THE UNIVERSITY OF MANITOBA

TYPE A BEHAVIOUR, AUTONOMIC ACTIVITY, STRESS AND PERSONALITY

by

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To my Parents who were

my first teachers,

with love and gratitude

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ABSTRACT

TYPE A BEHAVIOUR, AUTONOMIC ACTIVITY, STRESS AND PERSONALITY

Psychophysiological research has identified a behavioural syndrome which is associated with coronary heart disease. This syndrome, labelled Type A, is typified by an extreme sense of time urgency, excessive competitiveness and agression, and an intense drive to succeed. Further, in order to succeed, the Type A individual either denies or suppresses subjective feelings such as fatigue which may interfere with success. Several methods are available for identifying such people. In this experiment the Jenkins Activity Survey for Health Prediction (JAS) was used.

Pupillometric research has identified four behavioural types according to their differing pupillary response to repeated light stimuli, the differences being induced by fatigue within the automatic nervous system. Specifically the differences occur because the autonomic components - the sympathetic and parasympathetic nervous systems - tire differentially from individual to individual. This research hypothesized that Type A individuals would respond with a pattern indicative of sympathetic strength.

The effect of relevant stress was also investigated. It was hypothesized that cognitive stress (an ego threat) should elicit a greater degree of pupillary dilation and a greater heart rate in Type As as compared to Bs. Under physiological stress (a cold pressor) no differences between the types were expected. Finally, it was hypothesized that Type As, in comparison to Bs would be both sensory augmentors and extroverts.

Subjects were selected on the basis of their extreme scores on the JAS, then pupil diameter and heart rate were measured under three condition; no treatment, physiological stress and psychological stress. Self report measures of anxiety were obtained to assess induced stress.

The results indicated that those subjects classified as having a strong sympathetic component according to their pupillary response also tended to be classified as Type A. Hence the pupillary reflex should be further investigated as a possible predictor of coronary heart disease. The Type As responded to the ego threat with a greater heart rate than Type Bs, whereas Type Bs responded to the cold pressor with a greater heart rate than Type As, suggesting that the stressor must be relevent to the behavioural type. Pupil diameter was not so effected. Self-report measures indicated that Type As tended to either deny or not experience feelings of anxiety. Finally, the results indicated that Type As are more apt to be stimulus augmenters and to be extroverted in comparison to Bs.

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INTRODUCTION

Mortality due to heart disease is a major cause of death and disability in North America. Coronary heart disease (CHD) in its early stage refers to lesions of the coronary arteries, a condition known as arteriosclerosis, which results in the initiation of a self-healing process. Newly formed cells create a plaque to cover the lesions, and a thickening of the inner wall of the artery occurs. These cells, which consist of lipids, form "fatty streaks" which frequently become atheromatous and "are considered the basis of coronary artery disease" (Glass, 1977, p. 3). CHD may evolve into one of two forms: angina pectoris, in which blood flow to the heart muscle is restricted, or acute myocardial infarction, in which the plaque decays and ruptures due to a growth rate exceeding the available nutrition from the blood supply (Glass, 1977).

Dawber and Kannel (1961) have suggested that the risk of CHD is associated with certain specific factors such as: (1) aging; (2) sex (male); (3) elevated serum cholesterol; (4) elevated serum lipoproteins; (5) hypertension; (6) dietary intake of animal fats and cholesterol; (7) heavy cigarette smoking; (8) diabetes mellitus; (9) genetic factors; (10) specific diseases such as hypothyroidism; (11) obesity; (12) physical inactivity; and, (13) electrocardiographic evidence of left ventricular hypertrophy. Nevertheless, according to Jenkins (1971), the best combination of traditional risk factors still fails to identify most new cases of CHD. The following section will review Jenkins' personality/behaviour approach to the prediction and identification of CHD.

CORONARY PRONE BEHAVIOUR

Notwithstanding the lack of veridical clinical identifiers, Jenkins (1975) observed that those suffering from CHD were "somehow different on the average from their unafflicted neighbours" (p. 5). For example, he cited W. Osler, who, in 1897, said, "I believe that the high pressure at which men live and the habit of working the machine to its maximum capacity, are responsible rather than excesses in eating and drinking". Such statements would suggest that, quite early, the identification of the coronary prone individual was thought to be facilitated by examining behaviour patterns in addition to examining clinical manifestations.

Friedman and Rosenman (1959) have performed laboratory, clinical and epidemiological studies of the roles of behaviour and the Central Nervous System in the pathogenesis of coronary disease, and Friedman (1969) has contributed the following definition of the coronary prone behaviour pattern:

> A characteristic action-emotion complex which is exhibited by those individuals who are engaged in a relatively chronic struggle to obtain an unlimited number of poorly defined things from their environment in the shortest period of time and, if necessary, against the opposing efforts of other things or persons in this same environment (p. 84).

The behaviours typical of this complex were labelled Type A, and those, which are more or less opposite, as Type B. Many authors (e.g. Caffrey, 1979; Sparacino, 1979) view the A/B dimension as a behavioural "syndrome" rather than a personality dimension. Jenkins (1975) described this

syndrome as including extremes of competitiveness, striving for achievement, aggressiveness, haste, impatience, restlessness, feelings of being constantly under pressure and the deep commitment to vocation or profession.

But, however characterized, pure Type A or pure Type B behaviour is rarely found as they lie at opposite ends of a continuum. Most people lie between these extremes and, as argued by Friedman and Rosenman (1974), can be differentiated, in varying degrees, according to such behaviours. Extensive analysis of Type A behaviour (Carver & Glass, 1978; Glass, 1977; Rosenman, Friedman, Straus, Wiurm, Kositcheck, Hahn & Werthessen, 1964) has led to general agreement that the following three features play a primary role: a) an enhanced sense of time urgency, b) excessive competitiveness and aggression, and c) an intense drive to succeed. These features are discussed below.

Time Urgency

Several experiments have demonstrated the Type A sense of time urgency. For example, an analysis of time estimates (Burnam, Pernebucker & Glass, 1973) indicated that Type As signalled the passage of one minute sooner than did Type Bs, both types departing equally but in opposite directions from the accurate estimate. These authors viewed the struggle of As to overcome the constraints of time as stemming from an excessive drive to master as many aspects of their environment as possible. Similarly, Glass, Snyder, and Hollis (1974) compared the performance of Type As and Type Bs during a task involving differential reinforcement of low rates

of responding. Type A subjects received a significantly lower percentage of total reinforcements than did Type Bs, indicating their tendency to respond too quickly.

Another experiment demonstrated Friedman's (1969) contention that Type As exhibit irritation and anger when forced to slow down the rapid pace of their activities. Glass, Snyder, and Hollis (1974) had subjects engage in a discussion with a confederate of the experimenter in order to reach consensus on a series of decisions. The confederate deliberately slowed the discussion, and the conclusion was that Type A subjects, at least those who scored high on speed and impatience, were more impatient than Type B subjects when the activities of both were slowed down by another person.

Even in speech patterns, Sparacino (1979) reported, "In keeping with their chronic sense of time urgency Type As are also said to more frequently hurry their conversational partner along by interjecting back channel feedback such as 'mm-hm' or 'yes, yes' or by nodding the head rapidly" (p. 41).

Competitiveness and Aggression

The results of Glass et al. (1974), described above, also provided evidence for the second component of Type A behaviour - excessive competitiveness and aggression. Carver and Glass (1974) reported that Type As reacted with increased aggression to a threat to their sense of competence and mastery. No such increase occurred among the Type Bs and the two groups did not differ in their aggressiveness in the absence of threat.

Drive to Succeed

The third component of Type A behaviour, that of having an intense drive to succeed in achievement related activities (Glass, 1977), received support in an experiment which demonstrated that Type As tended to work at maximum capacity whether or not a time limit was present. In comparison, Type Bs worked at maximum effort only when there was an explicit deadline. Jenkins (1975) regarded this feature of Type A behaviour as a possible explanation of the prevalence of CHD in contemporary western society which rewards those who can think, perform and communicate more rapidly than their peers.

Closely associated to this third component is the suggestion that Type A individuals, in order to succeed and hence master their environment, must deny or suppress feelings of fatigue (Carver, Coleman & Glass, 1976; Walster & Aronson, 1967). The phenomenon of fatigue suppression is central to the proposed research because it forms the logical link between Type A/B behaviours, and the autonomic nervous system types categorized by Lowenstein and Loewenfeld (1951) which will be discussed later.

Type A Behaviour and The Denial of Fatigue

Walster and Aronson (1967) found that persons expecting a task to be relatively lengthy in time tended to suppress feelings of fatigue. Further, Snyder and Glass (1974) found a difference in fatigue suppression, Type As exhibiting greater suppression than Type Bs. The results, however, were confounded by differences between the groups in pre-test fatigue; therefore, Carver, Coleman and Glass (1976) replicated the general concept. College students were required to complete a Balke treadmill test at a

walking rate while rating their fatigue at two minute intervals. Subjects also completed a similar test at a running pace in order to assess maximum aerobic capacity. Both aerobic capacity and performance were determined by analysis of expired air, and walking performance was scored as a proportion of maximum aerobic capacity. Type As, although exerting greater effort, clearly suppressed feelings of fatigue to a greater extent than Type Bs. Glass (1977) stated, "In contrast to Bs, Type As work hard to succeed, (and) suppress, subjective states (e.g. fatigue) that might interfere with task performance" (p. 181).

The contention that Type As tend to suppress feelings of fatigue is significant, especially within the context of the contentions of Green, Moss and Goldstein (1974), who proposed the following three steps which should be taken by an individual experiencing CHD. First, the symptoms must be perceived; second, their seriousness must be recognized; and third, the need for immediate care must be realized. Carver et al. (1976) stated, "Type As may be less perceptive of early heart attack or preheart attack symptoms than Type Bs. This seems especially reasonable in light of the observation (Green et al., 1974 p. 151) that 'the longest and most frequent prodromal symptom in reference to myocardial infarction is . . . fatigue . . . tiredness . . . having to push (oneself)' " (p. 465). They concluded, "It is not unlikely that fatigue suppression, characteristic of the Type A even as a young man, may be an important factor contributing to greater susceptibility to coronary artery disease in later years (p. 165).

Classification

The first formal method of classifying subjects according to behaviour patterns was designed by Friedman and Rosenman (Rosenman et al. 1964). This and a second well known method, The Jenkins Activity Survey for Health Predition (Jenkins, Rosenman & Friedman, 1967), will be discussed in turn.

a. The Structured Interview. A four point scale is used to analyse the content and behavioural style of subjects' responses during a structure stress interview, as follows: A_1 - fully developed Type A; A_2 - incompletely developed Type A; B_3 - incompletely developed Type B; B_4 - completely developed Type B. There is also included a Type X which falls between Type A_2 and Type B_3 and accounts for 10% of the population (Friedman & Rosenman, 1974).

The subject is asked approximately 25 questions relating to intensity of ambitions, competitiveness, feelings of hostility and sense of time urgency. The questions are posed in a manner designed to create stress and hence elicit signs related to the above factors. Of more importance than the actual answers, however, is the manner and tone of delivery. The subject's general appearance, his bodily movements, his explosive speech accentuations and inflections are the critical factors. The developed Type A typically speaks rapidly emphasizing certain words, he anticipates what will be said next, and hurries the interview with nods. The contents of his answers indicate a need for power, a need for recognition of his achievements, a compulsive attraction toward competitive situations, a compulsive need to "get things done", a

tendency to be easily angered by others, and the belief that any obstacle can be overcome. He also appears to receive most gratification from his job and little gratification from other sources.

The Type B pattern of behaviour may include Type A characteristics but in less exaggerated form. Type B individuals feel less compelled by chronic time urgency and are generally more relaxed and gesture less. They appear less easily aroused to anger and less inclined toward competitive situations (Glass, 1977).

In a test of reliability, Jenkins, Rosenman and Friedman (1968) reported that two trained judges rated the behaviour-pattern interviews the same way 84% of the time. The sample consisted of 75 cases drawn from a larger sample of 3,000. Caffrey (1968), in a study of 1,433 American Benedictine and Trappist monks, obtained 75% to 77.4% agreement between all possible pairs of three interviewers. Finally Jenkins (1968) reported a test-retest agreement rate of 80% when 1,064 males were examined twice - 12 to 20 months apart.

b. Jenkins Activity Survey for Health Predictions (JAS). A second common assessment technique is the JAS which provides continuous scores for working males on the A-B dimension. There is also a version for college student populations. The survey consists of 54 questions, the scores being weighed and transformed into a distribution with mean zero and standard deviation 10. Positive scores denote the A direction. Jenkins (1971) reported that the test-retest reliability of the JAS A/B scale was .66 based on an interval of one year.

c. Comparison of the Structured Interview and the JAS. In one comparison, the JAS and the Structured Interview agreed 73% of the time, the rate increasing to between 88% and 91% when extreme JAS scores were used (Jenkins, 1971). Glass (1979) suggested that the somewhat low overall agreement occurred because the JAS relied solely on its content, whereas the interview emphasized style. The proposed research will ultimately use the JAS because of its objective nature and ease of administration.

Physiological Correlates

Several studies have attempted to identify physiological correlates of CHD. For example, Henry, Ely and Stephens, (1972) have reported that mice subjected to confrontation with other mice in order to obtain food developed hypertension and increased coronary arteriosclerosis associated with increased levels of enzymes which synthesize the neurotransmitters of the sympathetic nervous system. Lamprecht, Williams and Kopin (1973) have shown that chronically immobilized rats developed hypertension which was associated with serum levels of dopamine-beta-hydroxylase, the enzyme that synthesizes the sympathetic neurotransmitter norepinephrine. In human subjects, Friedman (1977) has observed that, "Type A subjects, while not suffering from any fixed error in the metabolism of either epinephrine or norepinephrine, nevertheless secrete more norepinephrine during working hours and also during any individual competitive activity than Type B subjects" (p. 598). These findings were confirmed by Carruthers (1969); Hames, Lightman and McDonough (1965); and Nestel,

Verghese and Lovell (1967). The latter two studies indicated that the majority of coronary prone subjects and the majority of those already suffering from angina pectoris excreted an excessive amount of catecholamines. Further, Freeman, St. George, Byers, Rosenman (1960) reported that Type As showed a greater increase than Type Bs in blood or urinary catecholamines when challenged by the stress of an ordinary working day. Friedman, Byers, Diamant and Rosenman (1975) assayed plasma norepinephrine and epinephrine in Type A men under resting, non-competitive conditions, and also immediately before, during, and after participation in a non-physical competitive struggle. They reported no differences in concentration of catecholamines in the two groups under resting conditions but under competitive conditions, norepinephrine concentrations rose about 30% with the Type A group, compared to no change with the others. Epinephrine concentration remained unchanged in both groups.

Dembroski, MacDougall, Shields, Petillo, and Luschene (1978), and Manuck, Craft and Gold (1978) have shown that Type A subjects compared to Type Bs responded with significantly greater blood pressure and heart rate increases when challenged to perform at maximum capacity in a choice reaction time task and tasks requiring problem solving skills. Dembroski, MacDougall, Herd and Shields (1979) summarized the general findings in this area:

> Biochemical and cardiovascular responses exhibited by Type A subjects are indicative of enhanced sympathetic

> nervous system action, which has the potential to damage the cardiovascular system. If research can firmly establish a link between Type A behaviour and excessive sympathetic arousal, a valuable lead will be established into the mechanism through which behaviour may excite pathogenic processes in CHD (p. 211).

Likewise, Williams (1975) argued that an increase in sympathetic nervous system activity may be implicated in the pathogenesis of coronary disease.

One physiological measure which has not received attention as a correlate of CHD is pupillary activity. This is surprising for two reasons. First, as will be indicated, pupillary dilation and constriction are controlled autonomically by the sympathetic and parasympathetic nervous systems, as are certain known correlates of CHD - the secretion of serum cholesterol and catecholamines such as epinephrine and norepinephrine, for example. The second reason, perhaps not quite so obvious, involves the Type A's tendency to suppress fatigue, and Lowenstein and Loewenfeld's (1951) categories (discussed below) which are based on the reflex shapes of the pupil and include incidents of fatigue suppression. In other words, the pupillary reflex which is mediated by the autonomic nervous system may provide a link between the tendency to suppress fatigue and CHD.

PUPILLARY RESPONSE TO LIGHT, AND FATIGUE

Lowenstein and Loewenfeld (1951) have described the normal pupillary reflex to light as being integrated at different levels of the nervous system, each level adding factors which contribute to the final shape of the reflex. They argued that the absence of any factor will modify the shape of the reflex curve. These levels of integration were given as follows: the afferent pathways (which if interrupted block the reflex entirely); the pretectal area; the third nerve nucleus; and, the ciliary ganglion. Lesions at these levels result in reflex curve shapes characteristic of parasympathetic damage; however, the shape of the curves are also modified by the sympathetic system. For example, interruption in the appropriate area of the cortex and its connection through the hypothalamus, or in its connection to the iris causes a slight increase in the extent of contraction. Also, damage to the posterior hypothalamus results in tonohaptic reactions when the lesions are non-irritative, and V and W shaped curves when the lesions are irritative. (see Appendix A Figure 1)

These shapes, which are permanent, may also appear as "transitory and reversible symptoms in the course of physiological fatigue, by which the normal autonomic regulation is disintegrated in a certain sequence" (p. 594). This sequence indicates that the influence of the cortical level disappears prior to the subcortical, and the sympathetic reflex activity vanishes prior to the parasympathetic reflex activity. The reflex shapes which reflect these central processes are: increased contraction speed, with drifting to the left of the differential curve; W-shapes; V-shapes; and tonohaptic reactions. The shapes, then, "are a measure of the actual condition of fatigue at the moment of reflex

elicitation, [and] the length of the rhythmically appearing periods of decrement and increment of autonomic (pupillary) reflex activity and the rate of deterioration of the reflex to light within each period are a measure of fatigability" (p. 581). (see Appendix A Figure 2)

To examine these concepts, Lowenstein and Loewenfeld performed various experiments. In one, a series of light stimulations were presented to subjects without known physiological disabilities. While all subjects yielded similar first reactions, differences appeared as early as the second and third stimulation. These differences indicated tendencies toward, or full development of, the pathological pupillary light reflex curves.

In certain cases there were indications of central sympathetic weakness - tonohaptic reactions, (flat bottomed curves); in others, there were indications of sympathetic irritation (W and V shaped curves); and in others, both tonohaptic reactions, and W and V shapes occurred. The distinguishing feature between the reactions of normals and true pathological symptoms was that, in the latter case, the tonohaptic reactions, and V and W shapes were always present. In another experiment, the authors investigated fatiguability by presenting the stimuli before and after work. These experiments resulted in the following four classifications:

Type 1

A syntonic type of autonomic regulation, in which the sympathetic-parasympathetic equilibrium is well balanced, the sequence of fatigue shapes corresponds to the statements of the general law, and the rate of fatigue is not increased.

Type 2

A type of central sympathetic irritability in which, as compared with the first type, W and V shapes of reaction occur prematurely.

Type 3

A type of central sympathetic weakness in which, as compared with the first type, tonohaptic reaction shapes develop prematurely.

Type 4

A type of central sympathetic irritative weakness in which, as compared with the first type, W and V shapes of reaction occur prematurely, as in Type 2, and are prematurely replaced by tonohaptic reaction shapes, as in Type 3 (p. 594).

Of special interest is the comment, "It seems as though these types are related to personality or behavior types" (p. 594). If "these types", can be related to the behavioral Types A and B, then perhaps one of the "links between Type A behavior and excessive sympathetic arousal", (Dembroski et al 1979; p. 211) mentioned earlier, will, indeed have been established.

Summary

Fatigue (and defatigue) are concerned with shifts in the sympathetic-parasympathetic balance, a sympathetic weakness being physiologically identical to initial fatigue. A permanent condition of "physical or mental irritation, by which the sympathetic system is stimulated and the sympathetic-parasympathetic equilibrium is chronically shifted in favour of the sympathetic system, results in the delay in the occurrence of symptoms of natural fatigue". (Lowenstein & Loewenfeld, 1951; p. 595). It is crucial to note here that it is the symptoms which are delayed.

No mention is made of fatigue itself being delayed. It may be, then, that it is only the awareness of an actual state of fatigue which is not immediately apparent.

The proposed research will utilize pupillary response to repeated light stimulation in order to examine the relationship between the categories of Lowenstein and Loewenfeld, and the Type A/B differentiation. Such a relationship already has some support in that the autonomic nervous system is directly related to both CHD and the pupillary response.

COMPARISONS OF TYPES 1 TO 4 WITH TYPES A AND B

This relationship will be discussed from behavioural and physiological points of view by comparing the descriptions of Types 1 to 4 by Lowenstein and Loewenfeld with typical descriptions of Types A and B.

A Behavioural Comparison

Sparacino (1979) described the individual categorized as Type A as: "... chronically restless, impatient and time conscious. These individuals are never truly content unless battling multiple deadlines, obstacles and harrassment" (p. 38). Lowenstein and Loewenfeld (1951), have described Type 2s as being excitable, restless, overactive and enthusiastic. Further, "after work there was little change in rhythm; the pupillary reactions which, owing to sympathetic irritation, were slightly inhibited before work appeared to have lost the inhibition after work" (p. 597). Work, it seems, restored the sympathetic-parasympathetic equilibriums. This shift toward an optimum sympathetic-parasympathetic balance may explain the Type A's ability to suppress fatigue - an ability which, as stated earlier, (Carver et al 1976), may be a prime factor in CHD. It is therefore, hypothesized that Type A individuals will display the pupillary responses to repeated light stimulation of Type 2

persons.

A comparison of Type 3 and Type B also yields certain behavioural similarities. Lowenstein and Loewenfeld (1951) describe the Type 3 medical student as: "... easily fatigued by either physical or mental work. Nevertheless, he works hard and steadily, is conscientious, concerned with his future, he is sensitive and reliable" (p. 585). During and after work, Type 3s were described as having, "... expended more effort and reported more sensations of fatigue than did persons representing Types 1 and 2" (p. 589). (It is of interest that these feelings of fatigue did not appear to exclude socioeconomic and educational success since Lowenstein and Loewenfeld's (1951) example was a medical student. This observation applies to Type Bs as well, for Glass (1977) asserted that such individuals often occupy positions of senior management). If the contention of Carver et al (1976) is correct, the admission of fatigue should contribute toward a lower incidence of CHD in Type 3 individuals and hence they should be found within the Type B population. Also, their behaviour patterns (sensitive rather than aggressive) support this contention.

In terms of fatigue during and after work, the Type 4 person (central sympathetic and irritative weakness) falls somewhere between Types 2 and 3. Lowenstein and Loewenfeld (1951) stated: "The type of central and sympathetic weakness shows fatigue symptoms to appear faster than in Types 1 and 2 but not as fast as in Type 3" (p. 599). Again, the reason fatigue symptoms of the Type 4 appear less quickly than Type 3, is that the initial imbalance (toward the sympathetic nervous system) is apparently corrected by fatigue. Nevertheless his

sympathetic weakness results in a final imbalance and an accompanied admission of fatigue. Therefore, as with Type 3, it is hypothesized that Type 4 falls in the Type B domain.

The comparison so far places Types 2, 3 and 4 in perspective with Types A and B. The question remains, what of the Type 1? Lowenstein and Loewenfeld (1951) described such as individual as, "a well balanced and pleasant personality...even tempered and unchanged under considerable and long lasting stress" (p. 585). And after work, he is described as follows: "the subjects in this group did not feel exhausted or even fatigued...Although they worked, the observers did not have the impression that much subjective effort was involved" (p. 592). (The actual increase in fatigue was measured at about 10%). The behaviour pattern of Type 1 suggests that he is also a Type B, but more strongly that he is not a Type A. It is likely that Sparacino (1970) would agree with this contention, as he has reported that, "Extreme Type Bs in general manifest the opposite of Type A behaviours. They are more relaxed and easy going, less hostile and overly competitive, and might be described as more subdued. They are not free of stress, but rather confront challenges and external threats less frenetically" (p. 38).

Figure 1 presents a simple model of the relationship between the Type A/B dimension and the Types 1 to 4 dimension. It seems that B_o and Type 1 are optimum in dealing with fatigue. Such individuals, due to their efficiency, are genuinely less fatigued. Those on the right feel fatigue and admit it, whereas those on the left are fatigued but are not as aware of it, and therefore may be prone to CHD.

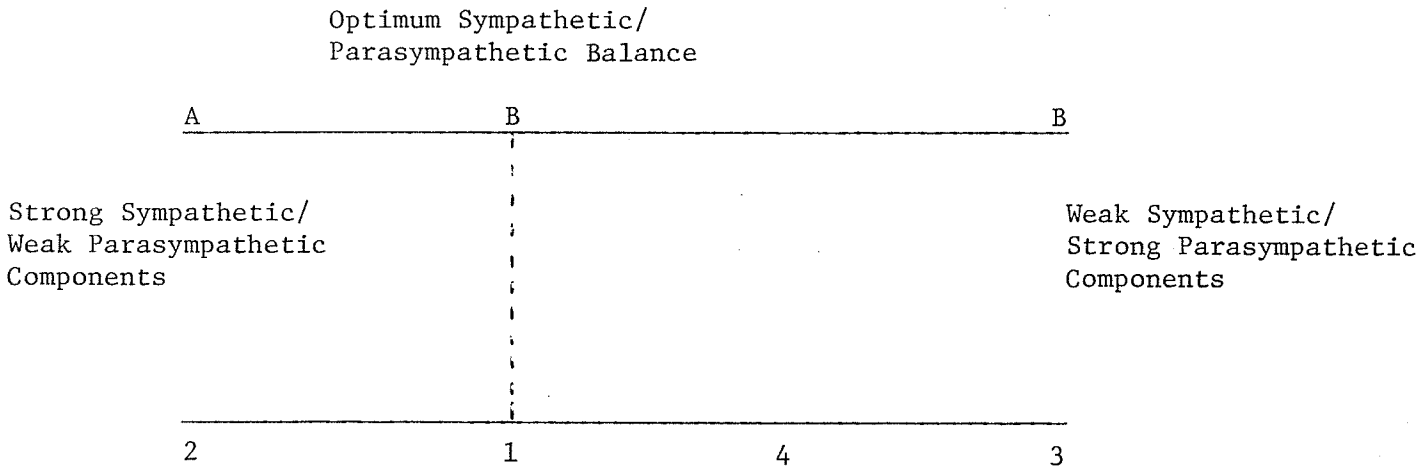
Figure 1

A Comparison of Types A and B

To Lowenstein and Loewenfeld's Types 1, 2, 3 and 4,

With the Overall Relationship to

The Sympathetic-Parasympathetic Balance


Optimum Sympathetic/
Parasympathetic Balance
A
B
B
Strong Sympathetic/
Weak Parasympathetic
Components
Weak Sympathetic/
Strong Parasympathetic
Components
2
1
4
3

A Physiological Comparison

Proceeding sections have indicated that there is at least one common physiological factor in individuals categorized as either Types A/B or Types 1 to 4 - the autonomic nervous system; specifically, the sympathetic-parasympathetic balance. In the former case, (Types A/B), increased sympathetic activity resulting in increased levels of norepinephrine is frequently found in Type As (e.g., Dembroski, 1979), and in the latter case (Types 1 to 4), the categorization of individuals according to their pupillary response to repeated light stimulation is also a function of sympathetic activity. This physiological relationship can be seen in Figure 1.

Relevent here is a discussion by Cotman and McGough (1980), concerning the widespread simultaneous effect of the sympathetic nervous system. They indicate that each post ganglionic cell of the sympathetic division usually receives input from a number of preganglionic axons from several different levels of the spinal cord, therefore, activity in this division will probably not be confined to a simple target organ, but will have widespread effects and produce high levels of arousal. On the other hand, the axons of the parasympathetic division are relatively more discrete. Thus it is hypothesized that Type A individuals will show sympathetic strength in their pupillary responses to light stimulation.

ANXIETY AND STRESS

Overview

There is evidence (Goldband, 1980) that anxiety and relevant stressors may influence the responses of Type A individuals. There is also evidence that stressors effect the pupillary light reflex (Lowenstein, Feinberg and Loewenfeld, 1963). The relevance of these concepts to Type As and to the pupillary response, as well as their applicability to the proposed research will be discussed below. A final section will discuss heart rate.

Typical anxiety indicators are classified as either physiological, behavioural or paper and pencil (Levitt, 1967). Physiological indicators such as heart rate, blood pressure, respiration rate, GSR and pupillary dilation, have several advantages in that they are responses of the autonomic nervous system whereas the others are subjective and often mediated. One disadvantage of physiological measures, however, is that they may not be consistent across subjects (Krause, 1961). In an effort to explain these phenomena, Spielberger (1966) differentiated between trait and state anxiety (Spielberger, Gorsuch & Luschene, 1970). Trait anxiety is said to measure the subject's potential to react anxiously while state anxiety is the actual anxiety reaction. These two types of anxiety are assessed by paper and pencil techniques and should be taken into account when measuring anxiety.

Finally, behavourial evidence of anxiety may be obtained from tasks performed under varying conditions of stress (Dumoff, 1978). Such tasks may include learning and memory (Gaudrey & Spielberg, 1970), or serial learning (Spielberg & Smith, 1966).

The Type A Individual

The appropriateness of a particular stressor for a particular individual has been a topic noted by several writers. For example, House (1975) has observed that "the experience of stress is a subjective response resulting from a combination of both particular objective conditions of work and particular personal characteristics" (p. 25).

As already indicated these "subjective responses" should reflect differing A-States, and research involving anxiety should attempt to identify appropriate stressful stimuli for people who differ in A-Trait. For example, Rappaport and Katkin (1972) and O'Neill, Spielberger and Hartsen (1969) found under ego-threatening conditions, that those high in A-Trait yielded greater changes in A-State than those lower in A-Trait. However, for situations involving physical danger, levels of A-Trait did not predict difference in A-State levels.

It seems that appropriate stressors are also necessary to elicit Type A behaviour. Glass (1977) stated "The coronary-prone behaviour pattern might thus be described as a characteristic style of responding to environmental stressors that threaten an

individual's self-control. Type As are engaged in a struggle for control, whereas Type Bs are relatively free of such conerns and, hence, free of characteristic Pattern A-Traits" (p. 181). Later in the same article, Glass adds, "Pattern A behaviour emerges in the presence of a specific set of eliciting conditions - namely perceived threats to environmental controls" (p. 182). Goldband (1980) performed two experiments to determine the influence of stimulus specificity on differences in physiological response to stress of Type A and Type B individuals. In experiment 1, Type A but not Type B subjects responded physiologically to a reaction time task only when it contained the components of competition, time urgency and loss of control. Such situations may be considered an ego threat for As but not for Bs. In a second experiment, when the ego threat was replaced by a cold pressor, there were no apparent differences between Type A and Type B. Lott and Gatchel (1978) and Shewitz, Berton and Leventhal (1978) also demonstrated that there were no differences in response to a cold pressor for Type A and Type B individuals.

The Pupillary Response

Janisse (1977) has summarized the literature indicating that in general, the pupillary reaction to anxiety or a stressor is dilation. More specifically, Patrick (1969) and Nunnally et al (1967) have demonstrated greater pupillary dilation in the presence of loud noise than in its absence. Nunnally et al (1967) argued that when noise becomes painful,

increased muscle tension causes pupil dilation. Of special interest to this research is Frith's (1976) study in which pupil size increased when subjects were exposed to a 95 db tone, but simultaneously, the pupillary light reflex amplitude decreased. The effect of the noise diminished after two presentations but there was not habituation in the light reflex. Frith concluded:

> "The pupil size response is a component of the orienting response, while the light reflex response is not. A simple explanation of this difference would be that the pupil light reflex reflects the amount of stimulation impinging on the organism whereas the pupil size response reflects arousal level which increases with the changes in stimulation, but rapidly adapts to them. (p. 8-9)

Lowenstein et al. (1963) concurred with this interpretation. They have stated that under conditions of sensory or emotional stress, a typical light reflect construction will be inhibited or even completely suppressed.

The experiments of Rubin (summarized in Rubin, 1976 b) offered strong support for these contentions. Briefly, in his studies concerning psychotics, he categorized subjects according to their adrenergic (sympathetic) and cholinergic (parasympathetic) components. He demonstrated that the pupillary light reflex of normal subjects was similar both at rest and under stress.

Relating stress, anxiety and pupillary response, Polt (1970) reported greater pupillary dilations during mental arithmetic tasks (the anxiety producing situations) for subjects who were threatened

concerning incorrect answers (the stressor) than for subjects who were not threatened.

To test the affect of pain (physiological stress) upon pupil size, Ramsay, Madak and McIntyre (1976), devised three trials: (1) pain - during which subjects received heat on the forearm for a maximum of 20 seconds; (2) sham pain - during which subjects expected to feel heat but none was administered; and, (3) control - subjects were told they would not feel heat. The subjects were allowed to end a trial at any time if they felt the pain to be too intense. Those who chose to terminate the two pain trials early showed a greater pupillary dilation at the onset of the heat than did those who terminated later or lasted twenty seconds. The authors interpreted this increased dilation as reflecting a greater subjective feeling of pain.

Kuc and Janisse (1976a) related a non-physical stressor to anxiety and the pupillary response. Subjects were presented with an eight-item digit-span stress. Subjects in the high stress condition were told that performance reflected intelligence (an ego threat). The A-State portion of Spielberger's State-Trait Anxiety Inventory (Spielberger et al., 1970) was also administered in an attempt to assess whether the stress instructions were arousing. The results indicated that the stress instructions produced both higher anxiety scale scores and larger pupil size.

In summary, Janisse (1977) concluded: "It seems clear....that a consistent response of the pupil to a stressor is dilation. Whether the construct of interest was actually called stress or anxiety, or fear, or something else, the response appears to be the same." (p. 63-64)

Heart Rate

Kuc (1976) examined pupillary and heart rate response in a digit-span task which included stress and intelligence as independent variables. The pupillary response discriminated subjects' intelligence and correctness better than did heart rate; however, heart rate distinguished better between stress groups than did pupil size.

Results of experiments designed to differentiate Type A and Type B individuals on the basis of heart rate have been equivocal. Dembroski et al, (1978) tested the hypothesis that Type A subjects would react with greater cardiovascular response than Type B subjects during the structured interview. No significant differences were observed between the groups although Type A subjects showed significantly greater decreases in heart rate variability than Type B subjects. On the other hand, Goldband (1980), in an experiment designed to measure the impact of stimulus specificity on physiological response to stress in Type A and Type B individuals reported that subjects in the relevant stress condition had significantly larger heart rate increases compared to those in the neutral condition. However, there were no differences in heart rate as a function of the Type A score alone.

Since both pupillary response (constriction and redilation) and heart rate (increase and decrease) are mediated by a sympathetic-parasympathetic balance, it is reasonable to assume that Spielberger's (1966) A-State-A-Trait process applies. In fact, the process may explain the differences between Goldband's (1980) and Dembroski's (1978) conclusions. That is, the stress induced by the structured interview may simply not have been great enough for the expected difference to occur. On the other hand, Goldband's (1980) results were mediated by a relevant and

strong stressor.

PERSONALITY DIFFERENCES

As stated earlier, Type A and Type B behaviour patterns were not intended to differentiate between personalities. Nevertheless, several studies have attempted to detect associations between measures of Type A behaviour and various personality traits. Sparacino (1979) summarized these results, citing for example, Rosenman, Rahie, Borhani and Feinleib (1974) who reported significant positive correlations between Type A behaviour and four of the seven scales from the Thurstone Temperament Schedule: active, dominant, impulsive, and sociable. Both Rosenman et al., (1974) and Glass (1977) found significant correlations between Type A behaviour and several adjective scales from Gough's Adjective Check List (Gough, 1952), including aggression, exhibition, self confidence, change, achievement, dominance (all positive), and self control and counselling readiness (negative).

It will be recalled from above that, with regard to their Types 1 to 4, Lowenstein and Loewenfeld (1951) have stated that "It seems as though these types are related to personality or behaviour types" (p. 594).

Because it has already been pointed out that both the behaviour patterns (Types A and B) and the categories based on pupillary light reflex (Types 1 to 4) have correlates of a physiological nature, it would be of interest to the proposed research to compare these differences to personality dimensions such as those proposed by Eysenck (1967), since they also have physiological basis.

Eysenck viewed personality as being comprised of two dimensions: neurotic-psychotic and introversion-extroversion. He related neuroticism or emotionality to autonomic nervous system activity, and in particular

to the sympathetic component. Introversion-extroversion on the other hand, is related to differences in the threshold of arousal in the various parts of the ascending reticular activating system, introverts being characterized by lower thresholds of cortical arousal than extroverts.

Previous research (e.g., Stelmack & Mandelzys 1975; Dumoff and Janisse, 1976) found pupil sizes to be larger for introverts. It may be that Type Bs are more introverted than Type As.

Also of interest to the proposed research are Petrie's (1967) proposals concerning individual differences in perceptual reactance. She suggested that nonpathological adults may be classified, according to their style of Stimulus Intensity Modulation, as sensory augmenters, reducers or moderates. Sensory augmenters, for example, after having their fingers stimulated will react by overestimating the size of a subsequently touched stimulus object. Reducers on the other hand will underestimate the stimulus object, while moderates will not deviate one way or another. It may be that these styles are related to the styles of behaviour typified by Types A and B.

STATEMENT OF PURPOSE

The purpose of the proposed research is to examine the relationship between individuals categorized as exhibiting Type A or Type B behaviour according to the JAS, and Lowenstein and Lowenfeld's (1951) four categories which are based on pupillary reaction to light stimuli. The research will also investigate this relationship under conditions of physiological stress (the cold pressor) and psychological stress (an ego threat). The variables which will be considered are stress, trait anxiety, state anxiety, pupillary response (reflex pattern, reflex speed, mean pupil diameter, and variance of pupil diameter), and heart

rate (mean and variance).

The reviewed literature suggests that there exists a direct relationship based on pupillary response between: Type A and Type 2; and between Type B and Types 1, 3 and 4. It also suggests that mean pupil diameter should be greater and variance should be smaller when repeated light stimuli are presented under stressful conditions. (Frith, 1976; Lowenstein, Feinberg & Loewenfeld, 1963). However, it is contended (Goldband, 1980) that the stressor must be relevant. Therefore, it is expected that the physiological stressor will be equally applicable to both Type As and Bs - hence there should be no difference in pupil measurements; whereas the psychological stressor should be more relevant to Type As causing the described pupillary differences.

The literature concerning anxiety, stress and heart rate (Demboski, 1978; Goldband 1980), although not as conclusive as the pupilometric data, suggests that heart rate also should only increase under conditions of relevant stress. Therefore, when physiological stress is applied it is expected that there will be no differences in heart rate between persons exhibiting Type A and Type B behaviours, but that differences will occur under conditions of psychological stress.

In order to ascertain whether the various conditions are relevant as predicted, A-Trait and A-State measures will be taken (Spielberger, Gorsuch & Luschene, 1970).

Secondary variables to be examined are personality, as defined by Eysenck (1967) and Style of Stimulus Intensity Modulation as defined by Petrie (1967). Specifically, the Neuroticism and Extroversion scales of the Eysenck Personality Inventory, and the Augmentation and Reduction scales

designed by Petrie will be administered.

If the expected relationships occur between Types A and B and Types 1 to 4, then the pupillary reflex to repeated light stimulation may be regarded as another predictor of CHD. Its benefits relate to the ease with which it is obtained, and to its autonomic basis which affords it protection from many unwanted biases.

STATEMENT OF HYPOTHESES

The following hypotheses are based on the physiological arguments and the literature interpretation contained in this introduction:

1. It is hypothesized that Type A behaviour is positively correlated with the Type 2 pupillary response to repeated light stimulation.
2. It is hypothesized that Type B behaviour is positively correlated with Types 1, 3 and 4 pupillary responses to repeated light stimulation.
3. It is hypothesized that both heart rate and pupil size will increase differentially for Type A and Type B subjects under conditions of relevent stress. Specifically, Type As will respond to psychological stress with greater dilation and heart rate than Type Bs whereas there will be no differences under physiological stress.

METHOD

Subjects

The Jenkins Activity Survey for Health Prediction (JAS), the A-Trait and A-State Scales (Speilberger, et al, 1970), the Eysenck Personality Inventory - Form A (Eysenck, 1967), and the Reducer/ Augmenter Scale (Petrie, 1967) were completed by 87 members of the Canadian Armed Forces during Phase 1 of this experiment. These scales are included in Appendices B to E respectively. All subjects were males between the ages of 18 and 24 years. Education ranged from 7 to 15 years although only one subject had more than 13 years. From this initial pool 16 subjects were selected from both the upper and lower quartiles of the JAS range (extreme As and extreme Bs). The two groups did not differ significantly on age or education.

Apparatus

Pupillary response was measured using a Whittaker Space Sciences Eye View Moniter and Television Pupillometer which provided an accurate assessment of pupil diameter. Infra-red light was reflected from the left eye to the camera which measured pupil size 60 times per sec. Light stimulation was provided by a 6 volt bulb placed 30 cms in front of the left eye. The bulb provided a 15 foot candle light source and was electronically controlled to emit 1 sec flashes every 5 seconds.

A Whittaker Space Sciences Pulse Watch was used to measure heart rate, the transducer being attached to the second finger of the right hand. The cold pressor consisted of a container of iced water maintained between 1^{o} and 4^{o} Celsius.

All information was recorded digitally on a Kennedy incremental tape recorder, Model 1600/360. The light stimulations triggered the

recording of a time marker. A two channel Sony tape recorder was used to record the procedures. Instructions were read to the subjects and all equipment was contained in a white room, the ambient lighting being controlled by a constant voltage transformer.

Experimental Conditions

The two groups of 16 subjects representing Type A and Type B populations underwent three experimental conditions as outlined in Table 1. Eight subjects from each group completed the experiment with the second and third conditions measured in reverse order.

EXPERIMENTAL CONDITIONS		
No Treatment	Physiological Stress (Cold Pressor)	Psychological Stress (Ego Threat)
Pupil Diameter Heart Rate State Anxiety	Pupil Diameter Heart Rate State Anxiety	Pupil Diameter Heart Rate State Anxiety

Table 1 Experimental Conditions, Dependent and Independent Variables

No Treatment. During this condition pupil diameter and heart rate measures were recorded for one minute while the subjects were exposed to the repeated light stimulations. The A-State Scale of the STAI (Spielberger et al., 1970) was administered prior to and after this condition to assess current feelings and identify subjects who experience anxiety induced by the condition. It was further used to assess the effectiveness of the stress manipulation with respect to the A-Trait Scale of the STAI (Spielberger et al., 1970) - also administered prior to this condition, and to investigate the relationship between state anxiety, heart rate and pupillary response with respect to Type A and Type B subjects.

Physiological Stress. The physiological stress was induced by means of the cold pressor. At the appropriate time subjects were requested to immerse their left hand in the water for a period of one minute. The perceived effects were a reduction with time in the sensation of temperature accompanied by a simultaneous increase in pain, resulting in an overall gradual increase in physiological stress. State anxiety was measured following this treatment.

Psychological Stress. Psychological stress involved the completion of a cognitive task. Subjects were required to state a word beginning with the letter B after each flash of the light. A minimum of 12 different words were required and the subjects were told that the task was a verbal indicator of intelligence. Hence it constituted an ego threat. It was expected that the perceived effects would be similar to that of the physiological stressor. That is, because difficulty increased as more words were required, the overall effect, as before, should be a gradual increase in stress. Again, state anxiety was measured following the treatment.

Other Measures

Eysenck's Personality Inventory (EPI) Form A (Eysenck, 1967), administered during Phase 1, was used to compare Type As and Bs on the Extroversion and the Neuroticism scales. Similarly they were compared using Petrie's (1967) Reducer/Augmenter scale. Finally Lowenstein and Loewenfeld's (1951) Type 2 and Types 1, 3 and 4 were compared on the basis of these scales.

Procedure

During pre-testing, (Phase 1) subjects were read instructions outlining the supposed intent of the research (Appendix F). Briefly, it was stated that the intent of the research was to investigate

relationships between life styles and certain physiological measures.

Sixteen subjects were then selected on the basis of their extreme Type A scores on the JAS, and sixteen others were selected on the basis of their extreme Type B scores. The two groups were approximately matched for age and eduction level. At the time of testing, however, several subjects in the extreme Type A group (upper 25th percentile or the JAS scale) were unavailable, therefore it was necessary to utilize 6 subjects slightly below the optimum scores. These latter subjects could be more accurately described as Type A_2 which lies more centrally on the Type A-B continuum.

During Phase 2 (the laboratory phase) the experimenter was unaware of the classifications (Type A or B) of the subjects, who then individually attended one experimental session. On entering the laboratory they received verbal instructions (Appendix G) which described the intent of the second phase of the research, alleviated unnecessary anxiety by describing the equipment, and described the experiment. Further, as indicated, in order to counterbalance order effects, 16 subjects (8 Type As and 8 Type Bs) completed the experiment with the final two conditions reversed.

After completion of the A-Trait and A-State Scales of the STAI (Spielberger et al., 1970) subjects were instructed to sit before the Eyeview Monitor at which time the No Treatment pupillary measurements were recorded under darkened conditions. The left eye was presented with 12 light stimulations, each lasting 1 second and spaced 5 seconds apart. Simultaneously No Treatment heart rates were recorded, following which the second state anxiety measure was obtained under normal light.

The second condition consisted of the repeated light stimulation under either physiological or psychological stress depending on the order group to which the subject belonged. Under the physiological stress condition, referred to as the Pressor Condition, the subject was instructed to place his left hand in the cold pressor immediately prior to the onset of the 12 light stimulations (which were of the same intensity and duration as in Condition 1). Following the treatment, state anxiety was again assessed.

Under psychological stress (the Cognitive Condition) the subjects completed the task described earlier (the ego threat) then again completed state anxiety questionnaire.

The subjects were then thanked and informed that the results of the experiment would be available at the completion of the research. It is emphasized that subjects were not told of the intent of that portion of the experiment pertaining to the prediction of coronary heart disease. They were told, however, that the word test contained in the cognitive stress condition was not related to intelligence.

Data Analysis

The experiment consisted of a 2 x 2 x 3 x 3 x 18 factorial design (BEHAVIOURAL SYNDROME X ORDER X CONDITION X TRIAL X EPOCH) using pupil diameter and heart rate as the dependent variables, and the results were analyzed according to the assumptions of a fixed effects model. Although the digital tape recorder recorded pupil diameter and heart rate 60 times per second, these readings were averaged every .25 second (15 readings) for pupil diameter and every .25 second using the previous 5 beats for heart rate. Each .25 second interval comprised one epoch. The first trial (completed constriction and redilation) to be utilized, then, was that for which heart rate was averaged over the required 5 beats - usually the

second 5 second cycle. The duration of the light stimulus was 1 second, hence the light was on from epoch 1 to epoch 4 inclusive.

In order to correct for differences in individual pupil dimensions and heart rates the first reading of each condition was subtracted from each measurement of pupil diameter and heart rate respectively within that condition. Hence, these "difference scores" were re-initiated three times per subject. Further, in a similar procedure to Carver et al. (1976), only the 8th, 9th and 10th trials (pupil constriction/redilation cycles) were included in the analyses. One unit of pupil diameter is equivalent to the width of one raster scan on the pupilometer and may be converted to millimetres by dividing by 21.25.

Of prime concern, the shapes of the reflex curves were analyzed and categorized according the Lowenstein and Lowenfeld's (1951) categories. The pupil responses were coded in order to eliminate experimenter bias and the bionomial distribution was utilized to assess the probability of obtaining the relationship between those subjects categorized as Type A or B and those categorized as Type 2 or Types 1, 3 or 4.

The degree of induced anxiety was assessed by performing a 2 x 2 x 4 (BEHAVIOURAL SYNDROME X ORDER X A-STATE SCORE) ANOVA.

Finally, T-tests were performed between Types A/B and Lowenstein and Lowenfeld's Types 2/1, 3, 4 for the Neuroticism, Extroversion and Reducer/Augmenter scores.

RESULTS

INTRODUCTION

This section will first present the results of the manipulation checks and then describe the probabilities associated with the subjective categorization of the pupillary reflex with respect to Lowenstein and Loewenfeld's (1951) Types. Next will be outlined the statistical analyses relating to personality, to the pupillary response, and heart rate.

MANIPULATION CHECKS

Trait Anxiety

Tests were performed between Type A and B subjects using the A-Trait self report measure of anxiety taken during Phases 1 and 2. The tests pertaining to Phase 1 did not differ significantly (t (30) = -1,28, $p < .011$) but differed significantly during Phase 2 (t (30) = -1.76, $p < .05$) with Type As ($\bar{X}$ = 32.44) reporting less general anxiety than Type Bs ($\bar{X}$ = 36.56). Appendix H, Table 1 contains these results.

State Anxiety

The difference between Types A and B for A-State measured during Phase 1 was highly significant (t (30) = -2.32, $p < .02$), again with the Type A subjects ($\bar{X}$ = 33.38) reporting less anxiety than Type Bs ($\bar{X}$ = 39.06). An analysis of variance (Appendix H, Table 2) for a 2 x 2 x 4 (BEHAVIOURAL SYNDROME X ORDER X CONDITION) was performed on the A-State self report measure. The analysis revealed significant main effect for Behavioural Syndrome (F (1, 28) = 7.72 $p < .01$), with Type As ($\bar{X}$ = 30.08) reporting less anxiety than Type Bs ($\bar{X}$ = 36.03). A second highly significant main effect was Condition (F (3, 84) = 7.86, $p < .001$). Table 2 summarizes the pertinent means.

COMPARISON OF THE PUPILLARY RESPONSE AND THE BEHAVIOURAL SYNDROME

The 32 pupillograms were coded to avoid experimenter bias and assessed according to Lowenstein and Loewenfeld's (1951) Types 1 to 4. Ten of the 16 Type A subjects were categorized as Type 2, and 10 of the 16 Type B subjects were categorized as Types 1, 3 or 4.

Order	Pre-NT	Post-NT	Post-Phys	Post-Psych	$\bar{X}$
Order 2	33.94	32.19	31.19	29.63	31.74
Order 1	36.00	34.25	32.94	34.31	34.38
$\bar{X}$	34.97	33.22	32.07	31.97	33.06
Type A	32.13	30.18	29.00	29.00	30.08
Type B	37.81	36.25	35.13	34.94	36.03
$\bar{X}$	34.97	33.22	32.07	31.97	33.06

Order 1: No Treatment (NT) - Physiological Stress (Phys) - Psychological Stress (Psych)

Order 2: No Treatment (NT) - Psychological Stress (Psych) - Physiological Stress (Phys)

Table 2 Means of State Anxiety Scores for Order and Behavioural Syndrome

The probability of obtaining these results by chance are less than .093. Further, of the 6 Type A subjects who were incorrectly categorized, 4 had JAS scores below the optimum cut off point (upper 25th percentile) and, as stated earlier, would be more correctly labelled as Type A_2 which falls toward the centre of the Type A-B continuum. Excluding these subjects

the probability of correctly identifying by chance 10 out of 12 Type As and 10 out of 16 Type Bs is less than .019. Figure 2 depicts examples of pupillograms of three subjects.

PERSONALITY COMPARISONS

The Neuroticism scores did not differ significantly, however, the differences between subjects on the Extroversion scale and the Reducer/Augmenter scale were highly significant (t (30) = 2.51, $p < .01$ and t (30) = 3.11, $p < .002$ respectively). Appendix H, Table 3 contains these scores.

Figure 2

Pupil Response to Light of Subjects

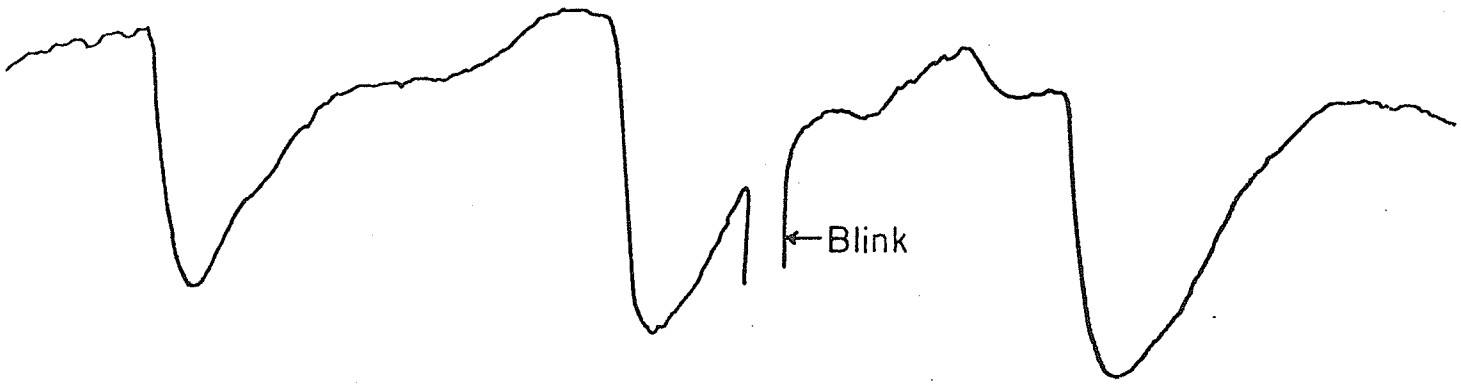
Classified as Follows:

Type B Classified as Type 1

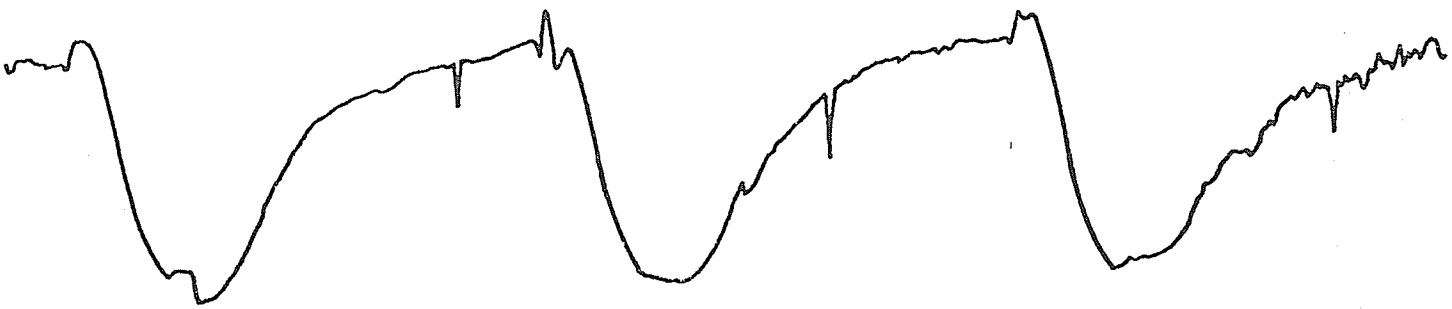
Type A Classified as Type 2

Type B Classified as Type 3

Type B / Type I : Relatively smooth curves



Type A / Type 2 : V-shaped bottoms, decrease in value of maximum amplitude



Type B / Type 3 : Tonchaptic bottoms

	Extroversion	Reducer/Augmenter
Type A	13.50	37.00
Type B	10.75	29.88
$\overline{X}$	12.13	33.44

Table 3 Means of Extroversion and Augmenter/Reducer Scores for Types A and B

Similar tests were performed between Type 2 and Types 1, 3 and 4 without significant results. Appendix H, Table 3 contains detailed results of all personality comparisons.

PUPIL DIAMETER

A multi-factor analysis of variance was performed on pupil diameter during the experimental period to determine the effects of the independent variables on pupillary response. Analysis was performed using a 2 x 2 x 3 x 3 x 18 (BEHAVIOURAL SYNDROME X ORDER X CONDITION X TRIAL X EPOCH) fixed effects model. A summary of the ANOVA is contained in Table 4 of Appendix H. Significant main and interaction effects are described below.

Epochs

The ANOVA yielded a highly significant effect for Epochs, (F (17, 476 = 207.58, $p < .001$) indicating that the expected constriction/redilation response to light was obtained (see Figure 3).

Conditions

The ANOVA yielded a marginally significant effect for Condition (F (2, 56) = 2.77, $p < .07$), the mean pupil diameter being largest in the cognitive condition. (See Figure 4)

Trials

A significant effect for Trials (F (2, 56) = 3.06, $p < .06$) indicated that the mean pupil diameter was smallest during the final trial.

Figure 3

Significant Main Effect of Epochs on

Pupil Size

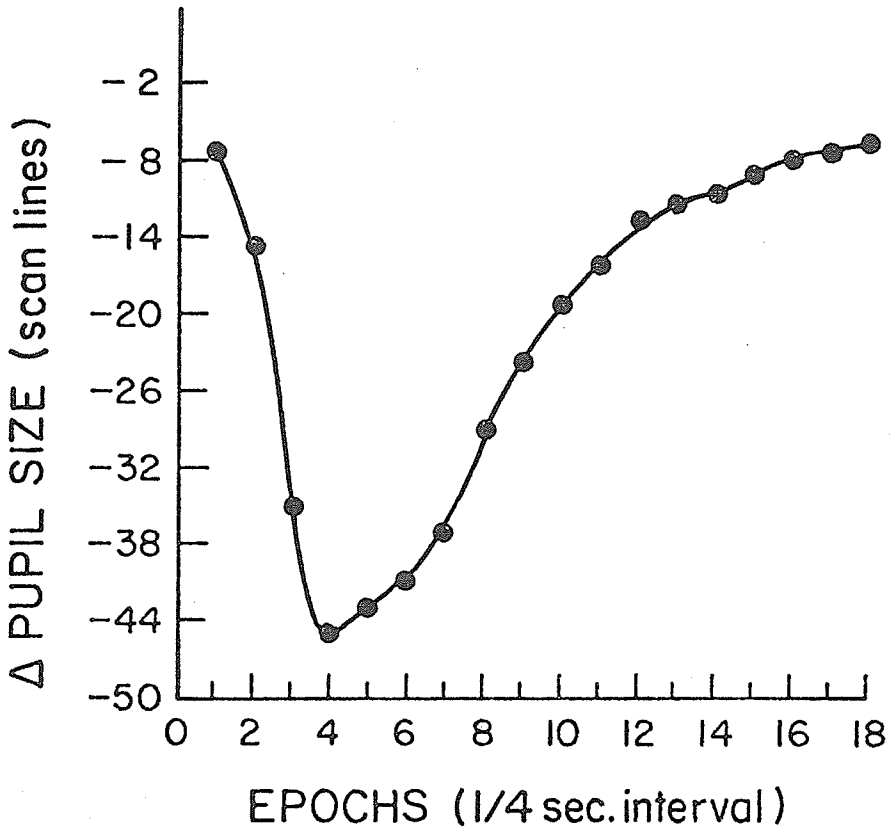
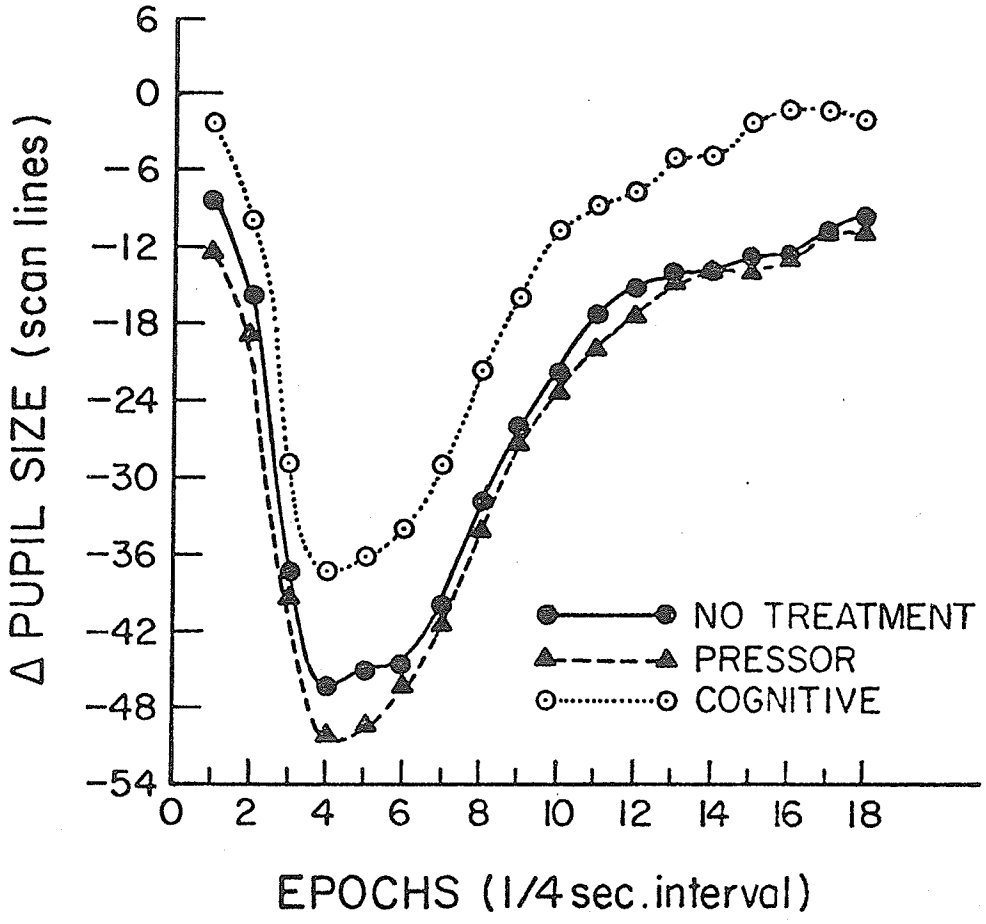

Δ PUPIL SIZE (scan lines)
-2
-8
-14
-20
-26
-32
-38
-44
-50
0
2
4
6
8
10
12
14
16
18
EPOCHS (1/4 sec. interval)

Figure 4

Significant Interaction Effect of Condition by

Epochs on Pupil Size


Δ PUPIL SIZE (scan lines)
6
0
-6
-12
-18
-24
-30
-36
-42
-48
-54
0
2
4
6
8
10
12
14
16
18
EPOCHS (1/4 sec. interval)
NO TREATMENT
PRESSOR
COGNITIVE

Conditions by Epochs

The interaction of Condition and Epoch was significant (F (34, 952) = 1.59, $p < .02$), pupil diameter being larger in the Cognitive Condition than in either of the other two conditions (see Figure 4).

Trials by Epochs

The interaction of Trial and Epoch was significant (F (34, 952) = 1.44, $p \leq .05$) but yielded no clear pattern.

Behavioural Syndrome by Epochs

The interaction between Behavioural Syndrome and Epochs was significant (F (17, 476) = 1.70, $p < .04$) with Type As having a consistenly smaller pupil diameter (see Figure 5).

Order by Epochs

The interaction between Order and Epochs was highly significant (F (17, 476) = 2.23, $p < .004$), pupil diameter being greater when the cognitive treatment was given last (see Figure 6).

HEART RATE

A multi-factor analysis of variance was performed on the heart rate data to determine the effects of the independent variables. A 2 x 2 x 3 x 3 x 18 (BEHAVIOURAL SYNDROME X ORDER X CONDITION X TRIAL X EPOCH) fixed effects model was utilized. A summary of this ANOVA is contained in Table 4, Appendix H. Significant main and interaction effects are described below.

Epochs

Although the main effect of Epochs was marginal (F (17, 476 = 1.50, $p < .09$), the change of heart rate throughout the cycle was not random (see Figure 7).

Figure 5

Significant Interaction Effect of Behavioural Syndrome by Epochs on Pupil Size

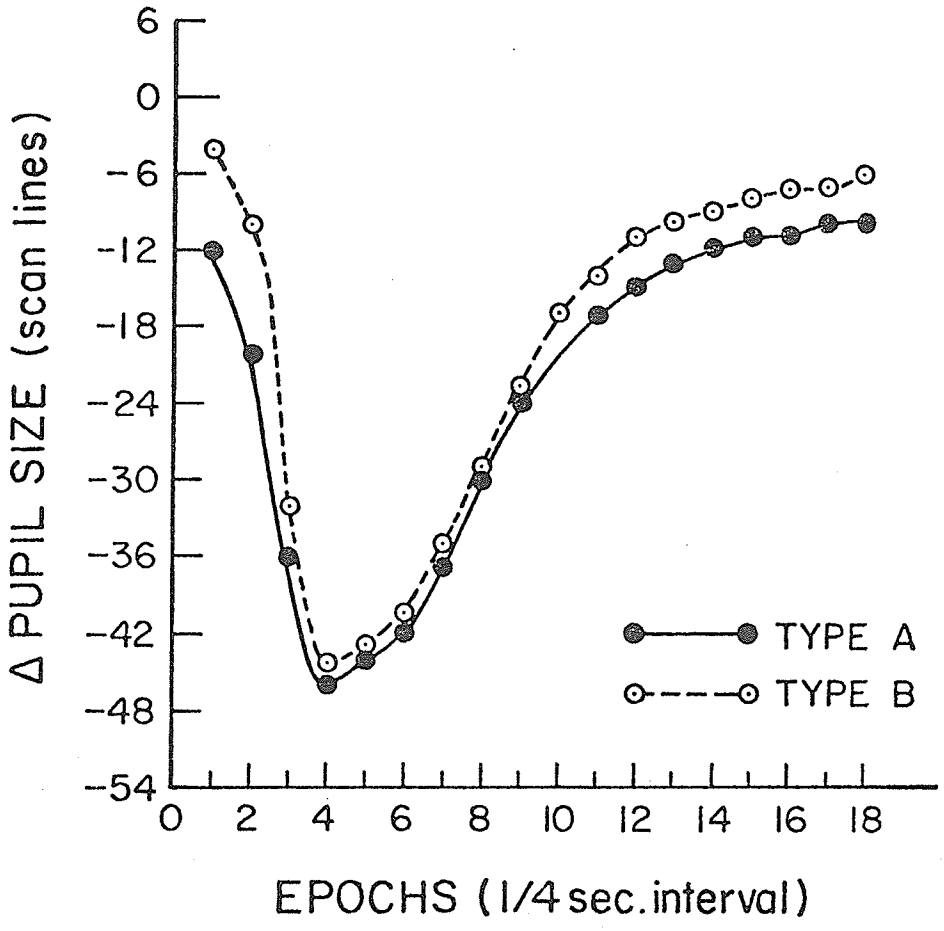

6
0
-6
-12
-18
-24
-30
-36
-42
-48
-54
Δ PUPIL SIZE (scan lines)
0
2
4
6
8
10
12
14
16
18
EPOCHS (1/4 sec. interval)
TYPE A
TYPE B

Figure 6

Significant Interaction Effect of Order by

Epochs on Pupil Size

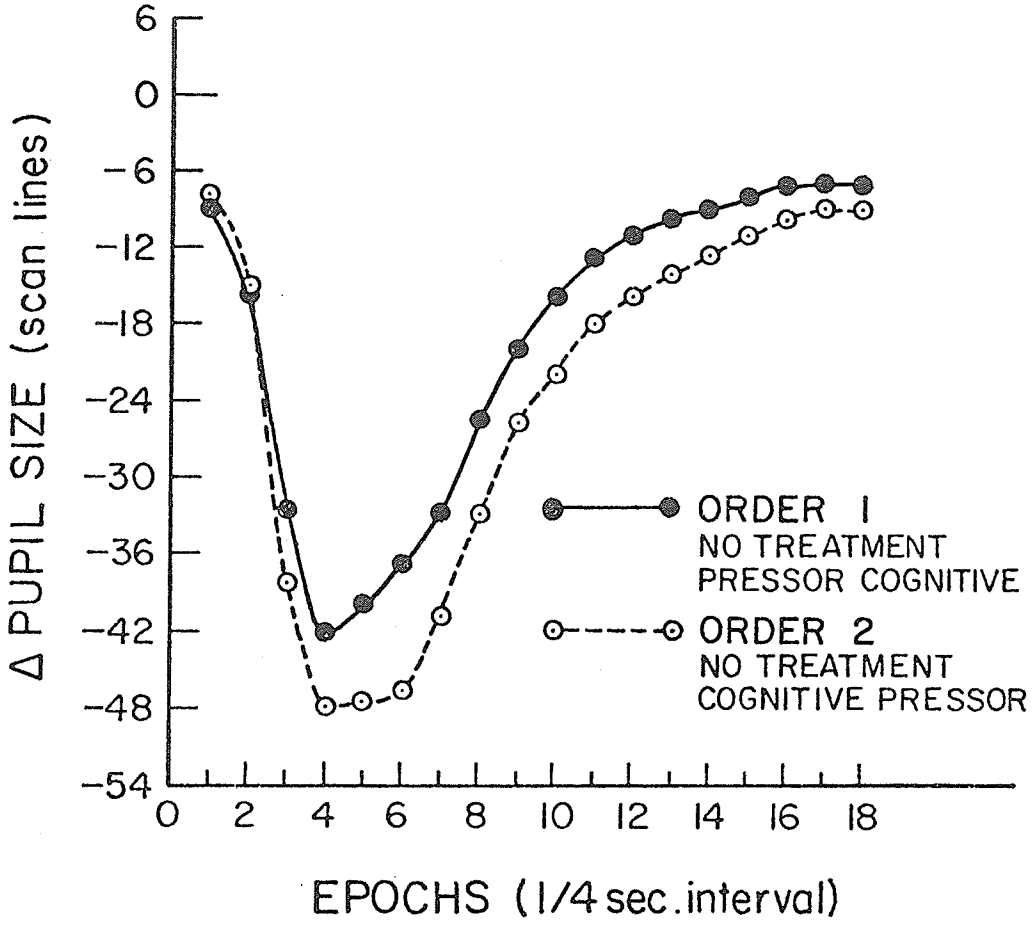
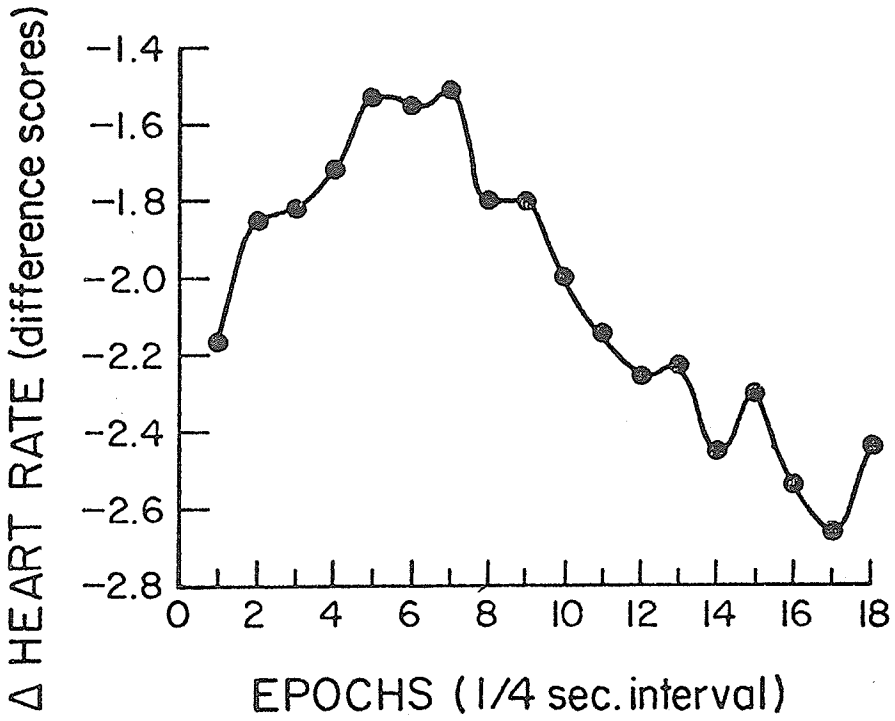

6
0
-6
-12
-18
-24
-30
-36
-42
-48
-54
Δ PUPIL SIZE (scan lines)
0
2
4
6
8
10
12
14
16
18
EPOCHS (1/4 sec. interval)
ORDER 1
NO TREATMENT
PRESSOR COGNITIVE
ORDER 2
NO TREATMENT
COGNITIVE PRESSOR

Figure 7

Significant Main Effect of Epochs on

Heart Rate


Δ HEART RATE (difference scores)
-1.4
-1.6
-1.8
-2.0
-2.2
-2.4
-2.6
-2.8
0
2
4
6
8
10
12
14
16
18
EPOCHS (1/4 sec. interval)

Conditions by Trials

A marginal interaction effect was observed between Condition and Trial (F (4, 112) = 2.31, $p < .07$) (see Figure 8).

Order by Epochs

A weak interaction effect was obtained between Epochs and Order (F (17, 476) = 1.60, $p < .06$), with heart rate decreasing after Epoch 7 when the pressor condition was presented last (see Figure 9).

Conditions by Epochs

A significant interaction effect was observed between Condition and Epochs (F (34, 952) = 2.49, $p < .001$) with heart rate decreasing after verbalization (Epoch 8) in the Cognitive Condition (see Figure 10).

Conditions by Trials by Epochs by Behavioural Syndrome

A significant four way interaction was obtained between Condition, Trial, Epoch and Behavioural Syndrome (F (68, 1904) = 1.32, $p < .05$) (See Figures 11 to 13).

Figure 8

Significant Interaction Effect of Conditions by Trials on Heart Rate

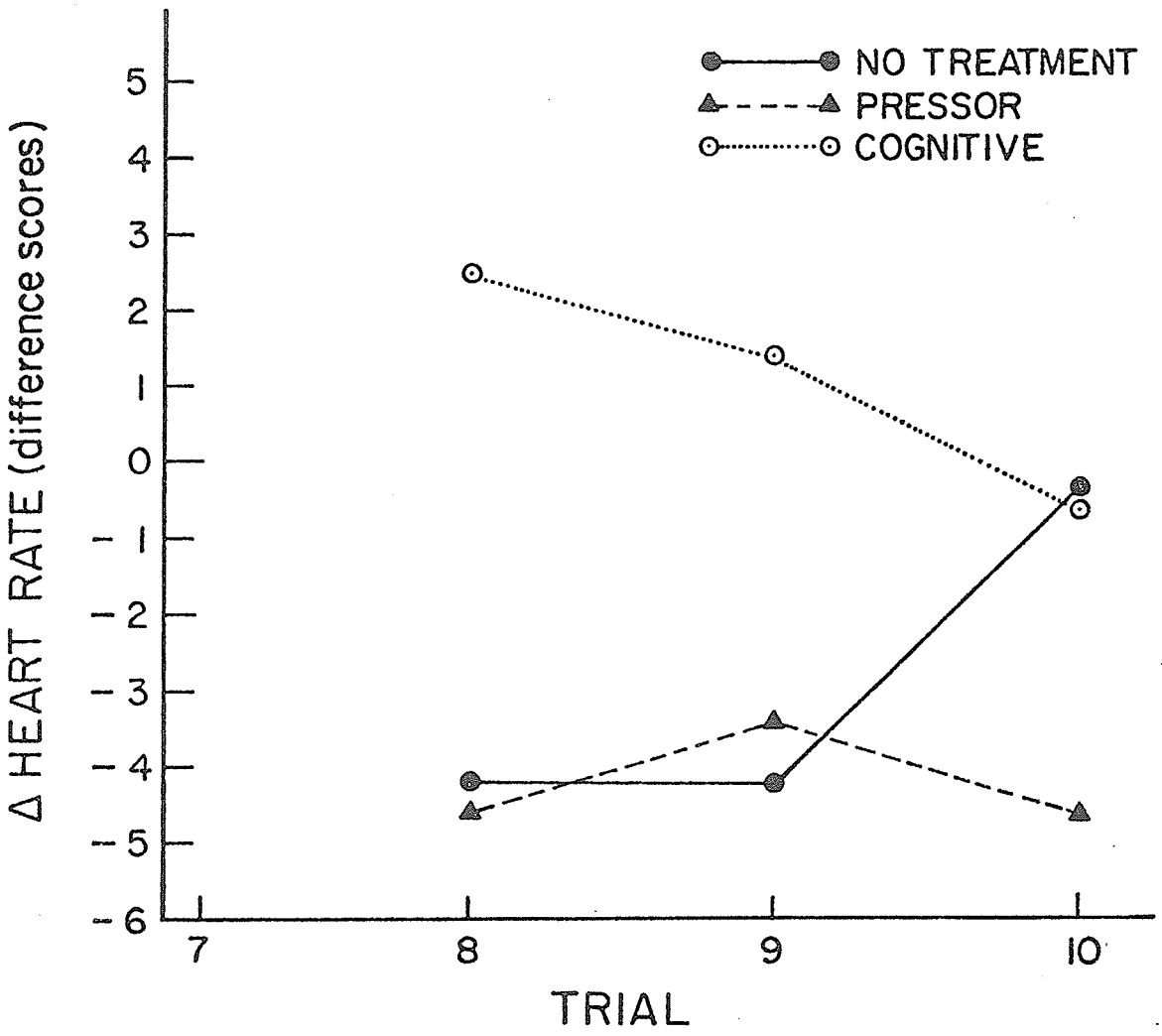

NO TREATMENT
PRESSOR
COGNITIVE
Δ HEART RATE (difference scores)
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
7
8
9
10
TRIAL

Figure 9

Significant Interaction Effect of Order by

Epochs on Heart Rate

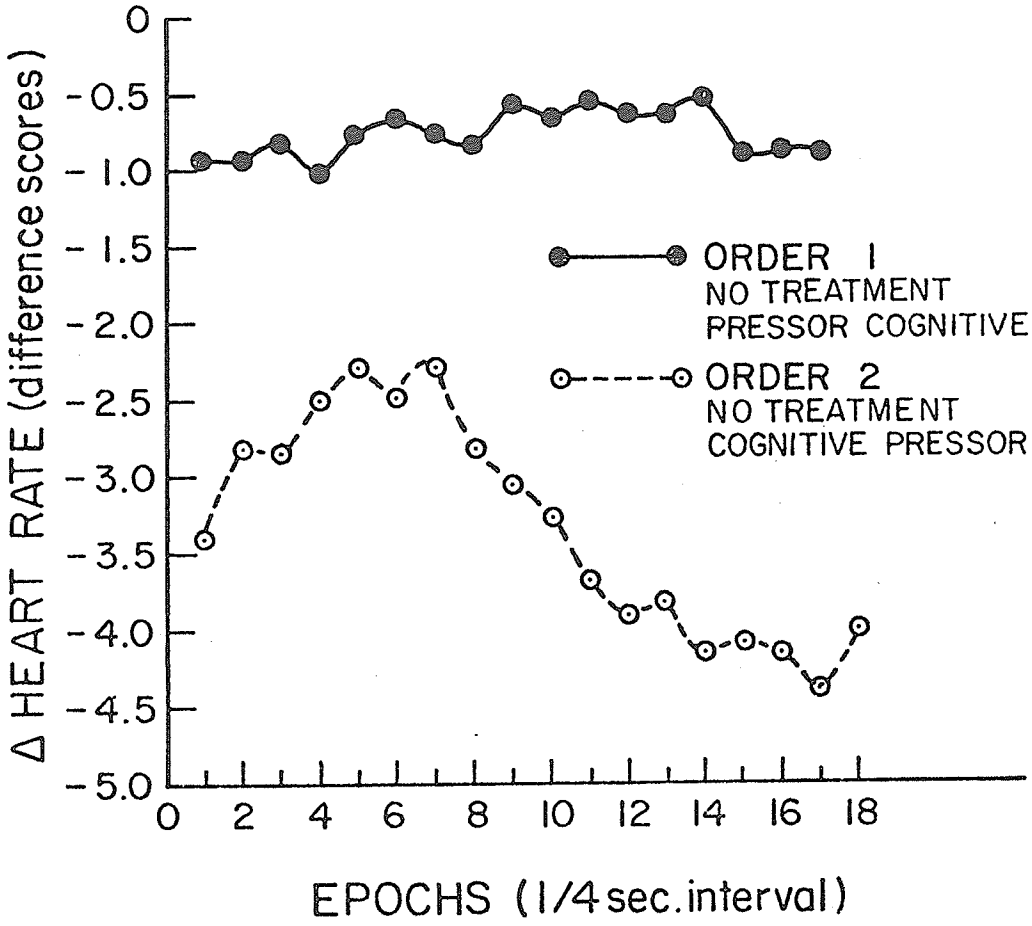

Δ HEART RATE (difference scores)
0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-3.5
-4.0
-4.5
-5.0
0
2
4
6
8
10
12
14
16
18
EPOCHS (1/4 sec. interval)
ORDER 1
NO TREATMENT
PRESSOR COGNITIVE
ORDER 2
NO TREATMENT
COGNITIVE PRESSOR

Figure 10

Significant Interaction Effect of Conditions by

Epochs on Heart Rate

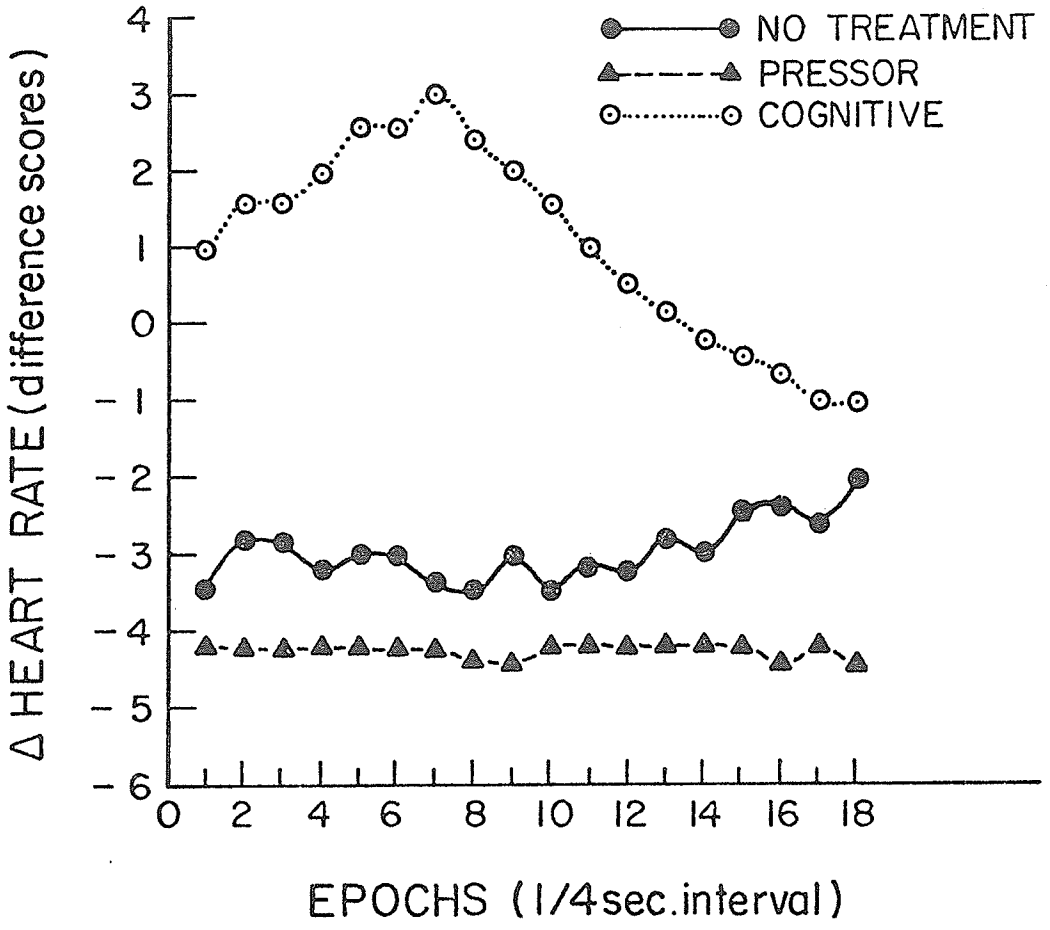

NO TREATMENT
PRESSOR
COGNITIVE
Δ HEART RATE (difference scores)
4
3
2
1
0
−1
−2
−3
−4
−5
−6
0
2
4
6
8
10
12
14
16
18
EPOCHS (1/4sec. interval)

Figure 11

Significant Interaction Effect of Epoch by Behavioural Syndrome by Trial for Condtion 1 (No Treatment)

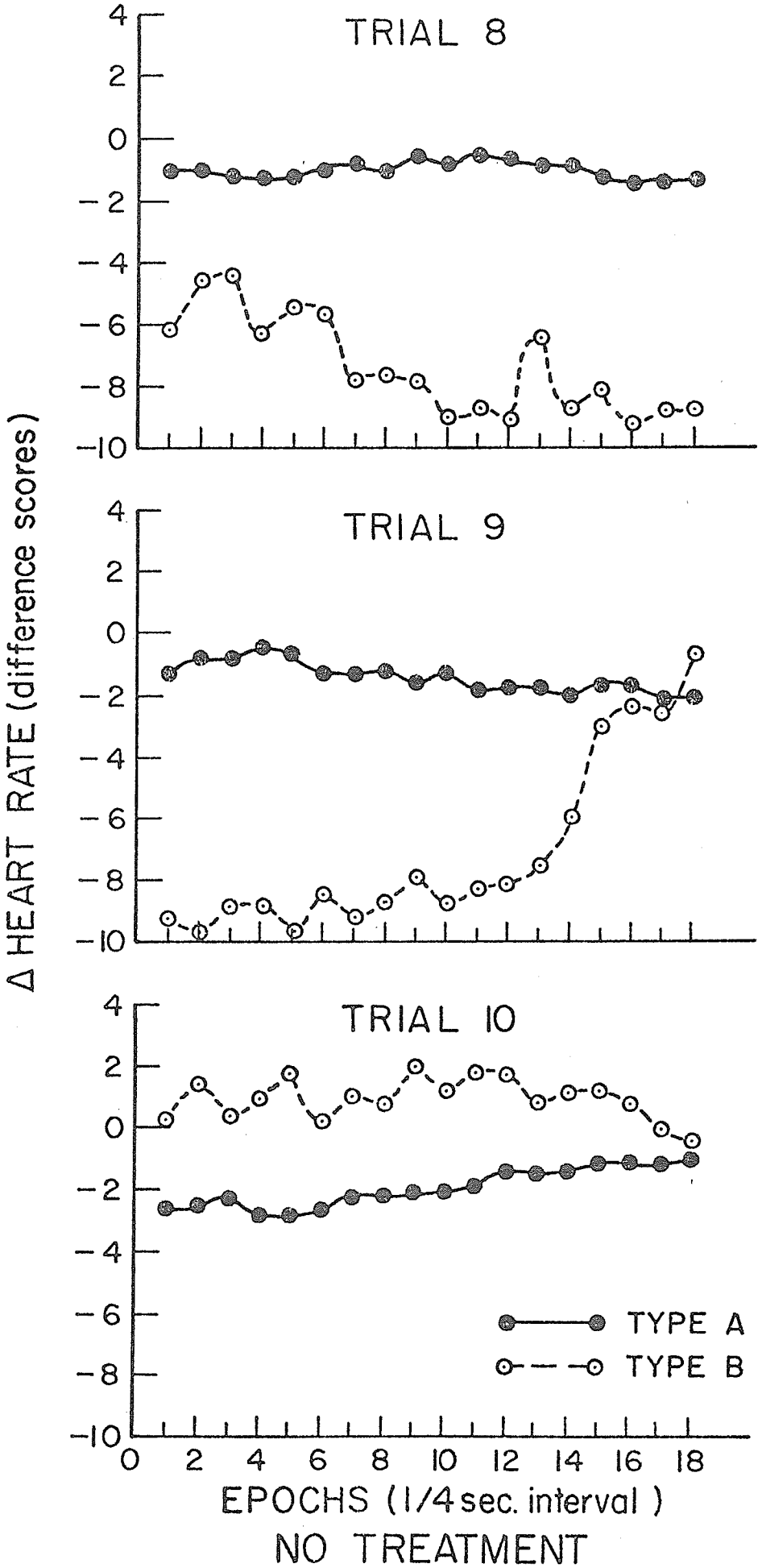

TRIAL 8
TRIAL 9
TRIAL 10
Δ HEART RATE (difference scores)
4
2
0
−2
−4
−6
−8
−10
0
2
4
6
8
10
12
14
16
18
EPOCHS (1/4 sec. interval)
TYPE A
TYPE B
NO TREATMENT

Figure 12

Significant Interaction Effect of Epochs by Behavioural Syndrome by Trials for Condition 2 (Physiological Stress)

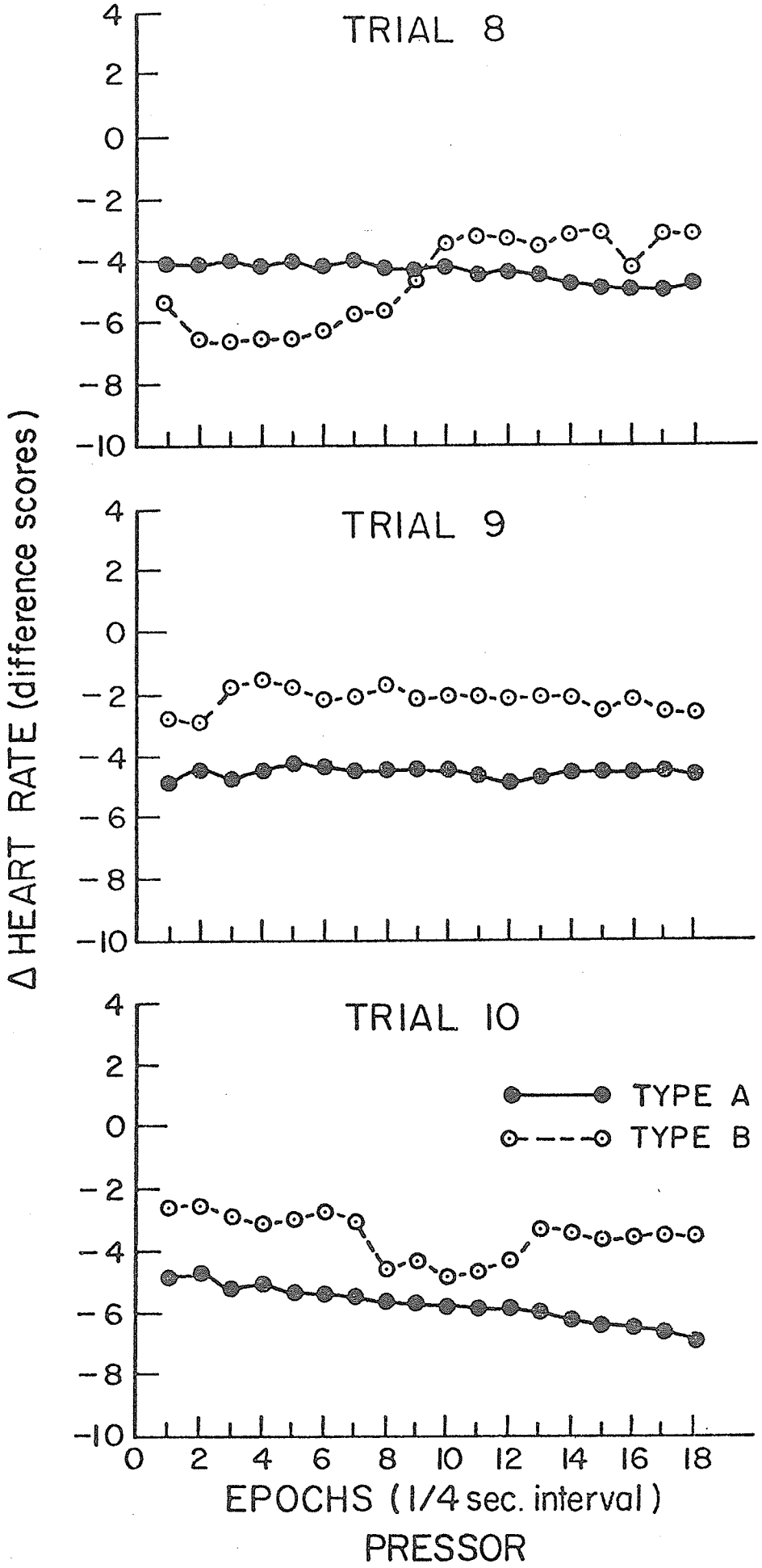
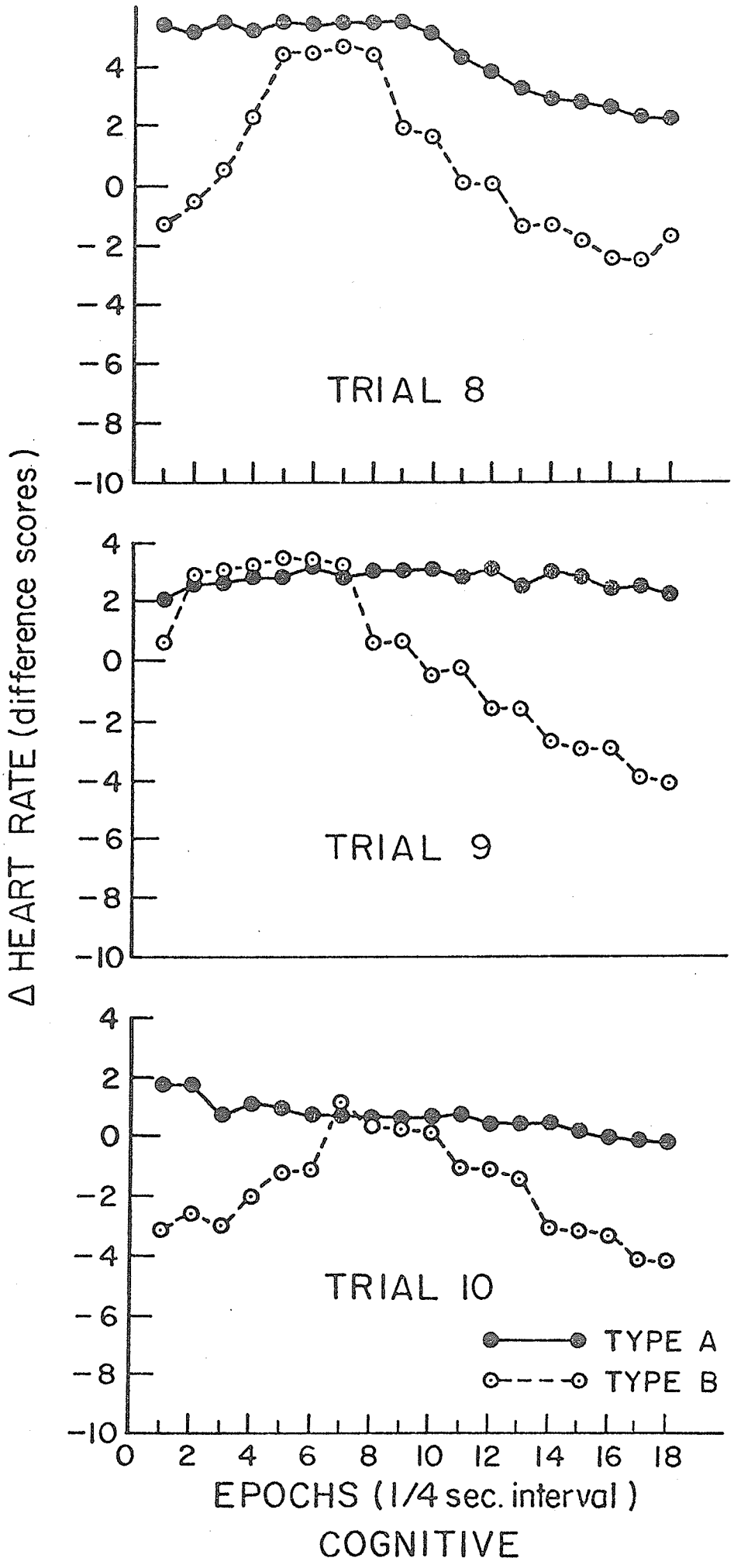

TRIAL 8
TRIAL 9
TRIAL 10
TYPE A
TYPE B
Δ HEART RATE (difference scores)
EPOCHS (1/4 sec. interval)
PRESSOR
4
2
0
-2
-4
-6
-8
-10
0
2
4
6
8
10
12
14
16
18

Figure 13

Significant Interaction Effect of Epochs by Behavioural Syndrome by Trials for Condition 3 (Psychological Stress)


Δ HEART RATE (difference scores)
4
2
0
−2
−4
−6
−8
−10
TRIAL 8
TRIAL 9
TRIAL 10
TYPE A
TYPE B
0
2
4
6
8
10
12
14
16
18
EPOCHS (1/4 sec. interval)
COGNITIVE

DISCUSSION

PUPILLARY RESPONSE AND BEHAVIOURAL SYNDROME

The primary purpose of this experiment was to utilize the pupillary response to light in order to differentiate males who exhibit Type A or Type B behavioural syndromes as defined by the JAS. The introduction described the implication of the sympathetic component of the autonomic nervous system to CHD and the contribution of it to the pupillary light reflect. It was argued that if a strong sympathetic component was involved in CHD then Type A individuals should react to repeated light stimuli with constriction/redilation patterns that reflect sympathetic strength (see Appendix A). Dembroski et al., (1979) regarded the establishment of a link between CHD and excessive sympathetic arousal to be of crucial importance.

The results of this research provide evidence for a relationship between Type A behaviour and the light reflex, hence the implication of the latter to CHD may be implied. Therefore the pupillary light reflex may be as reliable a predictor of CHD as the JAS, particularly since it is possible to fake responses on a paper and pencil test.

SYMPATHETIC AROUSAL AND RELEVANT STRESS

A secondary purpose of this experiment was to investigate further the findings of Goldband (1980) that relevant stressors influence the responses of Type A individuals. Specifically, the research tested the hypothesis that Type A individuals would respond to cognitive stress with greater sympathetic arousal (manifested in greater mean pupil diameter and greater heart rate) than Type B individuals. Further, it investigated the contentions of Snyders and Glass (1974)and Carver et al., (1976) that Type A individuals in comparison to Bs would deny subjective feelings which would interfere with performance - in this case anxiety.

A discussion of the results of the analysis are presented below.

Self-reported Anxiety

All self-report measures of anxiety indicated that Type As report significantly less anxiety than Type Bs, thus supporting the contentions of Snyder and Glass (1974) and Carber et al., (1976) that Type As deny feelings which interfere with performance. The prediction that anxiety would be reported as being greater for Type As during the Cognitive Condition, however, did not occur. State anxiety scores were equal for the Cognitive and Pressor conditions. Although a significant effect for Condition was reported, an examination of Table 2 indicates that time was the significant variable. That is, reported anxiety decreased with time spent in the experiment regardless of the order of the conditions or of the conditions themselves. It is possible that the scores indicate the anxiety felt at the precise time the scales were completed rather than that felt during the preceding condition. That is, the state anxiety scales had utility in the analysis of the tendency to acknowledge or deny anxiety, but failed as a manipulation check of the independent variables.

Pupil Diameter

Analysis of variance of pupillary response indicated that pupil diameter was slightly greater under the Cognitive Condition than either the No Treatment or the Pressor Conditions although there were no significant differences between Type As and Type Bs. This is probably due to the effect of the cognitive effort required during the Cognitive Condition.

As expected, the pupillary response to light resulted in the typical constriction/redilation pattern. Also, as was expected, the mean diameter was less in the final trial - probably indicative of a combination of fatigue in the applicable muscles and the lessening of

anxiety. Figure 4 depicts the significant interaction between Conditions and Epochs indicating that the stress induced by the Cognitive Condition caused greater mean pupil diameter than that reduced by either the No Treatment or the Pressor Conditions.

Examination of Figure 5 indicates that Type As were initially slower to constrict and faster to redilate, as would be expected in subjects having a stronger sympathetic component of the autonomic nervous system. Contrary to what was predicted, Type As had a smaller mean diameter than Type Bs. This is not surprising, however, given that the measures were taken during the 8th, 9th and 10th trials. If Type As are indeed equivalent to Type 2s then they would be expected to respond with a greater general decrease in both maximum and minimum pupil diameters in comparison to Bs (see Appendix A Figure 2B) although still showing greater range of pupil diameter. That is, an overall reduction in diameter need not imply a reduction in the amplitude of the light reflex.

Pertinent to the anxiety effect of the Cognitive Condition, all subjects who underwent it last had a greater mean pupil diameter than those who received the Pressor Condition last (see Figure 6). This may suggest that overall anxiety was held at a higher level until the supposed IQ test was completed.

In general the various effects were as anticipated except that the mean diameter of the pupils of Type As did not exceed those of the Type Bs. However, as indicated above, this prediction may have been in conflict with the expectations according to the pupillary patterns of Lowenstein and Loewenfeld (1951).

Heart Rate

The analysis of variance indicated a weak effect due to Epoch, however examination of Figure 7 depicts a consistent trend - that heart rate increased during the presentation of the stimulus (to Epoch 4), was maintained at a relatively high rate, probably due to cognitive activity, and then decreased in the absence of the stimulus at an approximately uniform rate to a point below its original level. This pattern corresponds to the expected sympathetic arousal caused by the light and roughly mirrors the pupillary response.

In the first two trials to be analysed (Trials 8 and 9) Figure 10 indicates that mean heart rate was greatest in the Cognitive Condition but in Trial 10 this difference disappeared. It is probable that the sympathetic arousal of the Cognitive Condition was gradually diminishing during all trails (1 to 10) reaching a point equivalent to the other conditions at Trial 10.

As was the case in the pupillary analysis, overall mean heart rate was greater when the Cognitive Condition was presented last (see Figure 9). Further, there was no reduction in heart rate following the light stimulus and cognitive activity as there was for those subjects who received the pressor last. These patterns may indicate that the threat of an IQ test tended to maintain sympathetic arousal throughout the experiment. This contention of greater sympathetic arousal in the Cognitive Condition received confirmation in the interaction of Condition and Epoch. Heart rate was significantly greater (3 to 4 beats per minute) in that condition than in the other conditions (Figure 10). This finding concurs precisely with the results of the pupillary analysis.

Finally, and most pertinent to this experiment, is the interaction between Condition, Trails, Behavioural Syndrome and Epoch (Figures 11 - 13). For No Treatment (Figure 11), the differences in heart rate from Epoch 1 to 18 were equivocal, with Type As having a greater heart rate than Type Bs during Trials 8 and 9 and Type B heart rate being greater during Trial 10. Comparing the Cognitive and Pressor Conditions, however, the results were opposite. During Trial 8 of the Pressor Condition the Type B heart rate was initially less than that of Type As but at Epoch 10 the conditions reversed themselves and this was maintained throughout Trials 9 and 10 (see Figure 12). Type Bs then, maintained a higher overall heart rate than Type As under physiological stress. In the Cognitive Condition (Figure 13) Type As had generally higher heart rates than Type Bs except at the point where sympathetic arousal was theoretically the greatest (after the light stimulus and during verbalization) at which point there was no significant difference. As predicted, then, Type As showed overall greater sympathetic arousal as manifested by heart rate during the Cognitive Condition (relevant stress) but were not as affected by either the light or the vocalization as were the Type B subjects.

In general the effects of the conditions were as hypothesized with respect to the Cognitive condition, with a differential effect for behavioural syndrome being observed across Trials and Epochs.

PERSONALITY AND BEHAVIOURAL SYNDROME

Tests were performed in accordance with the expectations of the introduction to this research (Appendix H, Table 3) and significant effects were found to support the hypothesis that Type As would be more extroverted, although there were no significant differences between Type As and Bs in Neuroticism. On Petrie's (1967) Sensory Reducer/

Augmenter scale there were significant differences between Types A and B with the Type A, as predicted, being the augmenter.

The description of the lifestyles of Type A individuals (Friedman and Rosenman, 1959) indicate that they have an "action-emotion complex", are constantly striving for achievement, are aggressive, hasty, impatient and restless, and, according to Snyder and Glass (1974), deny fatigue. Such a description is in agreement with the definition of an extrovert and intuitively it is to be expected that Type As would report enjoying too much exercise as opposed to too little, liking athletics as opposed to disliking them, preferring excitement to calm - all symptoms of an augmenter. Of course, Type As, in this latter case, may be "putting on a front" as is the case in their denying fatigue and anxiety under self-report conditions.

Finally the differences between Type 2 and Types 1, 3 and 4 were in the expected direction (Appendix H, Table 3) with Type 2s having similar mean scores to Type As, but the results did not reach significance.

CONCLUDING STATEMENT

The primary purpose of this research was to utilize the pupillary response to differentiate males who exhibit the Type A and Type B behavioural syndromes. It is contended that the experiment demonstrated that this is possible and hence the pupil may represent an efficient medium for identifying coronary prone individuals. These results also add evidence that excessive sympathetic arousal is implicated in Type A behaviour and hence in the pathogenesis of coronary disease.

A secondary purpose of the research was to investigate further the effect of various types of stress on Type A and Type B individuals. It was not found that Type As respond to an ego threat (the cognitive condition) with greater mean pupil diameter than Type Bs, however it is likely that any observable difference in the expected direction would be camouflaged by the general decrease in diameter due to fatigue in the reflex mechanisms. Heart rate on the other hand was differentially affected in Type As and Type Bs. As was predicted, heart rate was greater for Type As under psychological stress (the ego threat) but was greater for Type Bs under physiological stress (the pressor).

Previous research has indicated that Type As tend to deny subjective states which interfere with task performance, for example fatigue (Glass, 1977). This research supports this finding with respect to anxiety.

Finally the experiment indicated, as was predicted, that Type As are more apt to be stimulus augmenters in comparison to Type Bs, and are more extroverted.

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Appendix A

The Pupillary Response (Lowenstein and Loewenfeld, 1951)

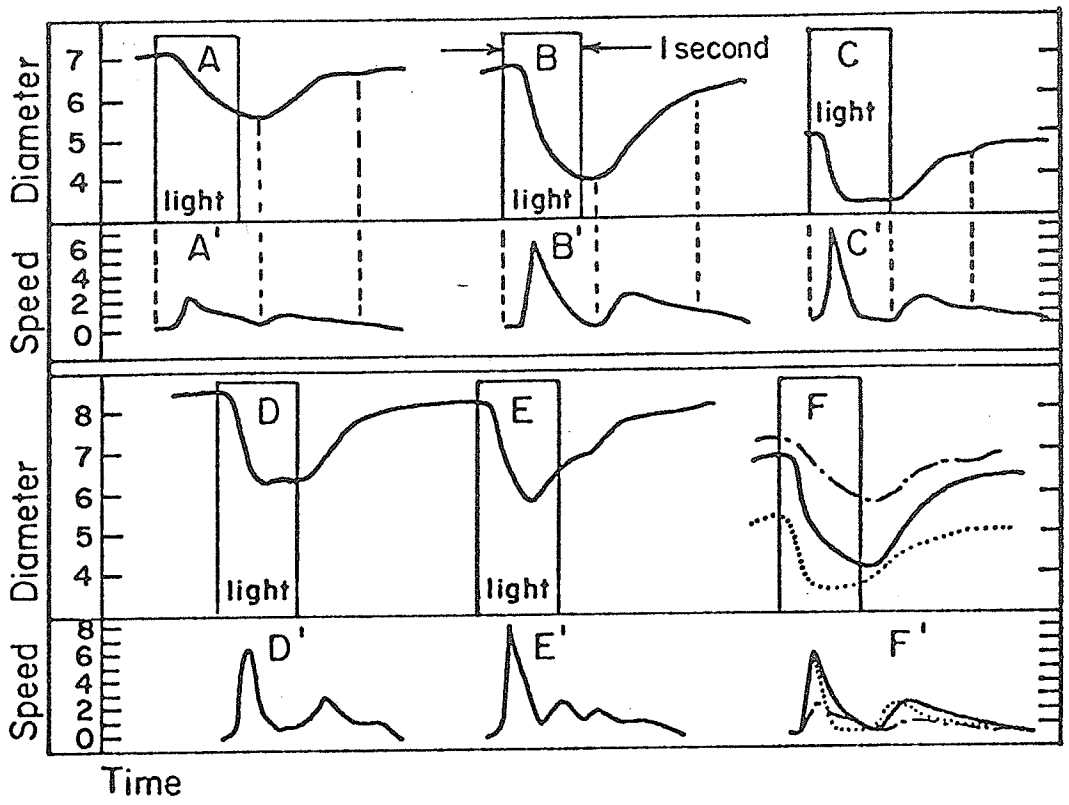

Figure 1. Normal and pathological pupillary reactions to light stimuli of average intensity.

In the pupillograms (A, B, C, D, and E) pupillary diameter is plotted (in millimeters) against time (in 0.1 second). Contraction and redilation consist of a fast primary and a slower secondary phase.
In the differential curves (A^1, B^1, C^1, D^1, and E^1) contraction and redilation within each successive tenth of a second (0.1 mm) are plotted against time (in 0.1 second). Contraction and redilation consist of different waves, of increasing and decreasing speeds of motion: C-wave contraction wave) and D- and E-waves (dilation waves).
B and B^1, pupillogram and differential curve of the normal reflex to light.
A and A^1, nonirritative lesion of the third nerve nucleus. The pupillogram (A) shows a large pupil, increased latency period for contraction, inextensive and sluggish contraction, and redilation. In the differential curve (A^1) this is expressed by low and delayed peaks of movement.
C and C^1, central sympathetic lesion. The pupillogram (C) shows a smaller-than-normal pupil, a shorter-than-normal latency period, and fast contraction (tonohaptic reaction shape). In the differential curve(C^1) this is expressed as an earlier and higher peak of the C-wave, which quickly drops to zero.
D and D^1, W-shape of the reflex.
E and E^1, V-shape of the reflext in a case of central sympathetic irritation. The differential curve shows the the peaks of the C-waves are not reduced, since the parasympathetic response is unimpaired.
F and F^1, comparison of A, B, and C and A^1, B^1, and C^1, showing the time relation described above. The solid line represents B and B^1, the broken line. C and C^1; the dotted line, A and A.

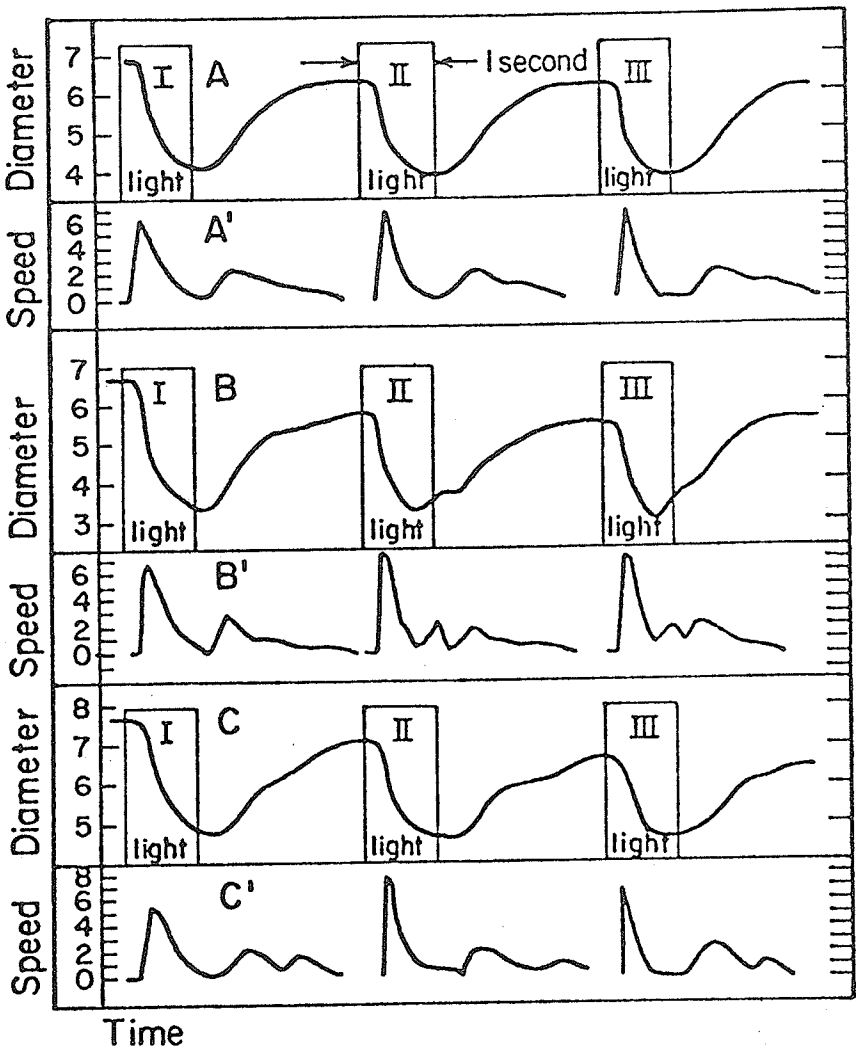

Figure 2. Influence of reiterated light stimuli on the various types of autonomic equilibrium.

A and A^1, pupillogram and differential curve of three reactions to light in a well-balanced normal subject.
The first fatigue symptoms produced by three successive light stimuli appear; they consist of a slight increase and shifting to the left of the ascending portion of the C-wave at the expense of the descending portion, which declines faster (slight weakening of the sympathetic activity).
B and B^1, pupillogram and differential curve of three reactions to light in a hyperactive normal subject.
The first reaction to light is normal; the second reaction already shows the W-shape, and the third reaction the V-shape, of the reflex.
C and C^1, pupillogram and differential curve of three reactions to light in the normal subject with functional weakness of the sympathetic nervous system.
The first reaction to light is normal; in the second reaction the tendencies described in A are exaggerated; the third reaction already shows tonohaptic shape.

Appendix B

Jenkins Activity Survey

C. David Jenkins, Ph.D. Stephen J. Zyzanski, Ph.D. Ray H. Rosenman, M.D.

FORM C

Name (last name first)

Age

Male ○
Female ○

The *Jenkins Activity Survey* asks questions about aspects of behavior that have been found helpful in medical diagnosis. Each person is different, so there are no "right" or "wrong" answers.

For each question, choose the answer that is true for you, and fill in the space in front of that answer. Use a black lead pencil, and make your marks heavy and dark. Mark only one answer for each question. If you change your mind, erase the old mark completely.

Do not make any stray marks.

1. Do you ever have trouble finding time to get your hair cut or styled?
A ○ Never
B ○ Occasionally
C ○ Almost always

2. How often does your job "stir you into action"?
A ○ Less often than most people's jobs
B ○ About average
C ○ More than most people's jobs

3. Is your everyday life filled mostly by
A ○ problems needing a solution?
B ○ challenges needing to be met?
C ○ a rather predictable routine of events?
D ○ not enough things to keep me interested or busy?

4. Some people live a calm, predictable life. Others often find themselves facing unexpected changes, frequent interruptions, inconveniences, or "things going wrong." How often are you faced with these minor (or major) annoyances or frustrations?
A ○ Several times a day
B ○ About once a day
C ○ A few times a week
D ○ Once a week
E ○ Once a month or less

5. When you are under pressure or stress, what do you usually do?
A ○ Do something about it immediately
B ○ Plan carefully before taking any action

6. Ordinarily, how rapidly do you eat?
A ○ I'm usually the first one finished.
B ○ I eat a little faster than average.
C ○ I eat at about the same speed as most people.
D ○ I eat more slowly than most people.

7. Has your spouse or a friend ever told you that you eat too fast?
A ○ Yes, often
B ○ Yes, once or twice
C ○ No, never

8. How often do you find yourself doing more than one thing at a time, such as working while eating, reading while dressing, or figuring out problems while driving?
A ○ I do two things at once whenever practical.
B ○ I do this only when I'm short of time.
C ○ I rarely or never do more than one thing at a time.

9. When you listen to someone talking, and this person takes too long to come to the point, how often do you feel like hurrying the person along?
A ○ Frequently
B ○ Occasionally
C ○ Almost never

10. How often do you actually "put words in the person's mouth" in order to speed things up?
A ○ Frequently
B ○ Occasionally
C ○ Almost never

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11. If you tell your spouse or a friend that you will meet somewhere at a definite time, how often do you arrive late?
A ○ Once in a while
B ○ Rarely
C ○ I am never late.

12. How often do you find yourself hurrying to get places even when there is plenty of time?
A ○ Frequently
B ○ Occasionally
C ○ Almost never

13. Suppose you are to meet someone at a public place (street corner, building lobby, restaurant) and the other person is already 10 minutes late. What will you do?
A ○ Sit and wait
B ○ Walk about while waiting
C ○ Usually carry some reading matter or writing paper so I can get something done while waiting

14. When you have to "wait in line" at a restaurant, a store, or the post office, what do you do?
A ○ Accept it calmly
B ○ Feel impatient but not show it
C ○ Feel so impatient that someone watching can tell I am restless
D ○ Refuse to wait in line, and find ways to avoid such delays

15. When you play games with young children about 10 years old (or when you did so in past years), how often do you purposely let them win?
A ○ Most of the time
B ○ Half the time
C ○ Only occasionally
D ○ Never

16. When you were younger, did most people consider you to be
A ○ definitely hard-driving and competitive?
B ○ probably hard-driving and competitive?
C ○ probably more relaxed and easygoing?
D ○ definitely more relaxed and easygoing?

17. Nowadays, do you consider yourself to be
A ○ definitely hard-driving and competitive?
B ○ probably hard-driving and competitive?
C ○ probably more relaxed and easygoing?
D ○ definitely more relaxed and easygoing?

18. Would your spouse (or closest friend) rate you as
A ○ definitely hard-driving and competitive?
B ○ probably hard-driving and competitive?
C ○ probably relaxed and easygoing?
D ○ definitely relaxed and easygoing?

19. Would your spouse (or closest friend) rate your general level of activity as
A ○ too slow—should be more active?
B ○ about average—busy much of the time?
C ○ too active—should slow down?

20. Would people you know well agree that you take your work too seriously?
A ○ Definitely yes
B ○ Probably yes
C ○ Probably no
D ○ Definitely no

21. Would people you know well agree that you have less energy than most people?
A ○ Definitely yes
B ○ Probably yes
C ○ Probably no
D ○ Definitely no

22. Would people you know well agree that you tend to get irritated easily?
A ○ Definitely yes
B ○ Probably yes
C ○ Probably no
D ○ Definitely no

23. Would people who know you well agree that you tend to do most things in a hurry?
A ○ Definitely yes
B ○ Probably yes
C ○ Probably no
D ○ Definitely no

24. Would people who know you well agree that you enjoy a "contest" (competition) and try hard to win?
A ○ Definitely yes
B ○ Probably yes
C ○ Probably no
D ○ Definitely no

25. How was your temper when you were younger?
A ○ Fiery and hard to control
B ○ Strong but controllable
C ○ No problem
D ○ I almost never got angry.

26. How is your temper nowadays?
A ○ Fiery and hard to control
B ○ Strong but controllable
C ○ No problem
D ○ I almost never get angry.

27. When you are in the midst of doing a job and someone (not your boss) interrupts you, how do you usually feel inside?
A ○ I feel O.K. because I work better after an occasional break.
B ○ I feel only mildly annoyed.
C ○ I really feel irritated because most such interruptions are unnecessary.

28. How often are there deadlines on your job?
A ○ Daily or more often
B ○ Weekly
C ○ Monthly or less often
D ○ Never

29. These deadlines usually carry
A ○ minor pressure because of their routine nature.
B ○ considerable pressure, since delay would upset my entire work group.
C ○ Deadlines never occur on my job.

30. Do you ever set deadlines or quotas for yourself at work or at home?
A ○ No
B ○ Yes, but only occasionally
C ○ Yes, once a week or more

31. When you have to work against a deadline, what is the quality of your work?
A ○ Better
B ○ Worse
C ○ The same (Pressure makes no difference.)

32. At work, do you ever keep two jobs moving forward at the same time by shifting back and forth rapidly from one to the other?
A ○ No, never
B ○ Yes, but only in emergencies
C ○ Yes, regularly

33. Are you content to remain at your present job level for the next five years?
A ○ Yes
B ○ No, I want to advance.
C ○ Definitely no; I strive to advance and would be dissatisfied if not promoted in that length of time.

34. If you had your choice, which would you rather get?
A ○ A small increase in pay **without** a promotion to a higher level job
B ○ A promotion to a higher level job **without** an increase in pay

35. In the past three years, have you ever taken less than your allotted number of vacation days?
A ○ Yes
B ○ No
C ○ My type of job does not provide regular vacations.

36. In the last three years, how has your personal yearly income changed?
A ○ It has remained the same or gone down.
B ○ It has gone up slightly (as the result of cost-of-living increases or automatic raises based on years of service).
C ○ It has gone up considerably.

37. How often do you bring your work home with you at night, or study materials related to your job?
A ○ Rarely or never
B ○ Once a week or less
C ○ More than once a week

38. How often do you go to your place of work when you are not expected to be there (such as nights or weekends)?
A ○ It is not possible on my job.
B ○ Rarely or never
C ○ Occasionally (less than once a week)
D ○ Once a week or more

39. When you find yourself getting tired on the job, what do you usually do?
A ○ Slow down for a while until my strength comes back
B ○ Keep pushing myself at the same pace in spite of the tiredness

40. When you are in a group, how often do the other people look to you for leadership?
A ○ Rarely
B ○ About as often as they look to others
C ○ More often than they look to others

41. How often do you make yourself written lists to help you remember what needs to be done?
A ○ Never
B ○ Occasionally
C ○ Frequently

For questions 42-46, compare yourself with the average worker in your present occupation, and mark the most accurate description.

42. In amount of effort put forth, I give
A ○ much more effort.
B ○ a little more effort.
C ○ a little less effort.
D ○ much less effort.

43. In sense of responsibility, I am
A ○ much more responsible.
B ○ a little more responsible.
C ○ a little less responsible.
D ○ much less responsible.

44. I find it necessary to hurry
A ○ much more of the time.
B ○ a little more of the time.
C ○ a little less of the time.
D ○ much less of the time.

45. In being precise (careful about detail), I am
A ○ much more precise.
B ○ a little more precise.
C ○ a little less precise.
D ○ much less precise.

46. I approach life in general
A ○ much more seriously.
B ○ a little more seriously.
C ○ a little less seriously.
D ○ much less seriously.

For questions 47-49, compare your present work with your work setting of five years ago. If you have not been working for five years, compare your present job with your first job.

47. I worked more hours per week
A ○ at my present job.
B ○ five years ago.
C ○ Cannot decide

48. I carried more responsiblity
A ○ at my present job.
B ○ five years ago.
C ○ Cannot decide

49. I was considered to be at a higher level (in prestige or social position)
A ○ at my present job.
B ○ five years ago.
C ○ Cannot decide

50. How many different job titles have you held in the last 10 years? (Be sure to count shifts in kinds of work, shifts to new employers, and shifts up and down within a firm.)
A ○ 0-1
B ○ 2
C ○ 3
D ○ 4
E ○ 5 or more

51. How much schooling did you receive?
A ○ 0-4 years
B ○ 5-8 years
C ○ Some high school
D ○ Graduated from high school
E ○ Trade school or business college
F ○ Some college (including junior college)
G ○ Graduated from a four-year college
H ○ Post-graduate work at a college or university

52. When you were in school, were you an officer of any group, such as a student council, glee club, 4-H club, sorority or fraternity, or captain of an athletic team?
A ○ No
B ○ Yes, I held one such position.
C ○ Yes, I held two or more such positions.

STOP. Do not make any marks below this line.

If machine scoring is desired, complete the following information (see Scoring Service Fact Sheet for instructions). Return questionnaire to The Psychological Corporation, Data Services Division, JAS Scoring, 757 Third Avenue, New York, NY 10017.

Identification Code

Mo. | Day | Year

Indicate desired scoring service:
○ Individual Report Form (Standard Service)
○ List Report and Punched Cards
○ Magnetic Tape

Return report to:

Name (please print)

Address

Billing address:

Name (please print)

Address

Appendix C

PERSONAL INVENTORY QUESTIONNAIRE

DIRECTIONS: A number of statements which people have used to describe themselves are given below. Read each statement and then blacken in the appropriate circle to the right of the statement to indicate how you feel right now, that is, at this moment. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.

		Not at all	Somewhat	Moderately So	Very Much So
1.	I feel calm	(1)	(2)	(3)	(4)
2.	I feel secure	(1)	(2)	(3)	(4)
3.	I am tense	(1)	(2)	(3)	(4)
4.	I am regretful	(1)	(2)	(3)	(4)
5.	I feel at ease	(1)	(2)	(3)	(4)
6.	I feel upset	(1)	(2)	(3)	(4)
7.	I am presently worrying over possible misfortunes	(1)	(2)	(3)	(4)
8.	I feel rested	(1)	(2)	(3)	(4)
9.	I feel anxious	(1)	(2)	(3)	(4)
10.	I feel comfortable	(1)	(2)	(3)	(4)
11.	I feel self-confident	(1)	(2)	(3)	(4)
12.	I feel nervous	(1)	(2)	(3)	(4)
13.	I am jittery	(1)	(2)	(3)	(4)
14.	I feel "high strung"	(1)	(2)	(3)	(4)
15.	I am relaxed	(1)	(2)	(3)	(4)
16.	I feel content	(1)	(2)	(3)	(4)
17.	I am worried	(1)	(2)	(3)	(4)
18.	I feel over-excited and "rattled"	(1)	(2)	(3)	(4)
19.	I feel joyful	(1)	(2)	(3)	(4)
20.	I feel pleasant	(1)	(2)	(3)	(4)

PERSONAL INVENTORY QUESTIONNAIRE

DIRECTIONS: A number of statements which people have used to describe themselves are given below. Read each statement and then blacken in the appropriate circle to the right of the statement to indicate how you generally feel. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe how you generally feel.

		Almost Never	Sometimes	Often	Almost Always
21.	I feel pleasant	(1)	(2)	(3)	(4)
22.	I tire quickly	(1)	(2)	(3)	(4)
23.	I feel like crying	(1)	(2)	(3)	(4)
24.	I wish I could be as happy as others seem to be	(1)	(2)	(3)	(4)
25.	I am losing out on things because I can't make up my mind soon enough	(1)	(2)	(3)	(4)
26.	I feel rested	(1)	(2)	(3)	(4)
27.	I am "calm, cool, and collected"	(1)	(2)	(3)	(4)
28.	I feel that difficulties are piling up so that I cannot overcome them	(1)	(2)	(3)	(4)
29.	I worry too much over something that really doesn't matter	(1)	(2)	(3)	(4)
30.	I am happy	(1)	(2)	(3)	(4)
31.	I am inclined to take things hard	(1)	(2)	(3)	(4)
32.	I lack self-confidence	(1)	(2)	(3)	(4)
33.	I feel secure	(1)	(2)	(3)	(4)
34.	I try to avoid facing a crisis or difficulty	(1)	(2)	(3)	(4)
35.	I feel blue	(1)	(2)	(3)	(4)
36.	I am content	(1)	(2)	(3)	(4)
37.	Some unimportant thought runs through my mind and bothers me	(1)	(2)	(3)	(4)
38.	I take disappointments so keenly that I can't put them out of my mind	(1)	(2)	(3)	(4)
39.	I am a steady person	(1)	(2)	(3)	(4)
40.	I get in a state of tension or turmoil as I think over my recent concerns and interests	(1)	(2)	(3)	(4)

Appendix D

EYSENCK PERSONALITY INVENTORY

FORM A

By H. J. Eysenck
and Sybil B. G. Eysenck

Name_____ Age_____ Sex_____

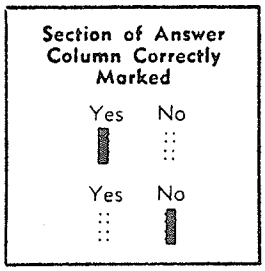
Grade or Occupation _____ Date_____

School or Firm_____ Marital Status_____

INSTRUCTIONS

Here are some questions regarding the way you behave, feel and act. After each question is a space for answering "Yes," or "No."

Try and decide whether "Yes," or "No" represents your usual way of acting or feeling. Then blacken in the space under the column headed "Yes" or "No."



Work quickly, and don't spend too much time over any question; we want your first reaction, not a long drawn-out thought process. The whole questionnaire shouldn't take more than a few minutes. Be sure not to omit any questions. Now turn the page over and go ahead. Work quickly, and remember to answer every question. There are no right or wrong answers, and this isn't a test of intelligence or ability, but simply a measure of the way you behave.

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BOX 7234, SAN DIEGO, CALIFORNIA 92107

1. Do you often long for excitement? . . . . . Yes No
2. Do you often need understanding friends to cheer you up? . . . . . Yes No
3. Are you usually carefree? . . . . . Yes No
4. Do you find it very hard to take no for an answer? . . . Yes No
5. Do you stop and think things over before doing anything? . . . . . Yes No
6. If you say you will do something do you always keep your promise, no matter how inconvenient it might be to do so? . . . . . Yes No
7. Does your mood often go up and down? . . . . . Yes No
8. Do you generally do and say things quickly without stopping to think? . . . . . Yes No
9. Do you ever feel "just miserable" for no good reason? Yes No
10. Would you do almost anything for a dare? . . . . . Yes No
11. Do you suddenly feel shy when you want to talk to an attractive stranger? . . . . . Yes No
12. Once in a while do you lose your temper and get angry? . . . . . Yes No
13. Do you often do things on the spur of the moment? . . . Yes No
14. Do you often worry about things you should not have done or said? . . . . . Yes No
15. Generally do you prefer reading to meeting people? . . Yes No
16. Are your feelings rather easily hurt? . . . . . Yes No
17. Do you like going out a lot? . . . . . Yes No
18. Do you occasionally have thoughts and ideas that you would not like other people to know about? . . . . . Yes No
19. Are you sometimes bubbling over with energy and sometimes very sluggish? . . . . . Yes No
20. Do you prefer to have few but special friends? . . . . . Yes No
21. Do you daydream a lot? . . . . . Yes No
22. When people shout at you, do you shout back? . . . . . Yes No
23. Are you often troubled about feelings of guilt? . . . . . Yes No
24. Are all your habits good and desirable ones? . . . . . Yes No
25. Can you usually let yourself go and enjoy yourself a lot at a gay party? . . . . . Yes No
26. Would you call yourself tense or "highly-strung"? . . . Yes No
27. Do other people think of you as being very lively? . . . Yes No
28. After you have done something important, do you often come away feeling you could have done better? . . . . . Yes No
29. Are you mostly quiet when you are with other people? Yes No
30. Do you sometimes gossip? . . . . . Yes No
31. Do ideas run through your head so that you cannot sleep? . . . . . Yes No
32. If there is something you want to know about, would you rather look it up in a book than talk to someone about it? . . . . . Yes No
33. Do you get palpitations or thumping in your heart? . . . Yes No
34. Do you like the kind of work that you need to pay close attention to? . . . . . Yes No
35. Do you get attacks of shaking or trembling? . . . . . Yes No
36. Would you always declare everything at the customs, even if you knew that you could never be found out? . . Yes No
37. Do you hate being with a crowd who play jokes on one another? . . . . . Yes No
38. Are you an irritable person? . . . . . Yes No
39. Do you like doing things in which you have to act quickly? . . . . . Yes No
40. Do you worry about awful things that might happen? . . Yes No
41. Are you slow and unhurried in the way you move? . . . Yes No
42. Have you ever been late for an appointment or work? . Yes No
43. Do you have many nightmares? . . . . . Yes No
44. Do you like talking to people so much that you would never miss a chance of talking to a stranger? . . . . . Yes No
45. Are you troubled by aches and pains? . . . . . Yes No
46. Would you be very unhappy if you could not see lots of people most of the time? . . . . . Yes No
47. Would you call yourself a nervous person? . . . . . Yes No
48. Of all the people you know are there some whom you definitely do not like? . . . . . Yes No
49. Would you say you were fairly self-confident? . . . . . Yes No
50. Are you easily hurt when people find fault with you or your work? . . . . . Yes No
51. Do you find it hard to really enjoy yourself at a lively party? . . . . . Yes No
52. Are you troubled with feelings of inferiority? . . . . . Yes No
53. Can you easily get some life into a rather dull party? . Yes No
54. Do you sometimes talk about things you know nothing about? . . . . . Yes No
55. Do you worry about your health? . . . . . Yes No
56. Do you like playing pranks on others? . . . . . Yes No
57. Do you suffer from sleeplessness? . . . . . Yes No

PLEASE CHECK TO SEE THAT YOU HAVE ANSWERED ALL THE QUESTIONS.

Appendix E

Name _____

REDUCER-AUGMENTER SCALE

INSTRUCTIONS: Below you will find a series of paired statements which you are asked to regard as choices. In some cases you will like both choices. In some cases you will dislike both choices. In other cases you will find the choices neutral. No matter how the items strike you, however, you are asked to choose between them. In each case you are to decide which of the alternatives you prefer in comparison to the other alternative and then to indicate your selection by drawing a circle around the (a) or the (b) to the left of the statement. It is important to answer all items. Do not skip any. It is best to work as rapidly as possible

1.	(a)	see a war drama	(b)	see a situation comedy
2.	(a)	play sports requiring endurance	(b)	play games with rest stops
3.	(a)	raunchy blues	(b)	straight ballads
4.	(a)	jazz combo	(b)	1001 strings
5.	(a)	stereo on too loud	(b)	stereo on too low
6.	(a)	own a goldfish	(b)	own a turtle
7.	(a)	conservatism	(b)	militantism
8.	(a)	too much sleep	(b)	too little sleep
9.	(a)	danger	(b)	domesticity
10.	(a)	passenger car	(b)	sports car
11.	(a)	have several pets	(b)	have one pet
12.	(a)	be a shepherd	(b)	be a cowboy
13.	(a)	motorcycle	(b)	motor scooter
14.	(a)	see the movie	(b)	read the book
15.	(a)	cocktail music	(b)	discotheque music
16.	(a)	do research in the library	(b)	attend a classroom lecture
17.	(a)	a hot drink	(b)	a warm drink
18.	(a)	a drum solo	(b)	a string solo
19.	(a)	too much exercise	(b)	too little exercise
20.	(a)	loud music	(b)	quiet music
21.	(a)	prepare medications	(b)	dress wounds
22.	(a)	a driving beat	(b)	a nice melody
23.	(a)	hardrock music	(b)	regular popular music
24.	(a)	like athletics	(b)	dislike athletics
25.	(a)	unamplified music	(b)	electrically amplified music
26.	(a)	smooth-textured foods	(b)	crunchy foods
27.	(a)	mind-expanding drugs	(b)	alcohol
28.	(a)	speed	(b)	safety
29.	(a)	The Beatles	(b)	Dean Martin
30.	(a)	soccer	(b)	golf

31.	(a)	excitement	(b)	calm
32.	(a)	a family of six	(b)	a family of three
33.	(a)	thrills	(b)	tranquility
34.	(a)	play contact sports	(b)	play noncontact sports
35.	(a)	live in a crowded home	(b)	live alone
36.	(a)	share intimacy	(b)	share affection
37.	(a)	games emphasizing speed	(b)	games paced slowly
38.	(a)	thinking	(b)	doing
39.	(a)	competitive sports	(b)	non-competitive sports
40.	(a)	emotionally expressive, somewhat unstable people	(b)	calm, even-tempered people
41.	(a)	be a nurse on an acute care ward	(b)	be a nursing supervisor
42.	(a)	be a NASA scientist	(b)	be an astronaut
43.	(a)	be a stuntman	(b)	be a propman
44.	(a)	a job which requires a lot of travelling	(b)	a job which keeps you in one place
45.	(a)	climb a mountain	(b)	read about a dangerous adventure
46.	(a)	body odors are disgusting	(b)	body odors are appealing
47.	(a)	keep on the move	(b)	spend time relaxing
48.	(a)	have a cold drink	(b)	have a cool drink
49.	(a)	being confined alone in a room	(b)	being free in the desert
50.	(a)	security	(b)	excitement
51.	(a)	continuous anesthesia	(b)	continuous hallucinations
52.	(a)	water skiing	(b)	boat rowing
53.	(a)	hostility	(b)	conformity
54.	(a)	Renoir	(b)	Picasso

Appendix F

INSTRUCTIONS FOR PHASE 1

First let me thank you for being willing to assist us today, we should not take much longer than two hours in completing the questionnaires - perhaps less.

First, some words about what we are doing. We are attempting to relate various physiological measurements such as heart rate or blood pressure to different life styles. For example, some people are very outgoing or extroverted and we may be interested in determining whether the heart rate of such individuals increases under certain conditions.

Our research is not very complicated as you can tell, but that is how behavioural science progresses - one step at a time.

Today we ask that you complete the questions in the booklet in front of you. You will see that they related to life style. That is, in fact,what we are doing today - classifying you according to life style. Now let me make one thing absolutely clear. Although your name will be written on the front page, it is only so we can contact you later for a reason I will explain in a minute. Apart from the research team no one will know what the results are. The military will not be involved and will not see anything. In other words there are no career implications whatsoever. The main reason why you are asked to participate is that you are a group of similar people and we need group results. Again the reason for your name is only so that we can contact some of you later. Are there any questions on that point?

Later, after our computer adds up all the scores we will ask some of you to come to the University so that we can take certain physiological measurements under different conditions which will be explained at that time. This takes about 20 minutes plus travelling time. I will pick you up at a time convenient to you and your unit and bring you back. We will be doing this over the summer, one or two at a time. If any one is not willing to do this would you so indicate at the end of the question booklet. Obviously the success of the research depends on the majority being willing to help so we hope you will. However, if you don't wish to, nothing will happen - in fact no one will know but us.

Again let me emphasize, we are interested only in group scores - not individual ones, therefore your individual military records or careers are of no interest and will not be involved.

Let me thank you for your help now so that you can leave when finished. Now please start and work steadily through the booklet. Do not take too long over any question, simply think briefly and indicate the response which fits closest to your situation.

Appendix G

INSTRUCTIONS FOR PHASE 2

Thank you for your participation. Please have a seat and I will explain what we are going to do. The remainder of this study is concerned with the recording of certain physiological measures under various conditions. You were selected to participate on the basis of the test responses made during Phase 1 which analysed your lifestyle.

Today, then, we are going to take the physiological measurements using this equipment which I shall describe in a minute. Also you will complete five short questionnairesof the type given last time. The last four are identical; however, each time you complete one your answers may be different. This is quite normal because if your feelings change then your answers should be different.

Now I will describe the equipment. You will place your chin here and the T.V. camera will photograph your left eye. It is connected to a computer which locks on to the image of your pupil - the black portion of your eye. At the same time the room will be darkened and this light will flash every five seconds. The flashes will make your pupil get bigger and smaller in sequence. At the same time we will also record your heart rate with this machine which is attached to your finger. Are there any questions so far?

We will take these measurements during three one minute periods. During the first you will do nothing; during the second sequence the light will again flash but this time your right hand will be in this bucket of ice water. If you find it too cold take it out when it hurts, but remember it will be immersed for a maximum of one minute. During the third sequence the light will flash but this time, after each flash you must say aloud word beginning with the letter "B".

Each time say aloud a different word starting with "B". In other words after the first flash say aloud a word which begins, with "B", then after the second flash say aloud a different word beginning with "B" and so on. This procedure allows me to record your pupillary response and heart rate at the same time as measuring your intelligence. But don't worry, I am the only one who will know the result.

It is important that you mumble the words because, as you can see, if you talk while your chin is fixed your head will move, which in turn will move your eyes out of the camera's view. Please practice.

Now, sit in the chair, take your watch off and we will begin. The instructions will be given again as we go along. Are there any questions?

NOTE

The above instructions are repeated sequentially as the experiment progresses. For 16 subjects the instructions for the final two conditions were reversed to reflect the counterbalanced order. At the conclusion the subjects were thanked and told that the results would be available for discussion a few months hence.

Appendix H

Table 1

Tests on A-Trait Between Type A and Type B Subjects

Phase 1

	Mean	T	df	p≤
Type A	32.63			
Type B	36.13	-1.28	30	.11

Phase 2

	Mean	T	df	p≤
Type A	32.44			
Type B	36.56	-1.76	30	.05

Table 2

Tests on A-State Between Type A and Type B Subjects

Phase 1

	Mean	T	df	p≤
Type A	33.38			
Type B	39.06	-2.32	30	.02

Phase 2 Analysis of Variance of A-State Scores

Source of Variation	df	MS	F	p≤
A (BEHAVIOURAL SYNDROME)	1	1134.07	7.72	.01
B (ORDER)	1	223.13	1.52	.23
AB	1	41.63	.28	.60
Error 1	28	146.92		
C (CONDITION)	3	62.44	7.86	.001
AC	3	.30	.04	.99
BC	3	15.07	1.90	.13
ABC	3	2.32	.29	.83
Error 2	84	7.94		

Table 3

Personality Comparisons

Tests Between Type A and Type B Subjects

	Mean	T	df	p<
Extroversion				
Type A	13.50			
Type B	10.75	2.51	30	.01
Neuroticism				
Type A	8.25			
Type B	8.00	.16	30	.44
Augmenter/Reducer				
Type A	37.00			
Type B	29.88	3.11	30	.002

Tests Between Type 2 and Types 1, 3 and 4 Subjects

	Mean	T	df	p<
Extroversion				
Type 2	12.68			
Types 1, 3 and 4	11.56	.95	30	.17
Neuroticism				
Type 2	8.69			
Types 1, 3 and 4	7.56	.73	30	.24
Augmenter/Reducer				
Type 2	35.81			
Types 1, 3 and 4	31.06	.91	30	.19

Table 4

Analysis of Variance of Pupil Response

Source of Variation	df	MS	F	p<
A (BEHAVIOURAL SYNDROME)	1	15582.66	.43	.52
B (ORDER	1	27213.26	.75	.39
AB	1	7252.22	.20	.66
Error 1	28	36237.57		
C (CONDITION)	2	57674.14	2.77	.07
AC	2	20206.73	.97	.38
BC	2	33123.20	1.59	.21
ABC	2	16875.28	.81	.45
Error 2	56	20787.25		
D (TRIAL)	2	778.72	3.06	.06
AD	2	113.51	.45	.64
BD	2	4.80	.02	.98
ABD	2	44.69	.18	.84
Error 3	56	254.85		
CD	4	390.38	1.94	.11
ACD	4	56.54	.28	.89
BCD	4	50.71	.25	.91
ABCD	4	107.08	.53	.71
Error 4	112	200.76		
E (EPOCH)	17	52954.22	207.58	.001
AE	17	433.39	1.70	.04
BE	17	569.16	2.23	.004
ABE	17	107.44	.42	.98
Error 5	476	255.11		

Source of Variation	df	MS	F	p<
CE	34	90.03	1.59	.02
ACE	34	37.36	.66	.93
BCE	34	71.88	1.27	.14
ABCE	34	62.06	1.10	.32
Error 6	952	56.57		
DE	34	56.72	1.44	.05
ADE	34	49.10	1.25	.16
BDE	34	38.02	.97	.53
ABDE	34	35.49	.90	.63
Error 7	952	39.39		
CDE	68	33.36	.82	.86
ACDE	68	45.73	1.12	.25
BCDE	68	24.49	.60	1.00
ABCDE	68	34.16	.84	.83
Error 8	1904	40.91		

Table 5

Analysis of Variance of Heart Rate

Source of Variation	df	MS	F	p<
A (BEHAVIOURAL SYNDROME)	1	2914.77	.34	.56
B (ORDER)	1	8639.60	1.01	.32
AB	1	15524.95	1.82	.19
Error 1	28	8526.86		
C (CONDITION)	2	13134.83	1.47	.24
AC	2	2825.38	.32	.73
BC	2	793.04	.09	.92
ABC	2	4755.50	.53	.59
Error 2	56	8921.53		
D (TRIAL)	2	21.38	.02	.98
AD	2	2090.03	2.19	.12
BD	2	221.87	.23	.79
ABD	2	131.50	.14	.87
Error 3	56	953.37		
CD	4	2087.83	2.31	.07
ACD	4	1057.54	1.71	.33
BCD	4	641.85	.71	.59
ABCD	4	468.94	.52	.72
Error 4	112	904.98		
E (EPOCH)	17	37.11	1.50	.09
AE	17	8.24	.33	.99
BE	17	39.59	1.60	.06
ABE	17	29.33	1.19	.27
Error 5	476	24.74		

Source of Variation	df	MS	F	p ≤
CE	34	72.16	2.49	.001
ACE	34	36.91	1.27	.14
BCE	34	28.69	.99	.49
ABCE	34	35.67	1.23	.17
Error 6	952	29.03		
DE	34	14.07	.54	.99
ADE	34	7.58	.29	1.00
BDE	34	21.64	.83	.74
ABDE	34	18.17	.70	.90
Error 7	952	25.97		
CDE	68	25.85	.81	.87
ACDE	68	42.24	1.32	.05
BCDE	68	19.93	.62	.99
ABCDE	68	18.33	.57	1.00
Error 8	1904	32.00		