



STUDIES OF COMPATIBILITY AND INVESTIGATIONS

OF A MODEL OF REACTION TIME

Glen A. Smith

B.Sc. (Hons.)

Thesis submitted in fulfilment of the
requirement for the degree of
Doctor of Philosophy

Department of Psychology
University of Adelaide

May 1978

Awarded February 1979

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SUMMARY

At its inception this research was addressed to a specific area of choice reaction tasks, namely key-pressing situations of extreme compatibility. The apparatus used to evoke maximal compatibility was based on the vibrotactile (VT) apparatus of Leonard (1959) with which he showed that there was no change in reaction time (RT) as the number of alternatives, N , increased from 2 to 4 to 8 after about 500 trials, although simple RT was shorter. This contrasts with the usual finding that RT is proportional to the logarithm of N . The first experiment reported here showed more conclusively than was possible with Leonard's design that subjects do respond with no increase in choice RT with N after relatively little practice, with simple RT again found to be faster. Several explanations of this lack of increase were considered and excluded, but two remained viable:- either there is actually no increase in processing time with N , or a small increase exists, but this processing overlaps other stages which dictate a minimum RT and mask the increase, at least for N up to 8. Data from the VT condition of experiment 2 which used children as subjects, since any increase would be larger for subjects with less spatial location experience, cast doubt on the second suggestion, while the visual stimuli condition supported the premise that children respond like less practised adults.

The most favoured conclusion therefore was that there is no increase in processing time with N in compatible VT situations.

This presents difficulties for many existing choice reaction models.

A further experiment using the VT apparatus in a set of related RT tasks produced results which are difficult to account for by considering the RT process as the aggregate of a sequence of nonoverlapping stages, an idea derived from the subtractive stage hypothesis (Donders 1868, see Koster 1969). Evidence and theory on this hypothesis was reviewed and it was concluded that it is generally too restrictive to be fully correct. Two principles seemed to explain most of the results in this experiment. These were: the temporal uncertainty principle - response inhibition is greater for responses made irregularly in time, which increases RT; and the latent stimuli principle - latent stimuli, i.e. all potential stimuli not given on the current trial, influence RT to the given stimulus.

The inadequacies of current models in fitting these results led to the development of a new model which satisfactorily covers these and previously published results. In essence this model depicts the choice reaction process as a flow of evidence from representations of the potential stimuli along stimulus-response (S-R) association lanes to their corresponding responses. This transformation continues until one of the responses accumulates a preset amount of evidence and is thereby triggered. The duration of the transformation from a stimulus to its response is a function directly of the amount of excitation for that stimulus and inversely with the compatibility or degree of association between it and

its response. In addition it is postulated that the rate of transformation increases within each trial. This feature gives the model its name - the accelerating cycle model. The temporary uncertainty principle and the latent stimuli principle are both incorporated in the model. The accelerating cycle model is not inconsistent with the additive stage approach as it can be applied whether RT processing is by serial or by overlapping stages.

Three further experiments showed that assumptions and predictions of the model received good support from the data. Firstly it is shown that the amount of noise is independent of the number of alternatives as the accelerating cycle model assumes, and that the shortest stimulus duration at which subjects achieve asymptotic information transmission values is independent of N . This can be interpreted as indicating that the time to gain a representation of the stimulus sufficient to process accurately is unaffected by N .

The model reconciles the two formulations of the logarithmic relationship between RT and N suggested by Hick (1952a), $RT = k \cdot \log(N+1)$, and Hyman (1953), $RT = A + B \cdot \log(N)$. Each can be derived as an extreme of the general relationship, $RT = A + B \cdot \log(N+D)$, where $0 \leq D \leq 1$, and D equals the internal stimulus strength divided by the response criterion. The final experiment presents evidence in accord with the model's prediction as to the effect of the two parameters determining D .

Overall, the validity of the model's approach is confirmed and it appears to offer a satisfactory alternative to current models. The model is not complete: for example it does not quantify the effect of practice on RT, although it does describe the general decrease found experimentally. It is designed so that other parameters can be incorporated into the model to account for the effect of other variables once the form of their interactions with the parameters currently in the model is fully known.

An earlier form of the model presented in Chapter IV, and the experiments in that chapter, were submitted in partial fulfilment of the requirements for the Honours Degree of B.Sc. in Psychology in the University of Adelaide.

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

Glen A. Smith

May, 1978

ACKNOWLEDGEMENTS

The author sincerely expresses his gratitude to Professor A.T. Welford for his invaluable encouragement, advice and criticism throughout this research.

He also thanks Dr. J. Brebner for his assistance during Professor Welford's leave, and Dr. P. Rabbitt for his friendly help while the author was at Oxford University in 1975, during which time the research reported in Chapter III was carried out.

He also wishes to thank Mrs. Margaret Blaber who typed the manuscript, and Mrs. Judy Fallon and Mrs. Helena Lomax who prepared the figures.