -5.7 (30.2)  | $t_{20} < 1$       |
|      | Stim     | +7.1 (8.0)  | -1.8 (18.2)  | $t_{20} < 1$       |

\*\*  $p < 0.05$  (2-tailed)

Table 8.8: Comparisons between the two professors in the audience treatment on 3 dependent measures (Pooled Error Term MS were used in the lsd comparisons for response and reinforcement rates, but not for IRT).

These data indicate that Professor 2 gave rise in acceleration of responding in the Nonstimulus component compared with Professor 1 in the same component. Professor 2 also gave rise to a greater reinforcement rate in both components than Professor 1. However, the suppression of responding shown to Professor 1 was not significantly different from the (very slight) acceleration shown to Professor 2 in the Stimulus component, although performance as measured by reinforcement rates was clearly better with Professor 2 than with Professor 1.

A consideration of subject's written responses to the question as to what strategies they used provided some illumination on this curious Professor difference. Reference to Appendix E5 shows the verbal (written) reports by subjects after the audience treatment. The responses pertaining to subjects' experiences to the audiences were classified by 3 independent judges not aware of the hypotheses, according to whether they belong to an "aversive" or "appetitive" category. All judges were given the data in Appendix E5 and were asked to indicate whether the responses to Question 2 indicated an "aversive" or an "appetitive" experience. All three judges gave exactly the same data (Table 8.9) with S<sub>10</sub> as the only subject not describing Professor 1 as aversive.

|           | Prof 1     | Prof 2 |
|-----------|------------|--------|
| Responses | Aversive   | 5      |
|           | Appetitive | 1      |

Table 8.9: Numbers of subjects describing the two audiences as either "aversive" or "appetitive" as rated by 3 independent judges.

A Fisher's Exact Probability test performed on these data indicates a significant relationship between type of audience and perception as aversive or appetitive ( $p < 0.05$ ). These data are supported by an examination of the cumulative records of e.g. two subjects,  $S_5$  who was observed by Professor 2, and  $S_8$  who was observed by Professor 1 (Figs. 10 and 11 respectively). Whereas the baseline performances of these two subjects are similar,  $S_5$ 's performance shows clear suppression of responding (e.g. during the last 10 mins. of audience exposure) and  $S_8$ 's performance shows no such suppression. The latter subject shows a high degree of acceleration during the second 5 min. period (nonstimulus period), demonstrating contrast between the components.

#### DISCUSSION

The large variability between subjects in performance is one of the most striking aspects of these results. The personality factor of extraversion seems to have affected only the performance on the response cost treatment, where extraverts showed a large degree of suppression generalised to both components and introverts showed acceleration generalised to both components. This indicates some repeated ambiguity about the efficacy of response cost as a suppressor of performance and hence as a suitable comparison condition for the audience treatment. Punishment contrast was not obtained in the response cost treatment which suggests again that the effect is difficult to obtain reliably, as was also suggested by the experiments in the previous chapter. The



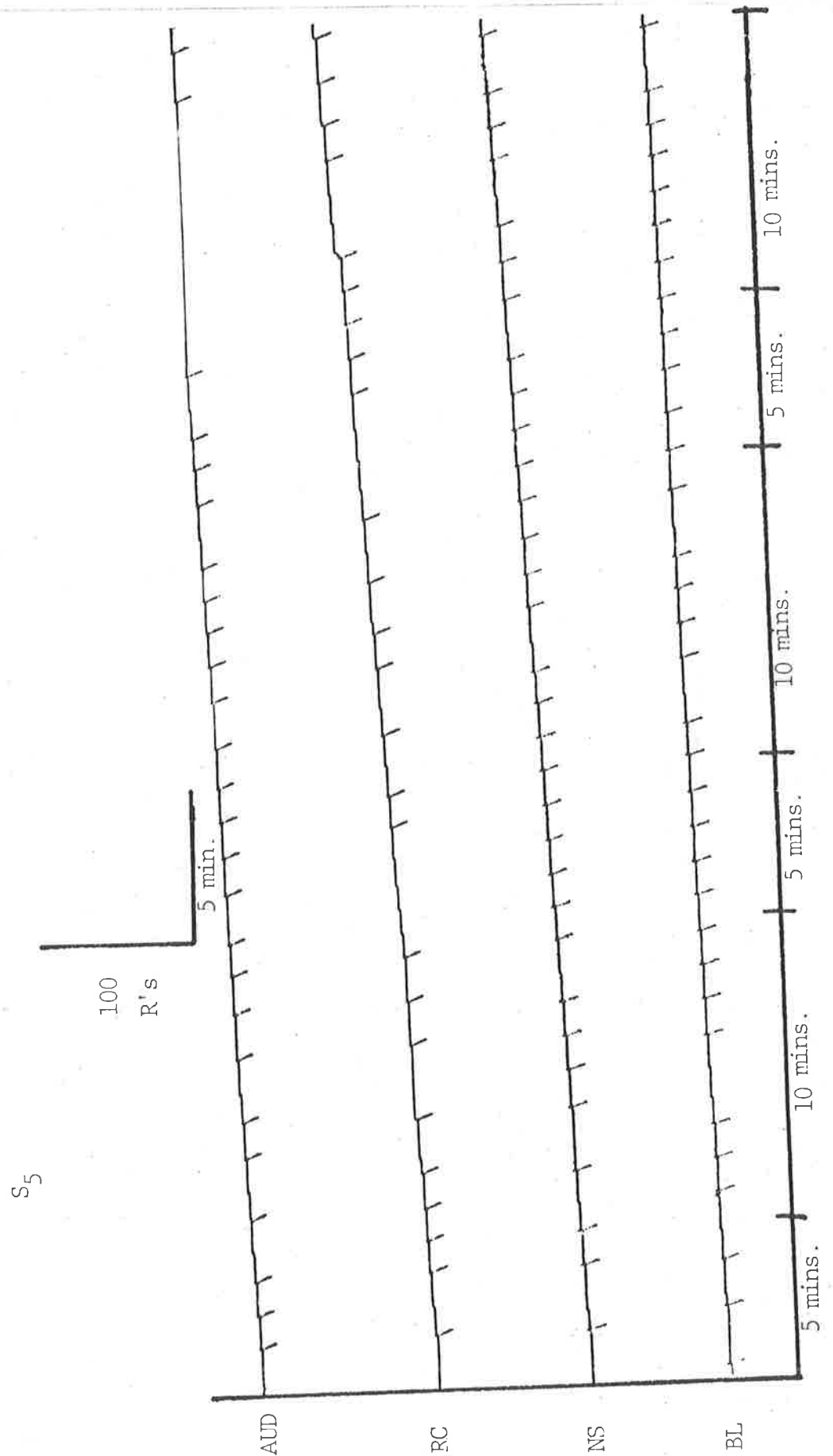


Fig. 10: Samples from cumulative records of  $S_5$  during Baseline and Treatments. The 5 min. periods constitute the Nonstimulus component; the 10 min. periods constitute the Stimulus component.

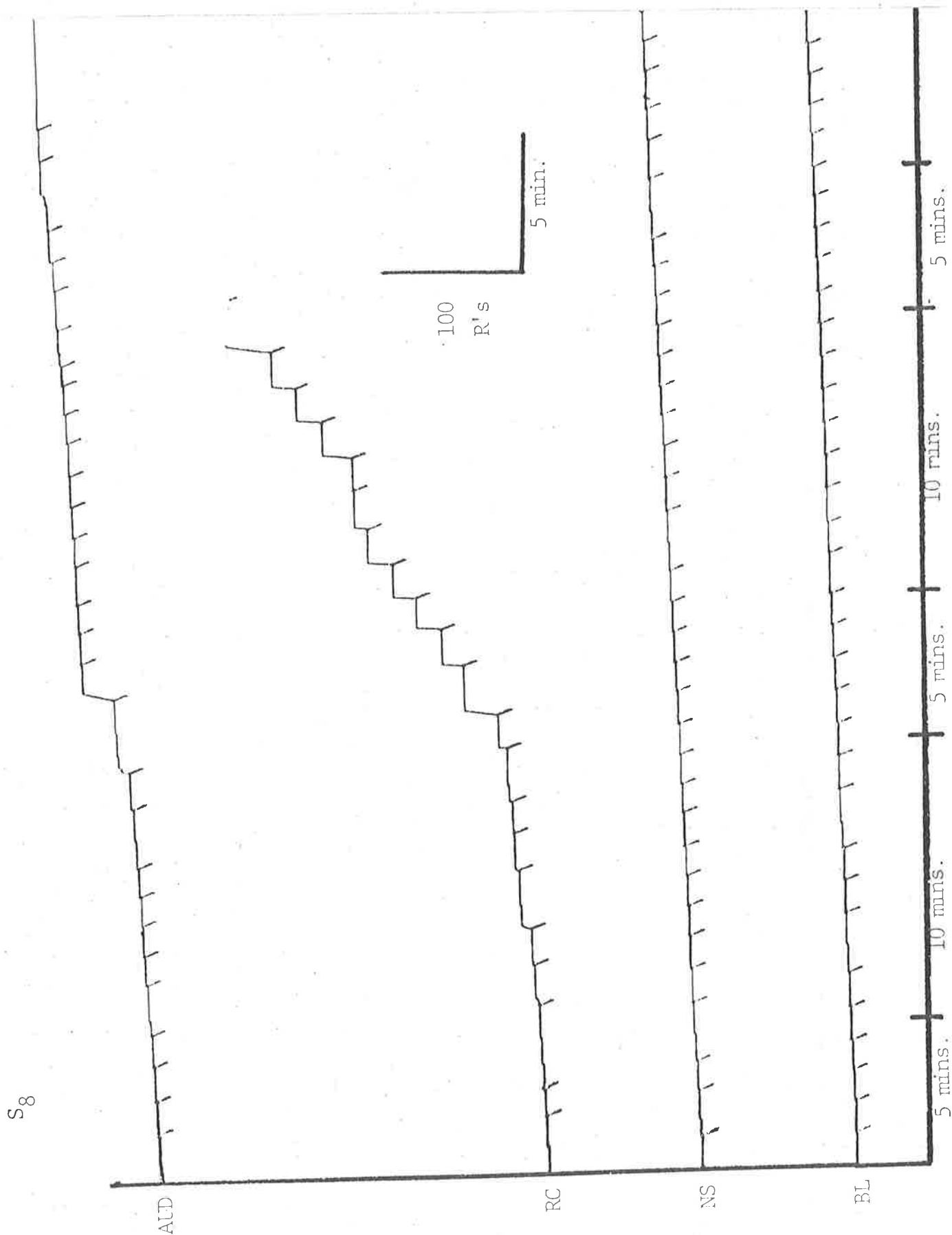


Fig. 11: Samples from cumulative records of  $S_8$  during Baseline and Treatments. The 5 min. periods constitute the Nonstimulus component; the 10 min. periods constitute the Stimulus component.

response rate changes for the response cost treatment also seem to contradict the hypothesis that extraverts form conditioned responses less readily than introverts, since the reverse was in fact obtained. An inspection of the reinforcement rate changes for extraverts and introverts in the response cost treatment tempers this tentative conclusion, as extraverts also missed out on more reinforcements during both components than introverts. This indicates that introverts performed better than extraverts during the response cost treatment.

The extraversion factor does not account for the relatively large variability in performance in the audience treatment. However, in this case, the differences between the Professors (Tables 8.8 and 8.9) seem to indicate fairly clearly that Professor 1 who produced suppression in the stimulus component was perceived by subjects as being "aversive", and Professor 2 who produced no suppression in the stimulus component was perceived by subjects as being "appetitive". Although this explanation is post-hoc, it may have drawn attention to a variable which has not been considered before in the literature : that of individual audience differences. The observed differences in this experiment cannot be explained by differences in (a) evaluative status, since both were professors, or in (b) anticipated negative or positive outcomes for the subject, since all subjects had similar limited experiences of the professors only in a large lecture class earlier in the year, and had not been assessed by them (this was confirmed by questioning

subjects at the completion of the experiment).

One possible explanation of these differences is to suggest that the effect of a passive audience is mediated by a host of nonverbal communication factors such as eye contact, body posture, facial expression, etc. These may or may not be perceived by the subject as evaluating or threatening, or imply negative outcomes of the social interaction. This is clearly an unexplored avenue worthy of further investigation.

There was very little evidence of a punishment contrast effect being the result of audience exposure. The overall results for audience in Table 8.7 are produced by subjects showing either suppression in the stimulus component, but not the two events being shown by any one subject. The acceleration in the nonstimulus components where it occurred, does seem indicative of a behavioural contrast effect, however (see for example the cumulative record of  $S_8$ , Fig.11). This effect, although not quite the same as predicted, does require some explanation.

Recall that behavioural contrast can be obtained by reinforcing responses in the presence of discriminative stimulus 1 in one component and by not reinforcing responses in the presence of discriminative stimulus 2 in a second component of the same schedule. The response rate during the second component decreases as a result of extinction to positive reinforcement, but responding is increased beyond baseline levels during the first component. Although at no stage was the audience associated with extinction in the present experiment (since responding was still reinforced on the DRL

schedule), it was present in one component and absent in the other.

If it is assumed that the audience itself had acquired reinforcing characteristics, then withdrawal of the audience would cause extinction. During the initial stages of extinction, an increase in responding is usually observed, before a gradual reduction of responding follows. This may explain the increase in responding observed during the non-stimulus component.

This explanation of the contrast effect observed in the present experiment agrees very nicely with how subjects perceived the audience. When the audience was perceived as "appetitive" the contrast effect described above was obtained, and when the audience was perceived as "aversive" suppression in the stimulus component was obtained.

A difficulty with interpreting the "appetitive" version, of the audience stimulus as a positive reinforcer arises, however, when no increase in responding is observed during its introduction during the stimulus component. What confuses the issue here is that responding during the stimulus component is maintained by another reinforcer (money), so that reinforcer interaction effects would be predicted - these cannot be separated from this experimental design (see Chapter X, X.4 for future research implication).

There were no significant differences between extraverts and introverts on the audience and the novel stimulus treatments. The former suggests that the audience effect is not sensitive to the personality dimension of extraversion, a

rather surprising finding in view of Eysenck's personality theory's predictions. The similar absence of significant differences between high and low N scorers in Experiment 4 also supports the broader conclusion that extreme personality differences according to these two dimensions are not important in determining sensitivity to audience stimulation in DRL tasks. It should be remembered however, that in both Experiment 4 and this experiment, the subject samples were relatively small compared with the large samples generally used in personality studies (Eysenck, 1967), so that the above conclusion must be tentative.

It is known that the amount of suppression in a punishment paradigm is dependent upon the manner of introduction, the contingency and the intensity of the aversive stimulus (Azrin & Holz, 1966; Church, 1963). In this experiment it was attempted to make the intensity as large as possible by the use of high status academics and first-year students as subjects. The manner of introduction was sudden and the immediacy of the presentation of the audience stimulus was within 2 sec. of the response. All these factors should have produced close to maximum suppression according to what is known about the punishment procedure, yet this was not reliably observed.

Generally the results of this experiment revealed three unexpected findings:

- (a) an audience contingency does not reliably have the effects normally expected of an aversive contingency in a DRL schedule,
- (b) an audience contingency has suppressive effects only if subjects perceive the audience as being "aversive".

- (c) an audience contingency gives rise to an increment in responding when it is removed only if subjects perceive the audience as being "appetitive".

#### SUMMARY

An experiment is reported which attempted to determine if an audience stimulus has aversive consequences for performance in a DRL60 schedule by human subjects (introverts and extraverts). After baseline training, subjects were given 3 treatments:

- (a) response contingent exposure to an audience of one or two professors, who observed the subject for 15 sec. following a response,
- (b) response contingent "cost", which involved a loss of money (a known aversive stimulus) following a response,
- (c) response contingent exposure to a novel stimulus for 15 sec. following a response.

These treatments were given in one (stimulus) component of a two-components session, where the other (nonstimulus) component was identical to baseline conditions. The results showed that there were differences between extraverts and introverts only on treatment (b), where extraverts showed suppression of responding and introverts acceleration during both components. Results from treatment (a) revealed that with one professor, suppression occurred during the stimulus component and subjects described the experience as "aversive"; with the other professor, acceleration occurred during the nonstimulus component and subjects described the experience

as "appetitive". There were no effects on responding by treatment (c) indicating that treatment (a)'s effects were not due to novelty. The aversive/appetitive nature of the audience stimulus was interpreted as being mediated by nonverbal communication.



CHAPTER IXEXPERIMENT 7 : THE EFFECT OF AN AUDIENCE CONTINGENCY ON  
DRL RESPONDING BY RATS.

In the last chapter, some of the ambiguous findings observed in the audience treatment were explained by associating subjects' perceptions as to the "aversiveness" or "appetitiveness" of the audience with suppression or acceleration of responding on the DRL60 schedule. An attempt was also made to maximise the audience effect by manipulating (amongst others) the variable of status of the audience to arouse evaluation apprehension in subjects. Both of the above concepts are clearly not applicable when animal subjects are used so that they are likely to be only (human) species specific explanations for the audience contingency effects.

If similar performance effects can be observed with rats, then the purported aversiveness or appetitiveness of an audience may not be specific only to the human species. If aversiveness of an audience is the dominant characteristic, then suppression of responding may again be predicted with response contingent audience exposure on a DRL schedule with food as the reinforcer, with punishment contrast being shown in a nonaudience component. If appetitiveness of an audience is a dominant characteristic, then no response suppression is predicted in the audience component, with behavioural contrast being shown in a nonaudience component. This behavioural contrast effect may indeed be transient if the extinction explanation in the previous chapter is accepted, i.e. withdrawal

of an appetitive response contingency leads to an immediate increment in responding.

In the previous human DRL experiments, most subjects were responding at highly efficient rates compared with pigeons (e.g. Holz et al, 1963) or rats (e.g. Richardson & Longhead, 1974). Typically, pigeons and rats on DRL schedules show bursts of responses even after many baseline training sessions. It is these very short IRTs which reduce performance efficiency. Short IRTs are sometimes observed in human DRL responding, but the previous experiments have shown that these occur either at the beginning of training or when the response contingency is altered. In the latter case, the occasional re-emergence of bursts of responses may be due to an attempt to find an optimal strategy for responding on the altered schedule. In the former case (pigeons' pecking responses and rats' bar pressing responses) bursts of responses are sometimes explained by considering these generally successful instrumental responses, both of which involve components of the unconditioned response to food, to be determined partly by anticipatory conditioning (Mackintosh, 1974). This explanation for bursts of responses in the case of animal studies is to be preferred over an "optimal performance strategy" explanation, as the behaviour tends to be both stereotyped and persistent, while not being reinforced.

Holz et al (1963) showed that introducing response contingent shock at medium intensity produced more efficient performance than on baseline by pigeons on a DRL30 sec. schedule. When the shock was removed in a second schedule component, responding was greater than baseline levels, with a resultant decrease in reinforcement (punishment contrast).

Since the performance of rats on DRL schedules is markedly less efficient than DRL performance by humans, any suppressive effects are predicted to produce a more dramatic increment in performance efficiency. To investigate whether an audience contingency produces this effect and hence can be considered to be "aversive", or whether it has effects on performance which can be considered to be "appetitive", an experiment along similar lines to Experiment 6 was carried out except that the subjects were rats performing on a DRL schedule.

Because both novel (Contrucci et al, 1971) and social stimuli (Wheeler & Davis, 1967) have been found to disrupt performance by rats on DRL schedules, several control conditions (treatments) were used. In one treatment, an audience (one rat) contingency was given. In another treatment, an anaesthetized rat was exposed following a response; in another a stuffed rat (novel stimulus) served as stimulus, and in another treatment neither a rat nor a novel stimulus was present. The anaesthetized rat treatment was used for two reasons : first, a non-anaesthetized audience rat may be active and display body movement, and this activity itself may be responsible for performance differences; second, there is some evidence that anaesthetized rats are as effective as active non-anaesthetized rats in facilitating avoidance performance (Marina & Bauermeister, 1974).

## METHOD

### Subjects.

Eight experimentally naive hooded rats, about 100 days old at the beginning of the experiment served as subjects, with another eight rats serving as spectator animals. All animals were housed individually and kept in an airconditioned room which housed numerous other rats used by the Psychology Department. A 12 hr. light - 12 hr. darkness cycle was maintained throughout the experiment. The rats were given ad lib water throughout the experiment and kept on a 22-hr. food deprivation daily schedule. Animals were run for one hour daily sessions at approximately the same time each day, after which they were given ad lib food for 1 hr. This procedure kept all animals at approximately 80 - 85% of their normal body weight determined before deprivation commenced.

### Apparatus.

Two specially constructed audience observation Skinner boxes were used (Fig. 12), each 22cm x 22cm x 22cm, with two aluminium walls and perspex roof, front door and back. In the back corner nearest the bar and food trough, a permanent stainless steel vertical grid arrangement covered a double aluminium walled door which could be vertically raised to expose an aluminium audience compartment measuring 20cm x 10cm x 10cm. When the vertical door was closed, no visual access was possible between the compartments. Sounds from all sources were masked by a 75 dB white noise generator. Olfactory sources within the boxes were masked by thoroughly

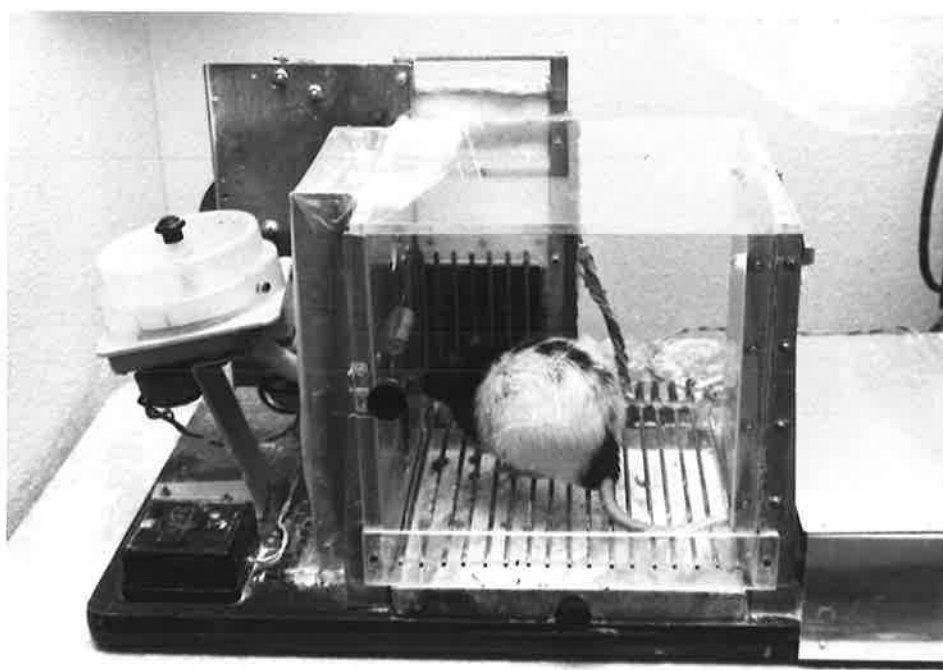


Fig. 12: Audience Observation Skinner Box  
(Subject Compartment in foreground;  
spectator compartment behind  
subject's head) in Experiment 7.

cleaning both compartments and liberally sprinkling a germicidal vanilla powder in the cleaning trays underneath the stainless steel grid floors in the compartments, before each animal commenced its daily session. The only air holes in both compartments were in and around the access doors to the compartments - these were the largest possible distance removed from each other. The vertical double door between the compartments ran in a double rubber track in an additional attempt to prevent or attenuate further olfactory and auditory sources from the audience rat, from reaching the subject when the vertical door was closed.

The subject compartment was a standard Skinner box with a bar 7cm. above the floor and food trough immediately below the bar. 45 mg. "Noyes" food pellets could be delivered by a rotating pellet dispenser. Both compartments contained two 5-watt houselights each to provide illumination. The grid floor of the subject compartment was wired to a Grason-Stadler shock scrambler and DC shock generator which could deliver 0.5 sec. shocks of varying intensity.

All stimulus programming and response recording was done by cabling to a digital PDP 11 computer situated in another room. Cumulative recorders hooked up to the system provided a further recording means. A logic circuit diagram of the vertical door arrangement is given in Appendix F1.

#### Experimental Design and Procedure.

Initially, all subjects were habituated to the subject compartment of the apparatus for 2 sessions of half an hour and then run on crf for 3 sessions of 1 hr. Training on DRL

followed a progression of increasing DRL values with successive sessions, so that all animals had 1 session on DRL5sec., 1 session on DRL10sec., etc., until DRL30sec. was reached. All subjects were then run to baseline criterion by daily 1 hr. sessions. The baseline criterion was set at the attaining of 3 successive sessions in which mean response rates did not vary more than 10%. The criterion was attained by subjects in different numbers of sessions ranging from 74 to 88 sessions.

A DRL30sec. schedule was chosen since Holz et al (1963) had earlier shown punishment contrast using this schedule using food reinforcers and electric shocks of varying intensities as the aversive stimuli. Their subjects, after baseline training, were put onto a 12 min. shock-on component alternating with a 3 min. shock-off component within each session. It was decided that, in the absence of literature studies using a similar design, this procedure should be followed. Hence, all of the experimental treatment sessions followed this design. Subjects were run on each of the experimental treatments for the number of sessions that they required to "stabilise" mean response rates to vary not more than 10% for 3 successive sessions. The mean of the latter was then taken for comparison purposes.

In the first phase of the experiment, each subject underwent four experimental treatments, superimposed on the DRL30 schedule:

- (a) Spectator treatment (Sp), which involved placing a spectator rat in the audience compartment. The animal had previously been habituated to the audience compartment to eliminate exploratory and emotional behaviours.

During the 12 min. audience stimulus components all responses were followed by a 15 sec. exposure to the spectator by raising and lowering of the vertical door. The time taken for the door to be fully raised was about 3 - 4 sec. from the time of the response - the door took about 1 sec. to be lowered when the 15 sec. exposure period had elapsed. If a response was emitted before the 15 sec. exposure period had elapsed, another 15 sec. exposure was given from the time of the last response. During the 3 min. nonstimulus components the vertical door was never raised. In all sessions of the spectator treatment, subjects were always exposed to the same spectator rat, and each subject had a different spectator.

- (b) Anaesthetized Spectator treatment (AnSp), in which identical conditions as in (a) were in operation, except that the spectator rat was replaced by a non-moving anaesthetized rat (the same rat which served also in the spectator treatment). The general anaesthetic (sodium pentobarbitone solution - 60mg/ml) was administered by intraperitoneal injection at the dosage of 55-60mg. per Kg. of body weight approximately 15 min. before the session was due to start. This dosage had earlier been determined to be optimal in preventing bodily movement for a period of at least 80 min.
- (c) Stuffed Spectator treatment (StSp), in which identical conditions as in (a) were in operation, except that the spectator rat was replaced by a stuffed hooded rat (prepared by courtesy of the South Australian Museum)



in a typical rat rest pose (4 legs on the ground with face looking straight ahead).

- (d) No Spectator treatment (NSp), in which identical conditions as in (a) were in operation, except that the spectator rat was removed and not replaced by any other rat or object.

These treatments were given to subjects according to the four different sequences of the balanced Latin Square design:

|           | Treatments |      |      |      |      | Subjects                        |
|-----------|------------|------|------|------|------|---------------------------------|
|           | 1          | Sp   | AnSp | StSp | Nsp  | S <sub>1</sub> , S <sub>5</sub> |
| Sequences | 2          | AnSp | StSp | NSp  | Sp   | S <sub>2</sub> , S <sub>6</sub> |
|           | 3          | StSp | Nsp  | Sp   | AnSp | S <sub>3</sub> , S <sub>7</sub> |
|           | 4          | NSp  | Sp   | AnSp | StSp | S <sub>4</sub> , S <sub>8</sub> |

Subjects were randomly assigned to these sequences with the proviso that in each of the four sequences the two subjects would not be assigned to the same Skinner audience box.

Between the treatments, subjects were returned to baselines. If the original baseline could not be retrieved, a new baseline response rate was determined according to the same criterion as before.

A second phase of the experiment started when each animal had completed its last treatment. Baseline was first retrieved. A series of successive sessions was then given to each subject which involved response contingent 0.5sec. duration shock through the floor grid of varying

intensities between 0.1ma to 0.6ma. The same temporal components (3 min. and 12 min) as in Phase 1 were used, with shock occurring only in the 12 min. component. The same shock intensity level was used for any one session, although varying numbers of sessions on particular shock levels were given to different animals. Some of these were expected to produce suppression (in the 12 min. component) and/or contrast (in the 3 min. component).

## RESULTS

### Phase 1:

Raw data in the form of mean response rates and reinforcement rates of baseline and the treatments are presented as a function of the two components ( $C_1$  = non-stimulus;  $C_2$  = stimulus) in Appendix F<sub>2</sub>. Percent changes between the respective baseline and treatment components were calculated for response rates, reinforcement rates and the DRL efficiency index (i.e.  $C_1$  in baseline which corresponded temporally was compared with  $C_1$  in each treatment, and  $C_2$  baseline was compared with  $C_2$  in each treatment). These were subjected to a two-way analysis of variance (mixed model, with treatments and components as fixed factors and subjects as a random factor). Summaries of the analyses of variance are given in Tables 9.1, 9.2 and 9.3.

The response rate changes were significantly different between the components ( $F_{1,7} = 17.53$ ) and also the treatments x components interaction was significant ( $F_{3,21} = 4.73$ ). Table 9.4 presents the means of all subjects' percent changes

| Source         | df | MS     | F       |
|----------------|----|--------|---------|
| Treatments (A) | 3  | 59.3   | < 1     |
| Components (B) | 1  | 2647.1 | 17.53** |
| Subjects (S)   | 7  | 153.7  |         |
| A X B          | 3  | 329.3  | 4.73*   |
| A X S          | 21 | 74.1   |         |
| B X S          | 7  | 151.0  |         |
| A X B X S      | 21 | 69.7   |         |

\*  $p < 0.05$ \*\*  $p < 0.005$ 

Table 9.1: Analysis of variance summary table for percent changes in mean response rates.

| Source         | df | MS    | F    |
|----------------|----|-------|------|
| Treatments (A) | 3  | 247.7 | < 1  |
| Components (B) | 1  | 874.7 | 1.97 |
| Subjects (S)   | 7  | 390.3 |      |
| A X B          | 3  | 448.6 | 1.13 |
| A X S          | 21 | 680.1 |      |
| B X S          | 7  | 443.4 |      |
| A X B X S      | 21 | 397.5 |      |

Table 9.2: Analysis of variance summary table for percent changes in mean reinforcement rates.

| Source         | df | MS     | F     |
|----------------|----|--------|-------|
| Treatments (A) | 3  | 328.6  | < 1   |
| Components (B) | 1  | 12896  | 6.88* |
| Subjects (S)   | 7  | 1183.5 |       |
| A X B          | 3  | 2152.0 | 3.69* |
| A X S          | 21 | 1098.5 |       |
| B X S          | 7  | 1873.7 |       |
| A X B X S      | 21 | 583.5  |       |

\*  $p < 0.05$

Table 9.3: Analysis of variance summary table for percent changes in mean efficiency DRL ratios.

in response rates in the treatments. Planned orthogonal comparisons were carried out to test for contrast effects between the components in each treatment, using the A X B X S Mean Square as an estimate of the population error variance. The results of these are:

Sp treatment  $C_1$  vs  $C_2$  :  $t_{21} = 5.15^*$   
 AnSp treatment  $C_1$  vs  $C_2$  :  $t_{21} = 4.67^*$   
 StSp treatment  $C_1$  vs  $C_2$  :  $t_{21} = 0.58$   
 Nsp treatment  $C_1$  vs  $C_2$  :  $t_{21} = 1.96$   
 (\*  $p < 0.05$ , 2-tailed)

|                                    | Sp    | AnSp | StSp | NSp  |
|------------------------------------|-------|------|------|------|
| Non Stim<br>Component<br>( $C_1$ ) | +10.4 | +9.8 | -2.6 | +4.5 |
| Stim<br>Component<br>( $C_2$ )     | -11.1 | -9.7 | -5.0 | -3.7 |

Table 9.4: Mean percentage changes in response rates from baselines in the components during the experimental treatments.

Contrast effects showing an increase in responding during the nonstimulus component and a decrease in responding during the stimulus component were evident for both the spectator and the anaesthetized spectator treatments, but were not significant for the stuffed rat and the no-spectator treatments.

Since none of the experimental effects for the percent changes in reinforcement rates were significant, no further

analysis was done on them.

The percent changes in efficiency of DRL index (raw data in Appendix F4) were significant again on the components effect ( $F_{1,7} = 6.88$ ) and on the treatments x components interaction ( $F_{3,21} = 3.69$ ). Table 9.5 presents the means of all subjects percent changes in efficiency of DRL index values in the treatments. Planned orthogonal comparisons testing contrast effects within each treatment yielded the following results:

Sp treatment,  $C_1$  vs  $C_2$  :  $t_{21} = 4.06^*$   
 AnSp treatment,  $C_1$  vs  $C_2$  :  $t_{21} = 3.90^*$   
 StSp treatment,  $C_1$  vs  $C_2$  :  $t_{21} = 0.26$   
 NSp treatment,  $C_1$  vs  $C_2$  :  $t_{21} = 1.18$   
 (\*  $p < 0.05$ , 2-tailed)

|                                   | Sp    | AnSp  | StSp  | NSp   |
|-----------------------------------|-------|-------|-------|-------|
| NonStim<br>Component<br>( $C_1$ ) | -7.4  | -16.6 | +8.5  | +1.2  |
| Stim<br>Component<br>( $C_2$ )    | +41.7 | +30.5 | +11.6 | +15.5 |

Table 9.5: Mean percentage changes in  $E_{DRL}$  from baselines in the components during the experimental treatments.

These data support the conclusion that during both the Sp and AnSp treatments an increase in efficiency of performance occurred during the stimulus component and a decrease in efficiency occurred during the nonstimulus component. These contrast effects were not significant for the StSp or the NSp treatment.

Differences between  $C_1$  and  $C_2$  on baselines were not significant when mean component response rates are compared (see Appendix F3) so that these response contrast effects are unlikely to have been caused by possible pretreatment component differences. Similarly, differences between  $C_1$  and  $C_2$  on baseline efficiency DRL index values were not significant, except for baselines immediately prior to the stuffed rat treatment in which performance in  $C_2$  was more efficient than in  $C_1$  (Appendix F3). The effect of the StSp treatment was to narrow this difference to nonsignificance, rather than produce further contrast.

#### Phase 2.

An attempt was made to obtain suppression and/or punishment contrast using different shock intensities to demonstrate the similarity of the punishment contrast effect obtained in the Sp and the AnSp treatments. Appendix F5 presents the mean response and reinforcement rates during the two components in each of the blocks of shock intensities (in mA). These different blocks of shocks were administered in the sequence orders in which they are listed in the appendix. Subjects were given a particular block of sessions of a given shock intensity until a criterion mean response rate was achieved which did not vary more than by 10% for 3 successive sessions. From an inspection of the response rates, the following conclusions may be suggested. Suppression of responding occurs in the stimulus component ( $C_2$ ) which seems to be proportional to the shock intensity used. Contrast in the nonstimulus component ( $C_1$ ) was

obtained in only three subjects ( $S_2$  at 0.4 mA:  $S_3$  at 0.4 mA and  $S_7$  at 0.1 mA). The more common finding was that of generalisation of suppression to the nonstimulus component.

#### DISCUSSION

The significant contrasts found in Phase 1 between the two components in the Sp and the AnSp treatments indicates some support for the hypothesis that an audience response contingency may be considered aversive. That no contrast effects were found in the StSp and the NSp treatments indicates that these audience effects cannot be attributed to any novelty effects of either the door raising event or the physical presence of the stuffed rat.

Rather a surprising finding was that the anaesthetized rat produced a very similar effect to the nonanaesthetized rat. This effect is not due to the presence of a different animal in the Sp and AnSp treatments, since this was controlled by having the same spectator and anaesthetized rat for each subject. Additionally, the competing social response theory may be ruled out by these data (see later). It also strongly suggests that activity or movement by the spectator is not important in producing the contrast effect. The unusual nature of this finding may be compared with those of two studies. First, Latané & Glass (1968) showed that rats are very much more attracted to each other than if one of two rats was anaesthetized in an open-field situation. A moving toy car was even less attractive to a rat, so that they concluded that movement or activity is not an important indicator of social attraction processes. If attraction



between rats were considered to be an alternative explanation for the results obtained in the present experiment, in the sense of competing social responses (competing with the bar press), it could not account for the similarity of the contrast effect between the Sp and AnSp treatments. The competing social response hypothesis would similarly be unlikely if the reasons given by Latané & Glass (1968) are accepted. These are that attraction between rats is subject to the necessary conditions of mutual responsiveness and interaction. In the present experiment, these were clearly very different in the Sp and the AnSp treatment, the latter allowing neither of these conditions. The StSp and the NSp treatments produced no contrast effects so that another explanation of novelty effects may be similarly rejected. It is, for example, difficult to accept that rats are attracted to an anaesthetized rat (when olfactory stimulation is controlled), but not to a stuffed rat if novelty effects were responsible.

Second, Marina & Bauermeister (1974) found that anaesthetized rats were as effective as nonanaesthetized rats in socially facilitating extinction of an avoidance response. As an explanation for this effect, which argues against Latané & Glass's theory, they postulated that both the anaesthetized and nonanaesthetized rats functioned as stimuli capable of eliciting competing responses incompatible with the avoidance behaviour, and that learning occurs of associations between the presence of other members of the species and positive reinforcement. This explanation is however also not tenable in accounting for the present

experiment's results, because it would predict a similar effect for the StSp treatment.

Two further studies producing results which argue for interference effects as a result of introducing social or nonsocial stimuli in a DRL schedule may be cited in supporting indirectly a contrast explanation of the present data. First, Wheeler and Davis (1967) found evidence of disruption of DRL performance in that rats showed decreased IRTs when another rat was placed in the Skinner box, and as a consequence received fewer reinforcements than during baseline training. Second, Contrucci et al (1971) found a similar disruptive effect when a novel auditory stimulus was introduced at various points in the DRL schedule. They interpreted this effect to a disinhibition mechanism. It is clear from the present experiment's results that because the response rate decreased and the efficiency rose during the stimulus component, neither of the above explanations are tenable for the Sp or the AnSp treatment.

It appears then, that we are left with the original hypothesis as the most reasonable explanation of the results. That is, the effect of the audience contingency was to decrease the response rate during the contingency; the response rate increased with lowered efficiency levels when the audience contingency was removed. This effect is similar to that obtained with a punishment contingency. This may be interpreted as providing some evidence that an audience stimulus can be regarded as an aversive stimulus. Two factors however, qualify this tentative conclusion.

First, an examination of the individual data (Appendix F2) indicates that during the Sp treatment's stimulus component only 3 subjects ( $S_1$ ,  $S_5$ ,  $S_7$ ) suppressed responding by about 20% or more, the other subjects showed suppression of less than 10%. Similarly during the AnSp treatment, 3 subjects ( $S_1$ ,  $S_4$ ,  $S_7$ ) showed suppression of about 20% or more, while the other subjects showed much smaller suppression (or sometimes even small increments). A similar but accelerating trend is apparent during the nonstimulus component in both treatments, so that very few subjects show independently punishment contrast - the contrast effect instead seems to be a group effect rather than a consistent individual contrast effect. Fig.13 gives some visual indication of one subject's performance in all of the treatments. Although the acceleration trends in the non-stimulus component during Sp and AnSp are apparent, the suppression during the stimulus component is not so obvious. The above indicates that the "audience contrast effect" is not as strong or consistent as might be indicated by the significant statistical differences.

Second, the results of Phase 2 of the experiment suggest that it is difficult to obtain reliable punishment contrast with shock as the aversive stimulus under the conditions used. Again only 3 subjects ( $S_2$ ,  $S_3$ ,  $S_7$ ) showed some evidence of punishment contrast (at 0.4 mA, 0.4 mA, 0.1 mA respectively) (see Appendix F5). This difficulty in obtaining punishment contrast is surprising. It is possible that Phase 1 of the experiment might have affected performance during Phase 2, although any suggestion as to how this could

have operated must remain purely speculative. They may range from the administration and characteristics of the aversive stimuli during Phase 2 to the possibility of different species specific mechanisms operating in the case of pigeons, rats or humans.

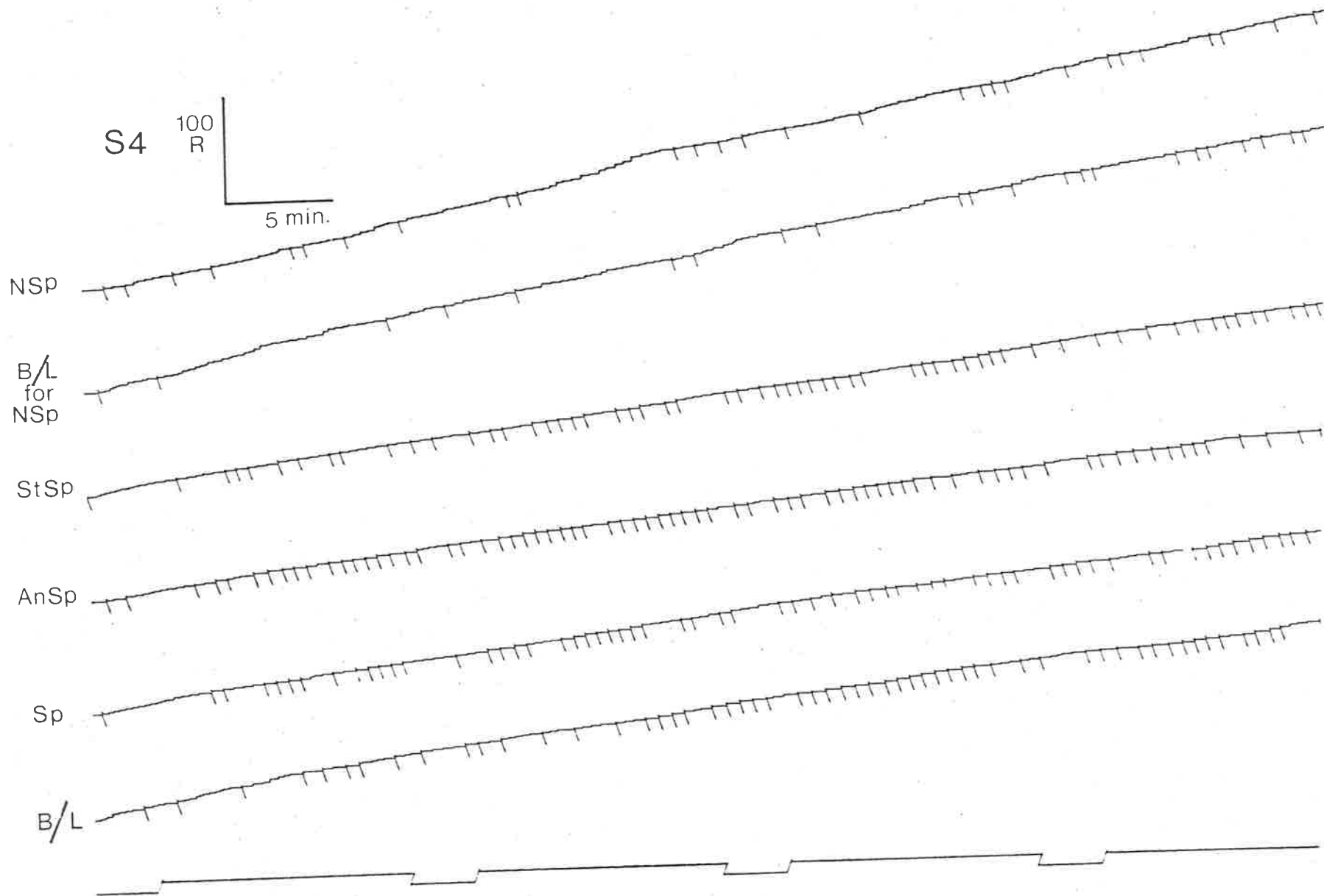


Fig. 13: Samples of cumulative records of  $S_4$  during Baseline and the Treatments in Experiment 7. The marker line at bottom indicates 3 min. periods constituting component 1 (lower lines) and 12 min. periods constituting component 2 (upper lines).

SUMMARY

An experiment is reported which attempted to determine if a spectator rat has aversive consequences for performance on a DRL30 food reinforced schedule by rat subjects. After baseline training, subjects underwent 4 treatments with retrieval of baselines between the treatments:

- (a) response contingent exposure to a rat spectator for 15sec.,
- (b) response contingent exposure to an anaesthetized rat for 15sec.,
- (c) response contingent exposure to a stuffed rat for 15sec.,
- (d) response contingent exposure to an "empty" spectator compartment for 15sec.

These treatments were given in one component ( $C_2$ ) of an alternating two component within session design, and were superimposed upon the DRL30 schedule, which was also in force during the other component ( $C_1$ ). The results showed contrast effects between the components in treatments (a) and (b), in which suppression of responding with a concomitant increase in efficiency was found in  $C_2$ , and acceleration of responding with a concomitant decrease in efficiency was found in  $C_1$ . Treatments (c) and (d) produced no significant performance changes. Similar contrast effects could be reproduced with shock as the contingent stimulus in three out of eight animals, the remainder showing suppression generalised to both components. These results were interpreted (with some reservations) as being consistent with the hypothesis that an audience is an aversive stimulus. The similarity of the results for treatments (a) and (b) suggests that the audience

effects cannot be explained by activity on the part of the spectator, and can also be used to argue against a competing social response theory.

## CHAPTER X

### GENERAL DISCUSSION

#### X.1. IMPLICATIONS FOR THE DRIVE/AROUSAL THEORY OF SOCIAL FACILITATION.

The major findings of the early experiments have important implications for the Drive theory of social facilitation. Recall that the first four experiments carried out were attempts to confirm predictions of summation of various sources of arousal, an audience stimulus being one such source according to the Drive Theory of social facilitation. While some of the data obtained tentatively seemed to support Zajonc's theory, there was not much support for the inverted U hypothesis. The results for Experiments 1 and 3 were considered to be more in accordance with a competing social response-arousal hypothesis. Where there was somewhat more control over subject and audience behaviour such as in Experiments 2 and 4, the Drive/arousal theory of social facilitation failed to be supported almost completely. These negative results must of course be limited to the experimental parameters which were used, but they seem to indicate that the theory may not be as widely applicable as is generally suggested. One of the revisions needed for the theory which seems to be suggested by the present experiments is the use of the general drive/arousal construct as a universal predictor of performance changes in the presence of an audience. Certainly the behavioural predictions of the



theories (both Zajonc's and the inverted U) did not survive these tests unscathed. As will be suggested later also (X.2), arousal changes (i.e. leading to quantitative behavioural shifts) have been shown not sufficient by themselves to accurately predict all possible behaviour changes in the presence of an audience. This is in addition to some of the complicating features of drive/arousal summation discussed in Chapter 6 (VI. 1). Similarly, the Spence-Hull basis of the theory, which has been the basis of the "irrelevant-drive" paradigm of social facilitation is in sore need of revision (see also X.4, paragraph 2). The results of Experiments 6 and 7, which have not used the ubiquitous "irrelevant-drive" design, show that fruitful and meaningful results may be obtained by response-contingency designs using operant - based technology. Yet the latter approach has not been reported in the literature with respect to behaviour changes with an audience (to the best of the author's knowledge).

## X.2. Competing Social Responses and Distraction as Possible Alternative Explanations for Audience Effects.

Especially where impairment in performance (or a reduction in response rates) is obtained, the initially plausible explanations of distraction and competing social responses should be considered in more detail. The competing social response explanation for some of the results of Experiments 1 and 3 has already been considered and tentatively accepted. This explanation seems to be particularly attractive whenever experimental conditions do not eliminate the

possibility of social interaction, such as orientation away from the manipulandum and towards the spectator, being responsible for the performance decrement. The same explanation however, cannot account for performance facilitation (or an increase in response rates) so that its generality is likely to be low.

Recently, Sanders & Baron (1975) have argued that distraction through drive-like properties can facilitate as well as impair performance. This counter-intuitive suggestion was made by these authors on the basis of their empirical findings that distracted subjects performed better than non-distracted subjects on a simple letter-copying task, but performed worse on a complex number-copying task. Although these results are consistent with those expected from an increment in general drive, several features of their methodology cast doubt on the authors' conclusion. First, the distracted group was instructed to raise their head and to briefly look at an "X" on the wall in front of them whenever an auditory distraction signal was given. The nondistracted group simply did the task without the visual and auditory stimulation. It might be quite reasonable to assume that the extra but task-unrelated stimulation increases the arousal level of the distracted subjects from what is known about, for example, the reticular formation's role in arousing the cortex. However, subjects' expectations that an (irregularly spaced) signal might be given at any time could also have produced a higher drive state - this was not present in the control group. The authors themselves admit that the distracted group's results might have been caused by

an element of "uncertainty", which may itself lead to greater stress. If the distraction were to be made more "certain", then habituation to the distracting stimuli may be expected, so that the increment in arousal may be nothing more than an initial novelty effect. Prevention of habituation, as the authors attempted, could easily prolong the novelty effect. Second, if one looks at the times which subjects spent at the tasks (10 trials of 40sec. each with an ITI = 10sec) it appears that habituation effects to the distracting stimulus may not have appeared yet, so that a novelty explanation cannot be ruled out. The meaningfulness of a distracting stimulus may likewise influence whether facilitation or impairment is obtained. A stimulus of low meaningfulness such as the one Sanders & Baron (1975) used might not be as distracting from task performance as a stimulus of high meaningfulness. Whether the social stimulus of the presence of another person is of high or low meaningfulness to a subject is probably dependent on the context of the situation and may vary with, for example, spectator status, evaluation apprehension by the subject, etc.

Furthermore, there is some evidence to suggest that although subjects may attend to distractors, there need be no effect on the performance of routine tasks. Waters (1979) has reported that subjects attended 95-100% of the time to a calculating task during baseline sessions. During experimental sessions, where powerful visual distractors in the form of bizarre and pornographic colour slides were presented subjects attended about 40% to the task, but no effect at all

was found on either the number of calculations correct or those completed.

If the "distracting" effects in the above studies are similar to novelty effects, then the present series of experiments need not seriously consider the distraction hypothesis much further. Sessions of relatively long periods were given, and in some of the experiments, many experimental treatment sessions were also given. Any effects on performance due to novelty should therefore have been habituated. Furthermore, some of the experiments (Experiments 6 and 7) included as part of the designs, treatments which attempted to test for novelty effects. In Experiment 6, the substitution of a bust of Augustus Caesar for a Professor was accompanied by a disappearance of the audience contrast effect. In Experiment 7, the inclusion of a stuffed rat treatment and a no rat treatment likewise did not produce contrast effects, although these were found in the spectator and anaesthetized spectator treatments.

The results of Experiment 7 seem also to discard a competing social response hypothesis. Whereas this explanation seems to be tenable in explaining some of the data in Experiments 1 and 3, it clearly has been eliminated by showing that the contrast effect in Experiment 7 is similar for both the spectator and the anaesthetized spectator treatments. It would be unreasonable to consider that competing social responses such as mutual sniffing and the touching of noses and limbs between the spectator and the subject are of a similar kind in both of the Sp and the AnSp treatments.

Although the data from Experiment 7 are inconsistent with a competing response explanation of the audience contingency effect obtained, the data from Experiments 1 and 3 seem to support it, at least partially, or in conjunction with arousal consequences from the electric shock (see e.g. Discussion of Chapter II). One consequence of the competing response explanation under this "irrelevant" drive paradigm is that responses occur (or are more probable) with an audience which are ordinarily (i.e. without an audience) less probable. These responses presumably include various social behaviours, attending to the audience, etc. This implies that the habit hierarchy may undergo changes with the presence of a spectator. A similar line of reasoning has been used by Rajecki et al (1975), who observed that qualitative rather than only quantitative response changes occurred in the presence of companions, strangers or alone, even though the subjects (chicks) had been deprived of food and were placed in a feeding situation so that pecking ought to have been the dominant response in all of the treatments. For example, distress calls increased with strangers but decreased with familiar companions, while food pecks decreased with strangers and increased with companions. These response shifts were interpreted as being consistent with alterations in the habit strengths rather than only arousal.

The data from Experiments 1 and 3 seem to also indirectly support such a contention, and generalise the effect to rats in a free-operant avoidance situation. The implication of all this is to again cast doubt upon the usefulness of the "irrelevant" drive paradigm in social facilitation research,

and to question the simple Zajonc's theory which deals only with arousal changes (i.e. quantitative response shifts) and does not consider competing responses elicited by audience or social stimuli. Where there is greater experimental control over stimulus conditions such as in Experiment 4 and with human studies in general, there would initially appear to be less possibility of competing responses being elicited by the audience. Although the results of the audience treatment in Experiment 4 are characterised by their nonsignificance and hence support this possibility, it should be remembered that alterations in hierarchies of covert behaviours such as various cognitive activities (e.g. thinking about the audience) may also be elicited. The latter of course, are somewhat more difficult to measure! It would also seem more likely that, in the case of human subjects, covert response hierarchies would change rather than overt response hierarchies, because given typical experimental demand characteristics, subjects would no doubt feel constrained with respect to overt responses other than those required by the experimental task. Tapping covert responses is often done by questionnaires, rating scales, etc. As these methods rely upon retrospective self-reports by subjects, they would appear to be less than adequate for the purposes of determining variations in strength of competing covert responses.

### X.3. The Role of Species Differences in Audience Effects.

The social facilitation effect is postulated to occur as a result of the presence of at least one member of the

same species. Although it may be somewhat premature to ask whether the effect will also occur if a member of a different species is present (for example a human and a dog), an affirmative answer would have implications about the underlying mechanism. It could, for example, question explanations relying upon constructs such as evaluation apprehension and social status as these seem limited to the human species. Of course it is not inconceivable that the presence of a member of a different species may, under certain circumstances, raise the arousal level of an organism (for example, a human with a dangerous dog), but these situations may probably be satisfactorily accounted for by Cottrell's (1972) suggestion that arousal levels can be raised by anticipating negative outcomes for the subject. If Zajonc's (1972b) reason as to why arousal increments occur in situations with conspecifics seems acceptable (he suggests that social stimuli are less predictable than physical stimuli - hence they generate states of greater alertness and preparedness), then there does not seem any obvious a priori reason to reject it with interspecies social situations. Until some evidence is collected however, this suggestion must remain merely conjecture.

Although evaluation apprehension may be used to explain some human data, it is difficult to see how it could be used to explain the wealth of animal data on social facilitation. High status (social, academic, etc.) of an audience, however, may have its analogy in dominance hierarchies in species where these are known to occur. Both the status /dominance and evaluation apprehension factors can be used in conjunction

with the Cottrell theory that the subject anticipates positive or negative outcomes from the encounter with the audience.

The choice of response to study in social facilitation tasks seems often to be determined by measures which are convenient, although these may not always reflect equally well motivational states. Pecking in chickens, for example, is the response usually studied in relation to social facilitation, although there is evidence that it occurs during grooming, exploring, aggressing, courting, as well as feeding (Feehes, 1972). Pecking therefore appears to be a general response which is not linked to any particular motivational state. Accordingly, responses which have a lower probability of occurrence may be more suitable as a response measure. Rajecki et al (1976) have used a drinking response to such ends and shown social facilitation, even though the response is infrequent.

Both Sidman avoidance and DRL schedules have been shown to be sensitive to motivational changes (see Chapter I for Sidman avoidance; Kramer & Rilling, 1970, for DRL). Performance on Sidman avoidance by humans shares the wide variability in response rates usually found in rats. This was confirmed by the findings of Experiments 1, 2, and 3. One probable reason for this species generality is the schedule's low (shock or money) stimulus control over the response and this was one reason for switching to a schedule in which the delivery of reinforcers assumed more control over the response. It is not possible to make comparisons between rats and humans for social facilitation on Sidman avoidance



as no audience effect was obtained with the humans.

However, some comparisons may be made of the audience effects on the DRL schedules. Before this is done, baseline DRL training and performance may be compared between the two species. Humans learned the requirements of a DRL60 schedule very quickly (usually to about 75% efficient performance in 2 or 3 45 min. sessions) in Experiments 5 and 6. This confirms earlier findings on human DRL performance by e.g. Dews & Morse (1958). The rats on the other hand took about 75 hourly sessions to reach stable mean response rates with some subjects still performing after this training with low efficiency in Experiment 7. Pigeons perform (key pecking) often at even lower efficiencies still (e.g. Holz et al, 1963). It is not immediately obvious what causes these interspecies learning differences, although some rationale seems required. One theory of DRL performance is that the response is mediated by collateral behaviours (Kramer & Rilling, 1970). These behaviours are believed to bridge the time interval between a response and the (delayed) reinforcer, and are used as controlling stimuli ( $S_D$ ) for subsequent behaviour. The mediating behaviours often develop as defined response chains (Holz et al, 1963) or as some repetitive activity (Mechner & Latranyi, 1963), which are maintained through conditioned (secondary) reinforcement. Why then, do these interspecies differences occur? Evidence provided by subject's answers to the post experimental question asking subjects to indicate their response strategies in Experiments 5 and 6 (see Appendices D and E5) shows that humans have a distinct

advantage over rats and pigeons. Most human subjects used a counting and/or monitoring their own pulse procedure, to both determine the minimum time interval required for reinforcement and thence maximise reinforcement. Some rat subjects in Experiment 7 on the other hand, were informally observed to develop gradually idiosyncratic mediating behaviour chains such as moving away from the bar after a response, grid floor biting, etc. Some rat subjects did not appear to show any systematic mediating behaviours. The answer to the earlier question as to why differences in efficiency occur between the two species could be that humans are better at the development of efficient mediating behaviours which more accurately bridge the required time interval between responses.

A second possible explanation why differences in efficiency occur between humans and infrahuman species is, of course, the existence of language in the former. This is possibly the most crucial of the differences considered, and gives humans clearly an advantage. The effective symbolic activity of counting, in order to measure the required IRTs, which has been found to constitute most human mediating behaviour, is part of a language system.

In view of these explanations, it seems surprising that (to any extent at all) similar contrast effects were found in Experiments 6 and 7 when an audience stimulus was made contingent upon responding in the stimulus component. The possibility that the presentation of an audience might upset DRL responding by interfering with the mediating behaviour requires performance to be impaired during the stimulus

components. Table 8.8 shows that this did occur, although only with Professor 1, for the human subjects in Experiment 6. It is difficult to understand though, why there was no impairment in performance during the stimulus components as a result of exposure to Professor 2. If interference with the mediating behaviour is predicted, then there is no reason to suggest that this is confined to one particular audience. However, if a difference in the nature of the audience stimulus (aversive vs. appetitive) is suggested, the observed results tend to be consistent with this explanation. Moreover, the results of Experiment 5A show that similar suppression of responding could be obtained fairly reliably with response cost, a known aversive stimulus. It is difficult to conceive of interference of mediating behaviour under these conditions. Similarly, it is difficult to explain acceleration of responding during the nonstimulus components according to the interference with mediation hypothesis - a slow return to baseline levels might be more appropriate, yet this was rarely obtained. With rats' performance in Experiment 7, where an overall punishment contrast effect was obtained a similar argument can be made against the interference of mediating behaviour. Again, the fact that almost identical results were obtained in the spectator and the anaesthetized spectator treatments, yet no effect was obtained in the stuffed spectator treatment, argues against an interference hypothesis.

Even in Experiment 7, not all rats showed punishment contrast - some animals showed a behavioural contrast effect

similar to that obtained by human subjects to Professor 2 in Experiment 6. The implication is that for these (rat) subjects, the audience appeared to be a appetitive rather than aversive stimulus. It is not clear what factors determine which of these alternatives will be observed. It is also not immediately apparent why Professor 1 was perceived as and gave rise to data as if he were an aversive stimulus, and Professor 2 as if he were an appetitive stimulus. Examination of Figs. 8 and 9 gives rise to some intuitive possibilities - for example, Professor 1 (Fig. 9) appears more "severe" and "austere", somewhat "older" and "balder" than Professor 2 (Fig. 8). It is also always possible that Professor 1 may have given rise to greater evaluation apprehension because of some of these factors, although it is not immediately apparent how these factors may have operated. There was no apparent difference in the behaviour of the audiences (see Appendix E2 for instructions to audiences) - both maintained gaze and eye contact whenever the subject chose to observe the audience during the "open-curtain" periods. Maintenance of eye contact itself should have proved an aversive part of the audience exposure to subjects, (Argyle, 1975), yet this was not the case with Professor 2. There is, however, a possibility that the two Professors conveyed other kinds of social information through slight differences in body posture, facial expression or even in attire. It is possible to think that similar principles could operate for the different rat spectators (although it is again difficult to see how an anaesthetized spectator could give rise to social cues of this kind), but for the complicating human capacity of language.

Language, as has already been suggested, is in many ways an advantageous feature of humans. In addition to the usual descriptive symbolic meaning associated with words, verbal labels with emotional significance also often accompany words. For example, on reading the word "Professor" on the audience's name tag, associated emotional labels might be "threatening" or "aloof" (or the labels suggested earlier in the previous paragraph). Although this clearly is not the whole story with respect to Professor differences in the audience effect, it does suggest a fundamental species difference with respect to rats or other infrahuman species. For example, conspecific rats may be more meaningfully perceived as potential dominance rivals, aggressors or mates, rather than as an "audience", by subject rats. The words "audience" and "spectator" seem to have distinctly human symbolic meaning, and one may well question how much of this can be generalised meaningfully to other species, and how much is merely anthropomorphism.

There probably is no such stimulus as the "mere presence" of a human spectator in a task situation in two distinct senses : (a) a task spectator will normally always be perceived to have some evaluative stance, and (b) the spectator will usually exhibit some social behaviour (even if it is merely looking at the subject) which may be classed as some kind of social interaction. The latter will no doubt be mediated by nonverbal cues which may be interpreted by the subject in a variety of ways, adjusting his task behaviour in accordance with these interpretations. Whether such an analysis can also apply to species other than humans remains similarly speculative. What does seem obvious in

this respect, is that different sense modalities will figure as primary signalling and recognition systems. With humans, visual information is traditionally regarded as being of prime importance. With rats, auditory and olfactory information is now generally regarded as being of greater importance in social communication than visual information (Barnett, 1976, p.192). With the auditory and olfactory masks provided in Experiment 7, the similarity between its findings and those of Experiment 6 is all the more surprising. (One weakness here is that no independent checks of the effectiveness of these masks were made).

Social behaviour in a species is a function of the species' sociability. In lower species, social behaviour, like other behaviour, is often determined by Fixed Action Patterns or other species-specific stereotyped behaviour resulting from particular environmental sign stimuli. In mammalian species, social behaviours are much more variable : cultural (learned) factors become much more important in their determination. Sociability then, clearly varies across species, and it seems reasonable to expect spectator audience effects to do likewise on a "sociability dimension" (which should be regarded as rather crude and hypothetical). Spectator/audience effects would be expected to be minimal or nonexistent in species where recognition systems are crude and undifferentiated and where social behaviour is not evolutionary advantageous (single-celled organisms are an example). They would be expected to become more important where activities such as sexual reproduction and group

behaviours become species advantageous (e.g. fish and birds). With mammals, social behaviour becomes much more important in the sense of rearing young, affiliation and intraspecific aggression which optimally make use of the environment. Within mammalia, sociability may also vary from e.g. herd animals to animals which come together only to mate. Even within particular mammalian species, variations in sociability occur due to seasonal factors, reproduction cycles, availability of natural resources, etc. The implication of this with respect to the nature of a spectator stimulus is that it may at times be perceived as aversive (e.g. as a rival) or sometimes as appetitive (e.g. as a herd leader,) depending on various combinations of these factors. Although these situations do not immediately indicate a "pure" social facilitation effect, questions may be asked whether this can ever be obtained separately under "natural" conditions.

A final point can be made with respect to the importance of the question of the aversive/appetitive nature of an audience. Many intraspecific social learning situations depend on processes such as modeling, imitation, etc. While these mechanisms are in themselves different from a straight audience situation, they would seem to be advantageous in an evolutionary sense. However, if observation by an audience is inherently (or in some other way) aversive, one would not expect the model(s) to remain under observation for very long! Hence, a "pure" social facilitation situation is probably seldom attained in the field (it is difficult enough to attain it in the laboratory), so that it must be seen in conjunction with many other processes which may lead to rewards and punishments.

#### X.4. Implications for Future Theorization and Research.

Several important features about social facilitation research seem to have emerged from experiments reported here.

First, it is time for the Hullian basis of the drive theory of social facilitation to be revised or even rejected. It is true that neo-Hullians such as Spence and Miller have, with some success carried out revision exercises of Hull's theories. Nevertheless, it may be more appropriate to carry out more descriptive analyses of the audience effect with Skinnerian methods and along lines advocated by Argyle (1975, 1969), rather than rely upon too many intervening constructs such as drive, apprehension, etc. Skinnerian methodology provides for drawing strong inferences about the causal nature of a few number of variables under tightly controlled experimental conditions. Yet, in spite of these apparently limiting features, operant methodology has proved to be an extremely powerful technique in many applied, real-life areas such as in managing behaviour in institutions, therapy and the development of physical and social skills. The nature of social stimuli may be further investigated usefully by response-contingencies (that is, by their effects on performance) and the establishment and ontogeny of these. More is becoming known about interactions of various reinforcers and schedules (contrast effects fall into the latter category), so that social stimuli can be studied in conjunction with other stimuli (physical or social), to guard against simplistic isolation of these variables.

Argylian descriptive methods for studying social stimuli



seem to provide also a useful methodology for further exploration of the audience effects. For example, Argyle (1969) lists several elements making up social interaction, which may prove to be important in the determination of audience effects: proximity and orientation; posture; physical appearance; facial and gestural movements; direction of gaze, etc. This technique has the appealing features of providing noninterpretive descriptions of behaviour which are also enjoyed by operant methodology.

Second, the aversive/appetitive nature of an audience should be investigated further, possibly along the lines advocated above. For example, the use of paradigms other than those of contrast may be used, since controls for the latter are difficult to effect and its interpretations are sometimes equivocal. Possible paradigms include those of avoidance (discriminated as well as nondiscriminated techniques) and escape whereby the purported aversiveness of an audience may be more directly tested. Another promising line of research appears to be with the use of the conditioned suppression paradigm. This line of research has already been commenced by Reiter & DeVellis (1976) who used a conditioned emotional response paradigm with human subjects. They first paired a human with an aversive event before subjects were asked to perform a simple repetitive task. The introduction of the person at one point in the task while the subject was doing the task showed up in a considerable suppressive effect on performance which disappeared when the person left the room. Although the experimental creation of an aversive situation (embarrassment) was relatively

unambiguous, its clearcut results support the possibility of using an audience stimulus in a similar paradigm. (N.B. A control group used by Reiter & DeVellis ruled out a distraction hypothesis, although novelty effects were not controlled).

Investigation of the aversive/appetitive variable of an audience stimulus may also proceed by taking more systematic observations of subject social behaviour during exposure to an audience. For example, Lalljee (1978) has recently found that the amount of gaze in a social interaction increases with a high scores on a "pleasantness" dimension of emotions in a similar way as it increases with high scores on a "liking" dimension (Exline & Winters, 1965). There is also some evidence that "liked" spectators may facilitate performance, but that "disliked" spectators do not (Matthews, 1969). These dimensions appear to have some similarities with an "appetitiveness" characteristic (and hence "aversiveness"), so that its investigation (with human subjects at least) may proceed along similar paths.

It may be too much to ask social facilitation research and theory to retain and develop its basic tenets with high interspecies generality. Certainly, judging from recent literature, theories and research seem to be becoming less so (e.g. Innes & Young, 1975; Rajcecki et al, 1976; Shaver & Liebling, 1976). This may be the long way to a parsimonious understanding of social facilitation - there are many gregarious species and it would be very surprising if, in the end, they all operated along vastly different mechanisms. This is the real reason why Zajonc's theory, weaknesses as it

has, was such an important pointer on the road towards a scientific theory of social facilitation. However, its major weakness stands out very markedly - the present series of experiments illustrates this well. This is, paradoxically, the very high generality of the Drive theory of social facilitation's central construct : the construct of general drive/arousal.

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# APPENDIX A : Experiment 1.

## A1 : Baseline<sup>1</sup> Comparisons in Expt. 1

|                 | RR                                       |       | SR              |       | S/R <sup>2</sup> |       | E             |       |
|-----------------|------------------------------------------|-------|-----------------|-------|------------------|-------|---------------|-------|
|                 | 0.5mA                                    | 2.0mA | 0.5             | 2.0   | 0.5              | 2.0   | 0.5           | 2.0   |
| S <sub>1</sub>  | 6.15                                     | 5.64  | 0.378           | 0.308 | 0.062            | 0.056 | 0.128         | 0.098 |
| S <sub>2</sub>  | DECEASED Session 123 : No 2.0mA baseline |       |                 |       |                  |       |               |       |
| S <sub>3</sub>  | 4.39                                     | 5.33  | 0.434           | 1.050 | 0.101            | 0.187 | 0.116         | 0.334 |
| S <sub>4</sub>  | 5.12                                     | 5.12  | 0.136           | 0.122 | 0.014            | 0.012 | 0.040         | 0.037 |
| S <sub>5</sub>  | 4.15                                     | 5.29  | 0.760           | 0.419 | 0.073            | 0.151 | 0.196         | 0.127 |
| S <sub>6</sub>  | 3.64                                     | 3.02  | 0.191           | 0.277 | 0.095            | 0.091 | 0.041         | 0.058 |
| S <sub>7</sub>  | 3.56                                     | 2.74  | 0.710           | 0.317 | 0.065            | 0.116 | 0.160         | 0.063 |
| S <sub>8</sub>  | 4.30                                     | 7.80  | 0.750           | 0.183 | 0.037            | 0.035 | 0.196         | 0.075 |
| S <sub>9</sub>  | 4.28                                     | 3.92  | 0.845           | 0.354 | 0.023            | 0.077 | 0.221         | 0.064 |
| S <sub>10</sub> | 3.13                                     | 6.63  | 3.210           | 2.300 | 1.323            | 0.340 | 0.723         | 0.790 |
| S <sub>11</sub> | 2.67                                     | 4.91  | 0.908           | 0.411 | 0.076            | 0.169 | 0.183         | 0.118 |
| S <sub>12</sub> | 2.35                                     | 3.54  | 2.650           | 0.800 | 0.890            | 0.377 | 0.462         | 0.183 |
| $\bar{X}$       | 3.98                                     | 4.90  | 1.00            | 0.59  | 0.251            | 0.146 | 0.224         | 0.177 |
| S               | 1.04                                     | 1.46  | 0.95            | 0.60  | 0.41             | 0.12  | 0.19          | 0.21  |
|                 | $t_{10}=1.94^*$                          |       | $t_{10}=2.13^*$ |       | $t_{10}=1.03$    |       | $t_{10}=1.24$ |       |

\*  $p < 0.05$  (1-tailed)

### (Footnotes)

1. The 0.5mA baselines measures do not correspond exactly with those in Tables 2.1. and 2.2 (Chapt. 2), since they were taken towards the end of the experiment and some permanent changes in responding had occurred.
2. The shock to response ratios do not correspond exactly with substitution in the formula  $\frac{SR}{RR}$ , because the baseline response rates were within 10% of the actual response rates.

A2 : Summary of analysis of variance for data in  
Table 2.3 (response rate changes) in Experiment 1.

| Source             | df | MS      | F     |
|--------------------|----|---------|-------|
| Between Subjects   |    |         |       |
| Response Level (A) | 2  | 11580.0 | 1.45  |
| Sequence (B)       | 3  | 2090.0  | <1    |
| Error (AB)         | 6  | 7972.9  |       |
| Within Subjects    |    |         |       |
| Treatments (C)     | 3  | 8209.2  | 8.81* |
| A X C              | 6  | 1779.8  | 1.91  |
| B X C              | 9  | 889.1   | <1    |
| Error (A X B X C)  | 18 | 931.4   |       |

\*  $p < 0.001$

A3 : Summary of analysis of variance for data in  
Table 2.4 (shock rate changes) in Experiment 1.

| Source             | df | MS      | F       |
|--------------------|----|---------|---------|
| Between Subjects   |    |         |         |
| Response Level (A) | 2  | 4310.7  | 1.12    |
| Sequence (B)       | 3  | 13960.0 | 3.64    |
| Error (AB)         | 6  | 3839.7  |         |
| Within Subjects    |    |         |         |
| Treatments (C)     | 3  | 30237.0 | 44.04** |
| A X C              | 6  | 3141.0  | 4.57*   |
| B X C              | 9  | 1586.9  | 2.31    |
| Error (ABC)        | 18 | 686.6   |         |

\*  $p < 0.01$

\*\*  $p < 0.001$

A4 : Summary of analysis of variance for data in  
Table 2.5 (shock to response ratio changes) in  
Experiment 1.

| Source             | df | MS      | F      |
|--------------------|----|---------|--------|
| Between Subjects   |    |         |        |
| Response Level (A) | 2  | 5782.0  | 1.12   |
| Sequence (B)       | 3  | 9050.9  | 1.75   |
| Error (AB)         | 6  | 5170.8  |        |
| Within Subjects    |    |         |        |
| Treatments (C)     | 3  | 28086.0 | 17.28* |
| A X C              | 6  | 3252.6  | 2.00   |
| B X C              | 9  | 1297.3  | <1     |
| Error (ABC)        | 18 | 1625.6  |        |

\*  $p < 0.001$

A5 : Summary of analysis of variance for data in  
Table 2.6 (efficiency index changes) in Experiment 1.

| Source             | df | MS      | F       |
|--------------------|----|---------|---------|
| Between Subjects   |    |         |         |
| Response Level (A) | 2  | 6925.1  | 1.59    |
| Sequence (B)       | 3  | 15272.0 | 3.50    |
| Error (AB)         | 6  | 4359.1  |         |
| Within Subjects    |    |         |         |
| Treatments (C)     | 3  | 21314.0 | 11.05 * |
| A X C              | 6  | 2645.1  | 1.37    |
| B X C              | 9  | 1725.5  | < 1     |
| Error (ABC)        | 18 | 1928.6  |         |

\*  $p < 0.001$



APPENDIX B : Experiment 3.

B1 : Mean Defecation (no. boluses) and Mean Latency (sec)  
measures in Experiment 3.

| High Scorers |                |                |                |                | Low Scorers |                |                |                |                |
|--------------|----------------|----------------|----------------|----------------|-------------|----------------|----------------|----------------|----------------|
| Rat No.      | D <sub>1</sub> | D <sub>2</sub> | L <sub>1</sub> | L <sub>2</sub> | Rat No.     | D <sub>1</sub> | D <sub>2</sub> | L <sub>1</sub> | L <sub>2</sub> |
| 21           | 3.0            | 2.7            | 1.3            | 9.0            | 39          | 0              | 0              | 3.7            | 21.7           |
| 42           | 5.7            | 6.0            | 16.3           | 16.0           | 69          | 0              | 0.7            | 2.0            | 11.3           |
| 46           | 2.3            | 3.3            | 19.0           | 81.7           | 102         | 0              | 1.7            | 1.3            | 13.3           |
| 47           | 3.3            | 4.7            | 6.0            | 51.7           | 146         | 0              | 1.3            | 1.0            | 11.0           |
| 54           | 4.0            | 3.7            | 7.7            | 20.7           | 158         | 0              | 1.0            | 3.0            | 10.3           |
| 90           | 3.3            | 3.3            | 31.0           | 3.7            | 163         | 0              | 0              | 1.3            | 17.0           |
| 93           | 3.7            | 3.0            | 9.0            | 30.0           | 173         | 0              | 1.3            | 1.0            | 15.0           |
| 180          | 2.7            | 5.3            | 9.3            | 5.3            | 199         | 0              | 0              | 1.0            | 22.7           |
| Means        | 3.5            | 4.0            | 12.5           | 27.3           |             | 0              | 0.8            | 1.8            | 15.3           |

D<sub>1</sub> : mean defecation scores in Test Period 1

D<sub>2</sub> : mean defecation scores in Test Period 2

L<sub>1</sub> : mean latency scores in Test Period 1

L<sub>2</sub> : mean latency scores in Test Period 2

B2 : Baseline and Audience treatment measures in Experiment 3

|     | B/Line |       | Aud  |      | B/Line |       | Aud   |       | B/Line |  | Aud |  | B/Line |  | Aud |  |
|-----|--------|-------|------|------|--------|-------|-------|-------|--------|--|-----|--|--------|--|-----|--|
| Ss  | RR     | RR    | SR   | SR   | S/R    | S/R   | E     | E     |        |  |     |  |        |  |     |  |
| 21  | 5.32   | 5.57  | 0.91 | 1.13 | 0.170  | 0.205 | 0.278 | 0.355 |        |  |     |  |        |  |     |  |
| 42  | 2.86   | 2.86  | 1.32 | 1.44 | 0.460  | 0.530 | 0.267 | 0.288 |        |  |     |  |        |  |     |  |
| 46  | 3.26   | 2.96  | 1.37 | 1.34 | 0.423  | 0.454 | 0.300 | 0.277 |        |  |     |  |        |  |     |  |
| 47  | 3.79   | 3.47  | 0.47 | 0.77 | 0.128  | 0.223 | 0.106 | 0.175 |        |  |     |  |        |  |     |  |
| 54  | 4.73   | 4.88  | 1.16 | 1.13 | 0.246  | 0.223 | 0.326 | 0.331 |        |  |     |  |        |  |     |  |
| 90  | 4.49   | 5.36  | 0.61 | 0.37 | 0.136  | 0.072 | 0.164 | 0.112 |        |  |     |  |        |  |     |  |
| 93  | 5.05   | 5.72  | 0.99 | 1.08 | 0.196  | 0.188 | 0.293 | 0.348 |        |  |     |  |        |  |     |  |
| 180 | 3.89   | 3.99  | 0.48 | 0.51 | 0.124  | 0.127 | 0.118 | 0.126 |        |  |     |  |        |  |     |  |
| 39  | 7.63   | 6.24  | 0.70 | 1.04 | 0.092  | 0.174 | 0.278 | 0.356 |        |  |     |  |        |  |     |  |
| 69  | 4.30   | 4.07  | 1.53 | 1.50 | 0.356  | 0.371 | 0.398 | 0.379 |        |  |     |  |        |  |     |  |
| 102 | 6.22   | 5.78  | 0.96 | 1.20 | 0.153  | 0.208 | 0.362 | 0.391 |        |  |     |  |        |  |     |  |
| 146 | 7.30   | 4.54  | 1.95 | 2.75 | 0.272  | 0.641 | 0.753 | 0.745 |        |  |     |  |        |  |     |  |
| 158 | 3.95   | 4.54  | 1.41 | 1.15 | 0.361  | 0.261 | 0.310 | 0.284 |        |  |     |  |        |  |     |  |
| 163 | 5.59   | 4.87  | 1.15 | 1.80 | 0.209  | 0.381 | 0.361 | 0.509 |        |  |     |  |        |  |     |  |
| 173 | 4.03   | 3.98  | 1.29 | 1.35 | 0.320  | 0.342 | 0.323 | 0.337 |        |  |     |  |        |  |     |  |
| 199 | 7.77   | 11.25 | 1.23 | 0.77 | 0.159  | 0.085 | 0.500 | 0.400 |        |  |     |  |        |  |     |  |

B/Line

Aud

Comps.

$t_{15}=0.02$

$t_{15}=1.41^*$

$t_{15}=1.59^*$

$t_{15}=1.16$

\*  $p<0.10$  (2-tailed)

RR = Mean response rates

SR = Mean shock rates

S/R = Mean shock to response ratios

E = Mean efficiency of avoidance index scores

Experiment 4

|        | B/Line | Aud   | B/Line | Aud   | B/Line | Aud    | B/Line   | Aud   | B/Line           | Aud              |
|--------|--------|-------|--------|-------|--------|--------|----------|-------|------------------|------------------|
| Ss     | RR     | RR    | RftR   | RftR  | RfdIRT | RfdIRT | UnrfdIRT |       | E <sub>DRL</sub> | E <sub>DRL</sub> |
| 1      | 0.556  | 0.466 | 0.428  | 0.433 | 120.5  | 126.4  | 45.0     | 75.0  | 0.770            | 0.928            |
| 2      | 0.559  | 0.367 | 0.363  | 0.333 | 152.5  | 153.8  | 43.5     | 91.5  | 0.683            | 0.909            |
| 3      | 1.375  | 1.483 | 0.309  | 0.317 | 120.8  | 118.4  | 15.8     | 16.4  | 0.226            | 0.213            |
| 4      | 0.659  | 0.417 | 0.348  | 0.317 | 128.7  | 176.9  | 22.8     | 37.2  | 0.546            | 0.760            |
| 5      | 0.487  | 0.533 | 0.426  | 0.483 | 126.6  | 112.0  | 78.0     | 62.3  | 0.875            | 0.906            |
| 6      | 0.439  | 0.417 | 0.417  | 0.417 | 140.3  | 142.8  | 28.5     | 28.5* | 0.962            | 1.000            |
| 7      | 0.478  | 0.450 | 0.398  | 0.400 | 156.4  | 139.1  | 93.4     | 61.0  | 0.820            | 0.889            |
| 8      | 0.517  | 0.483 | 0.433  | 0.467 | 112.3  | 120.8  | 93.0     | 92.0  | 0.836            | 0.966            |
| 9      | 0.457  | 0.400 | 0.368  | 0.333 | 150.6  | 162.6  | 79.0     | 87.0  | 0.816            | 0.833            |
| 10     | 0.570  | 0.550 | 0.451  | 0.450 | 112.2  | 121.9  | 92.5     | 43.5  | 0.796            | 0.818            |
| 11     | 0.595  | 0.517 | 0.457  | 0.416 | 118.7  | 132.2  | 56.2     | 49.0  | 0.772            | 0.807            |
| 12     | 0.500  | 0.496 | 0.437  | 0.496 | 121.2  | 121.0  | 92.0     | 92.0* | 0.874            | 1.000            |
| 13     | 0.416  | 0.466 | 0.337  | 0.466 | 160.1  | 127.4  | 75.8     | 75.8* | 0.809            | 1.000            |
| 14     | 0.604  | 0.583 | 0.426  | 0.450 | 109.7  | 112.6  | 75.0     | 78.3  | 0.710            | 0.771            |
| 15     | 0.391  | 0.500 | 0.305  | 0.433 | 146.5  | 128.8  | 43.5     | 76.0  | 0.765            | 0.867            |
| 16     | 1.893  | 1.933 | 0.410  | 0.416 | 143.2  | 123.6  | 7.1      | 4.8   | 0.221            | 0.216            |
| Means  | 0.650  | 0.628 | 0.395  | 0.414 | 132.5  | 132.5  | 58.8     | 60.6  | 0.718            | 0.805            |
| Comps. | t=1.15 |       | t=1.52 |       | t=0.09 |        | t=0.31   |       | t=4.48**         |                  |

\* Since there were no unreinforced responses, values are taken as baseline values

\*\*  $p < 0.001$

APPENDIX D : Experiment 5

D1 : Subject's answers to Question : "What strategies did  
you use to respond?" in Experiment 5A.

| Subject         | Last B/Line Session                                                                                       | Experimental Session                                                                                               |
|-----------------|-----------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|
| S <sub>1</sub>  | Counted to 100 at first, then progressively lowered count.                                                | Attempted longer intervals, then shorter intervals.                                                                |
| S <sub>2</sub>  | Count to 55 - 65                                                                                          | Started with 60 counts - progressed every 10 units up to 120 - then went back to 60 by units of 5.                 |
| S <sub>3</sub>  | Counted up to about 24                                                                                    | Counted to 23                                                                                                      |
| S <sub>4</sub>  | Counting to 150, then down to 117.                                                                        | Tried (as in B/Line) first. Then tried larger numbers (progressively) to 500.                                      |
| S <sub>5</sub>  | Counted to 60, then proceeded to go down in groups of 10's, then 5's then 1's.                            | Counted at random                                                                                                  |
| S <sub>6</sub>  | Constant length between responses.                                                                        | Lengthened and shortened time between responses.                                                                   |
| S <sub>7</sub>  | Leaving the switch a certain time.                                                                        | None really.                                                                                                       |
| S <sub>8</sub>  | Systematically decreased time interval to find constant (minimum) time needed.                            | Waited random allotments of time.                                                                                  |
| S <sub>9</sub>  | Started at a successful time, then reduced by a little until no response from meter. Used pulse at times. | Counting. Not searching to beat red light in case all would be lost - just wait for period when it would not show. |
| S <sub>10</sub> | Counting to 60                                                                                            | Tried counting to 120 or hitting lever twice after counting to 60.                                                 |
| S <sub>11</sub> | Counting to 60 seconds by picturing a clock in my head.                                                   | Counting to 120, 90, etc.                                                                                          |

(Continued...)

| Subject         | Last B/Line Session                                                                                        | Experimental Session                                                                                        |
|-----------------|------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| S <sub>12</sub> | Trying to reduce time between responses to a minimum once I had found one time interval around 40 seconds. | Many different time intervals tried.                                                                        |
| S <sub>13</sub> | I said the alphabet backwards and forwards to work the time out (approximately 60 secs.)                   | Same as yesterday (i.e. last B/Line session).                                                               |
| S <sub>14</sub> | Waited for approximately 25 seconds.                                                                       | I waited for a long amount of time, about 40 seconds.                                                       |
| S <sub>15</sub> | Counting to approximately 96.                                                                              | Waiting longer periods and trying to respond only in a frequency band where the red light wasn't operating. |
| S <sub>16</sub> | Time interval of 60 counts.                                                                                | Nothing seemed to work, so in the end I was just pressing at random.                                        |
| S <sub>17</sub> | Press down at 90 sec. intervals.                                                                           | Waited for longer intervals - up to 5 mins. Tried shorter time intervals.                                   |
| S <sub>18</sub> | Counted 40 between responses (about 60 seconds).                                                           | Counted time about one minute - when negative response stopped pressing lever.                              |

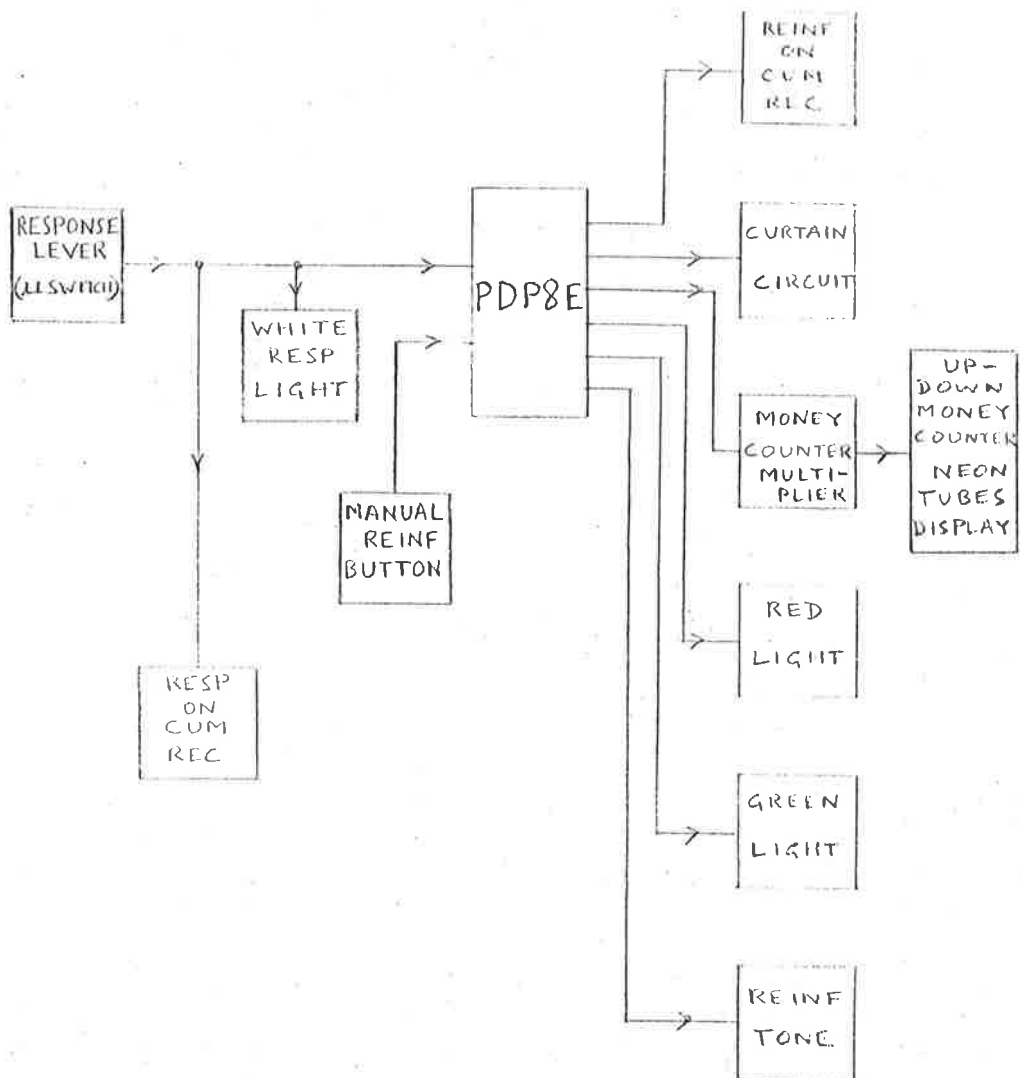
D2 : Subjects' answers to Question : "What strategies did  
you use to respond?" in Experiment 5B.

| <u>Subject</u> | <u>Last B/Line Session</u>                                    | <u>Last Experimental Session</u>                                                                                                                            |
|----------------|---------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| S <sub>1</sub> | (Data Lost)                                                   | Counting between 90, gradually increased to 130 - there seemed to be alternating sequences of 3 or 4 additions and 8 or 9 subtractions.                     |
| S <sub>2</sub> | Counted fast for 20 groups of 10 - used fingers to keep track | When red light on for first time I experimented - other times I did not respond when it came on.                                                            |
| S <sub>3</sub> | Waited for 70 - 75 secs, then responded.                      | First 4 presses with 70 sec. Then tried longer times 150 - 200 secs. - but still lost money - Then went back to 70 secs. and no losses - Then losses again. |
| S <sub>4</sub> | Used pulse & finger tapping to measure 50-60 sec.             | No red light indicated I could respond at 1 press / min. Red light indicated I could not respond at any frequency.                                          |
| S <sub>5</sub> | Counted slowly to 30.                                         | If respond during first 5 mins. then gain money after 30 secs. Then 10 mins, when lose money. Etc.                                                          |
| S <sub>6</sub> | (Data Lost)                                                   | Responded only when red light was off.                                                                                                                      |

## APPENDIX E : Experiment 6

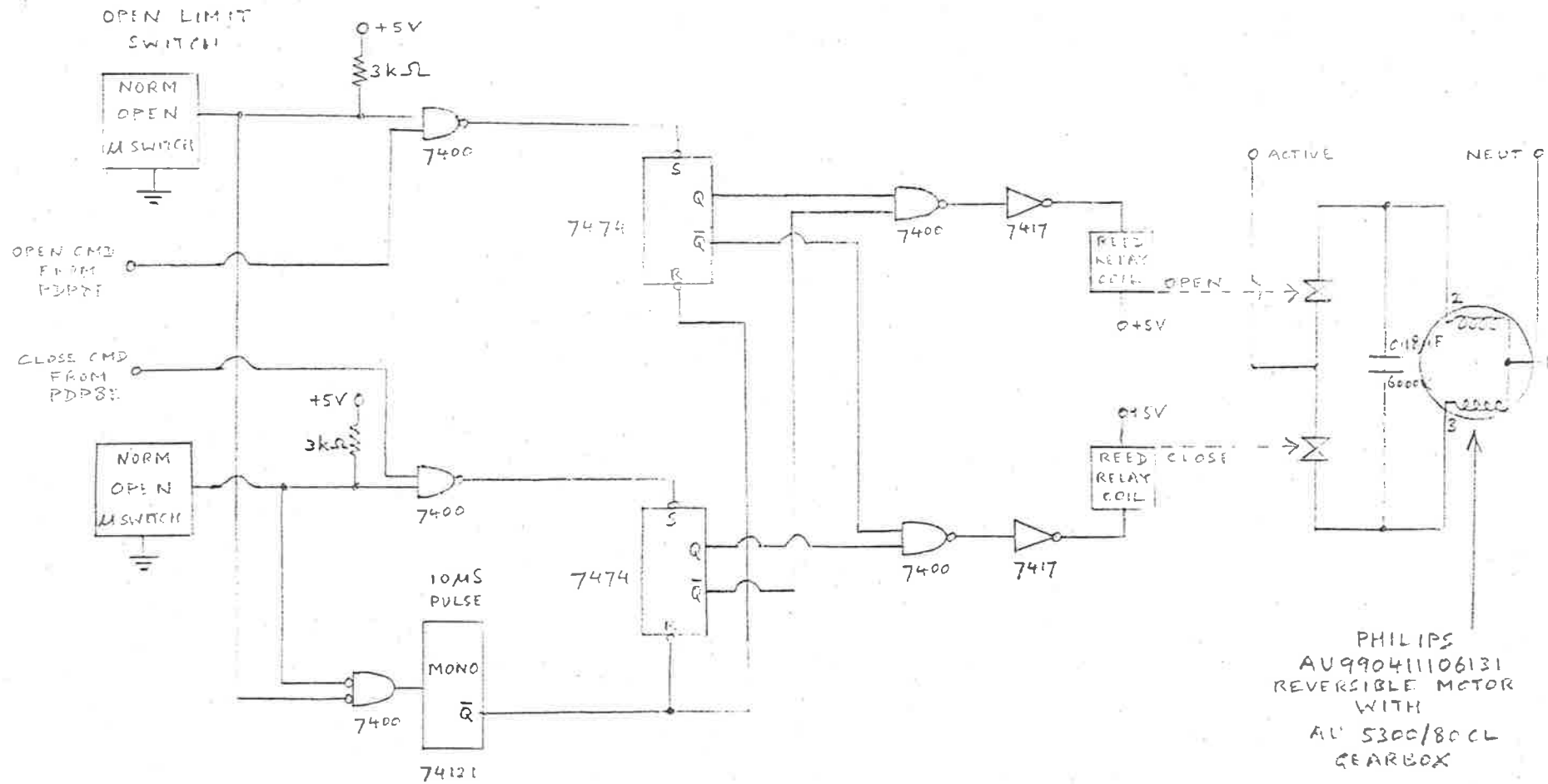
### E1 : Logic diagrams of apparatus.

#### E1.1 General Circuit



The computer waits for an output from the response lever and upon receipt of an output, the computer, according to its stored program, actuates the various circuits connected to its output.

El.2. Curtain Circuit





E2 : Instructions to Audience in Experiment 6.

1. Please remain out of sight of the subject until you are called by the experimenter.
2. Please fasten your name tag in a prominent place on your coat, jumper, etc.
3. Sit on the stool provided facing the curtain about 1 foot from the curtain, for the complete length of the session (45 minutes).
4. Try not to make any undue noise (coughing, shifting, etc.).
5. You may read or write for much of the time. Occasionally, the curtain will open for a period of 15 seconds, in which case you should "peer" at the subject, preferably over your glasses. It is intended that you appear to the subject as an "evaluating, high-status, and mildly threatening" observer. It may therefore be appropriate if you are seen by the subject to make a mark on a pad/book, etc.
6. Do not verbally interact with S. If S attempts to engage you in verbal interaction, or laughs, etc. simply continue observing as before, until the curtain closes.
7. Whenever the curtain is open, try to keep gross movements (e.g. head or arm movements) to an absolute minimum. The reason for this is that "activity" on part of the audience may be an unwanted variable.

Thank you for your cooperation.

E3 : Change scores between baseline and treatments on all  
dependent variables of all subjects in Experiment 6.

RR indicates mean response rates percent changes.

RftR indicates mean reinforcement rates percent changes.

IRT indicates mean interresponse times percent changes.

E indicates mean efficiency DRL percent changes.

M indicates mean amount of money earned percent changes.

A indicates mean anxiety ratings changes (on scale of  
-10 to +10).

| Treatment         | Aud      |       |       |       |       |       |       |       | R.C.     |       |       |       |        |       |        |       | N.S.     |       |       |       |       |       |       |       |
|-------------------|----------|-------|-------|-------|-------|-------|-------|-------|----------|-------|-------|-------|--------|-------|--------|-------|----------|-------|-------|-------|-------|-------|-------|-------|
| Component         | Non Stim |       |       |       | Stim  |       |       |       | Non Stim |       |       |       | Stim   |       |        |       | Non Stim |       |       |       | Stim  |       |       |       |
| Subject           | RR       | RftR  | IRT   | E     | RR    | RftR  | IRT   | E     | RR       | RftR  | IRT   | E     | RR     | RftR  | IRT    | E     | RR       | RftR  | IRT   | E     | RR    | RftR  | IRT   | E     |
| S <sub>1</sub>    | -13.0    | +9.0  | +25.6 | +26.9 | -11.1 | -7.2  | +7.9  | +3.2  | -20.0    | 0     | +51.5 | +23.9 | -30.0  | -31.3 | +29.5  | -4.3  | -13.0    | 0     | +16.2 | +14.9 | -3.3  | +3.8  | +1.8  | -1.1  |
| S <sub>2</sub> *  | -13.0    | +9.6  | +8.4  | +26.0 | -14.0 | -3.8  | +19.7 | +11.6 | -47.0    | -35.6 | +85.2 | +20.5 | -32.3  | -41.3 | +35.3  | -14.0 | 0        | +8.2  | +1.9  | -8.2  | -7.5  | -3.8  | +7.1  | +11.6 |
| S <sub>3</sub> *  | +25.0    | +9.0  | +0.7  | 0     | -27.8 | +12.5 | +27.0 | +8.4  | -12.5    | -29.9 | +15.7 | -14.0 | +20.6  | -21.3 | -19.2  | -34.9 | +62.5    | +19.4 | -30.4 | -31.0 | 0     | -3.8  | -6.5  | -6.0  |
| S <sub>4</sub> *  | +6.9     | -8.2  | -5.6  | -16.5 | +3.0  | -14.4 | -2.0  | -17.8 | -8.0     | -17.8 | -2.4  | -11.8 | -30.0  | -33.3 | +32.0  | -4.4  | +14.9    | 0     | -7.7  | -14.1 | 0     | -11.1 | -3.2  | -11.1 |
| S <sub>5</sub>    | -4.8     | 0     | +5.7  | +3.8  | -38.2 | -23.2 | +16.1 | +21.7 | +13.1    | -29.9 | -11.8 | -37.5 | +4.9   | -13.0 | -4.4   | -18.8 | +3.6     | +9.0  | -6.8  | +6.3  | -11.7 | +1.4  | +13.9 | +13.0 |
| S <sub>6</sub> *  | +16.3    | +21.7 | -3.9  | +2.2  | +3.8  | +3.8  | -11.2 | 0     | -59.7    | -55.0 | +97.1 | +11.1 | -62.5  | -66.3 | +65.4  | -11.0 | +29.8    | +21.7 | -6.6  | -5.6  | 0     | 0     | -7.8  | 0     |
| S <sub>7</sub>    | 0        | 0     | +4.6  | 0     | -8.8  | -13.7 | +7.5  | -6.5  | -20.0    | +13.2 | +22.4 | +41.5 | 0      | -27.4 | -15.7  | -45.6 | -20.0    | +37.7 | +6.0  | +42.4 | +8.8  | +9.6  | -8.7  | 0     |
| S <sub>8</sub>    | +228.0   | +13.2 | -70.0 | -52.8 | +34.0 | +3.9  | -24.9 | -21.5 | +165.0   | -11.3 | -69.1 | -56.6 | +147.7 | -13.0 | -63.9  | -43.0 | 0        | +50.9 | +3.5  | +62.3 | -7.8  | +3.9  | +5.2  | +12.7 |
| S <sub>9</sub>    | +3.8     | +8.8  | -4.5  | +3.3  | -15.0 | +4.1  | +18.3 | +20.5 | -13.8    | -17.8 | +11.2 | -7.8  | -61.3  | -50.0 | +112.4 | +6.0  | -5.0     | 0     | -4.1  | +3.3  | -11.3 | 0     | +15.4 | +15.7 |
| S <sub>10</sub> * | -1.1     | -29.7 | -36.5 | -25.8 | +12.9 | +27.0 | -2.0  | +12.5 | -70.9    | -65.8 | +84.6 | +22.6 | -95.1  | -45.9 | +183.4 | +9.4  | -0.5     | -29.7 | -0.4  | -29.0 | -1.5  | 0     | 0     | +3.1  |
| S <sub>11</sub>   | -12.0    | +26.4 | +4.8  | -9.0  | +38.2 | +63.8 | -19.1 | 0     | -12.0    | +13.0 | -0.5  | -18.0 | +40.0  | +15.4 | -22.3  | -22.0 | +4.8     | +37.7 | -2.7  | -15.0 | +27.3 | +34.6 | -19.0 | 0     |
| S <sub>12</sub> * | 0        | +11.7 | +2.1  | +11.7 | -8.4  | -2.5  | +4.4  | +2.3  | -7.0     | +11.7 | +11.8 | +18.3 | -16.3  | -15.2 | +19.4  | +1.2  | -7.0     | +21.7 | +1.8  | +31.7 | -5.4  | -2.5  | +1.5  | +2.3  |

\* Extraverted subjects

Subjects 4, 5, 7, 9, 10, 12, with Professor 1 during Aud; remaining subjects with Professor 2.

| Treatment         | Aud |       | R.C. |        | N.S. |       |
|-------------------|-----|-------|------|--------|------|-------|
| Subject           | A   | M     | A    | M      | A    | M     |
| S <sub>1</sub>    | +3  | -2.9  | 0    | -90.7  | 0    | -2.9  |
| S <sub>2</sub> *  | 0   | 0     | +1   | -107.9 | 0    | 0     |
| S <sub>3</sub> *  | +1  | -4.4  | +8   | -144.9 | 0    | +2.9  |
| S <sub>4</sub> *  | +3  | -13.2 | +5   | -11.8  | 0    | -7.9  |
| S <sub>5</sub>    | +7  | -14.8 | 0    | -136.9 | 0    | +4.9  |
| S <sub>6</sub> *  | 0   | +9.1  | +4   | -97.7  | -1   | +3.0  |
| S <sub>7</sub>    | 0   | -10.0 | 0    | -112.5 | 0    | +16.7 |
| S <sub>8</sub>    | +3  | -12.9 | 0    | -125.8 | -2   | +16.1 |
| S <sub>9</sub>    | +2  | +5.7  | +1   | -109.1 | 0    | +3.0  |
| S <sub>10</sub> * | -7  | +9.1  | +7   | -172.4 | 0    | -9.1  |
| S <sub>11</sub>   | 0   | +50.0 | +2   | -108.0 | -3   | +45.5 |
| S <sub>12</sub> * | -5  | 0     | +4   | -96.2  | 0    | +3.0  |

\* Extraverted subjects

Subjects 4, 5, 7, 9, 10, 12 with Professor 1,  
remaining subjects with Professor 2 during Aud.

E4 : Analyses of Variance Summaries for data in Experiment 6

E4.1. Percent changes in response rates.

| Source            | df | MS     | F     |
|-------------------|----|--------|-------|
| Between Subjects  |    |        |       |
| Extraversion (A)  | 1  | 7174.0 | 1.21  |
| Error (Subjects)  | 10 | 5936.8 |       |
| Within Subjects   |    |        |       |
| Treatments (B)    | 2  | 1814.8 | <1    |
| A X B             | 2  | 5873.4 | 3.14* |
| Error (B X S)     | 20 | 1870.0 |       |
| Components (C)    | 1  | 1918.9 | 1.58  |
| A X C             | 1  | 0.6    | <1    |
| Error (C X S)     | 10 | 1217.4 |       |
| B X C             | 2  | 686.0  | 1.06  |
| A X B X C         | 2  | 841.0  | 1.30  |
| Error (B X C X S) | 20 | 644.8  |       |

Subsidiary partial analysis of variance table with a pooled Error term. Inclusion within this Error term occurred only if the population effects for a MS involving "Subjects" were similar, and if they were also empirically similar (Hays, 1963, p.434):

| Source                         | df | MS     | F      |
|--------------------------------|----|--------|--------|
| Treatments (B)                 | 2  | 1814.8 | 1.10   |
| A X B                          | 2  | 5873.4 | 3.55** |
| Components (C)                 | 1  | 1918.9 | 1.16   |
| A X C                          | 1  | 0.6    | <1     |
| Pooled Error Term<br>(CS + BS) | 30 | 1652.4 |        |

\*\*  $p < 0.05$

\*  $p < 0.10$

E4.2. Percent changes in reinforcement rates.

| Source            | df | MS     | F       |
|-------------------|----|--------|---------|
| Between Subjects  |    |        |         |
| Extraversion (A)  | 1  | 3206.7 | 3.17    |
| Error (Subjects)  | 10 | 1010.7 |         |
| Within Subjects   |    |        |         |
| Treatments (B)    | 2  | 7542.0 | 27.84** |
| A X B             | 2  | 484.6  | 1.79    |
| Error (B X S)     | 20 | 270.9  |         |
| Components (C)    | 1  | 1113.1 | 2.43    |
| A X C             | 1  | 178.3  | < 1     |
| Error (C X S)     | 10 | 459.0  |         |
| B X C             | 2  | 174.9  | 1.31    |
| A X B X C         | 2  | 13.6   | < 1     |
| Error (B X C X S) | 20 | 133.1  |         |

Subsidiary partial analysis of variance table  
with pooled subjects Error term:

| Source                         | df | MS     | F       |
|--------------------------------|----|--------|---------|
| Treatments (B)                 | 2  | 7542.0 | 22.61** |
| A X B                          | 2  | 484.6  | 1.45    |
| Components (C)                 | 1  | 1113.1 | 3.34*   |
| A X C                          | 1  | 178.3  | < 1     |
| Pooled Error Term<br>(CS + BS) | 30 | 333.6  |         |

\*\*  $p < 0.001$

\*  $p < 0.10$

E4.3. Percent changes in interresponse times.

| Source            | df | MS     | F      |
|-------------------|----|--------|--------|
| Between Subjects  |    |        |        |
| Extraversion (A)  | 1  | 5125.8 | 2.03   |
| Error (S)         | 10 | 2531.0 |        |
| Within Subjects   |    |        |        |
| Treatments (B)    | 2  | 8678.5 | 4.41** |
| A X B             | 2  | 6608.2 | 3.35*  |
| Error (B X S)     | 20 | 1969.8 |        |
| Components (C)    | 1  | 1057.2 | 1.26   |
| A X C             | 1  | 351.6  | <1     |
| Error (C X S)     | 10 | 839.0  |        |
| B X C             | 2  | 146.2  | <1     |
| A X B X C         | 2  | 77.2   | <1     |
| Error (B X C X S) | 20 | 479.6  |        |

\*\*  $p < 0.05$

\*  $p < 0.10$

N.B. Pooling of Error terms according to the criteria in E.4.1. retains significance of the above F-ratios.

E4.4. Percent changes in efficiency DRL.

| Source            | df | MS     | F     |
|-------------------|----|--------|-------|
| Between Subjects  |    |        |       |
| Extraversion (A)  | 1  | 2.1    | <1    |
| Error (S)         | 10 | 646.3  |       |
| Within Subjects   |    |        |       |
| Treatments (B)    | 2  | 892.9  | 1.84  |
| A X B             | 2  | 1581.5 | 3.26* |
| Error (B X S)     | 20 | 485.1  |       |
| Components (C)    | 1  | 221.9  | <1    |
| A X C             | 1  | 79.0   | <1    |
| Error (C X S)     | 10 | 551.1  |       |
| B X C             | 2  | 613.6  | 2.95* |
| A X B X C         | 2  | 339.7  | 1.63  |
| Error (B X C X S) | 20 | 207.9  |       |

\*  $p < 0.10$

N.B. Pooling of Error terms according to the criteria in E4.1. retains the 0.10 level significance of the above F-ratios.



E5 : Subjects' responses to Questions :

(1) "What strategies did you use to respond?"

(2) "What did you experience in this session?"

(Q2 : Aud. treatment only - Answers in " ")

| Subject             | B/Line                                             | Aud.Prof 1                                           | B/Line                                                  | Aud.Prof 2                                             | Subject             |
|---------------------|----------------------------------------------------|------------------------------------------------------|---------------------------------------------------------|--------------------------------------------------------|---------------------|
| (I) S <sub>5</sub>  | 1R/69sec<br>(experimenting)                        | Superstitious Resp*<br>"punishing"                   | 1R per min<br>(pulse)                                   | 1R per min<br>"Curiosity surprise"                     | S <sub>8</sub> (I)  |
| (E) S <sub>4</sub>  | 1R/min<br>(Counting)                               | 1R/min (but counting faster).<br>"Mild shock"        | 1R per min<br>(Counting)                                | 1R per min.<br>"Enjoyable"                             | S <sub>11</sub> (I) |
| (E) S <sub>10</sub> | Superstitious Resp*<br>(Counting up lever presses) | Superstitious Resp*<br>"Surprise, amusement".        | 1R per 75 sec. (pulse)                                  | 1R per 85 sec.<br>"Curiosity interest"                 | S <sub>2</sub> (E)  |
| (E) S <sub>12</sub> | 1R/50 sec.<br>(Counting)                           | 1R/50 sec. (head swaying).<br>"Fright, distraction". | 1R per min<br>(heart-beat)                              | 1R per min<br>"Heart-beat sped up; relaxing; feet-up". | S <sub>3</sub> (E)  |
| (I) S <sub>7</sub>  | 1R/min<br>(Counting)                               | 1R/90 sec.<br>"disturbed, embarrassed".              | 1R/65-70 sec.<br>(counting)                             | 1R/65-70 sec.<br>"Less boredom than previous session"  | S <sub>6</sub> (E)  |
| (I) S <sub>9</sub>  | 1R/min<br>(Counting)                               | 1R/min<br>"more reluctant to respond".               | 1R/const-time lapse<br>(counting, foot tapping, pulse). | 1R/const-time lapse<br>"some tension, curiosity".      | S <sub>1</sub> (I)  |

\* Author's evaluation of subject's written comments.

I = Introvert

E = Extravert

F1 : Vertical Door Circuitry for Audience

The diagram illustrates a door alarm system. A door is shown with two sets of contacts: 'OPEN DOOR' and 'CLOSED DOOR'. A relay (Rel.) is connected to a +24V source. The alarm circuit is powered by a +5V source and a +24V source. The circuit includes several logic gates (1, 2, 3, 4, 5, 6) and resistors (1K, 2K, 270-Ω). A 'FROM COMPUTER OUTPUT' line is also shown.

F2 : Mean Response and Reinforcement Rates

for Subjects in Experiment 7 (Phase 1)

|                   |      | <u>Response Rates</u> |                      |                      |                      | <u>Reinforcement Rates</u> |                      |                      |                      |
|-------------------|------|-----------------------|----------------------|----------------------|----------------------|----------------------------|----------------------|----------------------|----------------------|
|                   |      | <u>B/Line</u>         |                      | <u>Treatment</u>     |                      | <u>B/Line</u>              |                      | <u>Treatment</u>     |                      |
| <u>Components</u> |      | <u>C<sub>1</sub></u>  | <u>C<sub>2</sub></u> | <u>C<sub>1</sub></u> | <u>C<sub>2</sub></u> | <u>C<sub>1</sub></u>       | <u>C<sub>2</sub></u> | <u>C<sub>1</sub></u> | <u>C<sub>2</sub></u> |
| S <sub>1</sub>    | Sp   | 5.41                  | 5.92                 | 5.50                 | 4.33                 | 0.25                       | 0.17                 | 0.17                 | 0.23                 |
|                   | AnSp | 4.25                  | 4.63                 | 4.94                 | 3.46                 | 0.19                       | 0.18                 | 0.11                 | 0.22                 |
|                   | StSp | 4.28                  | 3.97                 | 4.06                 | 3.68                 | 0.25                       | 0.28                 | 0.17                 | 0.29                 |
|                   | NSp  | 3.42                  | 3.54                 | 3.22                 | 3.42                 | 0.33                       | 0.41                 | 0.42                 | 0.56                 |
| S <sub>2</sub>    | Sp   | 1.97                  | 1.70                 | 1.75                 | 1.70                 | 0.89                       | 1.16                 | 0.97                 | 1.09                 |
|                   | AnSp | 1.97                  | 1.70                 | 2.16                 | 1.63                 | 0.89                       | 1.16                 | 0.94                 | 1.16                 |
|                   | StSp | 1.97                  | 1.70                 | 1.52                 | 1.82                 | 0.89                       | 1.16                 | 1.22                 | 1.20                 |
|                   | NSp  | 1.97                  | 1.70                 | 2.05                 | 1.65                 | 0.89                       | 1.16                 | 1.03                 | 1.21                 |
| S <sub>3</sub>    | Sp   | 1.92                  | 1.88                 | 2.41                 | 1.82                 | 1.13                       | 1.20                 | 1.08                 | 1.26                 |
|                   | AnSp | 2.13                  | 1.97                 | 2.28                 | 1.99                 | 1.05                       | 1.14                 | 0.89                 | 1.21                 |
|                   | StSp | 2.47                  | 2.62                 | 2.52                 | 2.21                 | 0.86                       | 1.02                 | 0.80                 | 1.02                 |
|                   | NSp  | 1.92                  | 1.88                 | 1.94                 | 1.91                 | 1.13                       | 1.20                 | 0.92                 | 1.26                 |
| S <sub>4</sub>    | Sp   | 1.94                  | 2.13                 | 2.39                 | 2.00                 | 0.92                       | 0.99                 | 0.78                 | 0.97                 |
|                   | AnSp | 1.94                  | 2.13                 | 2.17                 | 1.58                 | 0.92                       | 0.99                 | 1.00                 | 1.34                 |
|                   | StSp | 2.29                  | 2.00                 | 2.36                 | 1.84                 | 0.83                       | 0.94                 | 0.78                 | 1.08                 |
|                   | NSp  | 2.97                  | 3.14                 | 3.22                 | 2.92                 | 0.42                       | 0.42                 | 0.53                 | 0.56                 |
| S <sub>5</sub>    | Sp   | 2.53                  | 2.45                 | 2.75                 | 1.88                 | 0.78                       | 0.69                 | 1.00                 | 1.30                 |
|                   | AnSp | 2.05                  | 1.74                 | 2.20                 | 1.80                 | 1.06                       | 1.34                 | 1.02                 | 1.31                 |
|                   | StSp | 2.05                  | 1.74                 | 1.81                 | 1.77                 | 1.06                       | 1.34                 | 1.17                 | 1.28                 |
|                   | NSp  | 2.05                  | 1.74                 | 2.16                 | 1.76                 | 1.06                       | 1.34                 | 0.97                 | 1.26                 |
| S <sub>6</sub>    | Sp   | 2.25                  | 2.11                 | 2.92                 | 2.07                 | 0.83                       | 1.08                 | 0.75                 | 1.04                 |
|                   | AnSp | 2.25                  | 2.11                 | 2.61                 | 2.12                 | 0.83                       | 1.08                 | 0.94                 | 1.00                 |
|                   | StSp | 2.25                  | 2.11                 | 2.30                 | 2.06                 | 0.83                       | 1.08                 | 0.97                 | 1.09                 |
|                   | NSp  | 2.25                  | 2.11                 | 2.30                 | 2.00                 | 0.83                       | 1.08                 | 1.11                 | 1.11                 |
| S <sub>7</sub>    | Sp   | 3.67                  | 3.33                 | 3.39                 | 2.69                 | 0.28                       | 0.33                 | 0.33                 | 0.51                 |
|                   | AnSp | 3.11                  | 3.10                 | 2.97                 | 2.52                 | 0.47                       | 0.43                 | 0.39                 | 0.63                 |
|                   | StSp | 4.05                  | 3.88                 | 4.40                 | 3.55                 | 0.19                       | 0.19                 | 0.25                 | 0.21                 |
|                   | NSp  | 3.67                  | 3.33                 | 4.00                 | 3.06                 | 0.28                       | 0.33                 | 0.22                 | 0.40                 |
| S <sub>8</sub>    | Sp   | 2.02                  | 2.17                 | 2.28                 | 2.00                 | 0.81                       | 0.85                 | 0.83                 | 0.85                 |
|                   | AnSp | 2.02                  | 2.17                 | 2.33                 | 1.98                 | 0.81                       | 0.85                 | 0.67                 | 0.94                 |
|                   | StSp | 2.02                  | 2.17                 | 2.08                 | 2.02                 | 0.81                       | 0.85                 | 0.86                 | 0.98                 |
|                   | NSp  | 2.02                  | 2.17                 | 2.25                 | 2.16                 | 0.81                       | 0.85                 | 0.69                 | 0.89                 |

F3 : Comparisons between components during  
baselines in Experiment 7 (Phase 1).

Comparison of baseline response rates (between components) :

Sp :  $C_1$  vs  $C_2$   $t_7 < 0$   
AnSp :  $C_1$  vs  $C_2$   $t_7 < 0$   
StSp :  $C_1$  vs  $C_2$   $t_7 = 2.16 (p > 0.05, 2-t)$   
Nsp :  $C_1$  vs  $C_2$   $t_7 = 1.10 (p > 0.20, 2-t)$

Comparison of baseline efficiency DRL indices  
(between components) :

Sp :  $C_1$  vs  $C_2$  ,  $t_7 = 1.48 (p > 0.20, 2-t)$   
AnSp :  $C_1$  vs  $C_2$  ,  $t_7 = 2.13 (p > 0.05, 2-t)$   
StSp :  $C_1$  vs  $C_2$  ,  $t_7 = 2.67 (p < 0.05, 2-t)$   
Nsp :  $C_1$  vs  $C_2$  ,  $t_7 = 2.35 (p > 0.05, 2-t)$

F4 : Mean Efficiency DRL ratios of subjects  
in Experiment 7 (Phase 1).

| Components     |      | B/Line         |                | Treatment      |                |
|----------------|------|----------------|----------------|----------------|----------------|
|                |      | C <sub>1</sub> | C <sub>2</sub> | C <sub>1</sub> | C <sub>2</sub> |
| S <sub>1</sub> | Sp   | 0.046          | 0.029          | 0.031          | 0.053          |
|                | AnSp | 0.045          | 0.039          | 0.022          | 0.064          |
|                | StSp | 0.058          | 0.071          | 0.042          | 0.079          |
|                | NSp  | 0.097          | 0.116          | 0.130          | 0.173          |
| S <sub>2</sub> | Sp   | 0.452          | 0.682          | 0.554          | 0.641          |
|                | AnSp | 0.452          | 0.682          | 0.435          | 0.712          |
|                | StSp | 0.452          | 0.682          | 0.803          | 0.659          |
|                | NSp  | 0.452          | 0.682          | 0.502          | 0.733          |
| S <sub>3</sub> | Sp   | 0.589          | 0.638          | 0.448          | 0.692          |
|                | AnSp | 0.493          | 0.579          | 0.390          | 0.608          |
|                | StSp | 0.348          | 0.389          | 0.318          | 0.462          |
|                | NSp  | 0.589          | 0.649          | 0.474          | 0.660          |
| S <sub>4</sub> | Sp   | 0.474          | 0.465          | 0.326          | 0.485          |
|                | AnSp | 0.474          | 0.465          | 0.461          | 0.848          |
|                | StSp | 0.362          | 0.470          | 0.331          | 0.587          |
|                | NSp  | 0.141          | 0.134          | 0.165          | 0.192          |
| S <sub>5</sub> | Sp   | 0.308          | 0.282          | 0.364          | 0.692          |
|                | AnSp | 0.517          | 0.770          | 0.464          | 0.728          |
|                | StSp | 0.517          | 0.770          | 0.646          | 0.723          |
|                | NSp  | 0.517          | 0.770          | 0.449          | 0.716          |
| S <sub>6</sub> | Sp   | 0.369          | 0.512          | 0.257          | 0.502          |
|                | AnSp | 0.369          | 0.512          | 0.360          | 0.472          |
|                | StSp | 0.369          | 0.512          | 0.422          | 0.529          |
|                | NSp  | 0.369          | 0.512          | 0.483          | 0.555          |
| S <sub>7</sub> | Sp   | 0.076          | 0.099          | 0.097          | 0.190          |
|                | AnSp | 0.151          | 0.139          | 0.131          | 0.250          |
|                | StSp | 0.047          | 0.049          | 0.057          | 0.059          |
|                | NSp  | 0.076          | 0.099          | 0.055          | 0.131          |
| S <sub>8</sub> | Sp   | 0.401          | 0.392          | 0.364          | 0.425          |
|                | AnSp | 0.401          | 0.392          | 0.288          | 0.475          |
|                | StSp | 0.401          | 0.392          | 0.414          | 0.485          |
|                | NSp  | 0.401          | 0.392          | 0.307          | 0.412          |

F5 : Mean Response and Reinforcement Rates  
for Subjects in Experiment 7 (Phase 2).

|                |      | <u>Response Rates</u> |                |                  |                | <u>Reinforcement Rates</u> |                |                  |                |
|----------------|------|-----------------------|----------------|------------------|----------------|----------------------------|----------------|------------------|----------------|
|                |      | <u>B/Line</u>         |                | <u>Treatment</u> |                | <u>B/Line</u>              |                | <u>Treatment</u> |                |
|                | mA   | C <sub>1</sub>        | C <sub>2</sub> | C <sub>1</sub>   | C <sub>2</sub> | C <sub>1</sub>             | C <sub>2</sub> | C <sub>1</sub>   | C <sub>2</sub> |
| S <sub>1</sub> | 0.2  | 2.70                  | 2.74           | 2.32             | 1.75           | 0.56                       | 0.56           | 0.78             | 1.02           |
|                | 0.3  | 2.70                  | 2.74           | 2.10             | 1.19           | 0.56                       | 0.56           | 0.64             | 0.79           |
|                | 0.4  | 2.70                  | 2.74           | 1.36             | 0.74           | 0.56                       | 0.56           | 0.50             | 0.61           |
|                | 0.3  | 2.70                  | 2.74           | 2.61             | 1.45           | 0.56                       | 0.56           | 0.84             | 1.07           |
| S <sub>2</sub> | 0.6  | 1.92                  | 1.70           | 0.29             | 0.10           | 1.03                       | 1.18           | 0.08             | 0              |
|                | 0.1  | 1.92                  | 1.70           | 0.12             | 1.51           | 1.03                       | 1.18           | 0.84             | 0.93           |
|                | 0.3  | 1.92                  | 1.70           | 0.17             | 1.22           | 1.03                       | 1.18           | 1.25             | 1.25           |
|                | 0.5  | 1.92                  | 1.70           | 0.84             | 0.50           | 1.03                       | 1.18           | 0.84             | 0.49           |
|                | 0.4  | 1.92                  | 1.70           | 2.37             | 1.22           | 1.03                       | 1.18           | 1.00             | 0.97           |
| S <sub>3</sub> | 0.2  | 1.79                  | 1.96           | 1.87             | 1.77           | 1.05                       | 1.14           | 1.00             | 1.11           |
|                | 0.3  | 1.79                  | 1.96           | 1.38             | 1.13           | 1.05                       | 1.14           | 0.84             | 0.90           |
|                | 0.4  | 1.79                  | 1.96           | 2.09             | 1.13           | 1.05                       | 1.14           | 1.13             | 0.97           |
|                | 0.5  | 1.79                  | 1.96           | 1.50             | 0.79           | 1.05                       | 1.14           | 0.84             | 0.73           |
| S <sub>4</sub> | 0.1  | 1.54                  | 1.65           | 1.71             | 1.77           | 1.04                       | 1.17           | 1.08             | 1.09           |
|                | 0.2  | 1.54                  | 1.65           | 1.50             | 1.09           | 1.04                       | 1.17           | 1.08             | 0.97           |
|                | 0.3  | 1.54                  | 1.65           | 1.09             | 0.75           | 1.04                       | 1.17           | 0.79             | 0.72           |
| S <sub>5</sub> | 0.1  | 2.05                  | 1.81           | 1.42             | 1.05           | 0.88                       | 1.20           | 0.88             | 0.81           |
|                | 0.2  | 2.05                  | 1.81           | 0.54             | 0.60           | 0.88                       | 1.20           | 0.54             | 0.55           |
|                | 0.13 | 2.05                  | 1.81           | 0.83             | 1.02           | 0.88                       | 1.20           | 0.83             | 0.96           |
|                | 0.16 | 2.05                  | 1.81           | 1.59             | 1.48           | 0.88                       | 1.20           | 1.25             | 1.14           |
| S <sub>6</sub> | 0.1  | 2.59                  | 2.24           | 1.42             | 1.98           | 1.09                       | 0.95           | 1.04             | 0.96           |
|                | 0.2  | 2.59                  | 2.24           | 2.25             | 1.35           | 1.09                       | 0.95           | 1.09             | 1.14           |
|                | 0.3  | 2.59                  | 2.24           | 1.17             | 1.02           | 1.09                       | 0.95           | 0.88             | 0.95           |
|                | 0.4  | 2.59                  | 2.24           | 0.40             | 0.27           | 1.09                       | 0.95           | 0.30             | 0.26           |
| S <sub>7</sub> | 0.1  | 2.28                  | 2.23           | 2.50             | 2.02           | 0.89                       | 0.92           | 1.08             | 1.05           |
|                | 0.4  | 2.28                  | 2.23           | 1.67             | 0.77           | 0.89                       | 0.92           | 0.83             | 0.67           |
|                | 0.2  | 2.28                  | 2.23           | 1.96             | 1.83           | 0.89                       | 0.92           | 1.25             | 1.02           |
|                | 0.3  | 2.28                  | 2.23           | 2.08             | 1.34           | 0.89                       | 0.92           | 1.13             | 1.10           |
| S <sub>8</sub> | 0.1  | 2.04                  | 2.32           | 1.59             | 1.41           | 0.67                       | 0.78           | 0.55             | 0.62           |
|                | 0.3  | 2.04                  | 2.32           | 0.04             | 0              | 0.67                       | 0.78           | 0.04             | 0              |
|                | 0.2  | 2.04                  | 2.32           | 0.08             | 0.05           | 0.67                       | 0.78           | 0.04             | 0.03           |