TYPE A PERSONALITY AND HEART RATE PERCEPTION

by

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ABSTRACT

The present study sought to replicate previous findings on the discrepancy between Type A's self-reporting of stress and their physiological arousal. An attempt was also made to clarify whether this discrepancy was due to A's inability to detect their heart rate changes, or simply due to their "attentional style". Twenty-eight A's and twenty-eight B's were selected from 200 male Introductory Psychology students on the basis of extreme scores on the Jenkins Activity Survey (JAS).

After a 5-minute rest period, subjects were asked to estimate their heart rates, after which they were given feedback. Two minutes later, they were again asked to estimate their heart rates. The subsequent session was the limit period where the subjects were presented with tape-recorded string of digits of increasing length until they reached their own limit. Subjects then performed a digit recall task twice: under instructions to concentrate hard on the task to maximize performance or to focus on their heart rate during the task performance. The order of these two instructions was randomly assigned to each subject. Upon completion of each task, the subjects estimated their heart rates during the digit recall. They also completed the anxiety scale from the Multiple Affect Adjective Check List (MAACL) and a self-report questionnaire. Actual heart rate was recorded throughout the experimental session.

The results indicated that A's manifested greater heart rate increases than B's during the task, but no differences were noted in their anxiety scores on the MAACL, thus, replicating the previous reported discrepancy. Contrary to expectation, Type A subjects were found to significantly over-estimate their heart rates, compared to Type B's, both at rest and during the task performance. Feedback significantly improved Type A's accuracy of their heart rate estimation, although attention-directing instructions had no effect in either A's or B's. The findings of the present study are difficult to reconcile with the suggestion that A's do not report higher stress because they under-estimate their level of physiological arousal.

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INTRODUCTION

Recent studies have shown that Type A's did not report more stress than B's, although they exhibited greater physiological arousal (Holmes, Soloman, and Rump, 1982; Pittner and Houston, 1980). A's failure to detect physiological arousal may be related to the mechanism by which Type A behavior pattern translates into coronary heart disease (CHD), since it may mean that A's will chronically overexpose themselves to stressors, which in itself is a factor for CHD (Insull, 1973). To date, research has not established why A's do not report more stress. It has been suggested that A's deny physiological arousal as one of the characteristics of the behavior pattern (Holmes et al., 1982). Another explanation is that A's are unaware of their physiological changes (Holmes et al., 1982). The final explanation focusses on A's "attentional style". That is, in an effort to do well, they devote more attention to the task, thus they are less able to detect any physiological changes (Weidner and Matthews, 1978). The present study attempted to clarify this issue by examining A-B differences in heart rate perception in order to determine if the discrepancy between A's self-reporting of stress and their physiological arousal is due to their inability to detect heart rate arousal or their "attentional style".

THE TYPE A BEHAVIOR PATTERN

The Type A behavior pattern (TABP), first identified by Friedman and Rosenman, has been defined as "an action-emotion complex that can be observed in any person who is aggressively involved in chronic, incessant struggle to achieve more and more in less and less time, and if required to do so, against the opposing efforts of other things or other persons" (Friedman and Rosenman, 1974, pp 67). Jenkins (1971) has stated more specifically that,

> The Type A behavior pattern is considered to be an overt behavioral syndrome or style of living characterized by extremes of competitiveness, striving for achievement, aggressiveness (sometimes stringently repressed), haste, impatience, restlessness, hyperalertness, explosive speech, tenseness of facial musculature, and feelings of being under the pressure of time and under the challenge of responsibility. Persons having this pattern are often so deeply committed to their vocation or profession that other aspects of their lives are relatively neglected. Not all aspects of this syndrome or pattern need be present for a person to be classified as possessing it. The pattern is neither a personality trait nor a standard reaction to a challenging situation, but rather the reaction of a characterologically predisposed persons to a situation which challenges him (pp 307).

People who manifest this behavior pattern are called Type A individuals. The TABP is comprised of three components: time urgency, achievement striving, and hostility. Type A's tend to react rapidly. They hurry others along and become irritated when forced to slow their frenetic pace (Jenkins, 1975). When sitting or standing, Type A's seem "restless". They tap their feet, drum their knuckles, or

shake their legs (Jenkins, 1975). When emphasizing comments, they usually tense their jaw muscles or grit their teeth (Jenkins, 1975). Competition and challenges are of great attraction to Type A individuals. They are also compulsive about getting their work accomplished. Feelings of anger are more easily aroused in A's than in B's.

Type B individuals exhibit the opposite type of behavior - a relaxed, unhurried, mellow, and less-aggressive style (Friedman and Rosenman, 1974). They are not easily irritated. They work steadily, but they do not have a feeling of being driven by a lack of time. They are less competitive in their occupational pursuits. Individuals who infrequently show approximately equal amounts of both Type A and B behavior are designated "Type X" (Dembroski, MacDougall, and Lushene, 1979b).

The TABP is a response style elicited by conditions that threaten an individual's sense of environmental control (Glass, 1977). It is not a stressor situation or a distressed response.

THE TYPE A BEHAVIOR PATTERN AND ASSOCIATION WITH CORONARY HEART DISEASE

The TABP was first implicated in the occurrence of CHD about twenty years ago (Friedman and Rosenman, 1959). Since then much published evidence, both retrospective and prospective, has validated the association between the TABP and

the risk of CHD (Brand, Rosenman, Sholtz, and Friedman, 1976; Friedman and Rosenman, 1959; Jenkins, 1976; Rosenman, Brand, Jenkins, Friedman, Straus, and Wurm, 1975). The manifestations of CHD are independent of the standard risk factors such as the level of serum cholesterol, cigarette smoking, age, and elevated blood pressure (Jenkins, 1976; Keys, Arvanis, Blackburn, Vanbuchem, Buzina, Djordjenic, Fidanza, Karvonen, Menotti, Puddu, and Taylor, 1972).

Perhaps the strongest evidence regarding the relationship between the TABP and the incidence of CHD comes from the Western Collaborative Group Study. In this prospective study, 3,154 men aged 39 to 59 were followed for eight and a half years; about half of them comprised men classified as Type A. These Type A men exhibited 2 times the rate of new CHD, as compared to Type B men (Rosenman et al., 1975).

Another major prospective study was the Framingham Heart Study. Haynes and her co-workers (Haynes, Feinleib, and Kannel, 1980) investigated the prevalence of CHD in 1,822 men and women whose ages ranged from 45 to 77. Results on the Framingham Type A Behavior Scale showed that Type A men age 65 and under were almost twice as likely to have prevalent angina than their Type B counterparts. In every age group, Type A women were more likely to have angina pectoris. These findings were obtained even when the standard risk factors were controlled for.

Retrospectively, several studies have reported positive associations between the severity of coronary atherosclerosis and measures of the TABP (Blumenthal , Williams, Kong, Schanberg, and Thompson, 1978; Frank, Heller, Kornfeld, Sporn, and Weiss, 1978; Zyzanski, 1976). Krantz , Sanmarco, Selvester, and Matthews (1979) found evidence of a positive relationship between magnitude of Type A scores and the progression of atherosclerosis.

Several investigations have associated facets of the TABP with increased coronary risks. For example, in Wynn's study (cited in Jenkins, 1975), "work addict" has been found to be one of the characteristics of the coronary patients. They work many hours of overtime per week. They also work at two or more jobs simultaneously. In a case control study, Ganeline and Kraevsky (cited in Matthews, Glass, Rosenman, and Bortner, 1977) found that coronary patients were classified in a group that was characterized by high ambition.

The candidate for a myocardial infarction has been described as "unable to sit down and relax when there is no work" (Lovell and Verghere, 1967), is "unable to relax after a hard day" (Wardwell, Hyman, and Bahnson, 1968), and is "active, on the go and tending to speak, drive, work and eat more rapidly" (Brozek, Keys, and Blackburn, 1966).

ASSESSMENT OF THE TYPE A BEHAVIOR PATTERN

Various psychometric techniques have been used for the measurement of the TABP. The most common ones are the structured interview (Rosenman, 1978) and the JAS (Jenkins, Rosenman, and Friedman, 1967). Others include the Bortner Test Battery (Bortner and Rosenman, 1967), the Bortner Scale (Bortner, 1969), and various assessments of speech stylistics (Schucker and Jacobs, 1977; Sherwitz, Berton, and Leventhal, 1977).

The structured interview was the first psychometric device used to classify subjects as Type A or Type B (Rosenman et al., 1975). The subject is asked a series of questions designed to evoke voice and psychomotor manifestations that characterize the major components of Type A behaviors (Rosenman, 1978). These behaviors include: loud, explosive, rapid and accelerated speech, tautness of musculature, vigorous gestures, and verbal competitiveness indicative of hostility. These interviews are tape-recorded for later assessment by trained raters. Although the structured interview is one of the best techniques for assessing TABP, it has several limitations. First, it requires the services of a specially trained interviewer. Secondly, the interview is subjectively rated on a global basis. Thirdly, it is costly and time consuming (Rosenman, 1978). Finally, it is impractical for use with a large pool of subjects (Rosenman, 1978).

The JAS is a popular device for the measurement of TABP because it is easily scored and administered. It relies on a self-report of competitiveness, impatience, and irritability. Form B of the JAS was designed for adult working males. It consists of 54 items, 21 of which belong to the A-B scale. The other sub-scales include speed and impatience (S), hard-driving (H), and job involvement (J) (Zyzanski and Jenkins, 1970). Form T was based on the adult JAS but was modified for use within an academic setting (Krantz, Glass, and Snyder, 1974). Items in the adult form of the JAS were either eliminated or altered for the student version of the questionnaire. As a result, five items on the A-B scale of the adult JAS were modified. For instance, the original item which read "In the past three years have you ever taken less than your allocated regular vacations" was eliminated and substituted with "Do you maintain a regular study schedule during the vacations such as Thanksgiving, Christmas, and Easter?" (Krantz et al., 1974). Due to these elimination and modifications, the student version of the JAS embodies only 3 scales: the overall A-B scale (JAS A/B), the speed and impatience scale (JAS -S/I) , and the hard-driving competitive scale (JAS - H/ C).

THE TYPE A BEHAVIOR PATTERN AND PHYSIOLOGICAL RESPONSES TO STRESS

Although the association between the TABP and CHD seems well established (Haynes et al., 1980) the means that link the two remain uncertain. The first possibility is that the frequent, intense, and sustained autonomic nervous system arousal on the part of Type A individuals causes increased coronary atherosclerosis and subsequent CHD (Williams, Friedman, Glass, Herd, and Scheiderman, 1978). In this regard, a wealth of evidence has demonstrated that A's compared to B's displayed greater increases in cardiovascular arousal when confronted by challenging social situations or tasks.

The most common and consistent physiological finding is that Type A's react with larger systolic blood pressure increases than Type B's (Dembroski, MacDougall, and Shields, 1977; Dembroski, MacDougall, and Herd, 1979a; Dembroski, MacDougall, Shields, Petitto, and Lushene, 1978; Glass, Krakoff, Contrada, Hilton, Kehoe, Mannucci, Collins, Snow, and Elting, 1980; MacDougall, Dembroski, and Krantz, 1981; Manuck, Craft, and Gold, 1978; Weidner and Matthews, 1978). For example, while participating in a reaction-time task after receiving instructions emphasizing the need for rapid and accurate performance, A's responded with significantly larger increases in systolic blood pressure than B's (Dembroski et al., 1977). In the study of MacDougall et al., (1981), Type A women showed greater increases than Type B's

in systolic blood pressure during both the structured interview and a challenging American history quiz. Manuck and associates (Manuck et al., 1978) also found that Type A subjects responded to a challenging concept-formation task with greater systolic blood pressure than Type B subjects.

A few studies have reported that the magnitude of the environmentally induced diastolic blood pressure response differentiates A's from B's (Dembroski et al., 1978; Dembroski et al., 1979b; Pittner and Houston, 1980; Waldron, Hickey, McPherson, Butensky, Gruss, Overall, Schmader, and Wohlmuth, 1980). When subjected to the interview and a history quiz, Type A subjects evidenced a substantial increase in diastolic blood pressure. This increase was sustained over the course of the entire 12 to 15 minute interview (Dembroski et al., 1979b).

Among male college students and adults, those who were more Type A tended to have greater increases in heart rate in response to a variety of challenging experimental situations, such as reaction-time or problem-solving tasks (Dembroski et al., 1978; Manuck et al., 1978; Manuck and Garland, 1979; Holmes et al., 1982). Pittner and Houston (1980) found that A's responded with higher pulse rates than B's while working on digit tasks which had been presented as being important.

Type A's demonstrated substantially greater catecholaminic and hemodynamic reactions than that of B's while

participating in cognitive and psychomotor activities under instructions that stress rapid and accurate performance or the challenge of competition (Friedman, Byers, Diamant, and Rosenman, 1975; Dembroski et al., 1978).

Larger increases in noradrenalin levels (Friedman et al., 1975), plasma norepinephrine levels (Friedman, Rosenman, and Carrol, 1958),and serum cholesterol (Friedman et al., 1958; Lovalloo and Pishkin, 1980) have also been found in Type A subjects in response to various challenges and stressors.

THE TYPE A BEHAVIOR PATTERN AND SELF-REPORT OF STRESS

The notion that Type A's are hard-driving competitive individuals has led to the hypothesis that Type A's will suppress subjective fatigue and thus persist in doing a task at a high level (Friedman, 1969). Jenkins (1975) has also hypothesized that Type A's are characterized by an excessive use of denial. Consistent with these hypotheses, recent findings (Holmes et al., 1982; Pittner and Houston, 1980) have demonstrated that Type A's did not report more subjective responses to a stressor although they manifested significantly greater physiological arousal than Type B's. Other studies have also shown that A's fail to perceive physical symptoms (Carver, Coleman, and Glass, 1976; Hart, 1983; Weidner and Matthews, 1978).

Pittner and Houston's (1980) study indicated that Type A subjects exhibited higher pulse rates throughout the experimental sessions, although they did not report more negative affect than did Type B subjects. Type A's also employed more suppression in both threat to self esteem and shock conditions, and more denial in the threat to self esteem condition. The authors inferred from these results that, when subjectively distressed, A's "consciously try to suppress thinking about the aversive aspects of the situation" (pp 156).

Holmes et al. (1982) found that Type A subjects had a higher heart rate response to a cognitive challenge than Type B's, although they did not report higher subjective arousal in response to that challenge. The authors offered three suggestions to explain the discrepancy: (1) Type A's may not become aware of their physiological arousal; (2) Type A's may be aware of their arousal but refuse to admit it; (3) Type A subjects may become aware of their higher arousal but "suppress" that information.

In a study by Carver et al. (1976), it was found that although Type A subjects exerted greater effort on a treadmill exercise test as compared to Type B subjects, they reported less overall fatigue. These investigators concluded from these results that Type A subjects may suppress or deny any feelings of fatigue because it enables them to continue working at a high level. The acknowledgement of

fatigue, on the other hand, would interfere with task mastery.

In a study conducted by Weidner and Matthews (1978), Type A women reported less intense symptoms as compared to those of Type B during a stressful task performance of solving arithmetic problems while being exposed to bursts of aversive noise. However, following the completion of the task performance, both A's and B's reported the same level of symptoms. The authors suggested that in an attempt to do well, Type A's allocated more attention to the task and may have a higher threshold than Type B's for noticing symptoms while preoccupied.

Hart (1983) reported that Type A's relative to Type B's, under-report the frequency of symptoms and illness experienced. He interpreted the results in terms of the attentional style of Type A's. That is, Type A subjects in his study were considered to have allocated their attention externally. Thus, they reported lower levels of symptoms and also perceived themselves as being more healthy than Type B subjects.

The finding that A's are more reactive to stress, but do not report more subjective arousal has been explained in different ways. One explanation is that A's may be aware of their arousal, but because of their hard-driving characteristic are unwilling to label the arousal as a stress response. That is, they will not admit to vulnerability.

Another explanation is that A's are less sensitive to their subtle body changes. Evidence for these explanations is lacking. For example, it has not been demonstrated whether A's inability to detect their physiological arousal is one of the characteristics of their physiology, or simply due to their "attentional style". What is needed is a study assessing A's and B's ability to detect their levels of physiological arousal, both at rest and during stress.

THE PRESENT STUDY

The present study was designed to replicate the discrepancy between A's self-reporting of stress and physiological arousal, while also determining whether this discrepancy was due to their inability to detect heart rate changes, or simply due to their "attentional style" (that is, a decreased ability to detect heart rate changes because more attention is devoted to the task being performed). This study used a moderately stressful task, digit recall, as a stressor. Heart rate was used as a physiological measure of stress reaction. The anxiety scale from MAACL and a self-report questionnaire were employed as measures of reported stress level.

Following a 5-minute rest period, subjects were asked to estimate their heart rates, after which they were given feedback as to the accuracy of their estimation. Two

minutes later, they were again asked to estimate their heart rates , and again given feedback. Feedback was given to promote more accurate baseline information. This was followed by a limit period where the subject was presented with tape-recorded string of digits of increasing length until he reached his own limit (limit is defined as the level at which two consecutive series of digits failed to be recalled). The purpose of the limit period was to equate A's and B's stress level. Subjects then performed a digit recall task twice: under instructions to concentrate hard on the task (this is called a task period), or to focus on their heart rate during the task (this is called a physiological period). The order of these two instructions were randomly assigned to each subject, in order to control the order effect and to provide a within subject analysis.

If the "attentional style" explanation is correct, then no A-B differences should be noted in the accuracy of their heart rate estimation in the physiological period, but a difference should be shown in the task period. If the A's are unable to detect heart rate changes, their estimations should be poorer than B's in both the task and the physiological periods.

The secondary purpose of the present study was to see if A's and B's are equally able to detect their heart rates at rest. Less accurate heart rate estimations in A's would support a lack of awareness of physiological responses.

METHOD

(1) SUBJECTS

The student version of the JAS was administered to 200 male students in two Introductory Psychology classes. Since the main purpose of this study was to compare fully developed Type A and Type B subjects in terms of their ability to detect physiological arousal, a dichotomous classification was used. Subjects were selected from the extremes of the class distribution of the overall A-B scores on the JAS. Thus, those who scored 11 and above (Type A), and 4 and below (Type B) on the Type A subscale were contacted by telephone and asked if they were interested in participating in the "Individual Differences and Physiology" experiment. Individual appointments for the experimental session were arranged at this time.

The mean A/B score for those taking part in the study was 7.46, typical of young college males (Glass, 1977). The standard deviation was 4.48. The subject's ages ranged from 18 to 31 years, with a mean age of 22.07 years, and a standard deviation of 3.57 years. Each subject received one bonus point toward his final grade in the course.

An equal number of Type A (n=28) and Type B (n=28) males participated in the study. Males were used since previous findings (Jones and Hollandsworth, 1981; Katkin, Blascovich, and Goldband, 1981; Whitehead, Drescher, Heiman,

and Blackwell, 1977) have demonstrated that males show a much greater awareness of their heart beats than females. In addition, death rates from CHD are twice as high for men as for women (Waldron, 1976).

(2) APPARATUS

a) Pre-selection measure

The student version of the JAS was used to measure the Type A behavior pattern. This JAS version contains 44 multiple choice questions, 21 of which assess the Type A-B dimension (Appendix 1). It is based on the adult JAS but modified for college students. The median A-B score for college males typically falls between 7 and 8, where 0 is the maximal pattern B score and 21 is the maximal pattern A score.

b) Physiological measure

Heart rate was recorded by a photoplethysmographic transducer attached to the middle finger of a nondominant hand. The signal was amplified through a voltage/pulse/pressure coupler of a Beckman Type R polygraph. Heart rate was used as a physiological measure of stress since it has been known to be responsive to stress manipulations (Elliot, 1969), and a sensitive indicator of stress (Elliot, 1969). There is also evidence showing heart

rate increases as a reflection of an increase in stress caused by cognitive stressors independent of physical stressors (Blix, Stromme, and Ursin, 1974).

c) Experimental task

The digit span task consisted of the presentation of strings of digits selected from a table of random numbers (Kendall and Smith, 1938) (Appendix 2). A separate tape was prepared for (1) the initial determination of the digit span (limit period) , and (2) testing at the subject's limit (stress period). The first tape contained 12 series of digits with two series at each successive length from 4 to 9 digits. Four other tapes, each with 6 series of a specific number of digits (6,7,8, and 9), had been pre-recorded. Digits were presented at one half second intervals, with ten seconds permitted between each series to enable the subjects to repeat the digits.

d) Self-report measure

The Multiple Affect Adjective Check List (MAACL) (Zuckerman and Lubin, 1965) was administered to measure the subject's negative affect. In this study, only the anxiety scale was used (Appendix 3). These adjectives were either positively or negatively keyed. The subjects marked an "X" in the boxes beside the words which described how they felt during the digit recall. The total score is equal to the

number of positive items checked and the number of negative items not checked.

A 13-item self report questionnaire, modified from Hart and Jamieson's (1983) study, was used to measure cognitive, affective, and somato-viscero-perceptive reactions (Appendix 4). Questions were phrased in such a way that the subjects could check one of the four possible answers. The following is a typical example of the questions asked: "How challenging did you find the task?" (a) not at all (b) somewhat (c) moderately (d) very much so.

e) Experimental setting and materials

The experiment was conducted in a 2.1m x 3.3m room. The subject was seated on a comfortable chair. Directly in front of the subject was a table, measuring 0.8m x 1.5m. The experimenter was seated at the table, opposite the subject. On the table, to the experimenter's left, was a portable cassette tape recorder (Sony, model TC 110-A), used to present the digits. A polygraph was placed on the experimenter's right hand side. Parallel to the polygraph was another table where the consent forms, self-report questionnaires, and the MAACL forms were placed. The experimental setting is presented in Appendix 5.

(3) PROCEDURE

Subjects were tested individually by the same experimenter who was unaware of the subjects' A-B classification. The experimenter greeted and escorted the subject from the waiting room to the lab. Upon arrival at the lab, he was seated on a comfortable chair. He then received a general description of the experiment. After this, the subject was asked to read and then sign the consent form (Appendix 6). The subject then received the following general information: "The heart rate for normal people usually lies between 40-120 beats per minute. The maximum heart rate may reach 200 beats per minute. The average heart rate is about 70 beats per minute". This information was designed to assist those who were unfamiliar with their heart rate activity.

The photoplethysmograph transducer was attached to the subject and its function was explained (for the instructions, see Appendix 7). The subject was then asked to sit back and relax for five minutes. This period was used to allow the subject's physiological responses to come to a resting level.

At the end of the five minute period, the subject was asked to give an estimation of his heart rate in beats per minute. Specifically, he was asked the following question: "How many beats per minute do you think your heart rates are at this moment?" In this study, estimation is defined as the subject's estimation of his heart rate based on any events

or factors other than an instrument reading. These factors may include interoceptive cues and any stimuli from the external environment.

The actual number of the subject's heart rate in beats per minute was counted (from the polygraph output) and then reported to the subject. After an interval of two minutes, the subject was asked to make a second estimation of his heart rate in beats per minute. He was asked the same question: "How many beats per minute do you think your heart rates are at this moment?" The subject's actual heart rate was again provided to the subject and served as a basis for further estimation of his heart rate during the later phase of the experimental session. These two estimations also permitted examination of the effect of feedback on the subject's heart rate estimation.

The subsequent session was the limit period, where the subject was given a series of digits. The limit period was used to equate A's and B's stress level. The subject was presented with digit series of increasing length until he reached his own limit. This session was followed by either the physiological or the task period. The order of these periods was randomly assigned to each subject.

(i) Physiological Period

The subject was told that in a couple of minutes he would be presented with six series of digits to repeat.

During the task performance, he was asked to pay close attention to his heart rate since the major interest in this phase of the study was to see how accurately he could estimate his heart rate. Further, he was told that at the end of this phase, he would be asked to give a rough estimation of his heart rate during the digit recall (for instructions, see Appendix 8).

After these instructions, the subject was presented with six series of digits to repeat. After the digit recall, the subject was asked to give an estimation in beats per minute of his heart rate during the digit recall. He was then administered the MAACL anxiety scale as well as a self-report questionnaire.

(ii) Task Period

The subject was informed that in a few minutes he would be given some digits to repeat. He was further told that it was important in this phase of the study that he concentrate hard, so that he could respond quickly, yet not make any mistakes (for instructions, see Appendix 9).

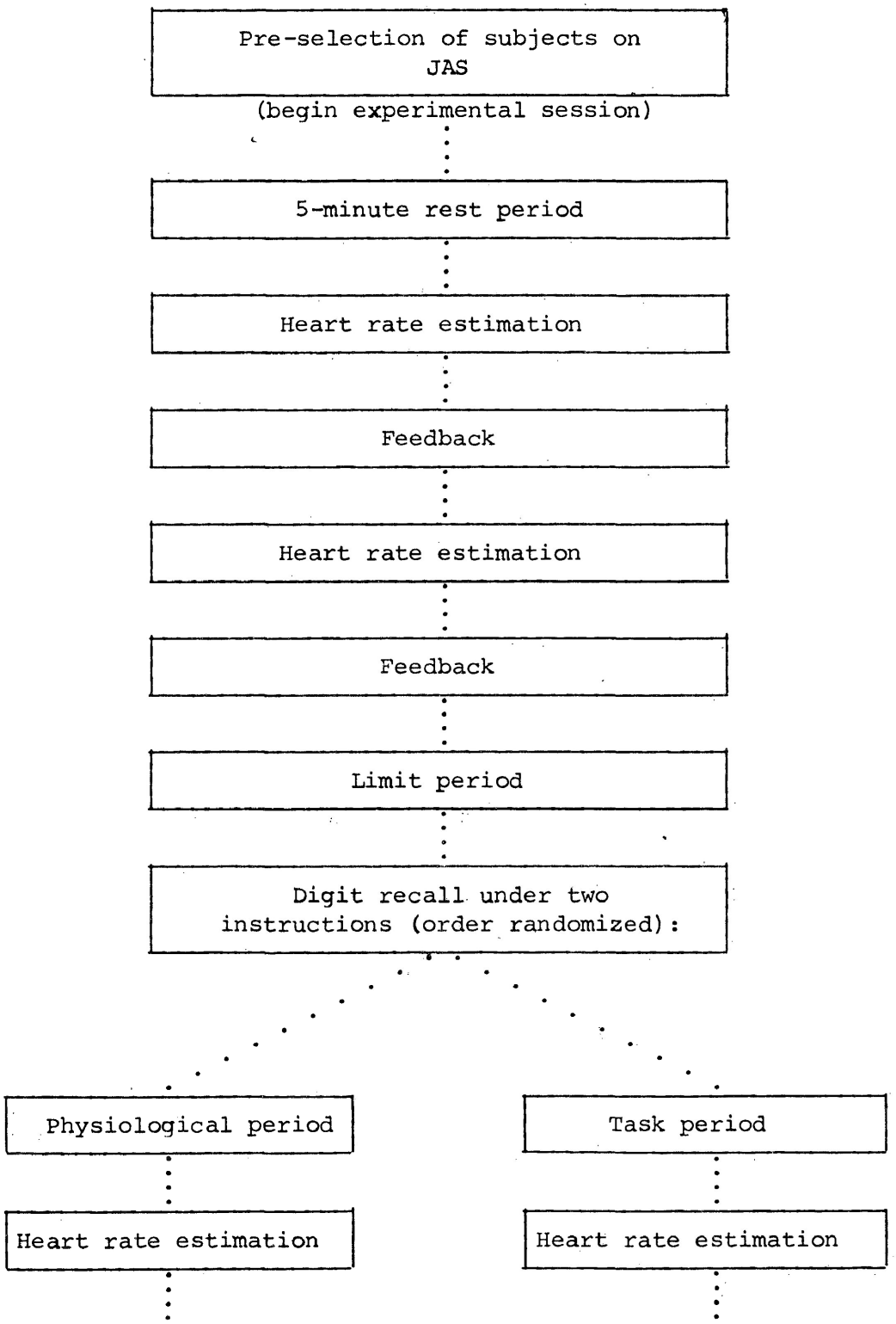
Another six series of digits were presented. At the end of the task, the subject was asked to make an estimate of his heart rate. These estimates were obtained to determine the subject's accuracy in estimating his heart rate when no instructions were given to attend to it. Another MAACL anxiety scale and self-report questionnaire were

administered.

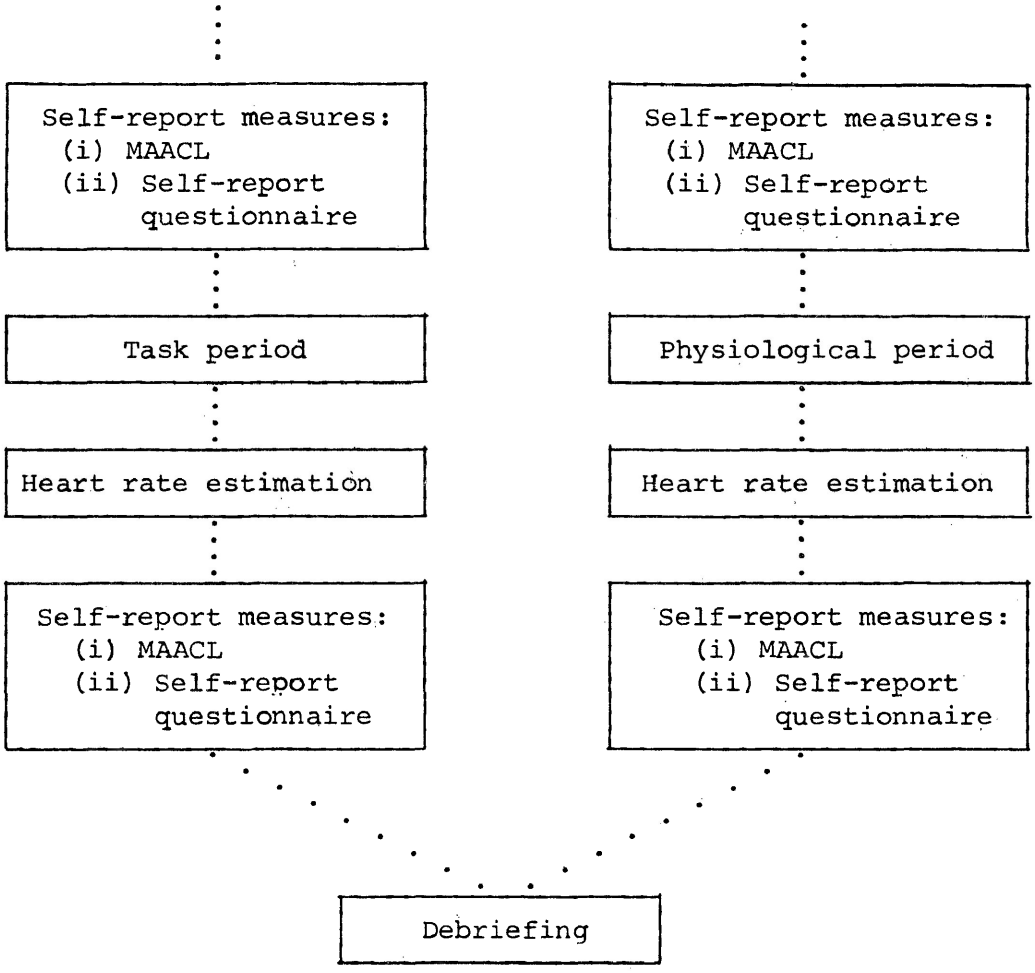
The two sets of six series of digits that were presented to the subjects were one and two digits less in length than his previously determined limit. The experimenter recorded the number of correct repetitions.

Upon the completion of the task, the apparatus was detached. The subject was then thanked for his participation and excused. Figure 1 illustrates the order of the experimental procedure.

Figure 1: Flow diagram of the experimental procedure



Flow diagram of the experimental procedure continued.



DATA ANALYSIS

Heart rate scores were collected during the resting, limit, and the two stress periods (physiological and task). The average heart rate was obtained by counting the number of beats that occurred on the polygraph output during the first and the last ten seconds of each period except for the resting period. Heart rate during the last ten seconds of the rest period was used as resting heart rate.

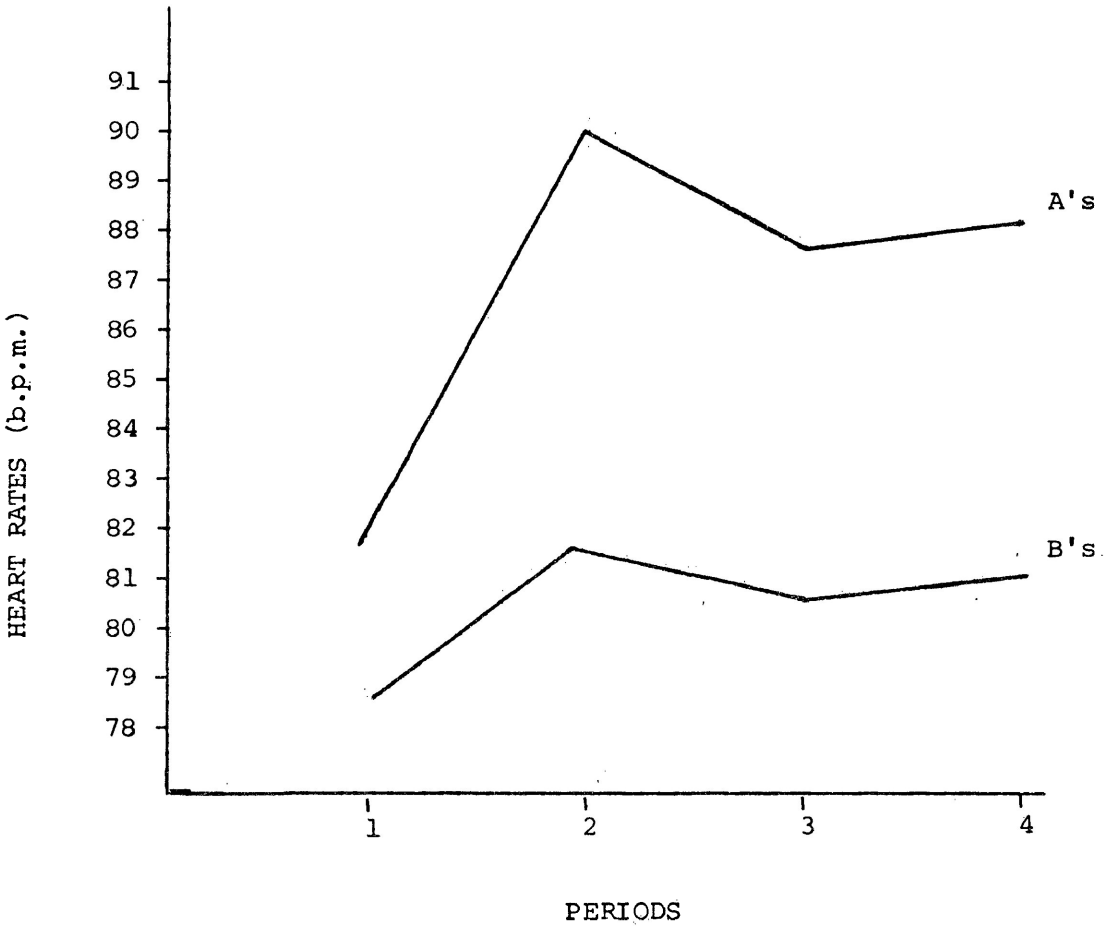
Correct number of digits recalled, scores from MAACL anxiety scale, and self-report questionnaire were obtained for the two stress periods.

RESULTS

(1) ACTUAL HEART RATE

Mean heart rate for Type A's and Type B's during the resting, limit, physiological, and task periods are shown in Figure 2. The limit period was examined to assess if there were any differences between A's and B's in heart rate response to the task before they were instructed to either pay attention to their physiological arousal or to concentrate hard.

FIGURE 2: AVERAGE HEART RATES FOR A's (n=28) AND B's (n=28) DURING THE RESTING, LIMIT, PHYSIOLOGICAL, AND TASK PERIODS.



1 - Resting Period

2 - Limit Period

3 - Physiological Period

4 - Task Period

A repeated measures analysis of variance with A-B as a factor was performed on the subjects' heart rates during the limit and the resting periods. The results showed a significant main effect of period, indicating heart rate increased to stress, $F(1,54)=69.78$, $p=0.001$. That is, the task was effective in increasing heart rate. There was a significant interaction between A-B and period, $F(1,54)=10.03$, $p=0.003$, indicating that Type A's manifested greater heart rate increases in response to the task. These results support A's being more reactive to stress. Appendix 10 contains a summary of these analyses.

Since there was initial differences, although not significant, between A's and B's in resting heart rates, a covariance analysis was performed to evaluate A-B differences in their actual heart rates during the limit, physiological, and task periods. The analysis revealed a significant main effect of A-B during the limit, $F(1,55)=10.37$, $p=0.002$, the physiological, $F(1,55)=8.23$, $p=0.006$, and the task, $F(1,55)=11.84$, $p=0.001$, periods. Thus, the covariance analysis also revealed that the A's are more reactive to stress.

Comparisons between A's and B's heart rates were made for the resting and the limit periods separately, using t-test analyses. These results indicated a significant A-B difference in heart rate during the limit period, $t=-2.35$, $p=0.02$, but not during the resting period, $t=0.63$, $p=0.53$.

These results indicated that A's and B's did not differ in their resting heart rate.

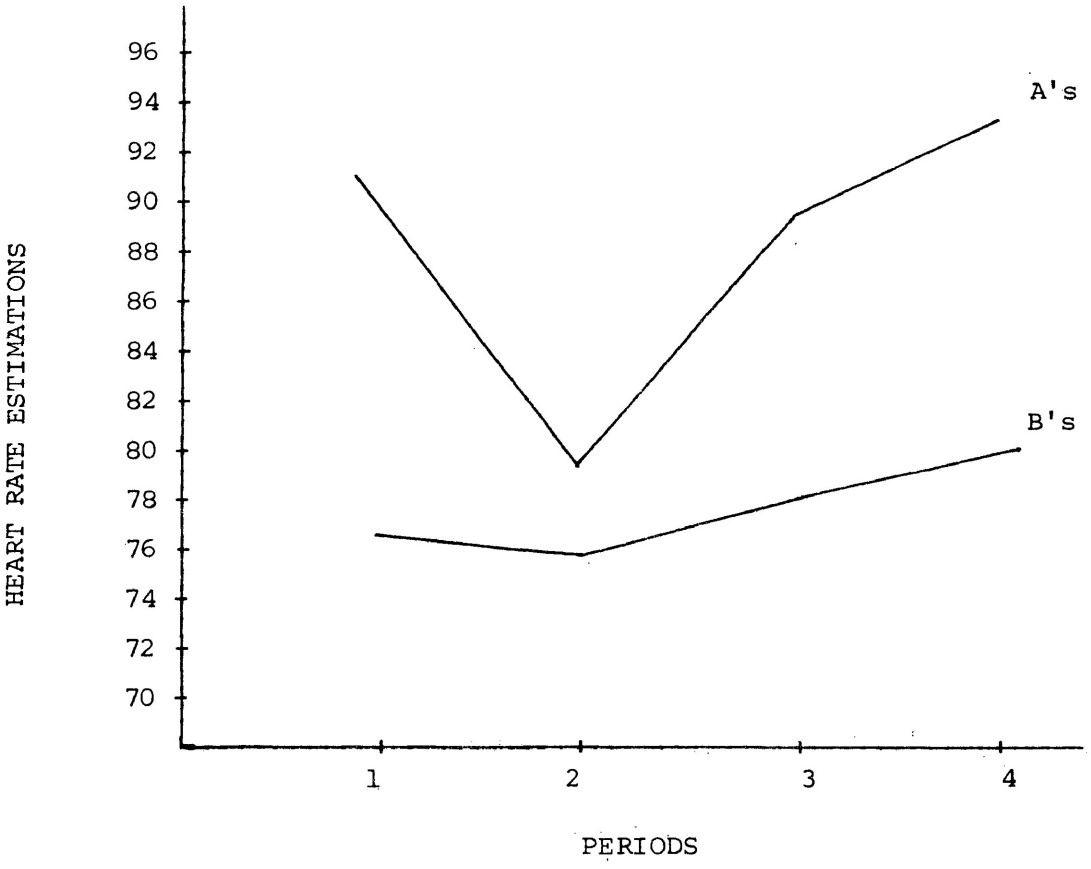
A repeated measures analysis of variance with A-B as a factor performed on the heart rates taken during both the physiological and the task periods, revealed a significant main effect of A-B, $F(1,54)=5.94$, $p=0.02$. These results indicated that A-B difference in heart rate response to the task was maintained over the two stress periods (see Appendix 11). That is, there was a siginificant difference between A's and B's heart rates during the physiological ($t=-2.24$, $p=0.03$) and the task ($t=-2.48$, $p=0.02$) periods.

(2) ACTUAL VERSUS ESTIMATED HEART RATE

Figure 3 shows heart rate estimations for A's and B's for each period. It is apparent that Type A's gave much higher estimation of their heart rate during the first heart rate estimation (before the feedback) ($t=-3.46$, $p=0.001$). However, after feedback, this difference was no longer significant ($t=-1.21$, $p=0.23$).

To assess if A's and B's differ in the accuracy of their heart rate perception, a repeated measures analysis of variance with A-B and period (before and after feedback) as factors was performed on the subjects' actual and estimated heart rates. The result showed a significant interaction of A-B x heart rate (actual versus estimated heart rate) x period, $F(1,54)=5.42$, $p=0.02$ (see Appendix 12). This

FIGURE 3: A's (n=28) AND B's (n=28) HEART RATE ESTIMATIONS.



1 - Heart rate estimation before feedback

2 - Heart rate estimation after feedback

3 - Heart rate estimation during the physiological period

4 - Heart rate estimation during the task period

indicates that A's over-estimated their heart rate before the feedback but not after (see means and t-tests in Table 1). A's over-estimation of their heart rate was an unexpected finding.

To assess if A's also gave higher estimates of their heart rate during the task performance, a repeated measures analysis of variance, with A-B as a factor, was performed on the heart rates taken during the physiological and the task periods. A significant interaction between A-B and heart rate, $F(1,54)=4.28$, $p=0.04$, indicated that A's over-estimated their heart rate more than B's.

Non-significant interactions of A-B x heart rate (actual versus estimated heart rate) x period, $F(1,54)=0.61$, $p=0.44$, (see Appendix 13) demonstrated that the accuracy of heart rate estimation did not differ as a result of attention directing instructions in either A's and B's. This further indicated the ineffectiveness of the instructions given. Had the instructions been effective, the subjects would have given a more accurate estimation of their heart rates when they were told explicitly to pay attention to their heart rate, than when they were told to concentrate hard on the task.

Figure 4 shows A's and B's actual and estimated heart rates at rest and during the two stress periods. The results indicated that A's but not B's over-estimated their heart rates.

Table 1: Mean, standard deviation, and t-tests of the subjects' heart rate estimation, before and after feedback.

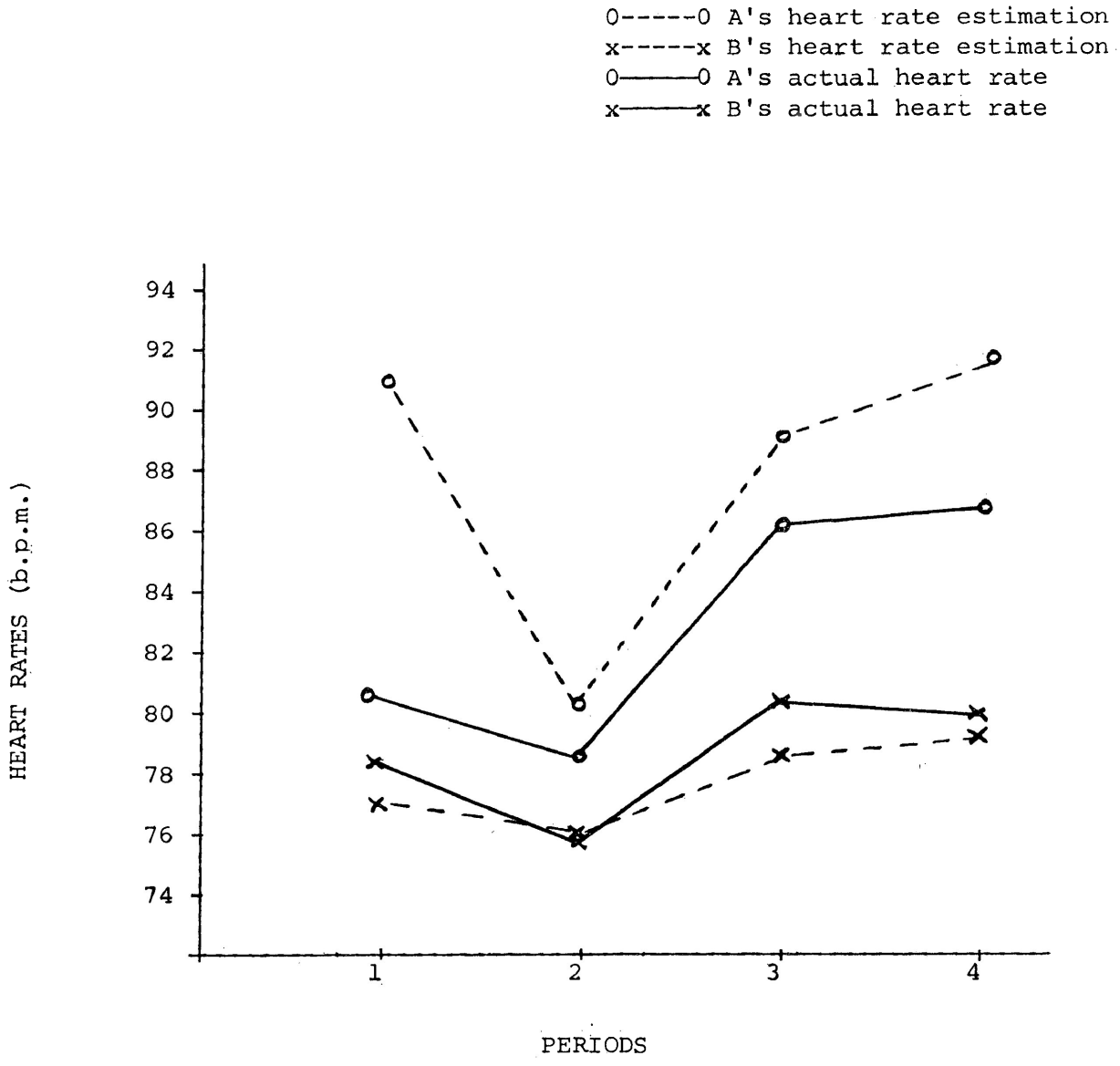
	Before feedback			After feedback		
	Mean	S.D.	$t\text{-test}_1$	Mean	S.D.	$t\text{-test}_2$
A's	90.61	19.81	-3.46***	80.50	16.83	-1.21
B's	76.79	7.43		76.29	7.39	

***$p < 0.001$

$t\text{-test}_1$: comparing A's and B's heart rate estimation before feedback.

$t\text{-test}_2$: comparing A's and B's heart rate estimation after feedback.

FIGURE 4: A's (n=28) AND B's (n=28) ACTUAL AND ESTIMATED HEART RATES AT REST AND DURING THE STRESS PERIODS.



1 - Actual and estimated heart rates before feedback

2 - Actual and estimated heart rates after feedback

3 - Actual and estimated heart rates during the physiological period

4 - Actual and estimated heart rates during the task period

Differences between the actual and estimated heart rates both at rest and during the stress periods were computed separately for A's and B's. T-tests analyses comparing these differences revealed a significant A-B difference only before the feedback ($t=3.64$, $p=0.001$) but not after the feedback ($t=0.84$, $p=0.41$), or during the physiological ($t=1.50$, $p=0.14$), or the task ($t=1.50$, $p=0.14$) periods. That is, except for before the feedback, A's and B's did not differ in the accuracy of their heart rate estimations.

(3) MAACL AND SELF-REPORT QUESTIONNAIRE

As a measure of subjective response to stress, the MAACL anxiety scores were obtained at the end of the physiological and the task periods. A repeated measures analysis of variance with A-B as a factor was performed on these anxiety scores. This analysis did not reveal any significant A-B differences, $F(1,54)=0.88$, $p=0.35$, indicating A's (mean=10.55) and B's (mean=9.91) did not differ in their reporting of stress. A non-significant main effect of period, $F(1,54)=0.03$, $p=0.86$, indicated that there was no effect of instructions on anxiety. The results of these analyses are presented in Appendix 14.

To provide a direct comparison between MAACL and heart rate changes, Z scores were calculated (Pittner and Houston, 1980) for MAACL and for heart rate change from rest to each of the two stress periods. Differences between these Z

scores were computed for each period, and t-tests comparing the differences between the Z scores did not reveal any significant A-B differences: t=-0.74, p=0.47 (physiological period), and t=0.87, p=0.38 (task period). These results indicated that A's did not report less stress on the MAACL relative to the stress levels exhibited by their heart rate changes, when compared to B's.

A repeated measures analysis of variance with A-B as a factor was performed on each one of the items in the self-report questionnaire obtained at the end of the physiological and the task periods. Results demonstrated that Type A's reported more affective reactions than Type B subjects (see Table 2).

(4) PERFORMANCE

A repeated measures analysis of variance with A-B as a factor performed on the correct number of digits recalled revealed no significant main effect on A-B, $F(1,54)=0.22$, $p=0.64$. This indicated that there were no performance differences between A's and B's. A non-significant main effect of period, $F(1,54)=0.05$, $p=0.83$, showed that there was no effect of instruction on the performance level (see Appendix 15). Had the instructions been effective, the subjects would have recalled more correct digits when they were told to concentrate hard than when they were told to pay attention to their heart rate.

Table 2: Differences between A-B on the items of the self-report questionnaire.

ITEMS	A-B	Mean	S.D.	F	P
Better performance	A's	1.643	0.636	2.46	0.12
	B's	1.411	0.452		
Stressful task	A's	2.339	0.594	15.78	0.001**
	B's	1.661	0.681		
Frustrated	A's	2.339	0.681	8.53	0.005**
	B's	1.750	0.822		
Angry	A's	1.929	0.858	5.56	0.022*
	B's	1.482	0.518		
Flushed	A's	2.250	0.799	9.19	0.004**
	B's	1.679	0.597		
Impatience	A's	2.214	0.927	4.94	0.03*
	B's	1.750	0.601		
Sweaty hands	A's	2.393	0.875	8.65	0.005**
	B's	1.804	0.598		
Challenging task	A's	2.893	0.762	33.55	0.001**
	B's	1.750	0.714		
Pleasurable task	A's	2.500	0.892	15.31	0.001**
	B's	1.625	0.777		
Time pressured	A's	2.786	0.907	30.53	0.001**
	B's	1.696	0.515		
Tense	A's	2.018	0.673	11.43	0.001**
	B's	1.482	0.500		

*$p < 0.05$

**$p < 0.01$

DISCUSSION

The main question posed in this study was whether the discrepancy between self-report and heart rate responses to stress among A's was due to their inability to detect their heart rate changes, or simply due to their "attentional style". The present findings do not provide a clear answer to this question. Instead several unexpected findings indicate the need to re-examine the claim that A's do not report higher affective responses to stress.

First, Type A's were found to significantly over-estimate their heart rate levels at rest. This finding is in part consistent with the assumption that A's are less aware of their levels of physiological arousal in that they are less accurate than B's. However, because A's have been reported to under-estimate their levels of arousal, one would clearly expect that A's should under-report but not over-estimate their heart rate levels. This over-estimation was a very strong effect, and cannot be dismissed as a Type I error. This finding seems to suggest that A's see themselves as being more physiologically aroused than do B's, an inference which directly contradicts the usual assumption about A's. There may be plausible alternative explanations for this over-estimation, perhaps related to either A's differences, compared to B's, in time perception (Burman, Pennebaker, and Glass, 1975), or their "chronic quest for quantity" (Friedman and Rosenman, 1974), but the finding

remains as a problem to be clarified through future research.

Following feedback, A's heart rate estimation decreased to the level that the A-B difference disappeared. However, following the two stress periods, A's again exhibited significant heart rate over-estimation. This finding is in direct contradiction of the assumption that A's either minimize or suppress their perceived level of arousal during stress (Carver et al., 1976). The conclusion from the heart rate estimation data is that A's over-estimated their heart rates at rest and during stress relative to B's. However, Brener and his associates (Brener, Ross, Baker, and Clemens, 1979) said that heart rate estimation is not a good procedure and that alternative methods are more accurate for determining ability to detect physiological arousal. Therefore, it would be of some importance to attempt to replicate the present finding of A's over-estimating of heart rates using alternative methodology.

Second, the results from the MAACL are consistent with the findings from Pittner and Houston (1980) and Holmes et al. (1982), in that A's and B's differed significantly in heart rate, but not in self-report. Thus, these results may be interpreted as replicating the under-reporting of A's. However, caution should be exercised in drawing inferences from indirect comparisons based on non-significance of one factor. A direct comparison based on comparison of Z scores

did not provide evidence that A's showed relatively greater physiological than self-report arousal, unlike Pittner and Houston (1980) which did demonstrate this effect using a similar analysis. Moveover, the self-report questionnaire administered after each stress period showed much higher reported affective reactions by A's than by B's. The results of this questionnaire are in contrast to the results from the MAACL, and raise the question of whether these two instruments are measuring different subjective phenomena or whether the self-report questionnaire is a more sensitive instrument than the MAACL. Regardless of the resolution of this issue, it is clear at least on the self-report questionnaire that A's do not show evidence of under-reporting their affective response to the task.

Another issue is the finding that the instructions designed to focus attention on either the task or on heart rate had no apparent effect on either A's or B's. There are various possible explanations for why the instructions were ineffective, and it is unfortunate that pilot testing was not conducted to select tasks and measures that would respond to these instruction. Because this instruction manipulation may shed light on the reasons underlying discrepancies between self-reported affect and level of physiological arousal, it should be investigated in future research.

Regardless of the reason, the finding that A's fail to

accurately estimate their heart rate is very significant. Previously, Greene, Moss, and Goldstein (1974) had discussed three cognitive steps that a person experiencing a heart attack must take in order to seek treatment. The person first must perceive his symptoms, then he must recognize the seriousness, and finally he must realize that the symptoms indicate a need for immediate medical care. Mechanic (1972) had also proposed that symptoms are labelled after detecting internal arousal and surveying the environment for appropriate symptom cues. Since our results suggest that Type A's may be less perceptive of their pre-heart attack symptoms, they would likely continue their exertions in their on-going activities. For example, Leventhal (1975) notes that people's health-seeking behavior is based on their perceptions of the states of their body. These continual exertions can produce the following results: they would experience increased delays before seeking treatment. This would mean that an on-going infarction might become more severe, or that the prodromal fatigue might result in a full-fledged heart attack.

The findings of the present study support the results of previous research (Dembroski et al., 1977; Dembroski et al., 1978; Glass et al., 1980; Manuck and Garland, 1979; Pittner and Houston, 1980; Van Egeren, 1979a), which showed that Type A's, in general, reacted to stress with greater physiological arousal as measured by heart rate than Type B. The differential arousal manifested by A's is quite striking

since the challenge used in the present study was only moderately stressful. There was no threat of shock, or direct social competition involved. These greater heart rate increases may have been due to A's trying much harder on the digit recall than did B's. Recently, Houston (1983) has indicated that physiological arousal is mediated by A's incentive for performance and their expectation with respect to the possibility of successfully completing the task. Thus, one can explain the differences in A's and B's heart rate increases in terms of A's achievement motivation and their hard-driving competitiveness.

It is of interest to note that Type A subjects did not perform any better on the digit recall than Type B subjects. This tentatively suggests that physiological arousal, as such, may not enhance the performance of the Type A subjects. Thus, the present results together with the findings from various studies (Dembroski et al., 1978; Holmes et al., 1982; Pittner and Houston, 1980) would argue against the notion that the physiological arousal associated with Type A behavior has inherent instrumental value. It is clear at least in the present study, that B's can perform just as well as A's in the digit recall task.

Results from the self-report questionnaire lend support to the construct validity of the Type A concept. In the present study, Type A's were more time pressured, impatient, frustrated, tensed, flushed, angry, and had sweatier hands

than Type B's. A's also perceived the task as being more stressful, pleasurable, and challenging. These findings are consistent with the clinical observations of Friedman and Rosenman (1974), and the results of Glass's (1977) social-psychological experiments.

In summary, the present findings indicate that, at least under the conditions of the present study, A's over-estimate their level of physiological arousal at rest and during stress, and do not under-report their level of affective arousal. These findings are difficult to reconcile with the suggestion that A's do not report higher level of affective arousal because they under-estimate their level of physiological arousal.

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LIST OF APPENDICES

APPENDIX 1.

NAME: _____ Telephone No. _____

Please answer the questions on the following pages by marking the answers that are true for you. Each person is different, so there are no "right" or "wrong" answers.

Your assistance will be greatly appreciated.

For each of the following items, please circle the number of the ONE best answer on your answer sheet.

1. Do you ever have trouble finding time to get your hair cut or styled?

   1. Never 2. Occasionally 3. Almost always

2. Does college "stir you into action"?

   1. Less often than most college students
   2. About Average
   3. More often than most college students

3. Is your everyday life filled mostly by

   1. Problems needing solution
   2. Challenges needing to be met
   3. A rather predictable routine of events
   4. Not enough things to keep me interested or busy

4. Some people live a calm, predictable life. Others find themselves often facing unexpected changes, frequent interruptions, inconveniences or "things going wrong." How often are you faced with these minor (or major) annoyances or frustrations?

   1. Several times a day
   2. About once a day
   3. A few times a week
   4. Once a week
   5. Once a month or less

5. When you are under pressure or stress, do you usually:

   1. Do something about it immediately
   2. Plan carefully before taking any action

6. Ordinarily, how rapidly do you eat?

   1. I'm usually the first one finished.
   2. I eat a little faster than average.
   3. I eat at about the same speed as most people.
   4. I eat more slowly than most people.

7. Has your spouse or some friend ever told you that you eat too fast?

   1. Yes often 2. Yes, once or twice 3. No, no one has told me this

8. How often do you find yourself doing more than one thing at a time, such as working while eating, reading while dressing, figuring out problems while driving?

   1. I do two things at once whenever practical.
   2. I do this only when I'm short of time.
   3. 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, do you feel like hurrying him along?

   1. Frequently 2. Occasionally 3. Almost never

10. How often do you actually "put words in his mouth" in order to speed things up?

   1. Frequently 2. Occasionally 3. Almost never

11. If you tell your spouse or a friend that you will meet them somewhere at a definite time, how often do you arrive late?

   1. Once in a while 2. Rarely 3. I am never late.

12. Do you find yourself hurrying to get places even when there is plenty of time?

   1. Often 2. Occasionally 3. Rarely or 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. Will you

   1. Sit and wait?
   2. Walk about while waiting?
   3. Usually carry some reading matter or writing paper so you can get something done while waiting?

14. When you have to "wait in line," such as at a restaurant, a store, or the post office, do you

   1. Accept it calmly?
   2. Feel impatient but do not show it?
   3. Feel so impatient that someone watching could tell you were restless?
   4. Refuse to wait in line, and find ways to avoid such delays?

15. When you play games with young children about 10 years old, how often do you purposely let them win?

   1. Most of the time 2. Half of the time 3. Only occasionally 4. Never

16. Do most people consider you to be

   1. Definitely hard-driving and competitive? 3. Probably more relaxed and easy going?
   2. Probably hard-driving and competitive? 4. Definitely more relaxed and easy going?

17. Nowadays, do you consider yourself to be

   1. Definitely hard-driving and competitive? 3. Probably more relaxed and easy going?
   2. Probably hard-driving and competitive? 4. Definitely more relaxed and easy going?

18. How would your spouse (or closest friend) rate you?

1. Definitely hard-driving and competitive? 3. Probably relaxed and easy going?
2. Probably hard-driving and competitive? 4. Definitely relaxed and easy going?

19. How would your spouse (or best friend) rate your general level of activity?

1. Too slow. Should be more active.
2 About average. Is busy much of the time.
3. Too active. Needs to slow down.

20 Would people who know you well agree that you take your work too seriously?

1 Definitely Yes 2. Probably Yes 3. Probably no 4. Definitely No

21. Would people who know you well agree that you have less energy than most people?

1 Definitely Yes 2. Probably Yes 3. Probably No 4. Definitely No

22. Would people who know you well agree that you tend to get irritated easily?

1. Definitely Yes 2. Probably Yes 3. Probably No 4. Definitely No

23. Would people who know you well agree that you tend to do most things in a hurry?

1 Definitely Yes 2. Probably Yes 3. Probably No 4. Definitely No

24. Would people who know you well agree that you enjoy "a contest" (competition) and try hard to win?

1. Definitely Yes 2. Probably Yes 3. Probably No 4. Definitely No

25. Would people who know you well agree that you get a lot of fun out of your life?

1 Definitely Yes 2. Probably Yes 3. Probably No 4. Definitely No

26 How was your "temper" when you were younger?

1. Fiery and hard to control.
2 Strong, but controllable.
3. No problem.
4. I almost never got angry.

27. How is your "temper" nowadays?

1. Fiery and hard to control.
2. Strong, but controllable.
3. No problem.
4. I almost never get angry.

28. When you are in the midst of studying and someone interrupts you, how do you usually feel inside?

1. I feel O.K. because I work better after an occasional break.
2. I feel only mildly annoyed.
3. I really feel irritated because most such interruptions are unnecessary.

(Remember, the answers on these Questionnaires are confidential information and will not be revealed to officials of your school.)

29. How often are there deadlines in your courses? (If deadlines occur irregularly, please circle the closest answer below.)

1. Daily or more often. 2. Weekly. 3. Monthly. 4. Never

30. Do these deadlines usually

1. Carry minor pressure because of their routine nature?
2. Carry considerable pressure, since delay would upset things a great deal?

31. Do you ever set deadlines or quotas for yourself in courses or other things?

1 No 2 Yes, but only occasionally 3. Yes, once per week or more often.

32 When you have to work against a deadline, is the quality of your work

1. Better? 2. Worse? 3. The same? (Pressure makes no difference)

33 In school do you ever keep two projects moving forward at the same time by shifting back and forth rapidly from one to the other?

1. No, never. 2. Yes, but only in emergencies. 3. Yes, regularly.

34 Do you maintain a regular study schedule during vacations such as Thanksgiving, Christmas, and Easter?

1. Yes 2. No 3. Sometimes

35. How often do you bring your work home with you at night or study materials related to your courses?

1. Rarely or never. 2. Once a week or less often. 3. More than once a week.

36. How often do you go to the school when it is officially closed (such as nights or weekends)? If this is not possible, circle 0.

1. Rarely or never. 2. Occasionally (less than once a week). 3. Once or more a week.

37. When you find yourself getting tired while studying, do you usually

1. Slow down for a while until your strength comes back.
2. Keep pushing yourself at the same pace in spite of the tiredness.

38 When you are in a group, do the other people tend to look to you to provide leadership?

1. Rarely. 3. More often than they look to others.
2. About as often as they look to others.

39. Do you make yourself written lists of "things to do" to help you remember what needs to be done?

1. Never 2. Occasionally 3. Frequently

IN EACH OF THE FOLLOWING QUESTIONS, PLEASE COMPARE YOURSELF WITH THE AVERAGE STUDENT AT YOUR SCHOOL. PLEASE CIRCLE THE MOST ACCURATE DESCRIPTION.

40. In amount of effort put forth, I give

1. Much more effort 2. A little more effort 3. A little less effort 4. Much less effort

41 In sense of responsibility, I am

1. Much more responsible 2. A little more responsible 3. A little less responsible 4. Much less responsible

42 I find it necessary to hurry

1. Much more of the time 2. A little more of the time 3. A little less of the time 4. Much less of the time

43. In being precise (careful about detail), I am

1. Much more precise 2. A little more precise 3. A little less precise 4. Much less precise

44 I approach life in general

1. Much more seriously 2. A little more seriously 3. A little less seriously 4. Much less seriously

APPENDIX 2.

1st Thousand

00	23157	54859	01837	25993	76249	70886	95230	36744
01	05545	55043	10537	43508	90611	83744	10962	21343
02	14871	60350	32404	36223	50051	00322	11543	80834
03	38976	74951	94051	75853	78805	90194	32428	71695
04	97312	61718	99755	30870	94251	25841	54882	10513
05	11742	69381	44339	30872	32797	33118	22647	06850
06	43361	28859	11016	45623	93009	00499	43640	74036
07	93806	20478	38268	04491	55751	18932	58475	52571
08	49540	13181	08429	84187	69538	29661	77738	09527
09	36768	72633	37948	21569	41959	68670	45274	83880
10	07092	52392	24627	12067	06558	45344	67338	45320
11	43310	01081	44863	80307	52555	16148	89742	94647
12	61570	06360	06173	63775	63148	95123	35017	46993
13	31352	83799	10779	18941	31579	76448	62584	86919
14	57048	86526	27795	93692	90529	56546	35065	32254
15	09243	44200	68721	07137	30729	75756	09298	27650
16	97957	35018	40894	88329	52230	82521	22532	61587
17	93732	59570	43781	98885	56671	66826	95996	44569
18	72621	11225	00922	68264	35666	59434	71687	58167
19	61020	74418	45371	20794	95917	37866	99536	19378
20	97839	85474	33055	91718	45473	54144	22034	23000
21	89160	97192	22232	90637	35055	45489	88438	16361
22	25966	88220	62871	79265	02823	52862	84919	54883
23	81443	31719	05049	54806	74690	07567	65017	16543
24	11322	54931	42362	34386	08624	97687	46245	23245

APPENDIX 3.

Name: _____ Age: _____ Sex: _____

Directions: On this sheet you will find words which describe different kinds of moods and feelings. Mark an X in the boxes beside the words which describe how you felt during the experiment. Some of the words may sound alike, but we want you to check all the words that describe your feelings. Work rapidly.

1.	Afraid	22.	Happy
2.	Agreeable	23.	Irritated
3.	Amiable	24.	Joyful
4.	Angry	25.	Kindly
5.	Bitter	26.	Loving
6.	Calm	27.	Mad
7.	Cheerful	28.	Mean
8.	Contented	29.	Nervous
9.	Cooperative	30.	Offended
10.	Cruel	31.	Outraged
11.	Desperate	32.	Panicky
12.	Devoted	33.	Pleasant
13.	Disagreeable	34.	Polite
14.	Discontented	35.	Secure
15.	Disgusted	36.	Shaky
16.	Enraged	37.	Steady
17.	Fearful	38.	Stormy
18.	Friendly	39.	Sympathetic
19.	Frightened	40.	Tame
20.	Furious	41.	Tender
21.	Good natured	42.	Tense

43. ☐ Terrified

44. ☐ Thoughtful

45. ☐ Understanding

46. ☐ Unsociable

47. ☐ Upset

48. ☐ Warm

49. ☐ Willful

50. ☐ Worrying

51. ☐ Vexed

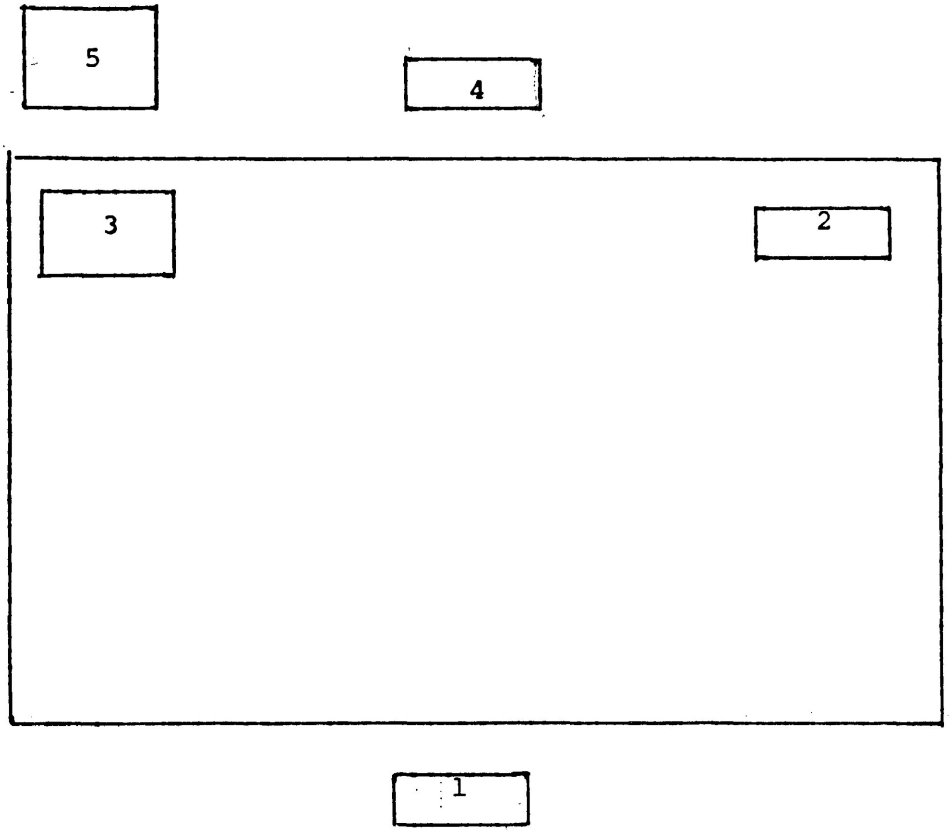
APPENDIX 4.

Self Report Questionnaire

Check the box which best describes how you felt while performing the digit recall task. Be as accurate as possible.

	not at all	somewhat	moderately	very much so
1. Do you think your performance was better than other students?				
2. Generally, how stressful did you find it?				
3. Did you feel frustrated?				
4. Did you feel angry?				
5. Did your face become flushed?				
6. Did you feel impatient?				
7. How sweaty did your hands become?				
8. How challenging did you find the task?				
9. Did you find the task pleasurable?				
10. How "time pressured" did you feel?				
11. Did your muscles become tense?				

APPENDIX 5: THE EXPERIMENTAL SETTING



1 - The subject

2 - The tape recorder

3 - The polygraph

4 - The experimenter

5 - A small table

APPENDIX 6.

Consent Form

I the undersigned, understand that the procedure I will be participating in is concerned with how people respond physiologically while repeating some digits. If at any time I wish to discontinue the experiment I may indicate this to the experimenter and I will be free to leave. I have been told by the experimenter that the research techniques are standard procedures that have been well thought out and tested. With this understanding, I have consented to be a participant.

I understand that all information collected in this research will be kept confidential, and that any published data from this research will not contain identifying information about individual participants.

I have read and understand all of the above information.

Signed: _____

Date: _____

APPENDIX 7

"This machine is called a polygraph and I am going to hook it to your finger. It is used to read your heart rates. It is harmless, so do not be scared. (After the subject is hooked up) Okay, in just a moment, I want you to relax for five minutes. I want you to sit quietly and not make any movement since it disturbs the recording of the physiological response. If possible, do not close your eyes, because you may fall asleep."

APPENDIX 8

"In a few minutes, you will be presented with six series of digits similar to the ones that you have been repeating. While you repeat the digits, I want you to pay attention to your heart rates. It is important that you focus your attention to your heart rates since what we are interested in, in this part of the study, is how accurately you can estimate your heart rate. At the end of this phase of the study, I will be asking you to give a rough estimation of your heart rates during the digit recall. Do not take your finger pulse or count your heart beats. Remember that you have to repeat, out loud, the digits after the tape. Any questions?"

APPENDIX 9

"In a few minutes, you will be presented with six more series of digits. These are similar to the ones which you have just been repeating. This time, I want you to really concentrate hard. It is important that you concentrate hard, because I want you to be able to respond quickly, yet not make any mistakes. Remember that you have to repeat, out loud, the digits after the tape. Any questions?"

Appendix 10: Anova on actual heart rates comparing baseline to limit periods.

SOURCE	SS	DF	MS	F
Between subject				
A-B	603.571	1	603.571	2.590
Error	12581.107	54	232.983	
Within subject				
Period	1590.035	1	1590.035	69.78**
A-B x Period	228.571	1	228.571	10.03**
Error	1230.393	54	22.785	

*$p < 0.05$

**$p < 0.01$

Appendix 11: Anova on actual heart rates comparing physiological to task periods.

SOURCE	SS	DF	MS	F
Between subject				
A-B	1358.036	1	1358.036	5.941*
Error	12343.214	54	228.578	
Within subject				
Period	32.143	1	32.143	1.996
A-B x Period	1.286	1	1.286	0.080
Error	869.571	54	16.103	

*$p < 0.05$

Appendix 12: Anova comparing actual to estimated heart rates, before and after feedback.

SOURCE	SS	DF	MS	F
Between subject				
A-B	1694.00	1	1694.00	3.824
Error	23918.214	54	442.928	
Within subject				
Period	714.286	1	714.286	13.673**
A-B x Period	311.143	1	311.143	5.958*
Error	2821.071	54	52.242	
Heart rate	355.018	1	355.018	5.992*
A-B x heart rate	693.018	1	693.018	11.697**
Error	3199.464	54	59.249	
Heart rate x period	168.018	1	168.018	2.715*
A-B x heart rate x period	335.161	1	335.161	5.415*
Error	3342.321	54	61.895	

*$p < 0.05$

**$p < 0.01$

***$p < 0.001$

Appendix 13: Anova comparing actual to estimated heart rates during the physiological and the task periods.

SOURCE	SS	DF	MS	F
Between subject				
A-B	4763.790	1	4763.790	8.046**
Error	31971.348	54	592.062	
Within subject				
Heart rate	112.862	1	112.862	1.689
Heart rate x A-B	285.754	1	285.754	4.276*
Error	3608.633	54	66.826	
Period	152.790	1	152.790	5.924*
A-B x period	33.790	1	33.790	1.310
Error	1392.670	54	25.790	
Heart rate x period	18.862	1	18.862	0.654
A-B x heart rate x period	17.719	1	17.719	0.614
Error	1557.669	54	28.846	

*$p < 0.05$

**$p < 0.01$

Appendix 14: Anova on the MAACL anxiety during the physiological and the task periods.

SOURCE	SS	DF	MS	F
Between subject				
A-B	11.571	1	11.571	0.885
Error	706.393	54	13.081	
Within subject				
Period	0.143	1	0.143	0.034
A-B x period	0.893	1	0.893	0.211
Error	228.964	54	4.240	

Appendix 15: Anova on the performance during the physiological and the task periods.

SOURCE	SS	DF	MS	F
Between subject				
A-B	0.321	1	0.321	0.216
Error	80.536	54	1.491	
Within subject				
Period	0.036	1	0.036	0.046
A-B x period	0.143	1	0.143	0.184
Error	41.821	54	0.774	

APPENDIX 16

```
TA LIST                 FIXED (2)/1 AB 1-2 GROUP 3 AGE 4-5 FHRE 6-8 FAHR 9-11
                        SHRE 12-14 SAHR 15-17 FRHR 18-20 LRHR 21-23
                        FLP 24-26 LLP 27-29 PFSP 30-32 PLSP 33-35
                        PSFHRE 36-38 PSFAHR 39-41 TSP 42-44 TLSP 45-47
                        TSPHRE 48-50 TSPAHR 51-53 PA 54-55 TA 56-57
                        PCA 58 TCA 59 PQ1 60 PQ2 61 PQ3 62 PQ4 63
                        PQ5 64 PQ6 65 PQ7 66 PQ8 67 PQ9 68 PQ10 69
                        PQ11 70 TQ1 71 TQ2 72 TQ3 73 TQ4 74 TQ5 75
                        TQ6 76 TQ7 77 TQ8 78 TQ9 79 TQ10 80/2 TQ11 1
OF CASES                56
LUE LABELS              GROUP (1) PAY ATTENTION TO PHYSIOLOGICAL AROUSAL.
                        CONCENTRATE HARD AND IGNORE PHYSIOLOGICAL AROUSAL.
                        (2) CONCENTRATE HARD. PAY ATTENTION TO
                        PHYSIOLOGICAL AROUSAL.
                        AGE.
                        FHRE   FIRST HEART RATE ESTIMATION.
                        FAHR   FIRST ACTUAL HEART RATE.
                        SHRE   SECOND HEART RATE ESTIMATION.
                        SAHR   SECOND ACTUAL HEART RATE.
                        FRHR   FIRST RESTING HEART RATE.
                        LRHR   LAST RESTING HEART RATE.
                        FLP   FIRST LIMIT PERIOD.
                        LLP   LAST LIMIT PERIOD.
                        PFSP   FIRST OF PHYSIOLOGICAL AWARENESS.
                        PLSP   LAST OF THE TASK CONCENTRATION.
                        PSFHRE   HEART RATE ESTIMATION DURING THE PHYSIO. AWARE.
                        PSFAHR   ACTUAL HEART RATE DURING THE PHYSIO.AWARE.
                        TSP   FIRST OF THE TASK CONCENTRATION.
                        TLSP   LAST OF THE TASK CONCENTRATION.
                        TSPHRE   HEART RATE ESTIMATION DURING THE TASK CON.
                        TSPAHR   ACTUAL HEART RATE DURING THE TASK CON.
                        PA    ANXIETY SCALE DURING THE PHYSIO.AWARE.
                        TA    ANXIETY SCALE DURING THE TASK CON.
                        PCA   CORRECT DIGITS RECALLED DURING THE PHYSIO.
                        TCA   CORRECT DIGITS RECALLED DURING THE TASK CON.
                        PQ1...PQ11    SELF-REPORT QUESTIONNAIRE DURING PHYSIO.
                        TQ1...TQ11    SELF-REPORT QUESTIONNAIRE DURING TASK CON.
MPUTE              HRCH=LLP-LRHR
MPUTE              HRCH1=PLSP-LRHR
MPUTE              HRCH2=TLSP-LRHR
MPUTE              DIFF1=FAHR-FHRE
MPUTE              DIFF2=SAHR-SHRE
MPUTE              DIFF3=PSFAHR-PSFHRE
MPUTE              DIFF4=TSPAHR-TSPHRE
MPUTE         AVREST1=(FRHR+LRHR)/2
MPUTE         AVREST2=(FLP+LLP)/2
MPUTE         AVREST3=(PFSP+PLSP)/2
MPUTE         AVREST4=(TSP+TLSP)/2
MPUTE         Z1=(PA-10.260)/3.113
MPUTE         Z2=(TA-10.196)/2.746
MPUTE         Z3=(HRCH-7.286)/8.420
MPUTE         Z4=(HRCH1-5.821)/8.724
MPUTE         Z5=(HRCH2-6.643)/9.178
MPUTE         DIFF5=Z3-Z1
MPUTE         DIFF6=Z3-Z2
MPUTE         DIFF7=Z4-Z1
MPUTE         DIFF8=Z4-Z2
MPUTE         DIFF9=Z5-Z1
MPUTE         DIFF10=Z5-Z2
MPUTE         DIFF11=AVREST3-PSFHRE
MPUTE         DIFF12=AVREST4-TSPHRE
MPUTE         DIFF13=DIFF1-DIFF2
MPUTE         HRCH3=AVREST2-AVREST1
MPUTE         HRCH4=AVREST3-AVREST1
```

```
COMPUTE          HRCH5=AVREST4-AVREST1
COMPUTE          Z6=(HRCH3-5.696)/6.828
COMPUTE          Z7=(HRCH4-4.071)/7.706
COMPUTE          Z8=(HRCH5-5.143)/6.794
COMPUTE          DIFF14=Z6-Z1
COMPUTE          DIFF15=Z6-Z2
COMPUTE          DIFF16=Z7-Z1
COMPUTE          DIFF17=Z7-Z2
COMPUTE          DIFF18=Z8-Z1
COMPUTE          DIFF19=Z8-Z2
=                (AB LE 4) TABP=1
=                (AB OE 11) TABP=2
COMPUTE          HRCH6=AVREST2-LRHR
COMPUTE          HRCH7=AVREST3-LRHR
COMPUTE          HRCH8=AVREST4-LRHR
COMPUTE          HRCH9=DIFF11-DIFF12
COMPUTE          HRCH10=FHRE-SHRE
COMPUTE          HRCH11=PSPHRE-TSPHRE
COMPUTE          HRCH12=HRCH11-HRCH10
COMPUTE          Z9=(HRCH6-7.536)/7.284
COMPUTE          Z10=(HRCH7-5.911)/7.302
COMPUTE          Z11=(HRCH8-6.982)/6.840
COMPUTE          DIFF20=Z9-Z1
COMPUTE          DIFF21=Z9-Z2
COMPUTE          DIFF22=Z10-Z1
COMPUTE          DIFF23=Z10-Z2
COMPUTE          DIFF24=Z11-Z1
COMPUTE          DIFF25=Z11-Z2
COMPUTE          AVREST5=(PA+TA)/2
COMPUTE          Z13=(AVREST5-10.232)/2.555
COMPUTE          DIFF26=Z9-Z13
COMPUTE          DIFF27=Z10-Z13
COMPUTE          DIFF28=Z11-Z13
COMPUTE          AVREST6=(PQ1 + TQ1)/2
COMPUTE          AVREST7=(PQ2+TQ2)/2
COMPUTE          AVREST8=(PQ3+TQ3)/2
COMPUTE          AVREST9=(PQ4+TQ4)/2
COMPUTE          AVREST10=(PQ5+TQ5)/2
COMPUTE          AVREST11=(PQ6+TQ6)/2
COMPUTE          AVREST12=(PQ7+TQ7)/2
COMPUTE          AVREST13=(PQ8+TQ8)/2
COMPUTE          AVREST14=(PQ9+TQ9)/2
COMPUTE          AVREST15=(PQ10+TQ10)/2
COMPUTE          AVREST16=(PQ11+TQ11)/2
COMPUTE          J1=ABS (FHRE-FAHR)
COMPUTE          J2=ABS (SHRE-SAHR)
COMPUTE          J3=ABS (PSPHRE-PSPAHR)
COMPUTE          J4=ABS (TSPHRE-TSPAHR)
COMPUTE          AVREST17=(AVREST3+AVREST4)/2
COMPUTE          AVREST18=(Z1+Z2)/2
COMPUTE          AVREST19=(Z4+Z5)/2
COMPUTE          AVREST20=(FHRE+SHRE)/2
COMPUTE          DIFF29=AVREST18-AVREST19
COMPUTE          AVREST21=(FAHR+SAHR+PSPAHR+TSPAHR)/4
COMPUTE          AVREST22=(FHRE+SHRE+PSPHRE+TSPHRE)/4
COMPUTE          AVREST23=(PSPAHR+TSPAHR)/2
COMPUTE          DIFF30=AVREST21-AVREST22
READ INPUT DATA
1122120102150102114108108102090102118108108102150096141532132121213121231323412

3119070090085092096096114108096126110108102096108120111034132112422131221221313

1129085066070066072060078072072078072072084072070084066064231111112321221111222
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122107207207207006607207808408407807707807807207708407062422211214342222223133 3
122608507807807207207208409007807808808408408409808403112133122323332212222333 2
122006506006005805406006007206606606806606007806506608082232213334441223333333 4
322908506006506006606607207208008407207207807208407212102213333122121133311144 4
422212009008209009609010810210210210009610210211409614051121233434141123344434 4
123108507007507007207208409609609009509008411410209006072121343441111223443144 33
322710007808007808407209008409008408008408408407008414112213233442341112234434 4
122309008208208008007208408008608407608408609007008611101221232114441134111344 3
421808008408008407807807207807808407508407208409007810111222121232111211112312 2
322108008408007808407809009608408409508407409010008410082421223111111123122334 1
422008008407607807807807807207807208207808407808007814112311122112211211112113 3
322006606006006006006006606606606606706606606606806603101111112111121111112211 1
422308008408207807808407807809008409008409008408407806083211121121221121111122 2
423109010209010210410210810810810210910210810810510810124533111111111123111131 11
222107407807807208407808660860840960800840900900820861011122311222211112112212 11
322208208408208008008007407607808407608607208008407609083321113321121112113114 1
321906806606606606606606806806806807006606806606606011072211221141123131122111 2
222008408007807607607607807607807608007608007608007611111131432111231123114111 2
222608607208008407207207807807808007408407208008407809112211221112311123111223 3
322109008008408008008008008007808007807808007808008008011103121111211211211311 12221
322208208208408208208008009009209409008308008208008508809092112121211222111211 3421
121908008407608008007808007207807808008408007808007812121141211124111223112341
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)NDESCRIPTIVE ALL
)NDESCRIPTIVE LRHR AVREST2 AVREST3
CARSON CORR    ALL
CARSON CORR    AVREST4 WITH TA
-TEST          GROUPS=TABP/VARIABLES=FA TA
NOVA           FAHR SAHR FHRE SHRE BY TABP (1,2)/
               WSFACTORS=HR(2) FEED(2)/
               WSDESIGN=HR,FEED,HR BY FEED/
               PRINT=SIGNIF (AVERF)/
               ANALYSIS (REPEATED)/
               DESIGN=TABP/
NOVA           FA TA BY TABP (1,2)/
               WSFACTORS=PERIOD(2)/
               WSDESIGN=PERIOD/
               PRINT=SIGNIF (AVERF)/
               ANALYSIS (REPEATED)/
               DESIGN=TABP/
OVA            PSPHRE TSPHRE BY TABP (1,2)
ATISTICS       3
```

```
ANOVA           AVREST2 AVREST3 AVREST4 BY TABP (1,2) WITH LRNR
FINISH
```

APPENDIX 17