REACTION TIME, PERFORMANCE AND LEVEL OF PHYSIOLOGICAL AROUSAL

Thesis submitted to the Department of Psychology, University of Cape Town in fulfilment of the requirements for the degree of Master of Arts.

Michael John Ellis-Smith BA (Hons)

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PREFACE

My interest in the effects of stress or arousal upon performance was initiated by my own flying experiences. As such this research was conducted, in essence, as a pilot selection programme. Prior to commencing this study I visited the South African Air Force Pilot Selection centre at the Military Medical Institute (M.M.I.) at Pretoria. Commander Gustav Pansegrouw S.A.N. was kind enough to furnish me with an immense amount of fairly confidential information with regard to selection procedures. In essence then, the present study does in fact conform to an aspect of pilot selection.

I have gone into some detail with regard to the rationale of reaction time tests. Similarly I have covered quite extensively the basis of the Taylor Manifest Anxiety scale. This was done so as to emphasize the Drive-Theory aspects of the scale, a factor of some importance in the present study, since the M.A. scale was employed as a means of assessing subjects' residual arousal level.

M.J. E-S.

Cape Town,
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SUMMARY PAPER

REACTION TIME, PERFORMANCE AND LEVEL OF PHYSIOLOGICAL AROUSAL

ABSTRACT

30 Male Students were used as subjects in a study to assess the effects of physiological arousal, induced by means of a placebo injection, upon visual reaction time. Two levels of task difficulty were employed : a two-choice test requiring manual responses and a four-choice test, in which the additional two peripheral stimuli were responded to by foot pedals. Manifest Anxiety scores were used as a means to categorize subjects and allow for individual differences. EEG was monitered as a controlling measure for each subject. Pulse rates, palmar sweat index and blood pressures were used as measures of physiological arousal. Results were interpreted in terms of the Yerkes-Dodson principle.

This study was conducted with a view to extending the principle of the Yerkes-Dodson Law to cover reaction time performance as functions of task difficulty and level of physiological arousal. In order to establish level of residual arousal in subjects, the Taylor Manifest Anxiety Scale was delivered prior to the experiment. Subjects were grouped into three Anxiety levels. Scores on the MAS ranged from zero to 26 with the mean of the distribution at 15·3 and the median at 10·5. (Taylor 1953).

The design allowed for a 3 x 2 x 2 Factorial Design with three levels of Manifest Anxiety, two levels of arousal and two levels of task difficulty. To circumvent the Positional Effect due to practice, half the subjects completed the easier Task 1 before the arousal situation (effected by a placebo injection) and then completed the more complex Task 2; while the other half of the subjects completed this sequence in reverse.

The apparatus was constructed in the form of an aircraft cockpit. The interior fascia was painted mat black. Two central red lights were mounted 30 cms apart. The box-shaped sides of the cockpit extended back and outwards. In these sides were mounted the two peripheral white lights. These were mounted at an angle of 60° from the central visual line being thus 90 cms apart. The cockpit was set onto a table of standard dimensions, such that when seated the subjects' vision was directed to the interior fascia. Responses were both manual and pedal. The central stimuli were responded to manually by two morse keys, while the peripheral stimuli were responded to on foot pedals. Task 1 involved only the central stimuli presented in random sequence and time. Task 2 involved both the central stimuli together with the peripheral stimuli, which were likewise presented in random sequence. The programme was presented by means of a 2114B Hewlett-Packard Computer with a timer which timed reaction times in milliseconds. EEG rhythm was monitored to serve as a control for each subject. Beyond a certain critical amplitude wave, a Schmitt-trigger fired and the pre-programmed computer presented the stimulus. Thus, for each subject the stimuli were presented only on an ascending brain-wave of sufficient amplitude to trigger the electrical response to the computer.

Lansing, 1957)

Physiological arousal was induced by means of a placebo injection of Normal Saline described to the subjects as adrenaline; the effects of which were described in full to each subject. Indices of physiological arousal taken were blood pressure, pulse rate, and a novel method of palmar sweat index. A chemical compound composed of 5 gm Polyvinyl formal (Formvar 15/95E) ml of butyl phthalate and 120 ml of chloroform was used to measure PSI. The compound was painted onto the subject's finger; it dried in a form of a skin revealing small pits at the site of sweat glands. The impression thus formed was placed onto a microscope slide and the number of pits in a 4 mm area defined the PSI (Dabbs et al 1968).

The results of the physiological indices were analysed in each case by a Two-Way Analysis of Variance with repeated measurements on Factor B (before and after arousal). Significant pre- and post- arousal effects were obtained for all the measurements taken, although no difference on the basis of MA scores was obtained.

DISCUSSION:

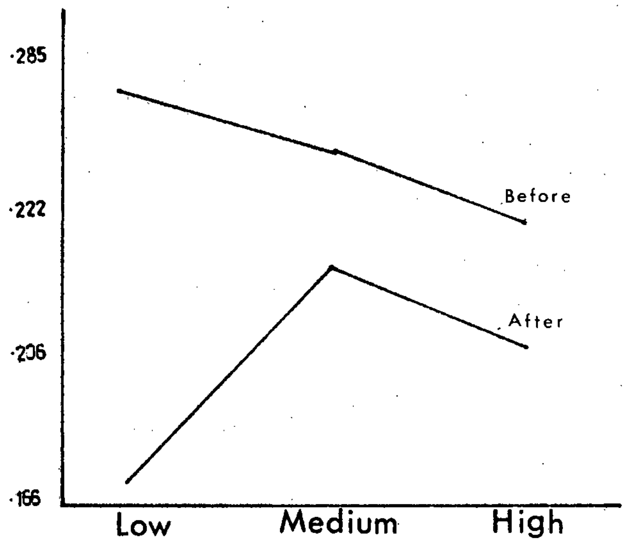
On the basis of the Yerkes-Dodson principle it was expected that reaction time performance as a function of increasing arousal would follow a curvilinear pattern (Corcoran 1965). Further it was hypothesized, that with increasing task complexity, optimum performance would be lowered. These two conditions define the Yerkes-Dodson principle (Broadhurst 1959). Results were analysed on a 3 way Analysis of Variance. The only significant interaction obtained was that between Factor B and Factor C. (Arousal level and Task Complexity). However, the results did show that in general high anxiety scores were associated with slower reaction times on both simple and complex tasks. See Figures 1 and 2 in the results. Moreover, results indicate that the arousal situation had an overall inhibitory effect upon performance of Task 1, while it showed a facilitatory effect upon Task 2, with high anxiety subjects utilizing most effectively the effects of induced arousal.

Further of analysis of the results on a 3 Way Analysis of Variance indicated the same trends shown in Figures 1 and 2. These results were comparable to those obtained in similar studies. (Kamin and Clark 1957; Olmedo and Kirk 1971). The Yerkes-Dodson principle served as a valuable tool for explaining results. However, owing to the apparent total lack of correlation between physiological measurements of arousal and Manifest Anxiety scores, the Manifest Anxiety score did not serve as an accurate means of assessing subjects' residual arousal. Consequently while larger trends were apparent - high anxiety associated with slow performance - the finer points of interaction between arousal level and performance were not obtained.

RESULTS

FIGURE 1

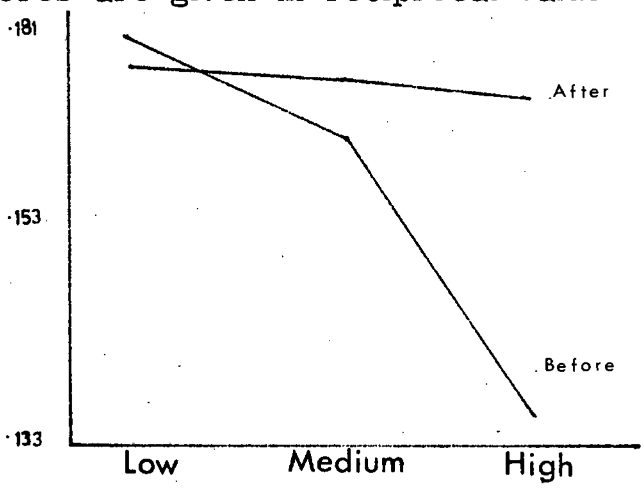
Graph showing mean performance on Task 1 before and after the administration of the placebo injection. Reaction time scores are given in reciprocal values x 100



Level of Manifest Anxiety

FIGURE 2

Mean performance on Task 2 before and after administration of the placebo injection. Reaction time scores are given in reciprocal values x 100



Level of Manifest Anxiety

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CHAPTER 1

APPARATUS

EXPERIMENTAL PROCEDURE

EXPERIMENTAL DESIGN

HYPOTHESIS

"The essence of my complaint is that by partly satisfying the investigator's demand for logical consistency, experimental design protects him from the acute discomfort which the general theoretical chaos should induce in him, and thereby inhibits him from lending a hand in the job of cleansing the Augean stables of current psychological theory. The need has been urgent for a long time, but so far the cleansing stream has been little more than a trickle, and for this I put at least part of the blame on blind faith in the efficacy of experimental design."

J.G. Taylor from "Experimental Design" : a cloak for intellectual sterility."

(1958)

APPARATUS.

The apparatus used in this study was consistent with the standard type used in most visual reaction time tests. However, certain modifications were introduced. The design of the experiment itself was based upon programmes employed in the South African and other Air Forces of the world. As such the apparatus was constructed in the form of an aircraft cockpit. The interior fascia was painted mat black. Two central red lights were mounted 30 centimetres apart, each one being 15 centimetres from the midline. The half-box-shaped cockpit's sides extended back and outwards. In these sides were mounted the 2 peripheral white lights. These were mounted at an angle of 60° from the central visual line being thus 90 centimetres apart. The cockpit was set onto a table of standard dimensions, such that, when seated, the subject's vision was almost entirely excluded by the interior of the cockpit, extraneous visual stimuli being reduced to a minimum. The ceiling of the cockpit also extended backwards and upwards, similarly focusing the the subject's attention onto the fascia.

Two manual response "Morse-keys" were placed on the table in the cockpit 30 centimetres apart, and 15 centimetres on either side of the midline. Thus the morse-keys were directly in line with each of the two central stimulus lights. On the floor were set two pedal switches which were depressed by the subject's feet whenever the peripheral lights were illuminated. The central lights were responded to by means of depressing either of the two morse-keys.

In both cases the subjects responded ipsilaterally depressing the left key when the left central light was lit and similarly the right foot pedal was depressed when the right peripheral light was lit. Stimulus presentations occurred randomly as prescribed by the computer programme written for the test. A 2114 B Hewlett-Packard computer with a timer was used to activate the stimuli and record response latencies.

On the basis of evidence from EEG studies in reaction time the present design incorporated a Beckman Dynograph EEG Recording Machine. EEG electrodes and a screened cable from the subjects' scalp transmitted the EEG data to the Dynograph. The reason for use of EEG monitoring in this study was purely as a means of control. Any "brain-wave" amplitude beyond a certain critical threshold value triggered a Schmidtt trigger which sent an impulse to the computer, which in tern presented the stimulus.

Clinical apparatus used included syringes, needles and Normal Saline solution. The apparatus used for assessing degree of physiological arousal included a stop watch, a sphygnomanometer (for obtaining blood pressures) and a palmar sweat index compound. The latter chemical compound consisted of the following ingredients:

5 grams of Polyvinyl Formal (Formvar 15/95E)
15 ML of butyl phthalate
100 ml of ethylene dichloride

Polyvinyl formal withdraws from moisture in the orifices of active sweat glands leaving holes or bubbles in the paint; butyl phthalate gives strength to the paint. The compound is painted onto a finger and dries in 10-15 seconds. It forms a plastic skin which can be removed and examined under a microscope slide. Under 10 x magnification active sweat glands appear as holes along the ridges of the fingerprint, and the number of holes in a 4 millimetre square area defines the Palmar Sweat Index (PSI).

Finally a portable tape-recorder fitted with headphones was used to give pre-experimental instructions to each subject. The headphones remained in position on the subject's head throughout the experiment and served as a convenient screen against extraneous auditory stimulation.

EXPERIMENTAL PROCEDURE.

The finding of subjects for an experiment of this nature can produce some amusing incidents; more often than not, however, it is a tedious and almost rather harrowing business. In acknowledgement of this, I pay credit to my undergraduate assistants who succeeded in scrounging together twenty of the thirty subjects used for this study.

Each subject was given a copy of the Taylor Manifest Anxiety Scale and asked to complete it. This procedure was completed some two weeks prior to the commencement of the experiment. According to scores obtained on the MAS, subjects were grouped into three groups corresponding to Low, Medium and High Anxiety groups. This process allows for a certain amount of categorization of subjects with respect to their individual differences in residual arousal, a point which has been emphasized in this study.

The actual experiment was conducted over five consecutive evenings working from approximately 5 p.m. till 10 p.m. on each evening. On arrival at the experimental laboratory subjects were ushered into a waiting room where they were asked to relax. They were given cups of tea and biscuits, (as promised when being engaged as subjects) and were then given a very brief and hazy account of the experiment which they were about to perform. It was indicated to the subjects that the author himself was a qualified pilot and that as such the test being conducted was one designed to assess subjects' probable ability with respect to aviation.

A qualified nursing sister then recorded the subject's pulse rate, blood pressure and palmar sweat index. The subject was then ushered into the laboratory where he was asked to seat himself comfortably at the "controls". EEG electrodes were then attached to his scalp and the three indices of physiological arousal were again taken. Headphones were then placed in position over the subject's ears.

At this point the subject's pulse rate, blood pressure and palmar sweat index were again recorded. This was done so as to make allowance for the undoubted arousing effects induced by the experimental surroundings and somewhat dramatic clinical procedure thus far. The mean of the two pre-arousal (injection) sets of indices was thus used as a baseline to assess the effects of the later induced arousal by the placebo injection. The following instructions were given to the subject through the headphones.

"Good evening, the test you are about to perform was developed during the Second World War as a means of selecting pilots best suited for aerial combat. Such a test must assess two basic qualities; firstly, the degree of bodily co-ordination a person possesses, and secondly an indication of how quickly he can react. In front of you you will see four lights; two red inner lights and two white outer lights which are termed "peripheral" lights. On the table in front of you are two morse-keys and on the floor are two pedal-switches. What you will be required to do is to depress with your finger as quickly as possible the left key when the left red light comes on and the right key when the right red light comes on. In the case of the peripheral white lights, you depress the left pedal with your left foot when the left peripheral light comes on and similarly depress the right pedal when the right peripheral light comes on. Now rest the index fingers of your left and right hands on the left and right keys respectively, and similarly lightly rest your left and right feet on the pedal switches. Do not be perturbed if the peripheral lights are not illuminated immediately, they will be in due course. If you understand all the instructions so far please smile. Thank you. Finally, before commencing, the electrodes that have been placed on your scalp are to measure your brain rhythm. It has been found that the best pilots have a characteristic "brain-wave". Please try to avoid sudden sharp movements of your head as the electrodes may become dislodged. Are you ready? If you are you may smile again. Thank you, and good luck"

At this stage the tape was discontinued and the test began. Subjects were not informed as to whether they were about to perform Task 1 or Task 2, that is whether or not the peripheral lights would also be illuminated. A practice period of 10 stimulus presentations was given prior to the commencement of the 50 experimental presentations. Task 1 was defined by 50 central stimulus presentations in random sequence and time; Task 2 was defined again by presentation of 50 central stimulus presentations, but superimposed on these were presented 60 peripheral stimulus presentations. The nature of Task 2 was such that it was a more complex and demanding test calling for a fair degree of bodily co-ordination, employing as it did the use of all four limbs. For purposes of this study, only responses to the central lights were recorded; the introduction of Task 2 being merely a means of raising the level of task difficulty.

On completion of the first half of the test, whether it was Task 1 or Task 2, a second tape recording was played to the subjects through the earphones still in position. The following information was then given to them: "So far you have been subjected to conditions of what might be considered to be "normal flight". Obviously in the case of aerial combat such a situation does not last. In a situation of aerial combat you would be in a state of extreme excitation, or more accurately perhaps, very scared. You will undoubtedly be familiar with the bodily sensations accompanying this state of fear. Among the symptoms that you will have been aware of are these: palpitations, or awareness of your own heartbeat, dryness of mouth, shallow, quick breathing and sweatiness on the palms of your hands. Other symptoms that you will not have been aware of are: increased blood pressure and dilation of the pupils of your eyes. Within your body are two small glands located above the kidneys, called the adrenals. These glands are responsible for the secretion into your bloodstream of the hormone adrenaline. It is this substance adrenaline which is largely responsible for the symptoms which have just been described. Now since in normal flight conditions the heavy secretion of adrenaline would not occur it would be impossible to simulate the state induced by its secretion. Would you consent to having a small injection of adrenaline so as to obtain this effect? You are not obliged to participate, but obviously if you do not we cannot draw any conclusions from your results. If you do consent will you please nod your head. Thank you. Immediately after receiving the injection you should become aware of the symptoms described. Once again these are: palpitations, dryness of mouth, sweatiness on the palms of your hands and most probably a mild dizziness. These effects should wear off in about five minutes as adrenaline is a very short-lived hormone. Shortly after this you will probably feel remarkably fine since adrenaline, amongst its other symptoms already described, tones up the system most effectively. Thank you for your participation so far".

Following the subject's consenting to receive an injection (only one subject declined this; his results were not recorded and another subject was found in his place) the attendant nursing sister administered the placebo injection. This consisted of 1 cc of Normal Physiological Saline injected intramuscularly into the left arm. Cottonwool and ether were used to cleanse the localized area on the skin. Ether was chosen as the spirit most suitable for this purpose since it has strong clinical and hospital connotations. This point is discussed in greater detail in Chapter V. Immediately after administration of the injection, pulse rate, blood pressure and palmar sweat index were again recorded. The difference in readings between the mean of the first two recordings of indices and the post-injection indices was used as the criterior for successful arousal inducement. (See Results.) With the completion of the physiological tests the next reaction time test was presented to the subject, thus if he had just completed Task 2, Task 1 was now presented. On final completion of the second task the subject was thanked for his participation in the experiment, pledged to secrecy concerning the "adrenaline" injection and given a cup of tea and biscuits.

Each subject's results were given in "print-out" form from the Hewlett-Packard computer's teletypewriter. These results were then recorded on the subject's experimental card on which were similarly recorded his Manifest Anxiety score and physiological indices. Results were kept confidential unless specifically asked for by the subject himself.

As the testing was conducted over five consecutive evenings, approximately six subjects were tested per evening. Notwithstanding the staggering of times at which subjects arrived, the inevitable delays and converse "concertinas" did occur. However, with practice and increased proficiency at their various duties the experimental team performed admirably under fairly trying conditions. Occasionally too, the computer lost its memory and had to be reprogrammed; nonetheless, testing was successfully completed on schedule having proved to be interesting and at times highly amusing.

ANALYSIS OF THE EXPERIMENTAL DESIGN.

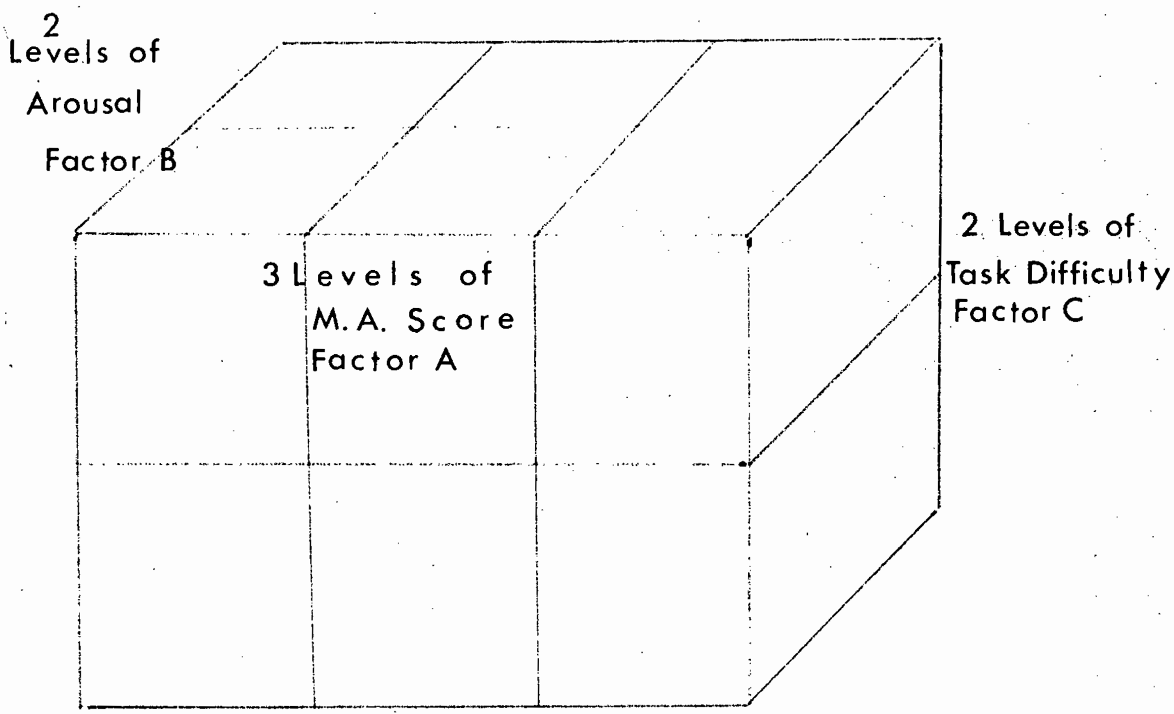
The experimental design employed in this study was accepted after the rejection of many possible alternatives. In essence the design had to allow for: three levels of Manifest Anxiety, two levels of task complexity, and two levels of arousal. At first glance this appears straightforward enough since a 3 x 2 x 2 Factorial Design would comply with the specifications. On further analysis, however, several difficulties become apparent. The most manifest of these is the Sequence or Positional Effect. Wherever one test precedes another and is likely to carry with it some practice effect, the sequence effect may be said to be operative. To circumvent this, the standard procedure is to split the subject sample into two halves, such that sub-sample A performs the tests in the reverse order from sub-sample B. A variety of more complex arrangements can similarly be employed but all are based upon this logically simple premise.

In the present study, use was in fact made of the above technique; however, further difficulties were encountered with regard to use of induced arousal. Since the essence of this research was an assessment of performance under conditions of arousal this latter

The most manifest shortcoming of this design is that one is unable to trace the performance of an individual subject across two levels of task difficulty at one level of arousal. However, on the basis of the points already enumerated and earlier research (Ellis-Smith 1971) conducted in which this procedure was adopted the present design was deemed adequate for the purposes of this study, allowing for comprehensive statistical analysis on a 3-way Analysis of Variance; data being broken into 12 cells. See Figure 1 · 2 also Appendix Table 5.

Figure 1 · 2

A three dimensional representation of the 3 x 2 x 2 Factorial Design employed in the experiment.



Furthermore, the design allows a comparative study of low arousal performance on both a simple and complex task and similarly for the same assessment under high arousal conditions. A perfect design, nevertheless, would obviously incorporate the three levels of Manifest Anxiety, two levels of task difficulty, performed at two levels of arousal, and would then require a further division to allow for positional effects. With these requirements met the sample must be large enough to allow accurate complex statistical analysis in which the smallest sub-group is not less than five in number, this being the lowest number at which significance can be reasonably assessed. If these conditions are fulfilled a sample size of nearly 150 subjects is arrived at. While this technique is obviously preferable from a theoretical standpoint the practical aspects are nothing short of monumental. The present design was therefore accepted as being the most expedient.

HYPOTHESIS

The elements of a study based upon an experimental law as complex as the Yerkes-Dodson principle are best understood following a fair analysis of the implications of such a law. This is done in some detail in Chapter 1V. However, two basic hypotheses adduced from this survey may broadly be expressed as follows:

(i) With increased arousal, performance will, when graphically described, follow a curvilinear pattern;

(ii) The above premise assumed, increased levels of task difficulty will lead to a lowering in the optimum level of performance.

CHAPTER II

Reaction time paradigms in historical perspective and relevant major independent variables in reaction time studies.

"The time elapsing between the onset of the stimulus and the elicitation of the response, is consumed not by a single unitary event but rather by the operation of distinct, non overlapping, cognitive sub-processes; these are not instantaneous but temporal and measureable."

F.C. Donders 1868
from Smith (1968)

Reaction Time paradigms consisted of two stimuli, two responses, and a 1 : 1 mapping between them; the "c" reaction involved two stimuli and only a single response that was required for one od the stimuli but not for the other.

Donders' assumptions may be paraphrased as follows:

(i) The time elapsing between the stimulus and response in the b and c reactions is consumed not by a single unitary event but rather by the operation of distinct, non-overlapping cognitive sub-processes. In the b reaction these sub-processes include discrimination of the stimulus (stimulus categorization) and a choice of response (response selection); while in the c reaction only stimulus categorization is involved.

(ii) The c reaction differs from the b reaction only in that the c reaction does not include response selection.

(iii) The b reaction includes both stimulus categorization and response selection and furthermore, these stages are added onto the a reaction to yield the b reaction. Arithmetically the time consumed by these stages can be determined by subtraction : stimulus categorization = c - a; and response selection time = b - c. (Woodworth 1938)

It is these latter arithmetic processes which have hall-marked Donders' work and consequently given rise to detailed studies on the basis that these component latencies are additive and arithmetically separable (Taylor 1966).

After 1900 mental chronometry and the work of Donders was discredited chiefly by Kulpe and his co-workers, who attacked Donders' approach from a strictly introspective standpoint. They maintained that a subject was able to bring his motor readiness to a higher pitch in the a reaction than in the b reaction; hence the a reaction was not a constant and so did not provide a reasonable estimate of the base time involved in the b reaction. Kulpe further maintained that, in general, a change of conditions indicated a change in processes; for example, stimulus categorization is not added to simple reaction time but is substituted for it. Thus Donders argued that the observed variations in Choice Reaction tasks are due to differential combinations of processes which have constant durations, while Kulpe maintained that the observed variations result from the operation of different processes with different time parameters.

With the advent of World War II and the rapid growth of experimental psychology programmes, work on reaction time studies began afresh with Donders' work regaining some of its rightful status. It would appear from the extensive amount of work conducted in the field that Donders' assumption which states that Choice reaction time involves a series of cognitive processes has not been discredited and is still a basic and useful premise for theory.

Welford (1960) for example, has postulated a system of information processing in Choice reaction time which involves three central mechanisms analogous to those of Donders : a perceptual mechanism concerned with stimulus categorization, a translation mechanism concerned with response selection and a central effector mechanism that deals with the actual execution of the responses. Other workers have extrapolated Donders' additive component logic (Christie and Luce, 1956) by conceptualizing the stimulus categorization stage as one composed of a number of tests or comparisons executed in serial order. Information - theory constructs have increased the use of the arithmetic theory, the key hypothesis to the theory being that at each instant of time the subject in a Choice reaction experiment makes optimal use of all the information that is available to him about the stimulus signal (Laming 1968). Arithmetically the work has frequently been summarized by the equation

$$CRT = a + b H_t$$

where : CRT = Choice Reaction Time
H_t = information transmitted

(Smith 1968). The constants a and b apply to simple reaction time and processing rate respectively. This premise is very comparable to Donders' assumption that Choice reaction time is simple reaction time with other stages merely inserted additively. Whether in fact these stages occur consecutively, as Donders assumed, or whether they do overlap has remained a legacy of the Donders - Kulpe dispute to this day. However, in terms of implicit value to experimental psychology, Donders has emerged an invaluable contributor, since contrary to his contemporaries' existing beliefs he demonstrated that mental events are not instantaneous, but temporal and measureable.

INDEPENDENT VARIABLES DIRECTLY AFFECTING THE PRESENT STUDY:

It is now axiomatic to assume that a reaction time task, be it of a simple, Choice or disjunctive type, involves a more involved and complex evaluation than a task composed merely of manual dexterity or perceptual acuity. The extensive amount of theoretical, mathematical and experimental literature in the field supports this notion. Nonetheless, experimental evidence gained using the standard repertoire of independent variables is supportive of the premise that reaction time is, nevertheless, a psychomotor task and is, as such, to a very large extent predictably affected by such variables. An extensive review of work would not be expedient here, thus only selected relevant studies will be included.

Practice Effects : Woodworth (1938) states that disjunctive reaction time becomes quicker with practice; but there is no evidence indicating that it ever becomes as rapid as simple reaction time. More recently, short-term improvement of Choice reaction times with practice has been demonstrated by several researchers. Leonard (1954) demonstrated how reaction time for three choices and for six choices decreased with practice, and more particularly how the difference between the two conditions of choice decreased in an almost linear fashion as practice increased. Bertelson, (1963) in a Choice reaction time experiment, demonstrated that repeated stimuli from trial to trial gave rise to faster reaction times than did new stimuli from trial to trial. Mowbray and Rhoades (1959) in a study which gained 15,000 reaction times from a single subject, demonstrated that practice reduces the times for two-Choice reactions at a faster rate than it does for four Choice reactions. Another result from this study showed that response latency and standard deviation display the same tendency. The authors conclude that Choice reaction times are significantly affected by practice.

In the present study, supportive of Mowbray and Rhoades' (1959) finding, significant correlations were found to exist between response latencies and standard deviations ($r = .917$, $p < 005$ and $r = .878$, $p < .005$ for Task 1 before and after the placebo injection respectively; and $r = .890$, $p < .005$ and $r = .682$, $p < .005$ for Task 2 before and after the injection respectively. See Table 1(a) in Appendix). Olmedo and Kirk (1971) obtained similar results in which they established that all reaction time measures used exhibited a significant practice effect. Conversely, however, Norrie (1967) found no such intra-individual variability for reaction time. It should, however, be noted that Norrie was investigating several complex, discrete motor tasks, so that a different set of operations would be required in each situation. The present study was designed to eliminate as far as possible the contaminating effects of practice, or as it is experimentally termed, the Sequence Effect. To this extent the subjects were randomly allocated to one of the two groups. Group 1 performed the easier two-choice task, termed Task 1, first, while group 2 performed the more complete four-choice test first, termed Task 2. While results do show a significant correlation between performance on Task 1 and Task 2 (see Table 3 in Appendix, $r = .591$, $p < .005$), the contaminating effects of practice appear to be minimal. Moreover, as is apparent from the Mowbray and Rhoades' (1959) study the effects of practice become manifest only after considerable exposure to the test to be performed.

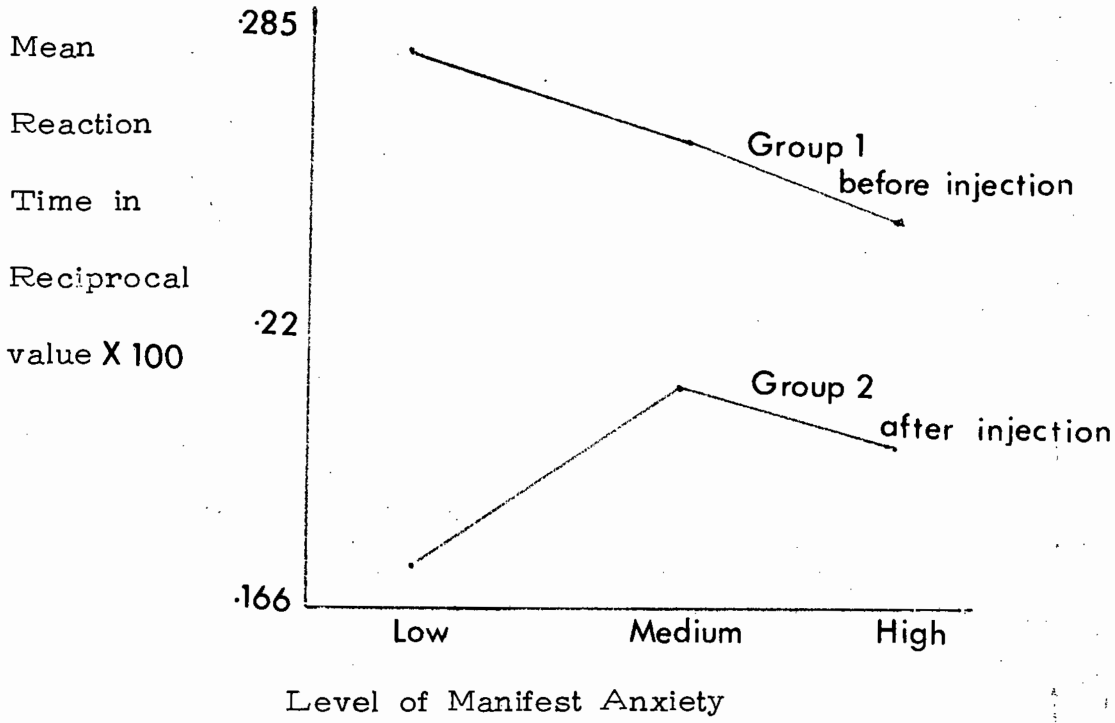
Effects of Arousal: Being of prime importance to the present study a review of some depth will be given here, if only to illustrate the confused and divergent results prevalent in this field of reaction time studies. Meyer's (1953) work would indicate that a moderate degree of excitation is likely to lead to a superior performance; the assumption being that small amounts of added excitation are believed to recruit neurones which would contribute to the response. Furthermore, Duffy (1962) in a review of the effects of induced arousal, posits that any factor which increases the rate of energy output should result in an increase in the rate of responding. In general, however, evidence seems to indicate that induced arousal in almost any form has some effect upon reaction time performance. Nash et al (1966) found that simple reaction time is slower under conditions of induced anxiety. This is a surprising result, more especially since simple reaction time involves no decision factor, and is, by its nature, a more reflex-type task than any choice situation. Nishisato (1966) found arousal states to be associated with longer reaction times. It should be noted, however, that this study employed only momentary changes in GSR to determine an arousal state from a non-arousal state. Porges (1971) has indicated that the stimulus signal itself has excitatory properties. He found that pulse rate and respiratory rate increased at the onset of the stimulus but dropped when a "no-react" signal was presented. Ellis-Smith (1971) found induced arousal - effected as in the present study, by the administration of a placebo injection - to have a negative effect upon two-choice reaction time. Danev et al (1971) in studying the relation between movement and reaction time in a choice reaction time test, found that under conditions without time stress reaction time and movement time were directly proportional. Under conditions of time stress, however, the two components were inversely related. As opposed to the aforementioned data, Allen (1969) indicated that subjects performing under conditions in which they were threatened by electric shock for slow response speed reacted faster than non-threatened subjects. Interpreted in the light of the Yerkes-Dodson Law of a curvilinear function between arousal and performance, this set of results seems to fit the picture admirably: in that increased amounts of arousal facilitate a faster performance. Against the earlier mentioned evidence, however, this picture is a particularly confounding one. If one allows that fear of electric shock is considerably more arousing than previously mentioned situations, one would expect performance to be vastly inferior under such extreme conditions. Nonetheless, this apparent non-congruity may feasibly be ascribed to the situational variables and the experimenter effect, factors upon which several authors have commented. (Sarason, 1960; Sarason and Palola, 1960; Kintz, et al, 1965). Where possible this latter variable was controlled for rigorously in the present study. Experimental instructions to each subject were given by way of earphones from a prerecorded tape, eliminating thus, interpersonal contact during a critical phase of the experiment. If motivating instructions are considered to be arousal inducing then a similar interpretation to the above for the diversity of results would seem possible. Kushner (1963) found motivating instructions to have no significant effect upon simple reaction time; however, in a more complete reaction situation Worrell and Worrell (1963) found motivating instructions to be consistent with a drive interpretation. That motivating instructions do affect performance is generally accepted; however, since situational and experimental procedures differ markedly it seems possible to submit that diversities in results obtained will occur. Similarly, the effects of knowledge or results would conceivably have arousing or motivating properties. Coules and Avery (1966) found that subjects informed of their results reacted significantly faster than subjects who were left uninformed and further, that fast mean reaction times were associated with a high GSR index. Locke, (1968) studying the effects of knowledge of results - feedback in relation to goals - on reaction time performance, found that it was the subjects' goal rather than the knowledge of their results which appeared to govern task performance. Finally the effects of induced muscle tension may be viewed as being systemically analogous to an arousal state. Murphy (1966) investigated the effects of dynamometer induced muscle tension (DIMT) upon auditory reaction time. It was found that in the initial stages reaction time was directly related to DIMT, but as subjects became habituated to the effects of muscular tension, so its influence diminished to a point of little, if any, effect. Yensen (1966) suggests that increases in muscular tension may occur just prior to the initiation of the response under conditions of artificially increased mass, contributing to the finding of significantly faster reaction times under these conditions. It should, however, be noted that generally, such conditions will follow a curvilinear pattern, such that beyond an optimum level of tension, stress or arousal performance will decline. (Shore, 1958; Wood and Hokanson, 1965).

Manifest Anxiety and reaction time:

Although the rationale and interpretation of the Taylor Manifest Anxiety Scale will be dealt with in detail in Chapter 3, several points are worth some scrutiny at this juncture. Results from studies in which level of manifest anxiety has been the independent variable are diverse and misleading, yet despite a marked incongruity in this area, a distinctive pattern can be seen. It would appear that in general, low anxiety subjects perform faster in the initial stages of experimentation. However, with diminishing task difficulty through practice effect, high anxiety subjects show a far greater improvement in performance than do the low anxious subjects. This relationship is corroborated in the present study in the two-choice reaction Task 1.

FIGURE 2 · 1

Graph showing mean performance on Task 1 before and after the administration of the placebo injection. (Reaction times scores are given in reciprocal values x 100).



From Figure 2 · 1 it can be seen that following the administration of the arousal-inducing placebo injection, performance of all anxiety groups was impaired. However, consistent with expectations, the high anxiety group utilized more expeditiously the effects of the arousal situation. Several points warrant mentioning here:

(i) Subjects performing task 1 first and then task 2 after the placebo injection are designated Group 1. Subjects performing task 2 first are designated as Group 2.

(ii) the level of task difficulty in Task 1 is relatively simple.

(iii) the patterns obtained in the two "before" - "after" graphs conform in essence to the principle of the Yerkes-Dodson Law in that with increasing arousal, performance should deteriorate once beyond the optimum.

(iv) Task 1, when performed after the administration of the injection was also therefore performed after the completion of Task 2.

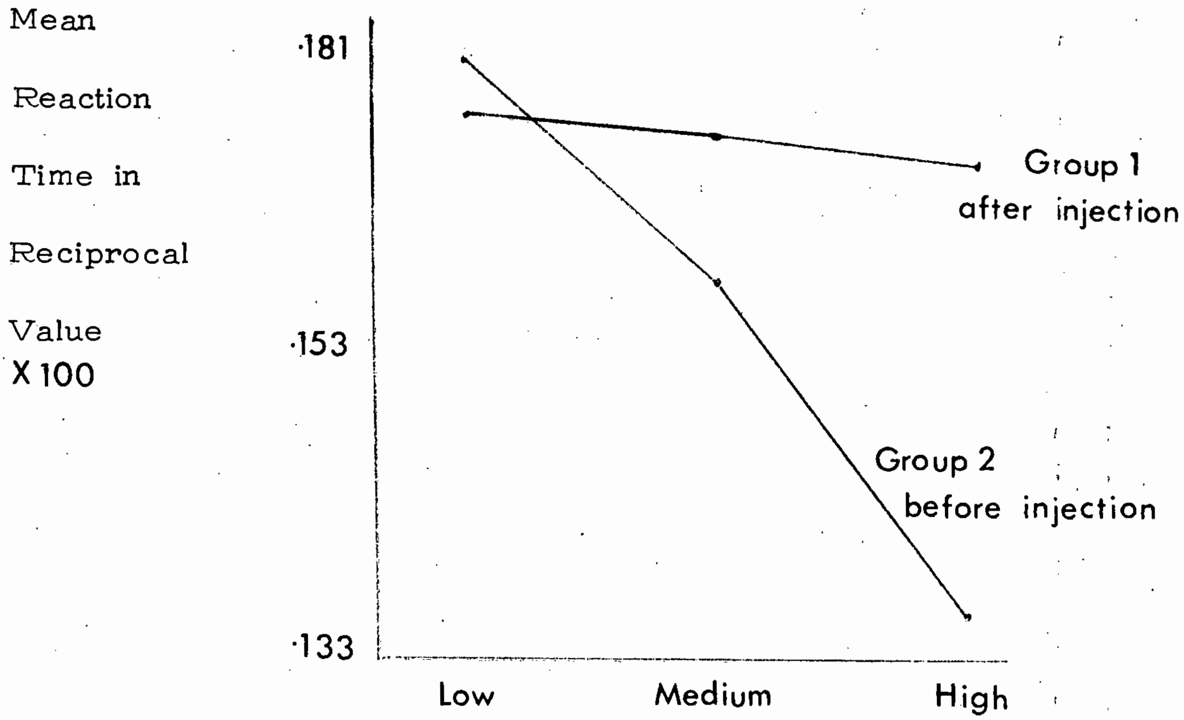
Rather than having facilitatory practice effects, this produced a negative effect upon reaction time. This was expected since subjects were not informed as to the complexity of task they were to perform either before or after the arousal situation. In consequence Group 2 who performed Task 1 after Task 2 were probably in a state of expectation and uncertainty, contributing thus to a greater state of arousal already induced by the placebo injection.

In contrast to performance on Task 1 performance on Task 2 reveals more complex results.

/FIGURE 2 · 2

FIGURE 2 . 2

Graph showing mean performance on Task 2 before and after administration of the placebo injection. (Reaction time scores are given in reciprocal value x 100)



Level of Manifest Anxiety

In Figure 2 . 2 the effects of the test situation and the complexity of the Task 2 are shown in clear profile by the performance of the High Anxiety subjects in Group 2, where performance is at its lowest. However, in the case of Group 1, the high anxiety subjects show no such trend, the low-, medium- and high anxiety subjects performing very nearly identically. In summary then it is apparent that performance on Task 1 was impaired by the arousal situation and by the preceding Task 2. In contrast, performance on Task 2 was facilitated by earlier performance on the easier Task 1 and by the arousal situation. These results are discussed in greater detail and given deeper analysis in a later section of this work under Results. For a combined illustration of both Task performances see Appendix Figure 1.

Similar results were obtained by Stabler and Dyal (1963) who likewise found High anxiety subjects to improve relatively more rapidly as the experiment progressed. Referring once again briefly to Figures 2 . 1 and 2 . 2 it will be noted that in both Task 1 and Task 2 the High anxiety subjects prior to the arousal situation are always the slowest performers, as the experiment advances to the post-arousal stage they improve markedly. A similar trend was obtained by Ellis-Smith (1971). Indirectly supportive of this finding are the results of a study by Kamin and Clark (1957) in which the same group of subjects was used first in a simple reaction time test, and then in an avoidance reaction time test; where subjects were told that they would be shocked if they responded too slowly. Results showed that the higher the anxiety level, the slower was both the simple and the avoidance reaction speed. However, the greater the anxiety score the greater was the increase in speed of reaction from simple - to the avoidance time conditions. Costello (1968) attempted to manipulate the level of subjects' emotional excitement by two means : by selecting high and low scoring subjects on the manifest anxiety scale and by giving half the subjects a threat of shock for poor performance. The results obtained indicated that the high anxious subjects had slower reaction times than did low anxious subjects. These results are consistent with the findings of Kamin and Clark (1957); however, Costello failed to find any interaction between anxiety level and threat of shock versus no threat of shock. Olmedo and Kirk (1971) found similarly that low anxious subjects gave a superior performance in a motor reaction time task to that of high anxious subjects. Worrell and Worrell (1963) reported level of anxiety to be unrelated to reaction time. Nash et al (1966) found similar results, but drew attention to a factor already mentioned in this chapter : that of the experimenter himself. They found the presence or absence of the experimenter to have a noticeable effect upon results. Desiderato (1964) in a simple reaction time experiment found high anxiety subjects to react significantly faster than low anxiety subjects when the stimulus was presented in the form of an electric shock. This mode of stimulus is in itself arousal-inducing, a factor which must significantly affect results.

From this latter paragraph emerge several distinctive patterns which warrant some attention. These are:

(i) The presence or absence of the experimenter in the study, i.e. the experimenter effect.

(ii) the level of task difficulty

(iii) the nature of the stimulus and

(iv) the apparent tendency of high anxious subjects to utilize more effectively than low anxious subjects any induced arousal in the test situation.

This last mentioned point, if interpreted in terms of a curvilinear relationship between performance and arousal, is supportive of Duffy's (1962) and Meyer's (1953) work, that added excitation contributes to level of response, provided that level of anxiety is seen as an increasing value on the ascending or left hand side of the curvilinear graph, below the optimum. It should, however, be noted that the relationship between individual differences in anxiety and response to stress is a complex one meriting intensive study.

Effects of extraneous stimulation and sense modality employed: Excessive non - task - relevant stimulation results, as a rule, in a lowering of performance. Paradoxically, at lower levels of intensity irrelevant stimulation may serve as a facilitatory mechanism. This may feasibly be explained in terms of Duffy's (1962) suggestion that increased energy mobilization accompanies a greater force of response. Illustrating this point is the study by Morgan (1916) which showed that distraction in the form of noise while the subject was striking the keys of a typewriter, both increased the force with which the keys were struck and improved the quality of the performance. An analogous situation appears prevalent in reaction time studies. Known as the intersensory effect, (Bernstein 1970) it has usually been noted that visual reaction time is facilitated by a simultaneous or near simultaneous auditory event. (Hershenson, 1961; Morrell, 1967; Bernstein, et al 1969; Madeiros, et al 1965). This corroborates the earlier finding of Todd (1912) who showed that when more than one sense modality is employed to perceive the stimulus, reaction time is shortened. In the present study, to eliminate this highly significant variable, earphones were placed over the subject's ears. Although the earphones served no purpose other than to deliver to the subject the procedural instructions prior to the commencement of the experiment, they did nonetheless, act as a highly efficient noise - screening device. Rutschmann and Link (1964) and Horinchi (1966) found auditory reaction time to be significantly shorter than visual reaction time.

Stimulus intensity: There appears to be a linear inverse relationship between the intensity of the stimulus and latency of response. This finding is corroborated by a large bulk of literature (Madeiros, et al, 1965; Thomas, 1967; Pollack, 1963; Purohit, 1966; Bixler, et al, 1967). Moreover, this relationship appears to hold true regardless of whether the stimulus is presented visually or aurally. In a long-term study on a single subject, Borghi (1965) obtained 4,000 visual reaction times using two intensities of stimulus luminance. For each luminance level a normal distribution of response latencies was obtained. In the first case (low luminance) the mean response latency was 221.3 m.secs. In the second case of high luminance the mean response latency was 209.3 m.secs. In the present study the stimulus lights used in Task 1 were at the intensity of .25 lumens/square foot; while the peripheral stimulus lights associated with Task 2 were at the intensity of .30 lumens/square foot. The red central stimulus lights were of a lower intensity as they were more easily perceived than the peripheral lights, which, in order that they should not be overlooked were white and of correspondingly greater intensity.

Sex differences: Coules and Avery (1966) found males to react significantly faster in all experimental conditions than females. Corroborative of this evidence is the finding by Tandon (1967), who used five different types of reaction time : natural, sensory, discriminative and choice. He found significant sex differences to exist, in that for every type of reaction test females were slower to react than males. For this reason sex was held constant in the present study and only male subjects were used, since any variability in performance in a both - sex study could well have been ascribed to an incorrect factor.

Finally a relevant factor worth noting in reaction time studies is the effect of the stimulus duration. The bulk of evidence indicates that slower reaction time performance is associated with longer stimulus presentations - i.e. a direct relationship exists between the two variables. (Pollack, 1963; Thomas, 1967; Bernstein 1970). In the present study two stimulus durations were used. For the central stimuli a duration of 750 milliseconds was employed, while the peripheral stimuli were presented for two full seconds. The reasons for the latter innovation were twofold, due to (i) the fact that the peripheral stimuli were more difficult to perceive, necessitating a scanning action on the part of the subject and (ii) the response required was of a g rosser nature, being the shar p depression of a foot pedal beneath the subject's foot.

Brain Rhythm and Reaction Time:

Evidence from neurophysiological and psychological sources suggests that the role of the Alpha rhythm, as the principle component of the autonomous electrical activity of the brain, might be as an excitability function. (Lindsley, 1952). Further evidence from studies by Bates (1951) and Kibbler and Richter (1950) showed that motor responses occurred predominantly in a particular phase of the alpha cycle. On the basis of the excitability hypothesis, Lansing (1957) experimented with the aspects of an excitability phase of brain rhythm with reference to visual reaction time. Allowing for a 50 m.sec. time lapse, from the onset of a visual stimulus to its transmission to the visual cortex, Lansing suggested that the varying speeds of reaction time may be ascribed to an excitability function. Using subjects selected for their dominant alpha rhythms, Lansing was able to demonstrate that when the stimulus was presented at the phase of alpha rhythm corresponding to the excitability phase, a mean reaction time decrease of 50 msecs was obtained.

In the present study, this aspect of reaction time was not the basis of the experiment and no attempt was made to select subjects according to their brain rhythms. However, EEG recordings were employed as a means of controlling the onset of visual stimulus. A trigger mechanism was used to detect and transmit any electrical stimulus beyond a value of .1 to .2 microvolts. Since the amplitude and voltage of EEG rhythms are proportional, the height of the wave recorded determined whether the trigger mechanism would fire. A

Beckman Dynograph was used to record the EEG data, and a Schmitt - trigger with an Active Filter incorporated, passed the signal to a Hewlett-Packard Computer, programmed to present visual stimuli at random intervals, but only on reception of the electrical impulse from the Schmitt-trigger.

This procedure allowed for a certain amount of control for the excitability phase of the brain, since for each subject the visual stimuli were presented only on an ascending wave of sufficient amplitude to trigger the signal mechanism to the computer. Coarse muscular movements do have the effect of creating vigorous high amplitude stylus movements, which would trigger the mechanism. However, subjects were requested to avoid sharp bodily movements, so that this occurrence was almost entirely eliminated. In conclusion then, the EEG data employed in this study served as an effective and systematic control.

CHAPTER SUMMARY.

With the exception of a few interactive relationships, experimental evidence on the major independent variables upon reaction time appears to be notably divergent. This does not necessarily indicate that no fixed relationships can be adduced from such evidence. What is, however, indicated is the importance to control for deceptively apparent minor experimental details. As mentioned earlier, several authors have already drawn attention to the effects the experimenter himself may have upon experimental studies.

(Kintz et al, 1965; Wintel and Sarason, 1964). Further, Duffy (1962) has stressed the overriding importance of allowing for individual differences in habitual individual activation level. Where possible, in the present study, these two contingencies have been circumvented : (i) by the use of earphones in conveying instructions as described earlier, and (ii) by assessment of individual levels of manifest anxiety by means of the Taylor Scale; this will be discussed in greater detail in the next chapter.

Reaction time studies are, by their nature, essentially quantitative and consequently therefore comparative, since a reaction time score in milliseconds has very little interpretative value unless compared to another. Thus data obtained are largely normative. As a direct consequence of this contingent, the microstructure of individual performances may suffer gross misrepresentation in the course of statistical analysis. Nevertheless, as Duffy (1962) has concluded, the bulk of experimental evidence cited in this respect indicates that differences between individuals in activation are basically differences in responsiveness or excitability; and despite the apparent inconsistencies, the studies have produced and will continue to produce some positive and valuable results.

CHAPTER III

THE TAYLOR MANIFEST ANXIETY SCALE

Its rationale and uses in

experimental procedure.

"Despite its usefulness it has not turned out to be the ultimate definition that science requires for the accumulation of knowledge and the development of sound theory."

Criticism of the Taylor Scale
in E.E. Levitt (1968)

DEVELOPMENT OF THE TAYLOR ANXIETY SCALE.

In 1951 Taylor constructed a manifest anxiety scale for use in a study of eyelid conditioning. Following Cameron's (1947) definition of chronic anxiety conditions, approximately 200 items from the MMPI were submitted to five clinicians. The judges were asked to list those items most indicative of residual manifest anxiety according to the given definition. Sixty-five items were ultimately selected. These items, supplemented by a hundred and thirty-five additional non-indicative "buffer" items were administered in group form to over three hundred undergraduate students. The measures obtained in this first administration of the initial test ranged from a low anxiety score of 1 to a high score of 36 with the median at 14.

Following several modifications, fifteen of the original items were rejected as being non-functional. Thus, at present, in its standard form the scale consists of fifty functional items supplemented by two hundred and fifty buffer items. Under the innocuous title of the "Biographical Inventory" the test in its present form has been delivered many thousands of times since its full publication in 1953. Normative data obtained from some of these studies show a slight positive skew with the fiftieth percentile falling at about 13 and the mean of the distribution at 14.56

THE DRIVE THEORY RATIONALE.

On the basis of Hull's Drive Reduction theory, anxiety or manifest anxiety, as measured by the Taylor Scale, has frequently been conceived of as being an habitual source of Drive.

Matarazzo et al, 1955; Farber, 1954; Taylor and Spence, 1952). Employed in studies on normal subjects, the scale gives an indication of the subjects' habitual level of general or residual anxiety. When used on neurotic patients, the mean scores obtained as feasibly predicted have been considerably higher. Although the scale was not designed essentially for clinical useage, such data do indicate a high degree of validity in predicting anxiety levels. Experimentally, however, the basis of the scale is the Hullian concept of Drive. In order that the use of the Manifest Anxiety Scale in the present study may be understood in its connection with the Yerkes-Dodson principle described in the next chapter, Hull's drive theory warrants brief elucidation here.

According to Hull (1943) all Habits (H) activated in a given situation combine multiplicatively with the total effective drive state (D) operating at that moment to form excitatory potential (E); where $E = f(H \times D)$. Total effective drive in the Hullian system is determined by the summation of all extant need states, primary and secondary, irrespective of their source and their relevancy to the type of reinforcement employed. Since response strength is determined in part by E, the implication of varying drive level in any situation in which a single habit is evoked is clear : i.e. the higher the drive, the greater the value of E and hence of response strength. Thus in simple experimental situations involving only a single habit tendency (or elicited response) the performance level of high-drive subjects should be greater than that for low-drive groups. However, higher drive levels do not lead infallibly to superior performance (i.e. probability of correct response). On the basis of interpretations on the Yerkes-Dodson principle of performance, task complexity and optimum motivation (Drive), the relative performance of high- and low- drive groups will depend upon the number and comparative strengths of the various response tendencies. (Broadhurst, 1959). Predictions concerning the performance of the groups in such complex tasks involve the introduction of additional Hullian concepts : oscillatory inhibition (O) and threshold (L). The concept of O was introduced by Hull in an attempt to allow for intraindividual variability in behaviour that occurs presumably because of uncontrolled variations from instant to instant within the organism and his environment. O is further assumed to play an inhibitory role, its value being subtracted from excitatory potential E, thus yielding momentary excitatory potential E. For E to activate a response, it must attain a maximum or threshold value, a value that is presumably the same for all similar habit tendencies evoked in a given situation. Thus R = f (E) = f (E-O-L). Consequently, any task in which a stimulus tends to evoke a number of competing responses, the response that will appear on a given occasion will be the one with the highest supra-threshold momentary excitatory strength (E) at that moment. Thus the response with the highest H and hence E value, will have a greater probability of occurring than any other response regardless of correctness or quality.

On the basis of inter-individual differences in drive levels it is apparent that the probability of appearance of the correct response involves an interaction between drive level and the number of comparative strengths of the correct and incorrect tendencies. Thus, when the correct response is weaker (has less H) than one or more of the competing response tendencies, high drive groups should be inferior in performance to low drive groups. It follows that because of the multiplicative relationship between habit strength and drive, the stronger, incorrect tendencies gain relatively more E than the correct tendency leading thus to a greater probability of occurrence of one of the stronger incorrect responses in the high drive group.

In the light of the Hullian interpretation of Drive, it is now possible to examine Taylor's (1956) explanation of the relationship between Drive and Anxiety, which conceptually forms the underlying rationale of the Manifest Anxiety Scale. The scale, when used as an indicant to select groups of subjects that differ in drive level in an experimental situation, relies on the assumption that scores on the scale are in some manner related to emotional responsiveness, which correspondingly contributes to drive level. Taylor posits two alternative hypotheses to fit this assumption, the first being that : test scores reflect differences in a chronic emotional state, so that individuals scoring high on the scale tend to bring a higher level of emotionability or anxiety to everyday matters than do subjects scoring at lower levels. The second possible explanation is that manifest anxiety scores reflect some potentialities for anxiety arousal; high scoring subjects being those who tend to react more emotionally and adapt less readily to novel or threatening situations than do low scorers. The former interpretation forms the basis in most experimental studies in which subjects are grouped to allow for individual differences in arousal. (Nance, 1965; Nishisato, 1966; Olmedo and Kirk, 1971; Ellis-Smith, 1971.) However, on the basis of obtained experimental results in which anxiety has been controlled for or eliminated, it would seem that it is in fact that second of the two hypotheses posited that is the operative one. (Sarason, et al 1960).

Sarason (1960) has made the point that most experiments which employ anxiety scales usually also involve some degree of induced arousal. Typically such arousal or stress has been created by means of verbal instructions, for example, informing the subject that the test he is performing is indicative of intelligence. Most investigators have assumed that high anxious subjects would be more sensitive to implied personal threat than would low anxious subjects. Indeed, the bulk of the findings (Mandler and Sarason, 1952; Sarason and Palola, 1960;) suggest that high anxious subjects are affected more detrimentally by motivating conditions or failure reports than are subjects lower in the anxiety score distribution. Illustrative of this type of study is that of Davidson, Andrews and Ross (1956) in which the three variables of MAS; reports on levels of failure; and speed of stimulus presentation were studied. Significant interactions were obtained among all of the variables, the authors concluding that high anxious subjects are more sensitive to experimental stress than low anxious subjects. As a corollory to this finding Sarason's (1958) study indicated that subjects scoring high in test anxiety responded more positively to reassurance in an experimental situation than do low anxious subjects. Consistent with this theme is the indication that there are no differences among groups differing in scores on anxiety scales when tested under neutral or non-threatening conditions. (Axelrod et al, 1956.) In a series of experiments involving the effects of anxiety and experimental stress in verbal learning, Sarason (1956) failed to find, under pre-experimental neutral conditions, significant differences in performance between groups which differed in anxiety, although varying performance was obtained under later conditions of personal threat. This suggests a sensitivity inter pretation of manifest anxiety as suggested by Wassenaar (1964) and Davidson et al (1956).

In the present study the personal threat implications were fairly extensive, the test being conducted under the g uise of a pilot-selection programme. Each subject consequently felt his performance to be very much "on show". That the present study's findings corroborate the aforementioned evidence is illustrated by the pre-arousal performance on both Task 1 and Task 2 of the High anxiety group of subjects. In both levels of task complexity the high anxiety subjects performance was inferior to that of the medium anxiety group which in turn was inferior to that of the low anxiety group. Following arousal, change of task complexity and habituation to the experimental situation, however, this picture altered markedly. For Task 1 the performance of the three anxiety groups as plotted graphically describe an inverted - U function, while on Task 2 the function is nearly linear, there being very little difference in performance level between the three anxiety groups. These functions are best seen in the Appendix Figure 1.

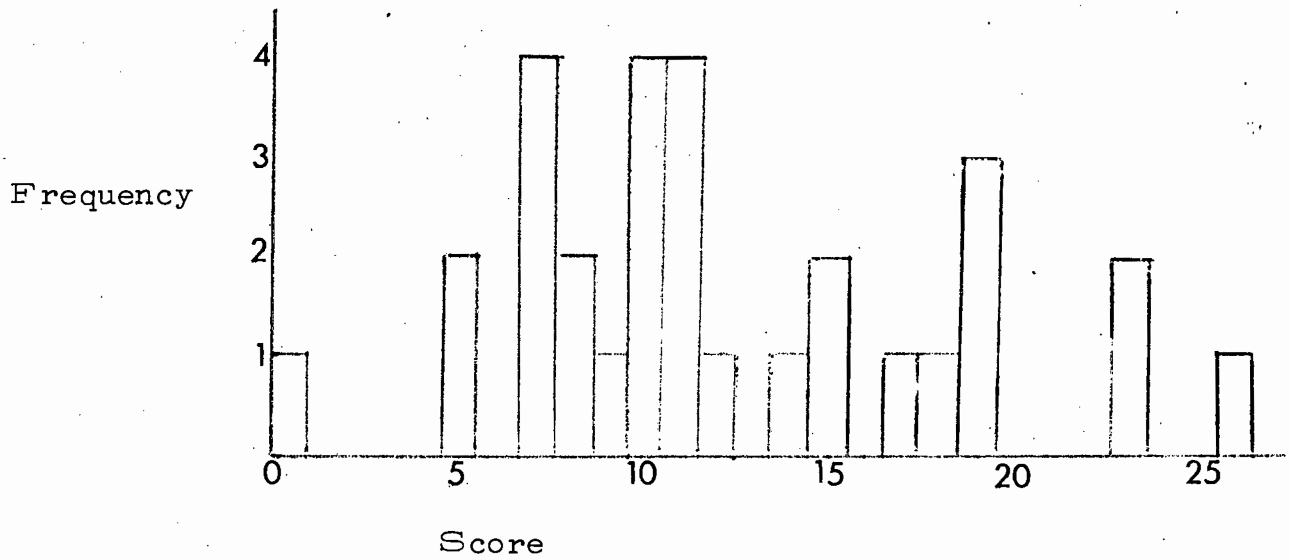
For the High Anxiety subjects in the present study then, it would seem that once they had overcome the initial overall inhibitory effects of adaptation to the experimental situation and task to be performed, performance equalled, if not surpassed, that of the lower anxiety subjects. This interpretation would be in line with the results of a study by Liebert and Morris (1967) in which it is suggested that task anxiety is composed of two major aspects. The authors table these two components as worry and emotionality. The worry (W) component is described as cognitive concern over performance, and emotionality (E) as the autonomic arousal aspect of anxiety. The authors devised a brief situational measure of Worry and Emotionality based on TAQ items. This scale was administered to subjects several days before an examination, immediately before and immediately after. Scores on the W component tended to be fairly constant while E scores reached a peak immediately before the examination, falling of rapidly immediately after. Analysis of the results indicated that emotional arousal appeared to bear no consistent relationship to performance on intellectual or cognitive tasks, while worry was consistently and negatively related to performance.

A point worthy of notice here is that of level of task complexity. This appears to be an independent variable equally important as that of the MA score itself. There tends to be an interaction between the two variables, such that where task complexity is low a high anxious subject may show better performance than a low anxious subject; but where task complexity is high a high MA score would serve as an inhibitory factor. Although the former point is not corroborated in the present study the latter point is clearly indicated, at least in the pre-arousal group 2. This is most clearly illustrated in Figure 2 · 2 in the previous chapter. In this connection Sarason and Palola (1960) manipulated simultaneously the variables of anxiety, differential motivating instructions and task complexity. Significant triple interactions involving the three variables were obtained in a pattern conforming to the Yerkes-Dodson principle relating motivation, performance and task complexity.

At this juncture it is expedient to review the findings in the present study. Thirty subjects were used allowing thus for the uniform allocation of ten subjects to each of the three anxiety groups, corresponding to high, medium and low scores on the Taylor Scale. In the distribution of the scores obtained the mean fell at 15·3 and the median at 10·5 giving the distribution a positive skew. This tendency is well illustrated in the histogram representation of the distribution. See Figure 3 · 1

FIGURE 3 · 1

Histogram representation of the thirty MA scores obtained



Allocation to the different anxiety groups was effected by labelling all scores below, but not including 10, to the low anxiety group; all scores between 10 and 14 inclusive to the medium anxiety group; and all scores of 15 and above to the high anxiety group. In this distribution the lowest score was an improbable zero, and the highest score was 26. The means of the three groups were 6 · 3, 11 . 0 and 19 · 4 for the low, medium and high anxiety groups respectively. See Appendix Table 2. While the distribution shows an average spread of scores, the technique used for allocation has obvious shortcomings. Ideally a far greater number of scores should have been obtained and a more selective appraisal of allocation given, such that say only scores of less than five be designated Low anxiety, and only scores greater than twenty be designated high anxiety. A clearer delineation of anxiety groups would consequently be allowed.

The degree of correlation between inventory scores and physiologically obtained scores of anxiety and arousal appears to be tenuous. However, Heilizer and Cutter (1971) using risk taking performance as arousal inducement and manifest anxiety score as level of chronic anxiety found : a high level of anxiety to be associated with a large degree of arousal; and the overlap between anxiety and arousal to be greater in a situation of high arousal. This study, at least, indicates that Malmo's (1957) theory of congruence between anxiety and arousal can be extended to include the range of normal, non-pathological anxiety. Results from the present study, however, sho w no such tendency, there being no significant correlation between MA scores and any of the physiological indices, although there is some correlation between the physiological indices themselves. (See Tables 4(a) and 4(b) in the Appendix). These results are discussed in greater detail in a later chapter.

Similar correlational studies in which anxiety and physiological correlates are studied show inconsistent results. As it is defined clinically, it is assumed that anxiety has important physiological correlates. Calvin et al (1956). In support of this assumption positive results were obtained experimentally by Kissel and Littig (1962) in a study involving GSR and Test Anxiety Quotient: TAQ. GSR scores were obtained while subjects worked at four unsolvable and hence failure inducing tasks. A high correlation between GSR reading and TAQ was obtained. Wing (1954) found significant positive correlations between GSR, EMG and pulse rate in patients with anxiety states. It should be noted, however, that most experimental studies do not aim to include extreme or pathological cases. Non-confirmatory evidence was obtained by Winter et al (1963) in which the two measures of anxiety used : score from the Affect Adjictive Check List (AACL) and PSI showed no significant correlation.

From the experimental evidence of the latter two paragraphs several factors became apparent:

(i) Where there is a continuous stress situation of sufficient intensity, physiological indices and inventory-assessed anxiety do show a positive correlation. This point throws some doubt on the lasting effects of placebo induced arousal employed in the present study;

(ii) Not all physiological indices correlate positively with each other as they are expected to do in a particular arousal situation. To this extent some studies may show positive results while others are inconclusive.

(iii) The various anxiety questionnaires may quite conceivably be assessing aspects of anxiety which in themselves are different, such that a positive result using the AACL might not be replicated using the MAS.

(iv) The essence of anxiety questionnaires is the measurement of predisposition to anxiety and not an immediate state.

(v) Inventories are subject to certain response biases, primarily those which result from the tendency of most people to present themselves in a desirable light; as such the reliability of such inventories is, to some extent at least, questionable.

Finally, of particular reference to the present study, which incorporated the use of peripheral stimuli to effect an increase in level of task difficulty, the interaction between manifest anxiety and cue utilization warrants some scrutiny. The implications of studies by Wine (1971) and Doctor and Altman (1969) are that the high anxious subject attends to fewer task cues than does the low anxiety subjects. Such an interpretation is consistent with Easterbrook's (1950) finding concerning the relationship between arousal level and task variables. His research indicated that emotional arousal consistently narrowed the range of cue utilization in task performance. Supportive evidence to this interpretation using anxiety levels is given by Agnew and Agnew (1963); West et al (1968); and Wachtel (1968). Wachtel's study showed more especially that anxiety did not generally impair all performance - different anxiety level groups did not differ significantly on the central task - but only performance on peripheral aspects of the task. These results would tend to indicate that there is a narrowing of attention to task cues as a result of test anxiety. In general, strong arousal states or high anxiety scores are usually associated with a certain amount of disruption of organization; this disruption being reflected in a reduction in the range of cues used by a subject. In the present study it was expected, though not established, that following an arousal situation high anxious subjects performing a complex task involving peripheral cues would show a marked deterioration in performance. That this effect was not obtained is most feasibly ascribable to the earlier mentioned factor that placebo induced arousal is probably short lived, and would consequently have no lasting deleterious effect upon complex performance. Nonetheless a similar set of results was obtained by Cornsweet (1969). In a study on visually presented task-relevant, peripheral cues in a choice reaction time situation, the results showed that the use of peripheral cues was actually enhanced under conditions of arousal. Despite the confirmation that these results might lend to the present study, Cornsweet's results are nonetheless particularly confounding, since the arousal inducement technique used (electric shock) was sufficiently intense as to elicit indications of acute discomfort from the subjects. While the left hand slope of the curvilinear function could explain the data in terms of arousal and optimum performance, the level of induced arousal as assessed by the subjects themselves, should have produced results well beyond the optimum.

CHAPTER CONCLUSION.

As Sarason (1960) and Levitt (1968) have indicated, the construct validation of anxiety itself is at a radimentary stage. Moreover, it may be asked, are "true" and "false" pencil-and-paper tests the most appropriate measure of anxiety? Probably the most parsimonious statement that can be made concerning what is measured by existing scales of anxiety is that they measure the extent to which an individual is willing to admit to experiencing anxiety in certain situations. Nonetheless, until a more comprehensive and accurate measure is devised, the Anxiety Scale is both a useful tool and indicant in studies which allow for individual differences in level of habitual emotional arou sal or general anxiety.

CHAPTER 1V

THE YERKS-DODSON LAW

and

THE CURVILINEAR RELATIONSHIP

..... "As difficultness of discrimination increases, that strength of stimulus which is most favourable to habit formation approaches the threshold."

Yerkes and Dodson (1908)

In this chapter the implications of the Yerkes-Dodson Law in any study involving performance and motivation - or arousal - will be discussed. Further, the effects of increased task complexity with respect to the present study will be assessed in the light of this principle. The use of the Manifest Anxiety Scale, discussed in the last Chapter, will be explained in terms of expected differential task performance on the basis of the inverted - U curve, and the interpretative value of this function in accounting for different levels of performance will be assessed. A brief historical survey of the field should, however, be given since this will explain the development and complexity of the principle for its use in the present study.

In 1908 Yerkes and Dodson jointly published a work which dealt with discrimination learning of the rat; where discrimination involved the distinguishing between different brightnesses of grey paper in a Yerkes box. The animals were rewarded for correct responses and punished with an electric shock for a wrong response. The authors found that in simple discrimination i.e. a large difference between the brightness of grey-coloured paper, increasing shock facilitated faster learning in the animals. However, an optimum or peak shock intensity was reached beyond which further increases led to slower rather than to faster learning. This was to be the first recorded illustration of the curvilinear relationship between motivation and performance. Notwithstanding, Yerkes and Dodson went on to investigate, concurrently with shock intensity, the effect of a second variable - task difficulty. By increasing the difficulty of the task, they demonstrated that the curvilinear relationship, just obtained, was altered. The optimum or peak learning point now oc curred at a lower shock intensity than before. As they expressed the finding they stated ......"An easily acquired habit may be readily formed under strong stimulation, whereas a difficult habit may be acquired readily only under relatively weak stimulation." (Broadhurst, 1959) It is this decrease in the optimum motivation with increasing task difficulty which constitutes the principle of the Yerkes-Dodson Law. More succinctly stated, the principle may read as stat ing : the optimum motivation for learning decreases with increasing task difficulty. (Broadhurst, 1957).

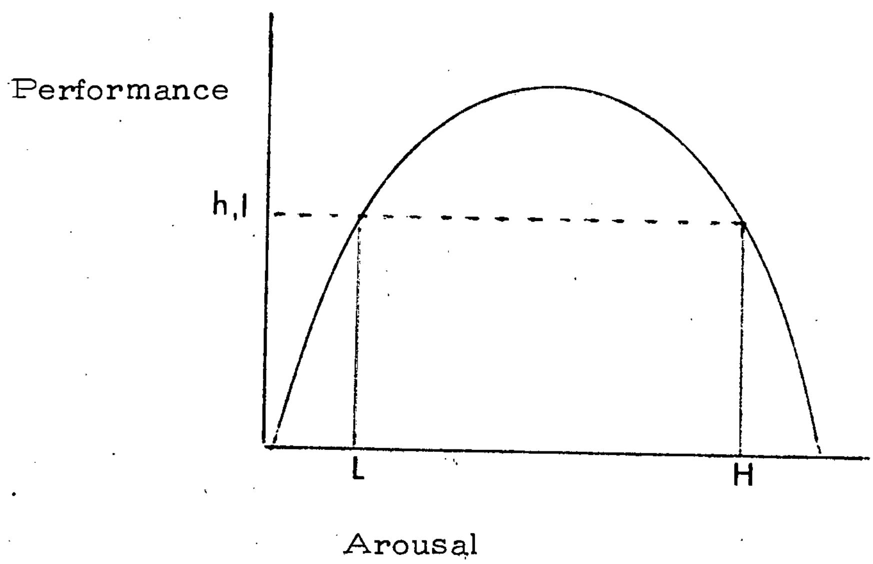
Having posited experimental principle so profound in its implications, it is strange to reflect that for the next fifty years nothing was to be heard of the work. However, on closer inspection the reasons for this can readily be found. Firstly, and most apparently, it is suggested that the original workers failed themselves to recognise the potential importance of the principle which they had formulated. Secondly, the spirit of the times in the first few decades of this century was, in America, strongly behaviouristic. The emphasis, consequently, lay on the conditioning process in learning, with less stress on the motivating conditions. It was only with the greater acceptance of Hull's revisions of the learning theory of Pavlov, and Hull's emphasis on drive reduction as a central concept, that motivation once again became a subject of study.

The third and final reason for the long neglect in the field is the complexity of the phenomenon it specifies. Until the introduction of Fisherian statistical methods, (after Sir Ronald Fisher) especially the complex analysis of variance, experimenters were unqualified to attempt any experimentation involving the effects of more than one independent variable upon a dependent variable. For the next fifty years then, this field of research remained dormant; the subject was, by all intents, closed.

In 1955 Hebb published a paper in which he summarised motivation theories from early studies on nervous conduction through to the time of writing. Paraphrasing and unifying the works of Hull (1943), Harlow (1950), Duffy (1941), Schlosberg (1954) and Lindsley (1951), Hebb reawakened interest in the curvilinear graph at a time when science was receptive to its implications. Hebb drew attention to the existence of a physiological mechanism probably underlying the notion of arousal : the arousal system in the brain stem. Lindsley (1951). Hebb equated arousal with drive .... "arousal in this sense is synonymous with a general drive state, and the conception of drive therefore assures anatomical and physiological identity." This arousal function, he argued, forms the basis of the curvilinear relation between it and cortical efficiency with an optimum level of response or learning. The field of interest thus awakened, studies based on the inverted - U curve began to proliferate. The reasons for this are necessarily the reverse of those which held for the dormancy period. Moreover, as composite relationships could now be quantified with the advanced statistical procedures available, and hypotheses pertaining to an unlimited range of behaviour could be formulated, the phenomenon rapidly developed as a fertile field for experimental psychology. Although curvilinearity and the Yerkes-Dodson principle are not the same thing, the latter necessarily includes the former. At this juncture a more thorough examination of the implications of any curvilinear graph is expedient.

An inverted - U relation such as that between performance and arousal, implies that for any given value of performance except the optimal, there will be two possible values of arousal; so that although level of performance is predictable, given level of arousal, level of arousal cannot be ascertained merely from knowledge of performance. Duffy (1941) and Taylor (1953) have indicated the necessity of allowing for individual differences in drive level and general arousal: a curvilinear interpretation accounts neatly and quantifiably for such differences (Corcoran, 1965).

Figure 4 · 1



The inverted U curve may be used to ascertain which members of a group of subjects are operating at high levels of arousal and which at low levels. A group of subjects who are high in arousal may be considered to occupy a position along the abcissa of the above graph, (Figure 4 · 1) somewhere to the right of the low arousal group. For convenience the high arousal group is located at H and the low arousal group at L, such that the level of performance of both groups is h, l. It is possible then to ascertain which group has the high level of arousal either by decreasing the level of arousal of all subjects or by increasing it, since if level of arousal is decreased then H's performance will improve by ascending the curve, while L's performance will decline. Similarly, H's performance will decline and L's performance improve if the level of arousal of both is increased. The two groups may be differentiated by these methods no matter what positions they occupy along the arousal dimension, provided that H is to the right of L.

While all the above information is axiomatic it does hinge on two basic premises : (i) that there is a suitable method for changing arousal, and (ii) there is some technique for assessing the level of arousal at which subjects habitually operate. The first requirement can be met in a number of ways. Examples of arousal inducement procedures include : threat of shock, threat of failure, urging instructions, DIMT, induced frustration and hostility, a variety of noxious stimuli, and of pertinence to the present study, the placebo phenomenon. (Shore, 1958; Patton, 1968; Martens and Landers, 1970; Broadhurst, 1957; Meyer, 1953; Stennett, 1957; Freeman, 1938; Ellis-Smith, 1971.) Arousal reduction is usually facilitated by the Experimenter himself who usually indicates that the experiment itself is unimportant, that the subject's performance is well above average. The second requirement, that there be some indication of the subject's residual arousal, is most frequently met by obtaining scores from inventories such as the Taylor Scale, the AACL or the TAQ discussed in the last chapter; or by delivering some form of self-rate inventory requiring the subject to indicate his subjective degree of bodily excitation at a given time.

In the present study, from the preliminary results shown in Appendix Figure 1 several points warrant explanation. While a more comprehensive analysis of the results is given in chapter 6, the performances shown in Appendix Figure 1 are nonetheless illustrative of predicted trends. It should be noted that in Appendix Figure 1 as in the case of Figures 2 . 1 and 2 . 2 in Chapter 2, the reciprocal values of the mean reaction time scores are given. This enables the graph to be conveniently inverted such that an upward trend indicates an improvement in performance and a downward trend a deterioration. This allows performance to be discussed in terms of the inverted - U graph. The actual reaction time scores are given in Appendix Table 5. In the light of the discussion in chapter 3, with respect to high anxiety subjects' tendency to perform poorly in novel situation, Group 1 on Task 1 and Group 2 on Task 2 highlight this tendency quirk clearly. Seen in larger profile on an inverted - U curve, these performance patterns would both fall on the right hand or descending side of the curve. This would appear to indicate, as assessed in a non-aroused condition, that high anxiety subjects are initially, generally beyond the optimum level of performance; this would account for the comparable results cited in chapter 3. That this relationship is fairly standard, is given further credence by the fact that an almost identical pattern of result was gained in an earlier study. (Ellis-Smith, 1971). A graphic presentation of these results is given in the Appendix Figure .2. Following the arousal situation, however, a new pattern emerges. Group 2 describes the predicted inverted - U curve in relation to the ascending levels of anxiety, with medium anxiety subjects performing at the optimum; Group 1, on the other hand, now performing the more complex Task 2, exhibits a near linear pattern showing very little difference in performance between anxiety levels.

From the above paragraph several points become apparent:

(i) To effect an arousal situation intense enough to drive performance beyond an optimum point, the arousal inducement should be continuous and intense.

(ii) To overcome the negative effects experienced by high anxiety subjects in the initial stages of experimentation, all subjects should be exposed to the experimental situation and several practice trials some time prior to the commencement of the experimental trials.

(iii) The arousal inducement technique used in the present study, while it might have been sufficiently intense, was not of sufficient duration to elicit the expected results. This point will be discussed in more detail in the next chapter.

Finally, an explanation for the concept of optimum interpretation would be expedient here. Meyer (1953) explained optimum motivation in the following terms - providing thus a neuro-physiological rationale for the curvilinear effect. He posited that the fact that a moderate degree of excitation is more likely to lead to superior performance, may be explained by the assumption that small amounts of added excitation are believed to recruit neurones which would contribute to the response. Greater degrees of excitation are believed to recruit more remote pools of neurones so that inappropriate neurones would also be activated. Interference with performance therefore, would be due to the facilitation of competing responses. Such an explanation would account for inappropriate muscular tension, to the extent of performance disruption at extreme levels of activation. Moreover, this hypothesis would explain, quite adequately, why inter-sensory disruption at high intensities usually has an inhibitory effect upon performance. In keeping with Meyer's interpretation, McNamara and Fisch (1964) found, in a study on the effects of level of motivation acts consistently to reduce the number of cues utilized in a performance task, when these cues are relevant to completion of the task. Supportive of Meyer's theory, Duffy (1962) has indicated that excitation in one part of the body appears in general to be accompanied by excitation in other parts and not, as might conceivably have been the case, by compensatory inactivity in other tissues. Wood and Hokanson's (1965) study supports this notion by demonstrating that heart rate as a function of increasing muscular tension, increased linearly throughout the range of tension; whereas a curvilinear effect was obtained on an intellectual task. As the level of muscular tension increased so performance on a simple intellectual task increased until an optimum point was reached, beyond which performance level decreased progressively. Duffy's interpretation of overall excitation could similarly be used to account for the result obtained by Di Scipio, (1971) who found that white noise facilitated massed psychomotor performance for an optimal period of time, after which the noise became a progressively more disruptive stimulus.

CHAPTER CONCLUSION.

It would appear from the findings discussed in this Chapter that while the inverted - U concept is a useful means of explaining differences in performance as a function of motivation or arousal, the method of establishing just where on the curve a particular arousal score will fall needs greater clarification. The elementary logic of the inverted - U relation is an appealing feature; moreover its implications apply to almost any study in which performance is measured against some ongoing independent variable.

CHAPTER V

THE PLACEBO EFFECT AS A MEANS OF INDUCING PHYSIOLOGICAL AROUSAL. PHYSIOLOGICAL INDICES EMPLOYED TO ASSESS AROUSAL

.... "Take thou this vial being then in bed,
And this distilled liquor drink thou off;
When presently through all thy veins shall run
A cold and drowsy humour for no pulse
Shall keep his native progress,
No warmth, no breath shall testify thou liv'st...."

Shakespeare's
Romeo and Juliet
Act 1V Scene 1.

Within the bounds of clinical psychology and psycho-pharmocology, the Placebo Effect has remained a poorly explained phenomenon. While the implications of placebos are used extensively in medicine, attempts at advancing a feasible rationale have been notably few. In the present study the placebo effect was used as an effective, though short-lived, method of inducing a state of physiological arousal. In tentative explanation of the phenomenon, this chapter reviews briefly some of the evidence in the field with reference to its use in the present study, and attempts to link such evidence with evidence from existing psychological and psychophysiological studies.

As the quotation from Shakespeare's Romeo and Juliet would tend to indicate, placebos can be used positively or negatively; moreover, suggestibility, or receptivity would appear to be of prime importance for the effectiveness of any placebo. Fischer and Dlin (1956) define a placebo as "an agent employed with or without some ritual, but always with the suggestion or implication of its power or helpful properties," and placebo reaction as, "the physiologic and psychologic reaction to the administration and acceptance of the placebo, this reaction can be positive and beneficial or it can be negative and detrimental." English and English (1958) define a placebo as...."a preparation containing no medicine and administered to cause the patient to believe he is receiving treatment." Of equal importance is that the patient have knowledge of the effect the placebo is to produce; the desired appearance or disappearance

point was effected by the rather overwhelming experimental situation and the insidious smell of diethyl ether, reminiscent of hospitals and surgeries. The second point was clarified in some detail by the pre-recorded tape recording played through headphones to each subject, in which the effects of adrenaline were explained as clearly as possible, and, in the light of the experimental situation it was deemed that this would lend further credence and atmosphere to the study. In the case of the third point, the subjects had little cause to doubt the nature of the substance being administered to them. The final point is worth note here, as the person administering the placebo injections was herself a qualified Nursing Sister. Both she, and the experimental assistants wore white coats, and in the case of the Sister, on her coat she displayed her Sister's epaulettes, and badges. The latter such details are of prime importance in producing a placebo phenomenon; termed "placebo-cues" they are, in effect, merely supplementary stage-props, adding to the authenticity of the clinical-like setting.

Studies in which the placebo has been the subject of experiment have been strangely few. In most cases of study, placebos are used merely as a control for experimental purposes in which the efficacy of a drug or medicine is assessed. As such, placebos have seldom been the exclusive subject of experiment. However, in a review of the current literature in the field, several interesting points emerge which warrant mention, if only to stress the potential effectiveness of placebos. Gelfland et al (1963) found the placebo to be an effective agent in pain tolerance. An experimental group was tested for pain perception and pain tolerance and then given a placebo, presented as a powerful pain reliever, after which pain tolerance and pain perception were again measured. The control group were submitted to the same procedure without the placebo. The prediction was made and confirmed that the experimental group would perceive pain later and tolerate pain for longer than the control group. Of particular relevance to the present study, Frankenhaeuser et al (1953) studied the efficacy of placebo introduced either as a stimulant or depressant. Comparisons between pre - and post - placebo measurements showed that the two treatments produced marked effects in opposite directions. The "depressant" placebo produced a statistically significant decrease in pulse rate, blood pressure, objective and subjective reaction speed, as well as significant effects on subjective mood in the expected directions. The "stimulant" placebo produced opposite and significant changes in all variables. The subjective reactions were, on the whole, more pronounced than the effects on performance and physiological functions.

In the present study to assess the efficacy of the arousal induced by the placebo, three physiological indices were used. These were : (i) blood pressure, (ii) pulse rate, and (iii) palmar sweat index (PSI). The interpretation of the blood pressure index is a complex one requiring some explanation.

Blood pressure, as measured with a Sphygmomanometer, is evaluated by two indices - a numerator : the systolic pressure indicating the pumping force of the left ventricle; and a denominator : the diastolic pressure, a comparatively low pressure obtained as the left ventricle is filled by the contracting left auricle. Consequently an index such as $\frac{120}{80}$ may be obtained. However, when compared with other blood pressures this shows very little interpretative value, and as such is usually reduced to one number called the Pulse Pressure, obtained by subtracting the denominator from the numerator. Thus a pulse pressure for the above example would be 120 - 80 = 40. With increased physiological arousal and the liberation into the blood stream of adrenaline, vasconstriction occurs, causing the ventricular contraction to become more vigorous - giving rise, thus to the awareness of one's own heartbeat - palpitation and increased pulse rate. This effect increases the systolic pressure, giving a consequently higher index on the numerator. Thus, in an arousal situation the above index may rise to $\frac{130}{75}$, for example. In this case the pulse pressure is 55 which represents a pulse pressure increase, over the first reading, of 15. Thus, for pre - and - post arousal, two indices of blood pressure may be taken and expressed as a single unit, representative of the relative increase or decrease in pulse pressure.

The second physiological index used in this study was that of pulse rate. Pulse was measured at the radial pressure point at the left wrist of each subject. As in the case of the above index, pre - and post - arousal measures were taken, the difference indicating the arousing effect of the placebo. The final measure taken in this study was based on the work of Dabbs, Johnson and

Leventhal (1968). Using a chemical compound resembling a "plastic skin", which is painted onto the fingertip and dries in approximately 10 seconds, the authors were able to obtain quick and simple measurements of palmar sweating. The compound consisted of 5 gm of polyvinyl formal (Formar 15/95E); 15 ml of butyl phthalate; 20 gm of a semi-colloidal dispersion of graphite in trichlorethylene; and 100 ml of ethylene dichloride. As indicated in the study .. "Polyvinyl formal withdraws from moisture in the orifices of active sweat glands, leaving holes or bubbles in the paint. Butyl phthalate gives strength to the paint; graphite provides visual contrasts; and ethylene dichloride is a solvent." The print, thus obtained, was transferred to a slide and viewed microscopically. Under 10 - 15 x magnification, active sweat glands appeared as holes or ridges along the ridges of the fingerprint, and the number of holes in a 4 mm square area determined the Palmar sweat index.

In the present study, ethylene dichloride was unobtainable, so that 120 ml of chloroform was used in its stead. This appeared to be an adequate organic solvent with similar properties to ethylene dichloride. With respect to the colloidal dispersion of graphite, it was found that the graphite particles remained too large to be of any value, and it was consequently omitted from the compound used in this study. The slides obtained were of sufficient clarity to be used successfully; and a 4 mm grid lens was used to delineate the specific PSI area.

The result of the physiological indices were analysed in each case by a Two-Way Analysis of Variance with repeated measurements on Factor B (before and after arousal). The results of the blood pressure tests are given in the Appendix Table 6(a) and 6(b). Table 6(a) shows a summary for the Analysis of Variance from which it can be seen that the only significant difference between blood pressure indices is between the pre- and post-arousal measurements, ($F = 4 \cdot 341$, df = 1,27, $p < \cdot 05$) there being no significant differences between groups based on Manifest Anxiety scores. Comparable results were obtained from the Pul se rate scores - there being no significant difference between Manifest Anxiety groups, but a highly significant difference within the groups, before and after arousal. ($F = 39 \cdot 147$, df = 1,27 $p < \cdot 01$) Appendix Tables 7(a) and 7(b) show the Analysis of Variance Summary and mean pulse rate scores respectively. The same trend is reflected from the scores obtained using the Palmar Sweat Index, no difference being shown between groups, but a significant difference within the groups pre-and post arousal ($F = 17 \cdot 714$, df = 1,27, $p < \cdot 01$). See Appendix Tables 8(a) and 8(b).

The common factor emerging from these results is the significant difference obtained in the indices before and after the arousal situation. To this extent it may be assumed that the placebo injection was an effective means of inducing arousal. However, a factor which should be taken into account in this respect, is the arousing effect induced merely by fear of the injection, regardless of the contents of the syringe. However, it is precisely this point which defines the placebo effect, since any bodily excitation experienced by the subject following the injection, would undoubtedly be attributed by him to the "adrenaline" just injected. Having just been informed that the injection would cause such effects, this explanation would fit the physiological changes being experienced by the subject. Support for this interpretation is given by the work of Schachter and Singer (1962). The corroborative evidence is succinctly formulated in three hypotheses:

(i) Given a state of physiological arousal for which an individual has no immediate explanation, he will label this state and describe his feelings in terms of the cognitions available to him.

(ii) Given a state of physiological arousal for which an individual has a completely appropriate explanation, no evaluative needs will arise and the individual is unlikely to label his feelings in terms of cognitions not available to him.

(iii) Given the same cognitive circumstances, the individual will react emotionally, or describe his feelings as emotions only to the extent that he experiences physiological arousal.

The above three points highlight an essential feature of placebos: the effect of sensory and proprioceptive feedback. To illustrate this point, a study by Bloemkolk et al (1971) showed how false feedback on heartbeat, presented visually on a screen before the subject, could produce positive evaluation of photographs, even where such pictures were of an entirely neutral nature. This was an ingenious study as it overcame the problem of requiring the subject to indicate faithfully his subjective assessment of excitation experienced by himself. In a previous study, (Ellis-Smith, 1971) a self-report inventory, to assess the subjects' subjective sensations of placebo induced arousal, was used. This assessment proved, however, to be highly unsatisfactory, for while pulse rates indicated a marked increase in activation, the subjects preferred to remain stoic concerning their degree of subjective excitation. Consequently scores on the self-assessment scale were invariably low and considered to be unreliable. To circumvent this occurrence in the present study, this procedure was not adopted, two further physiological indices of arousal being used instead.

A correlation of the physiological indices and manifest anxiety revealed disappointing results. Significant correlation were obtained between PSI and pulse rate ($r = .60$, $p < .005$) and between PSI and blood pressure ($r = .41$, $p < .025$) See Appendix Table 4(a). Thus far, however, the current evidence in this field shows similar rather inconclusive results. (Calvin, et al, 1956; Martin 1961). As was indicated in Chapter 3, there is little evidence to illustrate that Manifest Anxiety and physiological arousal are conceptually the same thing; although as it is defined clinically it is assumed that anxiety has important physiological correlates. (Levitt, 1968).

CHAPTER CONCLUSION.

In an evaluation of the effectiveness of a placebo injection as an arousal-inducing agent, it was indicated that while the injection did indeed show a general excitatory effect upon the physiological measures used, the intensity of the subjective stress experience was questionable. Moreover, the duration of the arousing effects was unassessed; this could, however, have been effected by taking the measurements on conclusion of each subject's test. In the light of Schachter and Singer's (1962) study, a tentative explanation for the action of placebos has been put forward. Two correlations between physiological measures of arousal were significant, but correlation between physiological indices and scores on the MAS were not significant.

CHAPTER VI

RESULTS

DISCUSSION

REFERENCES

APPENDIX

The present study employed a 3 x 2 x 2 Factorial Design : Such that Factor A consisted of the three levels of Manifest Anxiety; Factor B consisted of two levels of arousal; and Factor C consisted of two levels of Task difficulty. It was hypothesised: that there would be a significant difference in level of performances of subjects on the basis of their MA scores; that plotted on an inverted - U graph these results would show a curvilinear function, and on increasing the arousal level, these performances would differentially shift to the right; and finally that with increasing task difficulty this curvilinear function would be replicated but with a lower optimum level of performance.

Appendix Table 5 shows the data arranged in cells according to the 3 way design. Appendix Table 9 shows the summary of the 3 Way Analysis of Variance. Significant F-ratios were obtained for Factor A, Factor C and a significant interaction effect between B and C. Summary Tables of interactions are given in Table 10 of the Appendix. No interactive effect was obtained between level of Manifest Anxiety and arousal level (i.e. AB interaction), nor between Manifest Anxiety level and Task difficulty (AC Interaction). However, there was a significant interaction between arousal level and Task difficulty.

Appendix Figures 3, 4 and 5 show the prophiles of interaction between Factors AB; AC; and BC. Although the AB and AC interactions were not significant, they do nonetheless indicate trends mentioned earlier in Chapter II. Figure 3(a) shows the trend noted earlier, that the high anxiety subjects(A1 in this

graph) reacted more slowly, but following the arousal situation showed a greater improvement in performance than did either the medium or the low anxiety subjects. (Note that the true reaction time values, and not the reciprocals are given.) This effect is shown more clearly in Figure 3(b) appendix Figure 4(a) showing the interaction between Factors A and C (Anxiety level and Task difficulty) reveals the same trend as Figure 3(a), with High Anxiety subjects showing a slower reaction time performance on both Task 1 and 2. Performance on Task 2 by the High Anxiety subjects was relatively slower than the medium and low anxiety groups, with respect to their performance on Task 1; this relationship is shown in greater clarity in Figure 4(b). Figure 5 shows the significant interaction effects between Factors B and C. (Level of Arousal and Level of task difficulty, respectively). Figure 5(a) shows the effects of arousal on Task difficulty. From Table 11 it will be seen that the values of 3 at C1 are significantly different ($F = 6.201$, 13
df = 1,48 $p < .05$), although at C2 the difference does not reach significant level ($F = 2.316$ df = 1,48 $p < .05$) Note that B1 represents pre-arousal performance and B2 represents post arousal performance. Figure 5(b) shows how the effects of arousal differentially affect level of performance on the two tasks. Task 1 represented by profile C1 shows a slowing effect following arousal, while Task 2 (profile C2) shows a marked improvement in speed of response following arousal. This interaction is discussed in greater detail in the Discussion. As was to be expected, C at both B1 and

B2 was found to be significant; ($F = 58{\cdot}054$ and $F = 13{\cdot}011$, df = 1,48, in both cases, and $p < {\cdot}01$) indicating that Task 2 was significantly more difficult than Task 1.

In general performance did not follow the predicted inverted - U pattern, although the curvilinear relationship proved a useful means to interpreting results with respect to arousal level. Increased task difficulty had the expected effect of lowering the level of performance.

DISCUSSION.

The results on the whole were inconclusive, although certain predominant trends did become apparent on further analysis. In general, high manifest anxiety scores were associated with slower reaction times. This result is consistent with most findings and consistent with the earlier study (Ellis-Smith, 1971) which showed similar trends. (See Figure 2 and Figure 4(a) in the Appendix) The effects of arousal on performance are more difficult to assess; this being due largely to two factors:

(i) Firstly, the nature of the design itself which necessitated that prior to receiving the placebo injection, the subjects had all completed one reaction time task; either Task 1 or Task 2. For subjects who had completed Task 1 first, the arousal situation appeared to have an enhancing effect on performance in Task 2 (See Figure 1 and Figure 5 in appendix). For subjects who completed Task 2 before the injection, performance on Task 1 was notably impaired. (See again Figure 1 and Figure 5 in the Appendix). This impairment may feasibly be ascribed to the excitatory effects of having to perform a difficult task first with no "warm-up" period on the easier Task 1; such that, together with the arousing effects of the placebo injection, optimum arousal level for performance was surpassed; and any subsequent performance would thus fall on the right hand side of the inverted - U curve. A second explanation for this impairment, which was mentioned in Chapter II, was that subjects who had performed Task 2 first were possibly in a state of expectation; since they were not informed that Task 1 involved no peripheral stimuli. While this undoubtedly served as an added form of excitation, it also added to the difficulty of Task 1 since subjects continued to scan the peripheral lights in expectation of their illumination.

(ii) The second difficulty with respect to assessing the effects of arousal on performance has already been mentioned at some length in Chapter V: the duration of the effects of arousal. For while physiological arousal was undoubtedly induced by the placebo injection, it remained unassessed as to how long these effects would endure. It is suggested that should this technique for arousal-inducement be used again, the physiological measurements was notably impaired. (See again Figure 1 and Figure 5 in the Appendix). This impairment may feasibly be ascribed to the excitatory effects of having to perform a difficult task first with no "warm-up" period on the easier Task 1; such that, together with the arousing effects of the placebo injection, optimum arousal level for performance was surpassed; and any subsequent performance would thus fall on the right hand side of the inverted - U curve. A second explanation for this impairment, which was mentioned in Chapter II, was that subjects who had performed Task 2 first were possibly in a state of expectation; since they were not informed that Task 1 involved no peripheral stimuli. While this undoubtedly served as an added form of excitation, it also added to the difficulty of Task 1 since subjects continued to scan the peripheral lights in expectation of their illumination.

(ii) The second difficulty with respect to assessing the effects of arousal on performance has already been mentioned at some length in Chapter V: the duration of the effects of arousal. For while physiological arousal was undoubtedly induced by the placebo injection, it remained unassessed as to how long these effects would endure. It is suggested that should this technique for arousal-inducement be used again, the physiological measurements should be taken on the subjects' completion of the tests.

With respect to the curvilinear relationship between performance and motivation (or arousal) one major difficulty was encountered. There is no proof that subjects assessed to be highly anxious on the basis of an inventory, will necessarily show greater physiological arousal under stress or arousing conditions. It is significant that in the present study, while some of the physiological measures of arousal did correlate with each other, no correlation between physiological measures and MA Score was obtained. This being the case, a more physiologically orientated assessment of habitual arousal level should be used to gauge where on the inverted - U curve a subject will lie.

Finally, with respect to the relationship between performance and arousal, reaction time is possibly not the best type of performance to use. As was indicated at some length in Chapter II, reaction time is a mode of performance affected significantly by very small changes in practically any of the independent variables used. Even while as many influencing variables as possible were removed in the present study, by the use of EEG to determine the time of stimulus presentation, and by earphones to eliminate experimenter effect and extraneous noise, reaction time remains a highly sensitive dependent variable. Moreover, with the large amount of statistical analysis which must be performed in order to assess such fluctuations in performance, specific evaluation of an individual performance becomes well nigh impossible. However, Donders gave to psychology a field of research which proved to be invaluable, for he indicated that the performance of man could be and should be examined at all levels of observation, from the macroscopic to the microscopic.

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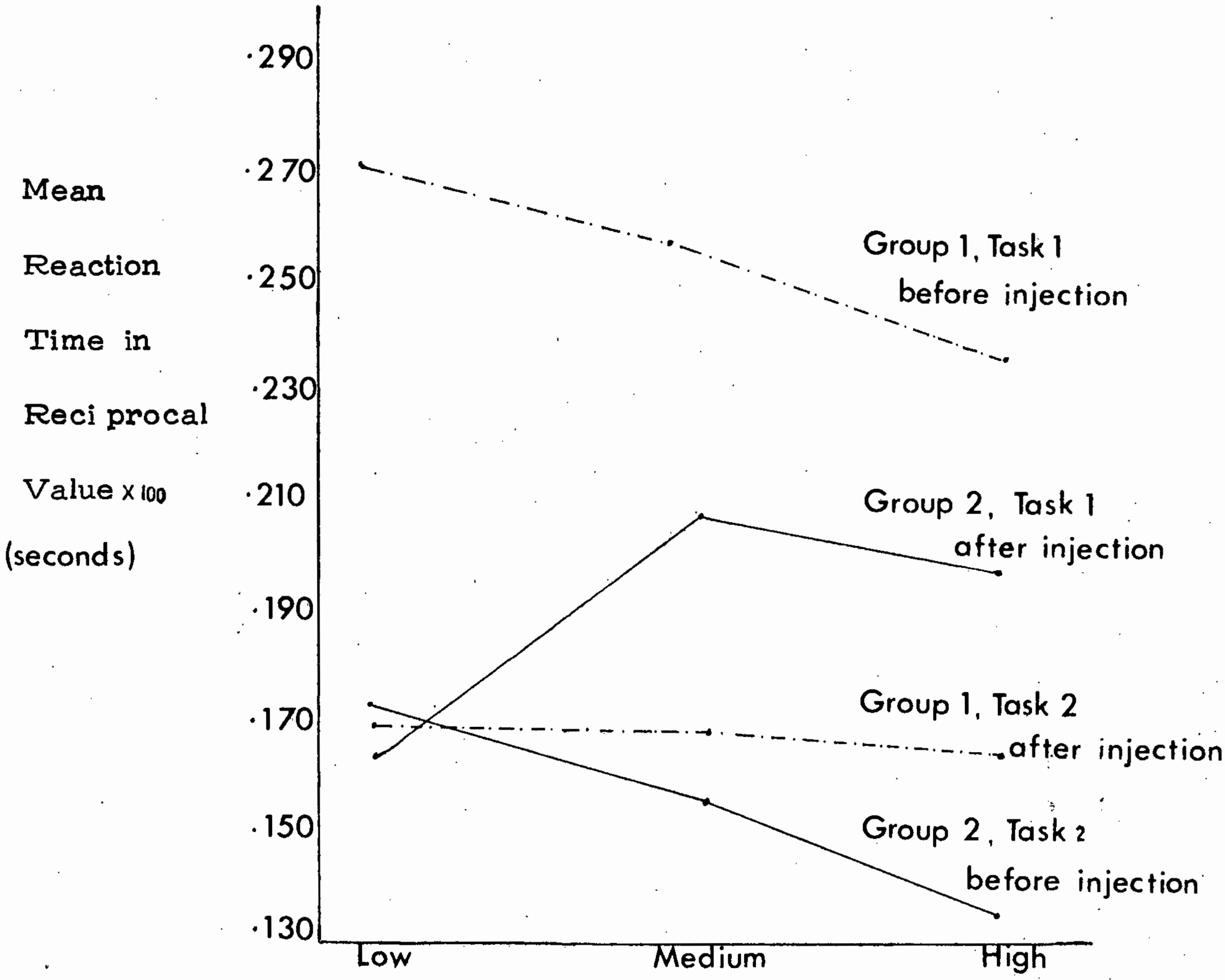
APPENDIX

GRAPHS AND TABLES

Figure I

Graph showing mean performance on Task 1 and Task 2 before and after administration of the placebo injection. (Reaction time scores are given in reciprocal values x 100)



Level of Manifest Anxiety

Figure 2

Graphic presentation of the results obtained in the 1971 study. (Ellis-Smith, 1971). Only one level of task difficulty was Employed. Arousal was induced by a placebo injection, as in the present study.

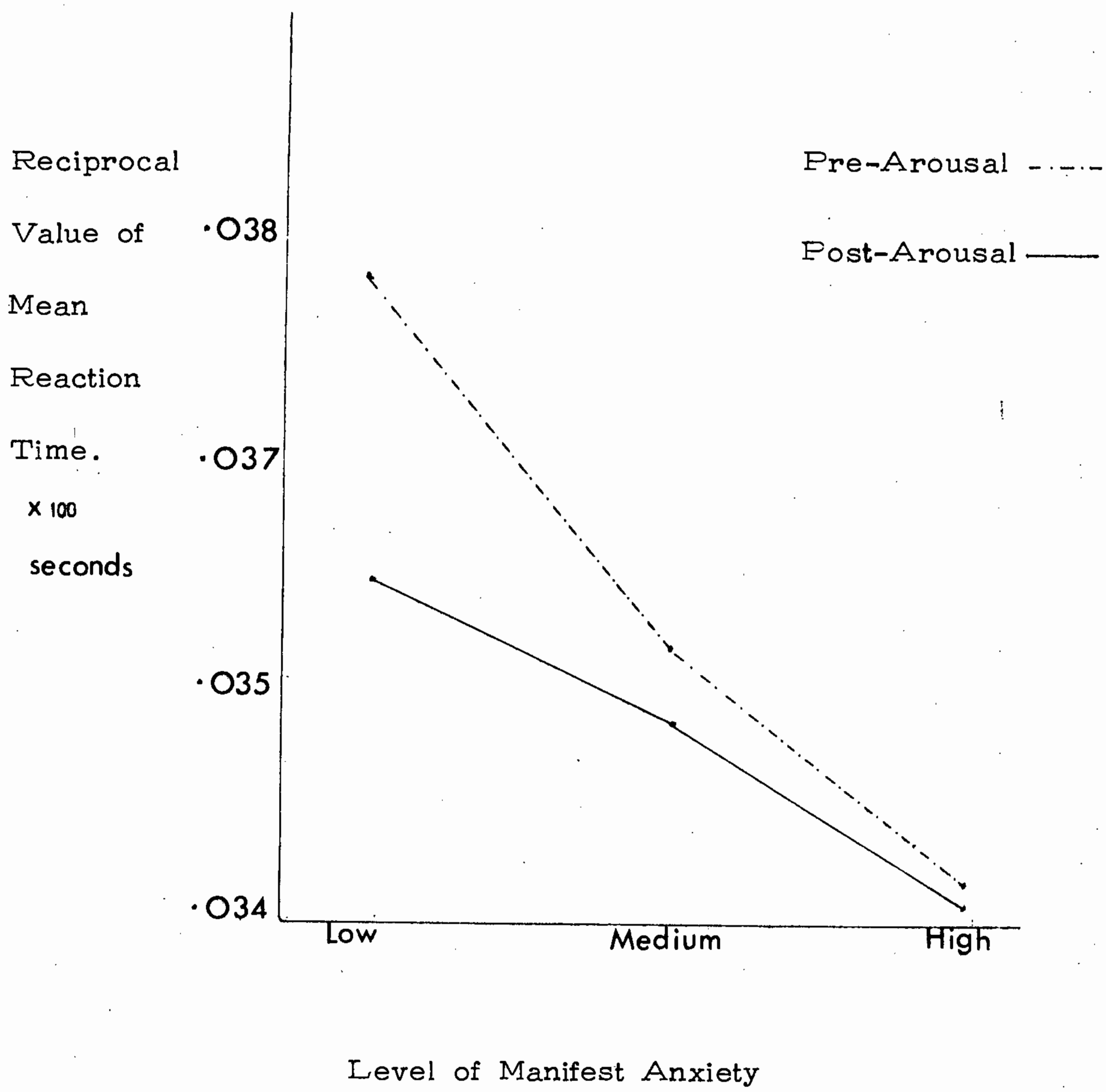


Figure 3.

Profiles showing interactions (although not significant) between factors A and B. (Manifest Anxiety and level of arousal)

Figure 3(a)

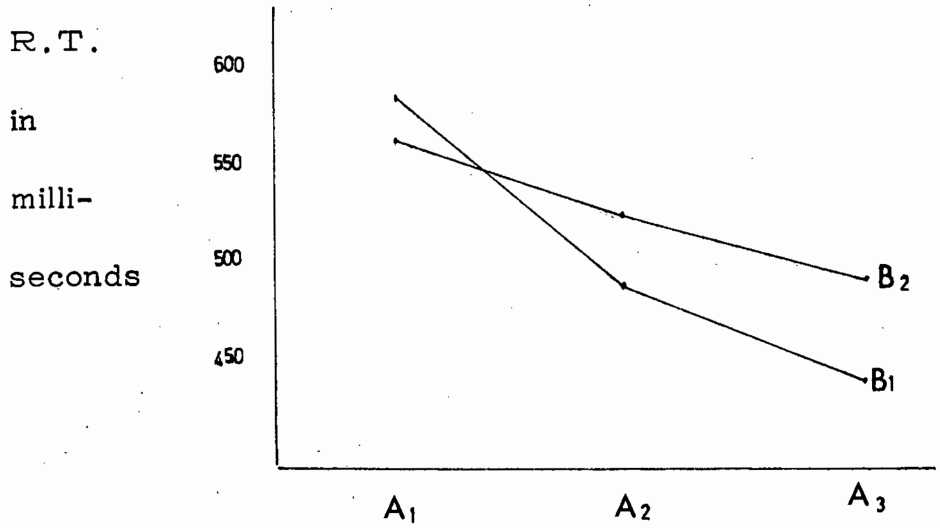


Figure 3(b)

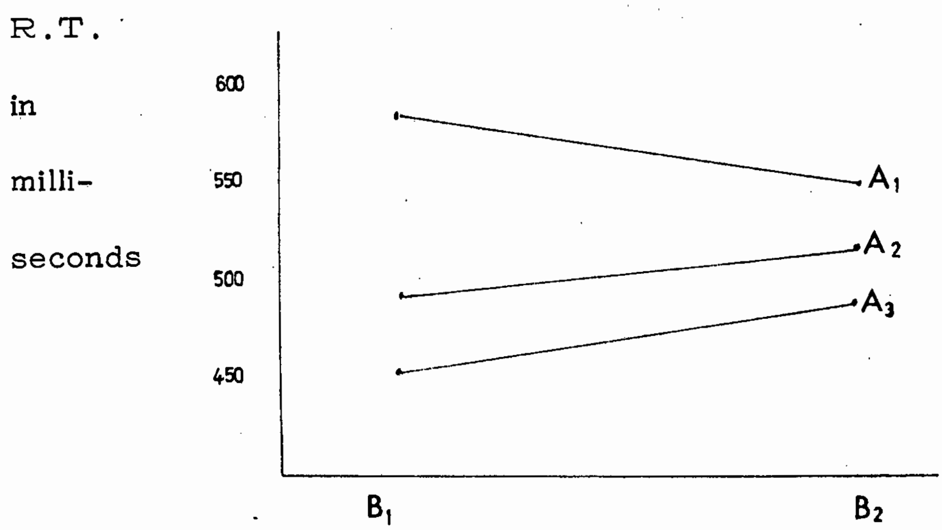


Figure 4

Profiles showing interaction between Factors A and C. (Anxiety level and level of task difficulty.)

Figure 4(a)

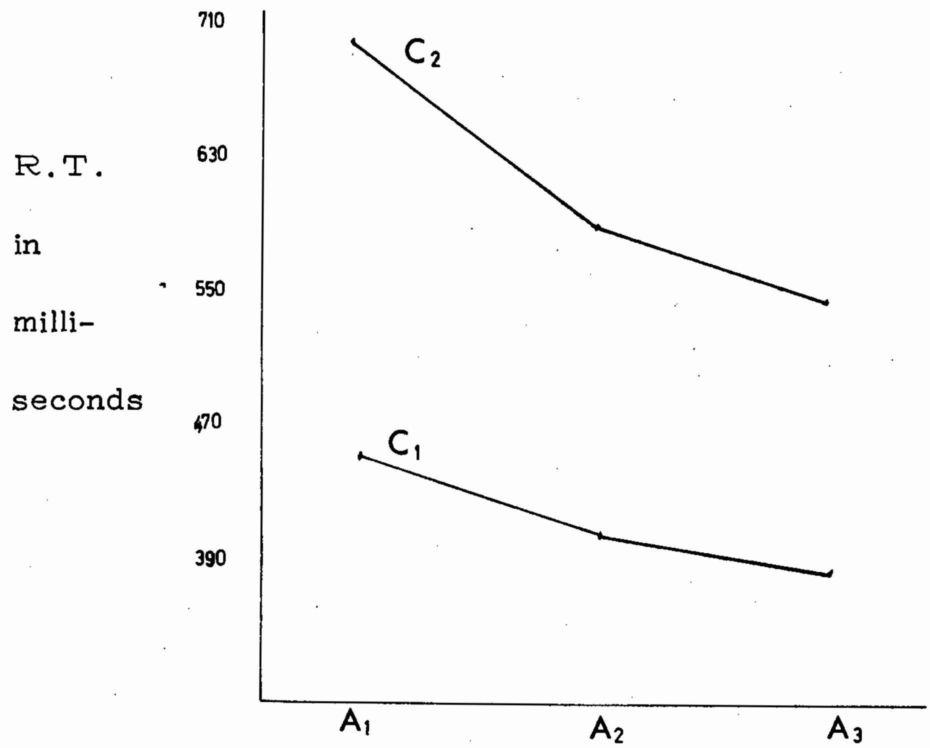


Figure 4(b)

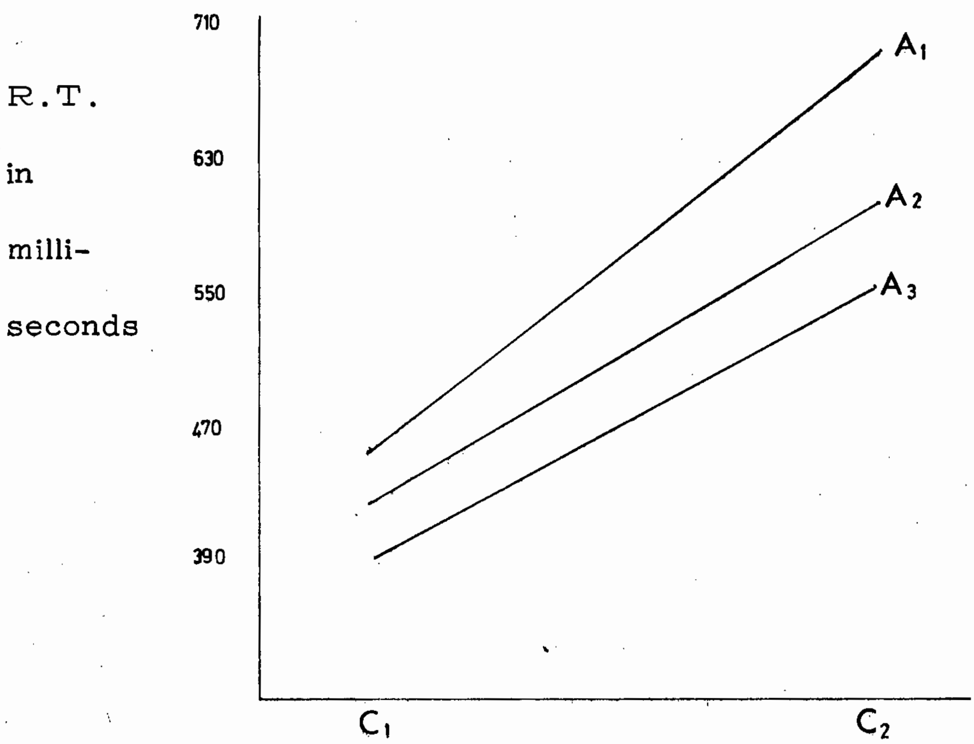


Figure 5.

Profiles showing the significant interaction effects between Factors B and C. (Level of arousal and level of Task difficulty)

Figure 5(a)

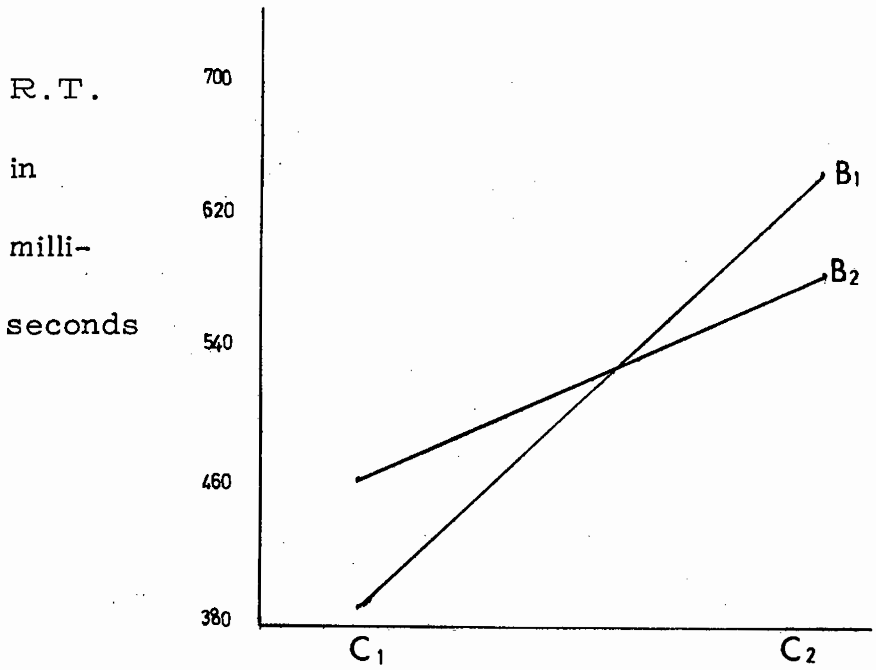


Figure 5(b)

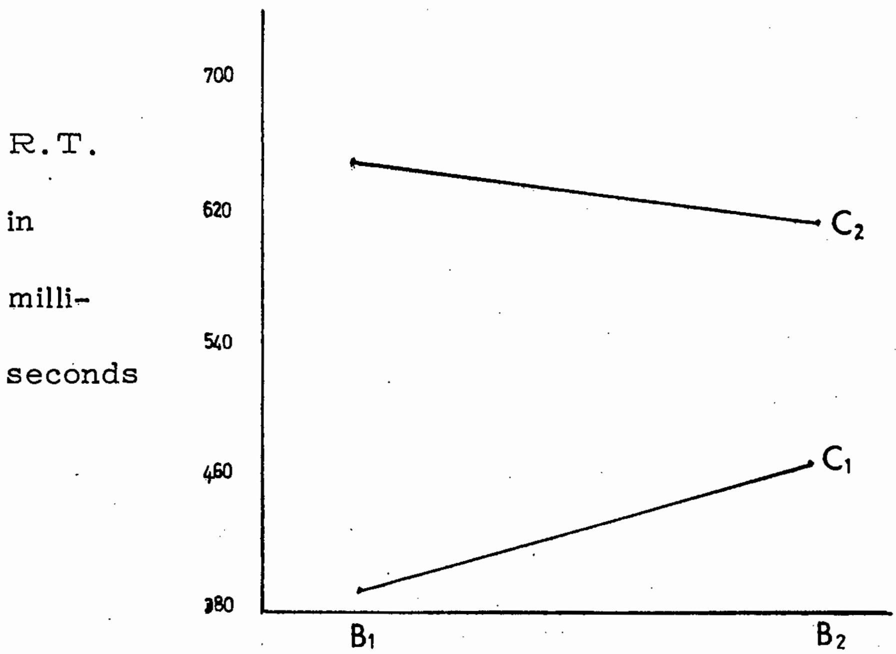


Table 1(a)

Summary of Correlation Matrix between mean reaction time scores and standard deviations.

Task difficulty	Arousal Level	N	df	r	level of significance
1	Before	15	13	·917	·005
1	After	15	13	·878	·005
2	Before	15	13	·890	·005
2	After	15	13	·682	·005

TABLE 1(b)

Correlation matrix showing correlations between reaction time pre- and post- arousal and standard deviation

Task 1	Before Arousal		After Arousal	
	R.T.	S.D.	RT	S.D.
	404.6	69.8	509.0	136.9
	372.3	49.3	508.9	286.2
	469.2	306.6	471.6	65.3
	329.6	45.4	563.4	396.1
	482.3	297.0	450.5	296.7
	343.7	44.5	389.3	49.2
	348.8	77.1	343.9	90.1
	378.8	65.7	488.6	294.4
	354.4	54.1	526.4	501.8
	456.4	294.7	656.1	614.6
	383.5	71.1	398.9	69.4
	362.6	62.1	642.4	464.7
	378.3	124.8	380.9	68.0
	374.5	58.0	410.4	52.2
	313.5	38.3	330.3	42.2
r = .917				r = .878
Task II				
	762.5	441.4	799.1	365.3
	729.4	342.4	537.3	242.4
	990.7	630.0	743.6	405.5
	612.8	159.9	604.4	316.6
	611.3	156.3	561.1	149.9
	586.8	231.5	461.4	64.6
	449.9	192.6	559.1	79.1
	741.3	303.3	522.4	87.7
	607.8	296.5	644.7	280.4
	688.1	371.6	636.5	181.4
	601.3	273.0	537.2	144.4
	587.2	152.1	643.4	206.5
	574.4	114.1	496.5	78.1
	568.5	166.6	615.5	555.7
	439.8	102.2	437.1	124.0
r = .890				r = .682

Appendix Table 2

Manifest Anxiety Scores of the 30 subjects used, as categorized into the respective anxiety levels.

	Low	Medium	High
	7	10	23
	7	10	15
	7	10	19
	8	11	19
	9	11	17
	7	11	26
	5	14	18
	5	12	15
	0	11	23
	8	10	19
Mean	6.3	11	19.4

Appendix Table 3

Correlation between mean reaction time scores on Task I and Task II.

	Task I	Task II
	330.3	439.8
	410.4	568.5
	313.5	437.1
	374.5	615.5
	378.3	496.5
	362.6	643.4
	383.5	573.2
	380.9	574.4
	587.2	642.4
	398.9	601.3
	456.4	636.5
	343.7	461.4
	348.8	559.1
	378.8	522.4
	354.4	644.7
	656.1	688.1
	526.4	607.8
	488.6	741.3
	343.9	449.9
	389.3	586.8
	471.6	612.8
	450.5	611.3
	404.6	799.1
	372.3	537.3
	469.2	743.6
	482.3	561.1
	329.6	604.4
	509.0	729.4
	508.9	990.7
	563.4	762.5
Mean	425.58	614.74

N = 30

df = 28

r = .591

$p < .005$

Appendix Table 4(a)

Correlation matrix summary of physiological indices used to assess arousal and manifest anxiety scores. Abbreviations used are B.P. for blood pressure; PSI for palmar sweat index; MAS for manifest anxiety score and PRI for pulse rate increase.

	PRI	B.P.	PSI
B.P.	.24		
PSI	.60	.41	
MAS	- .002	.07	.14

N = 30

df = 28

Two significant correlations only appear.

Between PSI and pulse rate increase ($r = .60$, $p < .005$)

and between PSI and blood pressure increase ($r = .41$, $p < .025$)

Appendix Table 4(b)

Correlation matrix between (i) Pulse change (ii) Blood pressure change, (iii) PSI change and (iv) MAS before and after arousal

Pulse	B.P.	PSI	MA
0	-12.5	1	8
26	12.5	15	7
12	2.5	11	8
6	7.5	5	5
16	7.5	3	5
8	-5.0	8	0
12	2.5	9	9
10	7.5	-3	7
10	7.5	7	7
6	5.0	7	7
16	-7.5	-1	10
0	2.5	-4	10
12	-2.5	3	11
14	2.5	4	10
0	-2.5	-5	11
18	10	10	11
-12	7.5	0	14
10	-2.5	8	12
20	5	12	11
8	-5	6	10
10	7.5	8	23
10	0	8	23
6	10	8	19
16	2.5	12	15
6	2.5	1	18
20	5	12	26
6	-10	-1	17
2	5	6	15
4	5	0	19
16	0	8	19

Table 6(a)

Summary Table of the Two-Way Analysis of Variance with repeated measurements on Factor B (Pre- and Post Arousal) for the physiological index of Blood Pressure.

ANOVA SUMMARY				
Source	SS	df	MS	F
Between Groups				
A	18.531	2	9.265	.1508
Error Between	1657.97	27	61.406	
Within Groups				
B	101.406	1	101.406	4.341
AB	82.437	2	41.218	1.764
Error Within	630.656	27	23.357	

Table 6(b)

Blood pressure scores (Pulse pressures) obtained for the three levels of Manifest Anxiety, Pre- and Post Arousal

	Low	Medium	High
Before Arousal	47.5	45.0	42.5
	45.0	55.0	45.0
	52.5	47.5	52.5
	37.5	42.5	47.5
	52.5	52.5	50.0
	42.5	42.5	55.0
	47.5	52.5	45.0
	42.5	52.5	47.5
	42.5	47.5	40.0
	42.5	57.5	35.0
After Arousal	35.0	40.0	55.0
	40.0	60.0	55.0
	55.0	45.0	55.0
	50.0	50.0	50.0
	70.0	50.0	55.0
	45.0	40.0	45.0
	55.0	55.0	50.0
	50.0	50.0	45.0
	50.0	50.0	54.0
	55.0	50.0	35.0

Table 7(a)

Summary Table of the Two-Way Analysis of Variance with repeated measurements on Factor B (Pre- and Post Arousal), for the physiological index of Pulse Rate.

ANOVA SUMMARY				
Source	SS	df	MS	F
Between Groups				
A	1024.12	2	512.062	.863
Error Between	16005.2	27	592.785	
Within Groups				
B	1306.62	1	1306.62	39.1471
AB	16.187	2	8.093	.242
Error Within	901.187	27	33.377	

Table 7(b)

Mean Pulse rate scores obtained for the three levels of Manifest Anxiety, Pre- and Post Arousal.

	Low	Medium	High
Before Arousal	110	66	76
	76	64	108
	82	92	74
	72	86	70
	66	92	84
	78	92	106
	100	64	78
	96	64	92
	80	74	74
	88	64	52
After Arousal	136	76	76
	88	52	124
	84	100	84
	88	104	76
	72	108	104
	88	112	112
	112	64	84
	104	64	108
	80	88	76
	104	76	56

Table 8(b)

Mean Palmar Sweat Index scores obtained for the three levels of Manifest Anxiety, Pre- and Post Arousal

Low	Medium	High
35	34	30
22	30	61
30	57	33
27	54	28
22	61	57
35	63	59
51	25	32
49	28	45
32	23	33
44	28	20
50	42	25
33	30	73
35	63	41
30	60	30
27	60	69
32	75	60
60	20	31
57	24	53
33	27	39
45	31	20

Table 9

Summary Table of the 3-Way Analysis of Variance.
Factor A = 3 levels of Manifest Anxiety;
Factor B = 2 levels of Arousal;
Factor C = 2 levels of Task difficulty

ANOVA SUMMARY				
Source	SS	MS	df	F
A	103735.0	51867.5	2	6.078
B	4017.5	4017.5	1	.4708
C	536625.0	536625	1	62.8895
AB	2452.5	1226.25	2	.14371
AC	18795.0	9397.5	2	1.1013
BC	68987.5	68987.5	1	8.0849
ABC	8232.5	4116.25	2	.4824
Error	409576.0	8532.83	48	

Table 10

Summary Tables of interactions between :

(i) Factors A and B;

(ii) A and C; and

(iii) B and C

	B	
A	582.5	574.8
	495.5	522.8
	463.8	487.2

	C	
A	456.1	701.2
	428.6	589.7
	391.9	559.1

	C	
B	383.5	644.4
	467.6	588.9

Table 11

Summary Table of the 3-Way Analysis of Variance for Simple Main Effects.

ANOVA SUMMARY				
Source	SS	df	MS	F ratio
A at B1	67366	2	33683.0	3.947
A at B2	38791	2	19395.5	2.273
A at C1	20615	2	10307.5	1.2079
A at C2	102106	2	51053.0	5.983
B at A1	11	1	11.0	.0028
B at A2	3645	1	3645.0	.472
B at A3	2762	1	2762.0	.323
B at C1	52920	1	52920.0	6.201
B at C2	19762	1	19762.0	2.316
C at A1	286802	1	286802.0	33.611
C at A2	129605	1	129605.0	15.189
C at A3	140282	1	140282.0	16.440
C at B1	495368	1	495368.0	58.054
C at B2	111021	1	111021.0	13.011
Error		48		