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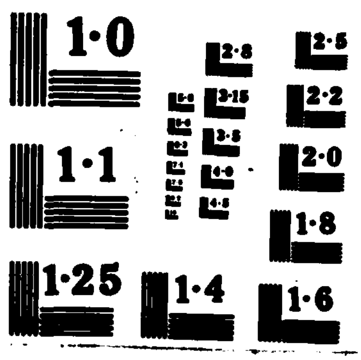
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This is the final report under Air Force Office of Scientific Research grant AFOSR-83-0304. The report details the background, findings, and conclusions of two studies completed in the Psychophysiology Laboratory of Baruch College, City University of New York, over the past twelve months.

In Experiment I 36 individuals, 18 classified as coronary prone (Type A) and 18 as non-coronary prone (Type B) (Jenkins Activity Survey) performed a Perceptual

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered) motor task (simulated race car driving) along with a secondary task (simple reaction time) while a number of physiological measures were obtained. The measures were heart rate (HR), electromyogram (EMG) and skin temperature (ST). Analyses of performance results indicated that Type A individuals significantly slowed their reaction times (secondary task) when performing qualifying trials compared to practice trials. Type B individuals did not evidence this slowing in RT. Type As and Bs did not differ in perceptual-motor task performance. Physiological data indicated that Type A individuals had higher levels of EMG during all conditions of task performance. Type A and B subjects did not differ with respect to entry (baseline) EMG. Another finding of interest was that Type Bs who had lower HR performed better in the perceptual motor rask. In addition, multiple correlational analyses suggested that, in general, lower HR, higher ST and higher EMG were related to better scores.

Experiment II tested a different sample of 36 subjects (18 each of Type A and B) in a design which compared the effects of participation in both a perceptual-motor and a cognitive (short term memory) task. The results showed that Type A subjects produced faster RT responses than Type Bs, but only while engaged in the cognitive task. The As also outperformed the Bs in the cognitive task. In general, the cognitive task seemed to absorb more of the subjects' attention since RTs were significantly slower in the cognitive as compared to the perceptual-motor task. Increased effort in performing the cognitive task is also suggested by the fact that Type As had significantly higher HR than Bs for this task, but not for the perceptual motor one. The Type As also had significantly higher skin conductance than Bs, although this was not differentiated according to task. It was, however, performance related since SC levels of the two groups did not show baseline differences. An interesting finding here is that while SC is higher for As than Bs, skin temperature (ST) is also higher. Since an increase in SC indicates increased SNS response, while higher ST reflects relatively less SNS activity, we may be observing a special case of directional fractionation of physiological response as it relates to the Type A/B construct.

Multiple correlational analyses indicated that lower HR and higher ST were related to faster RTs. In Experiment I this same relationship was found, but for tracking scores not RT. The fact that the pattern was similar in both experiments suggests a type of physiological patterning in which lower activity level is related to better performance. Tracking scores were related to Jenkins sub-scale scores in a manner indicating superior performance for those high in Type A behavior, but not for those scoring high in the H scale (hard driving, competitive behavior). Persons scoring high in the S scale (speed and impatience) performed better in the short term memory task. The H scale again was negatively weighted indicating that those who scored lower in the hard driving, competitive scale performed better.

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Holmes et at. (1982) administered the digit symbol subtest of the Wechsler Adult Intelligence Scale (WAIS) to 20 male and 19 female subjects classified as Type A or Type B. All subjects also completed the Affect

PSYCHOPHYSIOLOGICAL STUDIES II: PERFORMANCE AND PHYSIOLOGICAL RESPONSE IN CORONARY PRONE AND NON CORONARY PRONE INDIVIDUALS

Prepared by: John L. Andreassi
and
N. Mauro Juszczak

Psychophysiology Laboratory
Baruch College
City University of New York

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PSYCHOPHYSIOLOGICAL STUDIES II: PERFORMANCE AND PHYSIOLOGICAL RESPONSE IN CORONARY PRONE AND NON CORONARY PRONE INDIVIDUALS

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Abstract

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We have performed this research to be described cognizant of the fact that certain military personnel perform their jobs under either task induced or environmental stress. The task induced stress might be a result of information/task overload whereby the individual is required to process a great deal of information in a short period of time. In some instances the person may be required to respond to two or more simultaneous inputs. What effect does the requirement to process two inputs simultaneously have upon physiological response of the individual? What are the performance effects? Do effects differ as a function of task type, i.e., whether it is motor or

cognitive? An additional question involves possible differential effects depending on whether the individual demonstrates coronary prone (Type A) or non-coronary prone (Type B) behavior. These are the questions that this research was designed to answer. The results are of potential interest to both military and civilian organizations, especially in the context of selection and job placement, since they might reveal the kinds of individuals best suited to perform certain types of tasks under a dual or multi-task structure in terms of performance and ability to maintain physiological homeostasis in the face of task and other environmental challenges.

In Experiment I 36 individuals, 18 classified as Type A and 18 as Type B using the Jenkins Activity Survey, performed a perceptual-motor task (simulated race car driving) along with a secondary task (simple reaction time) while a number of physiological measures were obtained. The measures were heart rate (HR), electromyogram (EMG) and skin temperature (ST). Analyses of performance results indicated that Type A individuals significantly slowed their reaction times (secondary task) when performing qualifying trials compared to practice trials. Type B individuals did not evidence this slowing in RT. Type As and Bs did not differ in perceptual-motor task performance. Type A and B subjects did not differ with respect to entry (baseline) EMG. Another finding of interest was that Type Bs who had lower HR performed better in the perceptual-motor task. In addition, multiple correlational analyses suggested that, in general, lower HR, higher ST and higher EMG were related to better scores.

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Introduction

The concept of the Type A behavior pattern has stimulated a good deal of research over the last 15 years. the concept describes the behavior profile of a coronary prone individual who is a competitive, hostile, and an impatient achiever (Friedman and Rosenman, 1969). Individuals lacking these characteristics are said to be non coronary prone or Type B.

Clinical studies suggest that Type A individuals are more likely to suffer from a variety of cardiovascular disorders such as coronary heart disease and atherosclerosis (Jenkins, 1976). It is also argued that these disorders may be due in part to greater cardiovascular reactivity of Type As compared to Type B individuals (Mathews, 1982).

Research findings indicate that Type As exhibit physiological changes suggestive of sympathetic nervous system (SNS) arousal under a variety of different experimental situations some of which involve manipulation of different stressors such as uncontrollable noise, harassment/ego-threat, competition, task difficulty, challenge, and incentives. Investigators have also questioned whether the type of task (e.g., cognitive, perceptual-motor, physical) may be one of the mediating variables underlying Type A-B differences in physiological reactivity.

In the following paragraphs we shall review studies that have used various kinds of stressor techniques and situations to study possible Type A-B differences.

Stressors:

Aversive Situations: Harassment, Ego Threats, Goal Bloacking

Systolic blood pressure (SBP)and heart rate (HR) were examined by

Diamond et al. (1984) as a function of conditions of harassment, goal blocking, or competition (control condition). The harassment condition elicited significantly elevated SBP and HR changes relative to the other two conditions with both the As and Bs. Although there were no differences in SBP and HR between Type A and Type B subjects during conditions of competition and goal blocking, the As exhibited greater SBP and HR changes than did the Bs during harassment.

A total of 32 male Type A and Type B subjects were examined as a function of ego threats and reactivity to the cold pressor test (Malcom et al., 1984). The physiological indices were HR and pupil diameter. It was hypothesized that the As would respond to ego threats, but not the cold pressor, with higher HR and larger pupil size than Type B subjects. The major hypothesis was confirmed, but only with HR. That is, the As had higher HR activity in response to ego-threat but lower activity in response to the cold pressor, as compared to their pre-task baseline HR activity. The Type Bs, on the other hand, had only slight (non-significant) increases from baseline to the two stress situations. These findings were not confirmed with pupillary responses, i.e., there were no differences in pupillary responses for the As between the two stressors.

Noise, Electric Shock

Subjects performed a choice reaction time task while they received loud noise bursts and/or electric shocks in a study by Contrada et al. (1982). Behavioral control was manipulated by telling half of the subjects that they could avoid noise and shock by attaining a criterion of reaction time speed (contingency group) while the remaining subjects were told that their responses had no effect on the noise or shock (non-contingency group). In addition, the two contingency situations were divided by having half of the subjects in each group perform under high frequency aversive stimulation while the other half of each group performed under a low frequency aversive condition. Thus, there were four situations (contingent-high frequency, contingent-low frequency, non-contingent-high frequency, non-contingent-high frequency). All subjects (i.e., both Type A and Type B) produced significantly faster reaction time responses and higher SBP, DBP, and plasma epinephrine in the contingent situation relative to the non-contingent situation. However, the As had higher SBP and HR responses than the Bs in both situations since the contingent-high frequency aversive stimulation condition elicited faster reaction time responses and higher levels of plasma norepinephrine relative to the Bs.

Moch (1984) examined the sensitivity of 20 Type A and 20 Type B females to steadily increasing noise levels while they performed a simple (crossing out) and a complex (memorizing nonsense syllables) task. Although this investigator did not measure physiological responses, sensitivity was measured by the extent to which the noise levels adversely affected performance. A short rating scale of Type A behavior was used to assess the JAS type. The results indicated no differrence in performance between the As and Bs in the simple task. On the more complex task, the As and Bs performed differently, with the As maintaining their level of tolerance (performance) while the Bs lowered theirs. These results led the investigator to suggest that high investment and the desire to succeed may lead Type A subjects to ignore the acoustic environment and deny the aversive aspects of noise. It would have been particularly informative to compare HR and BP of Type A and B subjects under these conditions as well.

Lovallo and Pishkin (1980) had subjects perform two tasks (pattern recognition and anagram solution) under conditions of stress, which was induced during the task by the occurrence of uncontrollable noise, the requirement to work on unsolvable anagrams (failure) or both (failure and noise). The pattern recognition task was considered to be relatively easy, even when completed in the presence of uncontrollable noise. A total of 80 medical and dental students exhibiting high or low coronary prone behavior patterns (i.e., Type A or B, respectively) were selected according to criteria on a structured interview. The physiological measures consisted of blood pressure, peripheral vasomotor activity, HR, HR variability, skin conductance (SC) and serum lipids. It was found that Type A subjects had higher SC levels and rates of spontaneous fluctuations during the tasks than did Type Bs, leading these authors to conclude that Type A individuals show greater SNS arousal than Bs under stressful situations. There were no differences between the As and Bs in SC during the unsolvable anagram plus uncontrollable noise condition. The As were found, however, to have higher SC levels than the Bs during successful performance on the pattern task. This finding was interpreted as an indication that Type A subjects showed greater interest and involvement in the tasks. Another finding of importance was that during a rest condition, Type A subjects showed more vasoconstriction than did Type Bs. Finally, but just as significant, was the observation that extreme As had higher serum cholesterol both before and after testing, and showed an increase in triglyceride levels as a function of increasing noise.

In summary, Type A individuals produced greater physiological changes than Bs under the different aversive situations described (e.g., harassment, ego threats, electric shock). These changes have been demonstrated with both HR and BP (DBP and SBP).

Task Difficulty

Van Schijndel et al. (1984) used an anagram solution task to examine the effects of behavioral control and Type A behavior on cardiovascular response. Sixty adults performed the task under three conditions of solvable anagrams: 30%, 50% and 100% solvable. Apparently, behavioral control was operationally defined in terms of solvability with the 30% condition affording the most behavioral control. The Dutch version of the JAS was used to assess the Type A behavior pattern. Systolic BP, DBP, and HR were measued before, during, and after the task. The results revealed significantly higher blood pressure elevation (both SBP and DBP) for Type As as compared to the Bs. This effect was particularly enhanced in the 50% solvable anagram condition.

Type A and Type B susbjects worked on solvable and unsolvable anagrams in a study by Gastorf (1981). Half of the subjects were told that the anagrams were very difficult to solve while the other half were told that they were very easy. Thus there were four experimental conditions: hard, solvable: hard, unsolvable: easy, solvable: easy, unsolvable. All subjects were given about two minutes to complete the task. The results showed that the As and Bs did not differ reliably in psychophysiological arousal (SBP) while working on the anagrams that were described as easy and were solvable. However, Type A subjects manifested significantly higher SBP responses than did Type Bs while working on anagram problems under the other three conditions.

Holmes et al. (1984) had 30 Type A and 30 Type B male subjects work on a short term memory task (digits backward recall) that was easy, moderately difficult, or extremely difficult. Psychophysiological arousal was measured in terms of SBP, DBP, pulse rate (PR), pulse volume (PV), skin resistence (SR) and subjective arousal. The major finding was that the Type As evidenced significantly higher SBP than did Type Bs, but only during the extremely difficult condition. There were no reliable differences between the As and Bs with any of the other physiological measures at the other levels of difficulty, nor were there any differences between the As and Bs in subjective arousal.

Changes in HR and performance were monitored in 70 Type A and 70 Type B students (assessed with JAS, college student version) by Perkins (1984) to determine if these groups differed as a function of task difficulty and response cost. The task required that subjects detect the onset of one of five lights arranged in a semicircle (continuous button pushing task). Response cost (RC) was manipulated by informing subjects that performance failure would result in loss of money (high RC), loss of points (low RC), or no loss at all. Although there were no differences in performance between the two groups, Type A subjects showed greater HR increases from practice to task conditions than did Type Bs. In addition, the As also showed greater HR increases from low to high response cost conditions. Thus, Type A subjects showed greater cardiovascular reactivity to changing response costs. It was also found, however, that the As produced greater HR increases than did Bs from practice to the no cost condition. The authors explained this finding by suggesting that during no cost or no feedback, Type A subjects may perceive greater demand for better performance from the experimenter. It was concluded that overall differences in heart rate reactivity between the two groups during the task is due to Type A's greater motivation toward avoidance of cost or punishment.

Thus there seems to be less agreement with respect to the level of task difficulty required to induce physiological differences in Type As and B. For example, Van Schijndel (1984) showed that their Type As had higher BP elevation than the Bs which was enhanced in the moderately solvable (difficult) condition while Holmes (1984) found greater SBP reactivity for their Type A subjects only during an extremely difficult condition. Finally, Perkins (1984) failed to demonstrate differences in cardiovascular reactivity to changing levels of difficulty.

Incentive

Manuck and Garland (1979) had 44 Type A and Type B subjects perform a difficult cognitive task (visual-verbal test) under conditions of incentive (monetary reward) and no incentive (no money). In addition to performance, these researchers examined HR, SBP, DBP, and pulse pressure (PP). It was expected that under the incentive condition, Type Bs would perform as well as Type As and show similar cardiovascular responses, indicating that Type B subjects show more effort and responsiveness to external demands (i.e., monetary rewards). Further, an ambiguous or less stringent situation (no reward) was expected to result in lower performance and responsiveness among Type Bs as compared to Type As. The results indicated that during the no-incentive condition, Type B subjects performed as well as the Type A subjects. Thus, the incentive factor resulted in an improvement in performance, but only with Type B subjects. With respect to the cardiovascular measures, (HR, SBP, DBP, PP), the only significant finding was that overall, Type A subjects had greater SBP responses than did Type B subjects, supporting earlier reports of greater physiological reactivity among Type A individuals. These investigators did note a non-significant trend in which Type B no-incentive subjects tended to show smaller cardiovascular responses relative to the other three groups (i.e., Type B incentive, Type A incentive, Type A no-incentive). In another study, Blumenthal, et al. (1980) used a verbal problem solving task (Word Finding Test) and found that a monetary incentive condition affected the performance of Type A susbjects to a greater degree than Type B subjects. This finding was confirmed in a follow-up investigation (Blumenthal et al., 1983) which included the collection of physiological data (HR, SBP, and FPV). What was puzzling, however, was that the pattern of results was reversed when the physiological measures were considered. To elaborate, Type As showed significantly elevated HR and SBP responses regardless of incentive condition, despite the fact that they performed better when an incentive was provided. In contrast, Type B subjects, while showing no performance differences between incentive and no-incentive, responded with a significant increase in HR and SBP during the incentive condition. Thus, Type As responded physiologically with enhanced arousal regardless of the demand characteristics, while Type Bs showed arousal only when the challenge of performance, i.e., opportunity for reward, was explicit.

Contrada et al. (1984) gave 41 subjects an opportunity to earn a monetary award during an arithmetic task varying in two levels of difficulty. Heart Rate and SBP were taken immediately prior to (pre-task anticipatory period) and five minutes after the task. It was found that Type A subjects had higher HR prior to solving difficult problems as compared to HR responses obtained from the Type B subjects. Further, Type As had higher pre-task SBP responses than Type Bs, regardless of condition. These authors, however, did not examine the performance of these subjects.

To briefly summarize, there is uncertainy as to whether Type As reliably show cardiovascular reactvity under incentive conditions. It appears from the studies that Type A individuals evidence greater HR and SBP regardless of incentive condition. One of the reviewed studies reported that Type Bs responded with increases in SBP and HR during and incentive condition.

Houston (1983) reviewed the literature in an attempt to explain some of the inconsistencies concerning task difficulty and incentive. He proposed that Type As manifest greater psychophysiological arousal than Type Bs only when there is a moderate level of external incentive to perform well on a task, or if there is an intermediate probability of failure. In other words, if the task is too easy Type A subject may exert little effort and hence produce little physiological change. If the task is too difficult, Type A subjects may perceive the impossibility of the situation and simply give up. The consequence of simply giving up, of course, is little physiological change. Houston further suggested that moderate levels of incentive and probability of failure engages the achievment striving and competitiveness that characterizes the Type A behavior pattern. Jennings (1984) demonstrated that cardiovascular reactivity of Type A subjects depended on two main factors: a) The components comprising Type A behavior (i.e., speed and impatience, hard driving and competitive) and b) The nature of the task they are engaged in. For example, Jennings showed that Type As scoring high on the speed and impatience scale evidenced greater HR variability in an RT task requiring controlled accurate responding after a long interstimulus interval. The As who scored high on the competitiveness scale showed enhanced between trial HR variability and sustained cardiac responsivity in the RT task when monetary incentive was introduced. Holmes (1983) proposed that the failure to consistently demonstrate greater task related differences in physiologic reactivity between As and Bs may indicate that the link between the Type A behavior pattern and psychophysiological reactivity to tasks is weak. He illustrated numerous studies in which investigators found significant changes in one cardiovascular variable (e.g., HR) but not others (e.g., SBP and DPB). Further, when the mean difference in SBP between the As and Bs was computed across the numerous experimental investigations, it was found to be only 6 mm Hg, a difference he considers to be negligible. Holmes review, however, failed to take into account the studies that have used other psychophysiological indices (e.g., skin conductance - Lovallo and Pishkin (1984), Blumenthal (1980,1983), that have reliably demonstrated greater sympathetic nervous system activity with Type As relative to Type Bs in certain situations.

Type of Task:

Cognitive, Perceptual Motor, Physical Excercize

Dembroski et al. (1978) had Type A and Type B subjects engage in a simple reaction time task, an electronic pong game, and a series of difficult anagrams under a time limit. The Type As showed significantly greater SBP and HRthan their Type B counterparts across the three tasks, i.e., there was greater physiological arousal among the As compared Bs. Thus, there were no differences between the As and the Bs in the cardiovascular indices used with respect to the different tasks, but merely a generalized task effect.

Holmes et at. (1982) administered the digit symbol subtest of the Wechsler Adult Intelligence Scale (WAIS) to 20 male and 19 female subjects classified as Type A or Type B. All subjects also completed the Affect Adjective Checklist. In addition, both JAS types participated in a step task (a timed excercise). The Type A and B subjects did not differ with respect to baseline HR activity, nor did they differ in subjective arousal during this period. Further, there were no differences in HR activity between the As and Bs during physical exercize. During the digit symbol test, however, the As had significantly higher HR than the Bs, and the effect was more pronounced among males.

Williams et al. (1982) examined a range of cardiovascular and neuro-endocrine responses from Type A and Type B subjects while they performed in a mental arithmetic (cognitive) and a choice reaction time task (sensory intake). The As showed significant increases in norepinephrine, epinephrine, and cortisol secretions than did Type Bs, but only during the cognitive (i.e., mental arithmetic) task. There were no differences in neuroendocrine secretions between the As and Bs during the sensory intake task (i.e., choice reaction time). Although there were no significant differences in cardiovascular responses (HR, SBP, DBP, forearm blood flow - FBR, forearm vascular resistance - FVR) between the As and Bs within either task, there was an observable trend in which Type A subjects manifested larger HR, SBP, and DBP than the Bs during the cognitive task. The magnitude of this difference between the As and Bs was smaller during the sensory intake task. In addition, there were no performance differences between the As and Bs with either task. It was oberved that the Type As had significanly greater FBR and lower FVR than did the Type Bs during the cognitive task, indicating that As had significantly greater muscle vasodilation. It was proposed that the greater muscle vasodilation among the As may have attenuated any BP increases that might have resulted from the heart rate increase. The author also pointed out that their findings may have implications for understanding the underlying mechanisms that lead to increased coronary heart disease, namely that enhanced endocrine and cortisol secretions may play a role in accelerating atherogenesis.

Lundberg (1982) had 24 Type A and 24 Type B subjects complete a self paced RT task, a vigilance task characterized by understimulation, and the Stroop inteference characterized by overstimulation. Elevated psychophysiological arousal (i.e., high SBP) was found in the Type As during understimulation but not during active performance on the self paced RT task. The author suggested that differences in cardiovascular reactivity between Type A and Type B individuals may be related to the pace of the environment to which they are exposed.

The type of task that Type A and Type B subjects are exposed to seems to play a role in determining the magnitude of differences in physiological reactivity between these two groups. It is apparent that cognitive tasks result in reliably greater physiological changes among As relative to Bs (e.g., Holmes et al., 1982; Williams et al., 1982). Perhaps cognitive tasks (e.g., mental arithmetic) make greater demands upon the information processing capacities of individuals which in turn lead to higher levels of physiological reactivity.

The Present Research

We have designed two studies to address some of the questions concerning the type of task, level of challenge, and difficulty required to induce differences in physiological reactivity in Type A and B individuals. In the first experiment subjects exhibiting extreme Type A and Type B behavior (JAS) were required to engage in a perceptual-motor task (a race car simulation called "Pole Position") at varying levels of task difficulty. However, subjects were also required to meet a performance criterion during an additonal "qualifying condition". It was expected that the requirement to qualify might provide enough incentive and/or challenge to produce differences in both performance and physiological responses between Type A and Type B subjects. In addition, subjects were required to perform in a simple reaction time task while they were engaged in the perceptual motor task. There were two major reasons for doing this. The first is that performing two tasks simultaneously would result in a significant increase in information load, thereby providing a considerable degree of stress. This would permit the formulation of relevant research hypotheses concerning the extent to which Type A and Type B individuals would differ in physiological reactivity to stress. The second concerns the behavioral characteristics of the Type A individual. One salient characteristic of the Type A person is an exaggerated sense of time urgency which may manifest itself in a tendency to do many things at the same time. Thus under a dual task situation without explicit instructions as to which task requires primary attention, the As may attempt to do well in both.

The following hypotheses were proposed:

1) The Type A subjects will produce faster RT responses under the requirement to qualify while the Bs will not show differences in RT between Practice and Qualifying conditions.

2) The Type A subjects will show faster RT responses than the Type B subjects.

3) Type A subjects will show greater increases in HR, EMG, and decreases in ST than their Type B counterpart with the requirement to qualify, since this condition is expected to produce greater information load, stress, and SNS arousal.

4) Type A subjects will show greater SNS and somatic involvement (i.e., greater HR, lower ST and higher EMG levels) than Type B subjects regardless of task conditions.

The following research questions were addressed.

1) Will Type A subjects perform better than the Bs, i.e., will their race track scores be higher?

2) Will the various physiological indices predict performance, i.e., will changes in HR, EMG, and ST reflect changes in scores or RT?

In Experiment II a cognitive task (Rebeep) requiring tonal short term memory was added. Skin conductance (SC) was an additional physiological variable in Experimental II. Only one level of diffuculty, moderate, was used. Thus, Type A and Type B subjects (as assessed by the JAS - Form C) were required to engage in both perceptual motor and a cognitive tasks and to qualify in both. With respect to Experiment II the following additional hypotheses were proposed:

1) Reaction time will distinguish the As from the Bs in the cognitive task, i.e., Type A subjects will show faster RT responses than the Bs.

2) Type As will perform better than Bs in the cognitive task.

3) Type B subjects will show faster RT responses with the requirement to qualify, in the cognitive task, i.e., RT will decrease from practice to qualify condition while the Bs will show little or no difference in RT between the two conditions.

4) The Type A subjects will show greater physiological change (i.e., increases in HR, EMG, SC, and lower ST) than the Bs with the requirement to

qualify in the cognitive task, again indicating greater responsivity to processing load and stress.

5) Type As will show greater SNS arousal than Type B subjects regardless of task conditions.

The following research questions were addressed:

1) Will the Bs show faster physiological recovery than the As to baseline levels at the conclusion of the experiment?

2) Will the various physiological indices predict performance, i.e., will changes in HR, EMG, ST and SC reflect changes in performance and RT?

Experiment I - Perceptual Motor Performance and Physiological Responses of Type A and Type B Individuals

Method

Subjects: A total of 36 right-handed subjects (18 males, 18 females) affiliated with the City University of New York participated in this study. Right-handedness was determined by simply asking subjects and by insuring that they could manipulate a joy-stick with their right hands. They ranged in age between 21 and 39 years. Subjects were selected according to whether they scored high (75th percentile and above; N=18) or low (25th percentile and below; N=18) on the Type A scale of the Jenkins Activity Survey (Form C, Psychological Corporation). The high and low groups were designated Type A and Type B, respectively. Each subject met the criterion of normal visual acuity (corrected to at least 20/25 with corrective lenses) as tested with a Bausch and Lomb Orthorator. None reported any personal or familial history of cardiovascular problems. In addition, all subjects reported that they had not smoked nor taken any medication for at least one hour prior to participation in the experiment.

Apparatus and Procedure: Subjects were seated in an electrically shielded, sound attenuated IAC chamber while heart rate (HR), skin temperature (ST), and electromyogram (EMG) activity were recorded. The HR was recorded with a Cyborg BL907 heart rate monitor. A pressure sensitive transducer was placed over the radial artery of the left arm to measure HR in beats per minute (BPM). The continuous average switch on the BL907 was set at two beats (two beat average) and HR was displayed digitally on a continuous basis.

The ST measurement was obtained with a Cyborg Thermal P642. Temperature was recorded by a thermistor placed on the dorsal surface of the middle finger of the left hand (second phalanx) and was displayed to .01 degrees Farenheit. Electromyogram activity was measured with a Cyborg P303. Measurements (to .1 uV) were made from the skin surface over the flexor digitorum muscle of the left arm. Electrode placement was accomplished by measuring the distance (in cm) between the medial epicondyle of the humerus to the styloid process of the radius. The first electrode was placed at a point one-third the distance from epicondyle to styloid. The second one was placed three cm distally from the center of the first. A third electrode on the forearm served as ground. Resistance between active leads was 5,000 Ohms or less as measured by a Grass impedance meter.

The EMG data were fed into a Cyborg Q700 data accumulator which provided 10 second averages of the EMG. All measures including EMG were also fed into two Cyborg Q740 digital printers that printed out the displayed values, including averaged EMG, every 10 seconds.

Subjects performed two tasks simultaneously: a simulated auto race (Pole Position - Atarisoft, 1983) and a visual reaction time task. The auto race was presented via a Commodore 64 microcomputer and Comrex Color monitor and required that subjects race under three levels of difficulty: easy, moderate, and difficult. The level of difficulty was determined by the number of competing race cars on the racetrack, i.e., a greater number of cars led to greater levels of task difficulty. Subjects who had played Pole Position in pilot trials reported that the greater number of competing cars made the task harder and their scores reflected variations in difficulty. These subjects were not part of the actual experiment. The reaction time task simply required that subjects respond to a group of nine randomly presented "Xs" while they were engaged in the auto race. The nine Xs were presented simultaneously in a three by three arrangement and subtended a visual angle of six degrees of arc.

To illustrate, subjects were seated in the chamber facing a Comrex color monitor. A VR-14 (Digital Equipment Corporation) was placed on a two foot support behind the color monitor. This enabled subjects to peripherally view the Xs on the CRT while looking directly at the center of the color monitor. Subjects placed their left index finger over a telegraph key. The position of the key was adjustable to allow for differences in arm length. The right hand was used to manipulate a joy stick which controlled the speed (foward-backward pressure) and direction (left-right pressure) of the race car. The instructions given to subjects were as follows:

> You will play the arcade game called Pole Position, which requires that you compete with other cars as you attempt to complete a race track as fast as you can. You will be given a series of practice and qualifying runs before the actual races begin. At the end of each race your score will appear in the upper left hand portion of the color monitor. Please do not look up to check the score during a run. There will be another part to your task. At unpredictable times a group of Xs will appear behind and just above the color monitor. These Xs will probably appear as brief flashes of light. You are to respond to these Xs by pressing a telegraph key with the tip of your left index finger. We will record how fast you respond so please respond as quickly as possible without missing any X s or flashes.

Subjects were reminded to restrict unnecessary body or arm movements. After a given race, each lasting 90 seconds, the total score was recorded by the experimenter. Within that 90 seconds the visual stimuli were presented nine times on the CRT at random intervals (inter-stimulus-interval between 4 and 20 seconds). Reaction time was recorded to the nearest msec (Lafayette clock/counter Model 54419). The subject started the second race by pressing a "start" key on the Commodore computer. A given condition consisted of three races. Thus, a condition lasted for four and a half minutes, with a total of 27 reaction time measures for each.

Prior to the start of the actual race, subjects were given three practice runs to insure familiarity with the task. These practice runs were followed by three qualifying runs. Subjects were told that in order to enter the main race, their average qualifying score had to meet a criterion level. Each condition was repeated within the session. Thus, with one practice and one qualifying condition, there were a total of eight conditions. The entire experimental session lasted for about one hour and a half.

At the beginning of the session three minute baseline HR, ST, and EMG measures were taken. This was accomplished by asking subjects to close their eyes, relax, and maintain a blank mind while these measures were printed out at 10 second intervals. After the last condition HR, ST, and EMG measures were taken during a final three minute rest period. All sessions began with an initial baseline period, followed by practice and qualifying conditions. The remaining six conditions were counterbalanced across subjects.

Results

Performance

Reaction Time

Two-way Analyses of Variance (ANOVAs) were conducted on the reaction time data. A fixed model was used (Winer, 1971) in which Subjects and Conditions served as main effects. All data were log-transformed prior to data analysis to insure conformity with the ANOVA model. In addition, several t-tests for uncorrelated data were conducted to compare the RTs between the As and Bs. The mean RTs for the Type A and Type B groups separately as a function of the experimental conditions are presented in Table 1.

Table 1
Mean Reaction Time (msec) for Type A and Type B Subjects for Experimental Conditions

CONDITIONS	TYPE A	TYPE B
Practice	510	538
Qualify	546	567
Easy	526	567
Moderate	534	573
Difficult	540	573

When the Type A and Type B subjects are considered together (Subjects X Conditions: N=35) a significant Condition effect was found, $F=3.69$ (1/136), $p<.01$. Newman-Keuls multiple comparison test results indicated that subjects RTs were significantly slower under the qualifying condition (556 msec) as compared to RT responses recorded during the practice period (523 msec), with

$p<.01$. There were no significant differences between any other condition comparisons (e.g., difficult vs easy; difficult vs moderate etc. - $p>.05$). An examination of the RT data showed rather large differences in performance between qualifying and practice conditions for Type As and Type Bs. For this reason, additional statistical tests were conducted on the RT data recorded during qualify and practice and during easy, moderate, and difficult conditions for the As and Bs.

Easy vs Moderate vs Difficult - t-test for correlated data - Task difficulty had no effect on reaction time responses with either Type A or Type B subjects, as indicated by the non-significant t-values obtained in the t-tests which compared these three conditions ($p>.05$ for all comparisons - Type A, Type B).

Qualify vs Practice - When the RT responses recorded during the qualifying condition were compared to those recorded during the practice period with a t-test for correlated data, the Type A group showed a significant difference ($t=2.41$, 17 df, $p<.05$), while the Type B group did not ($t=1.90$, 16 df, $p>.05$). Thus, the requirement to qualify for the main series of races seem to have affected the RT responses of the Type A subjects, i.e., RTs during the qualifying condition were significant longer than RTs during practice. Although Type Bs also showed an increase in RT response time from practice to qualify, this increase was non-significant, as previously mentioned. These findings are illustrated in Figure 1. In addition, a t-test for uncorrelated data was conducted to compare Type A reaction times with Type Bs (across conditions). The computed t was found to be non-significant ($t=1.36$, 33df, $p>.05$). Separate t-tests (unccorrelated data) were conducted to compare the A's RT with the B's within each condition (i.e., practice, qualify, etc.). None of the computed ts reached significance ($p>.05$ for all comparisons between As and Bs). Thus, task difficulty had little or no effect

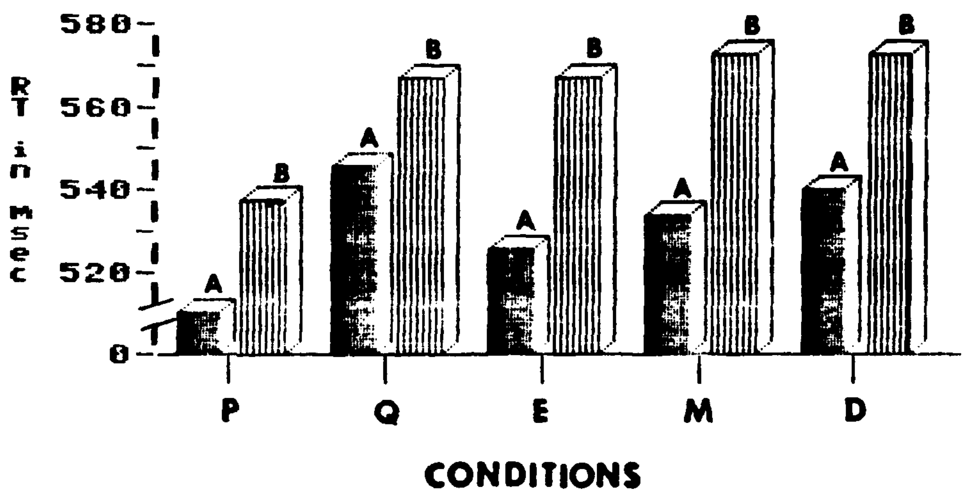

Figure 1 - Mean reaction time (in msec) for Type A and Type B subjects under the different conditions of the experiment. The letters P, Q, E, M, and D denote practice, qualify, easy, moderate, and difficult conditions respectively.

on reaction time responses with either Type As or Type Bs. However, the requirement to qualify lengthened RTs of the Type A group.

Score

The two-way ANOVA (Subject X Condition) conducted on all subjects' race track scores (i.e., combined group) revealed a significant Condition effect, F=5.28 ((4/140), p<.01. Separate two-way ANOVAs conducted on the Type A and Type B subjects also showed a significant Condition effect with F=5.88 (4/68), p<.01 for Type A and F=7.73 ((4/68), p<.01 for Type B. These significant effects were examined more closely with the Newman-Keuls test. It was found that all possible subject groupings (combined and Type A and B separately) showed significantly higher scores when the race was relatively easy as compared to scores obtained during moderate (p<.05) and difficult races (p<.01). Further, all subjects showed significant improvement in scores from practice to qualify (p<.05 for combined, Type A, Type B). The two-way ANOVAs (Type X Conditions) which compared Type A scores with Type B scores indicated that both groups were equally proficient in the task (F=1.75 (1/179), p>.05). The mean race scores for the Type As and Type Bs were 9548 and 9686, respectively.

Physiological Responses

Two-way ANOVAs were performed on the physiological data after log transformation (i.e., Subject X Condition). The mean HR, ST, and EMG are presented in Table 2 for Types A and B subjects as a function of conditions.

Table 2
Mean Heart Rate, Skin Temperature and Electromyogram for Type A, Type B for the Baseline, Rest, and Experimental Conditions

	TYPE A			TYPE B		
CONDITIONS	HR	ST	EMG	HR	ST	EMG
Baseline	74.1	82.37	4.23	75.5	80.70	3.34
Rest	72.9	84.49	5.11	76.3	82.42	4.71
Practice	76.4	81.64	7.96	80.6	79.62	6.53
Qualify	79.9	81.42	7.80	79.6	79.62	6.37
Easy	77.2	82.94	7.61	79.3	81.17	5.97
Moderate	77.8	82.77	7.76	80.0	81.17	5.97
Difficult	78.1	82.88	7.56	81.5	81.06	5.86

Heart Rate

The two-way ANOVAs conducted on the combined groups and on the Type A and Type B subjects separately indicated that the main effect of Conditions was non-significant (Combined : F=1.19 (4/140); Type A - F=1.83 (4/68); Type B - F=.53 (4/68), p>.05 for all three). Thus, the experimental conditions had little effect on heart rate. A closer analysis of the data, however, revealed, that Type A subjects showed a trend in which heart rate increased from practice to qualifying conditions (practice - 76.4 bpm vs qualify - 79.6 bpm). The Type B subjects, on the other hand, showed slight heart rate decreases from practice (80.6 bpm) to qualify (79.6 bpm). The two-way ANOVA which compared overall HR for Type As with HR of the Type Bs was also non-significant., F=2.72 (1/179), p>.05.

Electromyogram (EMG)

A significant Type effect was found in the two-way ANOVA (Type X Condition) conducted on the EMG data, F=13.94 (1/179), p<.001. This finding indicated that overall, Type A subjects had higher EMG levels than did Type B subjects. The mean EMG for the Type A and Type B groups was 7.72 uV and 6.14

uV, respectively, a difference of 1.58 uV. This difference was not related to any of the task conditions since a closer analysis of the data revealed little or no difference between conditions (e.g., qualify vs practice; easy vs moderate vs difficult etc.) with either Type A s or Type Bs. This observation was supported by the separate ANOVAs conducted on the Type A and Type B data, which indicated that the main effect of Conditions was non-significant (Type A - F=.18 (4/68), p>.05; Type B - F=.56 (4/68), p>.05). Figure 2 depicts the EMG data for Type As and Type Bs as a function of the experimental condition. It is apparent from the figure that the Type A subjects had consistently higher EMG activity, regardless of condition.

Skin Temperature (ST)

The combined two-way ANOVAs (Subject X Condition) performed on the ST data indicated a significant Condition effect with F=25.98 (4/140), p<.01. The Newman-Keuls tests indicated that ST was significantly lower during practice and qualifying conditions as compared to STs recorded during actual task conditions (easy, moderate, and difficult: p<.01 for all comparisons between practice and easy/moderate/difficult and between qualify and easy/moderate/difficult). Separate ANOVAs on the Type As and Type Bs revealed significant Condition effects as well, with F=11.74 (4/68), p<.01 for Type A and F=13.80 (4/68), p<.01 for Type B. Again, Newman-Keuls tests indicated that STs recorded during practice and qualifying conditions were significantly lower than STs recorded during easy/moderate and difficult conditions. There were no significant differences in ST between practice and qualify (p>.05) or between easy, moderate, and difficult (p>.05). The two-way ANOVA which compared Type As and Type Bs showed a significant Type effect, which indicated that Type B subjects had lower ST than did Type A subjects (F=5.10 (1/179), p<.03). The mean ST was 82.33 degrees Farenheit for Type As and 80.52 degrees

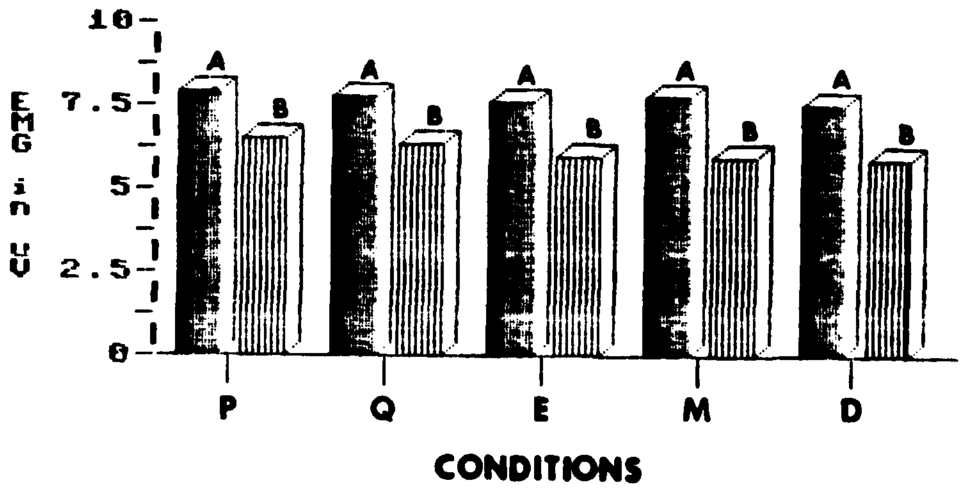

Figure 2 - Mean electromyogram (in uV) for Type A and Type B subjects under the different conditions of the experiment. The letters P, Q, E, M, and D denote practice, qualify, easy, moderate, and difficult conditions respectively.

Farenheit for Type Bs.

Multiple Correlations

Multiple correlations were computed to examine possible relationships among performance (RT, Score) and the various physiological measures (HR, ST, EMG). In addition, multiple Rs were computed to determine relations among physiological measures, e.g., HR and EMG, etc.

Table 3 shows a significant negative correlation of -.48 between race track scores and HR, but only for Type Bs. The effect of adding ST and EMG is to produce a multiple R of .68 ($p<.05$) with both ST and EMG being positive correlations. This result would suggest that lower HR, higher ST, and higher EMG during the race car task were related to better performance. The multiple Rs for Type B reaction time and physiological measures and for Type As and RT and tracking scores show low to moderate multiple Rs, none of which are significant. The Multiple R indicated a significant relationship between EMG and ST, and again, only for the Type B subjects ($r=-.57$, 16 df, $p<.01$), revealing that higher EMG activity was associated with lower STs.

The baseline HR, EMG, and ST recorded from the As were compared to those recorded from the Bs with t-tests for uncorrelated data. The only significant t was obtained in the ST comparison ($t=3.49$, 16df, $p<.01$), which indicated that Type B's baseline ST was significantly lower than the Type A group. Changes in HR, EMG, and ST from baseline to task conditions were also examined with a t-test for correlated data on the Type A and Type B data separately. Both HR and EMG activity increased significantly from baseline to task conditions with each group (HR : Type A - baseline to task, $t=2.82$, 17df, $p<.05$; Type B - baseline to task, $t=3.90$, 17df, $p<.01$; EMG: Type A - baseline to task, $t=7.15$, 17df, $p<.001$; Type B - baseline to task, $t=4.00$, 17 df, $p<.001$).

Table 3
Mutiple Correlation Results for Type A Subjects

TYPE A

VAR	MULTIPLE R	SIMPLE R	BETA	F	D.F.	*p*
		Tracking Scores				
EMG	.20	-.20	-.02	.07	1,16	.05
ST	.21	-.08	-.09	.41	2,15	.05
HR	.24	-.04	-.08	.03	3,14	.05
		Reaction Time				
HR	.21	-.21	-.20	.70	1,16	.05
EMG	.21	.03	-.03	.34	2,15	.05
ST	.21	-.09	-.03	.21	3,14	.05

Table 3 (cont.)
Mutiple Correlation Results for Type B Subjects

TYPE B

VAR	MULTIPLE R	SIMPLE R	BETA	F	D.F.	*p*
		Tracking Scores				
HR	.48	-.48	-.44	4.78	1,16	.05
ST	.55	.35	.59	3.19	2,15	.05
EMG	.68	.08	.52	3.95	3,14	.05
		Reaction Time				
HR	.25	.25	.22	1.06	1,16	.05
ST	.30	-.21	-.34	.74	2,15	.05
EMG	.37	-.038	-.27	.73	3,14	.05

DISCUSSION

The hypothesis that Type A subjects would produce faster RT responses under the requirement to qualify was not confirmed. In fact the Type As had slower RT responses during the qualifying period as compared to responses made during practice. The Bs, on the other hand, did not show any significant differences in RTs between practice and qualifying trials. Thus, contrary to our expectation that characteristics of Type A individuals (e.g., time urgency, impatience) would lead them to become equally involved in both tasks, the As clearly became more involved in the perceputual-motor task, apparently to the detriment of their RT performance. Perhaps in their zeal to qualify, the Type As emphasized the task aspect that would assure qualification and neglected the subtask. This is in itself revealing since the Bs still distributed as much effort to the RT task during qualify as under practice conditions. Does the emphasis on qualifying indicate the competitive nature of the Type A individual compared to Bs? Does it also indicate a certain selectivity in behavior of Type As that optimizes goal-directed performance? The Bs did not appear to respond differently to the qualifying condition since there were no changes in RT from practice to qualify. In any event the fact that the As showed a change to slower RTs under the qualifying condition while the Bs did not suggests that the incentive and/or challenge of qualifying affected the As more than it affected the Bs and is somewhat in agreement with the findings of Blumenthal et al (1980, 1983). Recall that these investigators found monetary incentives to affect the performance of their Type A subjects to a greater degree than the Bs. Perhaps greater task involvement was the underlying factor contributing to the performance improvement found among the As in the studies of Blumenthal and colleagues. We did observe an interesting non-significant trend in which, overall, the As had faster RTs than the Bs.

The race track scores failed to distinguish the Type As from the Type Bs, i.e., there were no performance differences. As expected, we did find that subject's scores were higher when the task was easy as compared to scores recorded when the task was difficult. This was true for both Type As and Bs. We also noticed significant improvements in track scores from practice to qualify and, again, this was found to be the case with both types. This improvement probably reflects aquisition of skill as subjects became more practiced. One might have expected the Type A subjects to show greater improvement from practice to qualify as compared to the degree of improvement observed with the Type B subjects since, as noted earlier, the Type A subjects became more involved in the primary task with the requirement to qualify, i.e., their RTs became longer. Perhaps, a moderate level of task involvement was all that was required to produce optimum performance (i.e., race track scores). Thus, the apparently greater levels of task involvement among Type A subjects did not lead to higher track scores suggesting that Bs can equal the performance of As even though they may not evidence the same level of involvement.

With respect to the physiological variables examined in this study, we did find that, overall, Type A subjects produced greater EMG activity than did Type B subjects, regardless of task condition. In addition, although all subjects showed significant increases in HR and EMG from Baseline to Task conditions, the magnitude of the EMG increase was greater for the Type A subjects. Thus, Type A subjects showed greater task induced changes, at least with respect to EMG. If one considers increasing EMG activity to reflect increasing levels of arousal, then the present finding is in agreement with those of Dembroski et al. (1978) and Contrada et al. (1984). We suggest, as do others (e.g., Contrada et al.) that Type A individuals exhibit greater physiological reactions to environmental task conditions than do Type B individuals. The significantly higher EMG level found with the Type A subjects seems to be strictly task related since baseline EMG activity recorded from the two groups did not differ. The EMG did not appear to reflect differences in degree of task involvement since there were no changes in EMG from practice to qualify with Type As or Type Bs.

The As showed a greater increase in HR from practice to qualify than Bs but it was not a significant rise. The Type B subjects had lower STs than did Type As. This finding was not due to gender since there were an equal number of females and males in both groups. This was apparently a characteristic of the sample of individuals since they also had significantly lower ST levels during baseline recordings.

Another finding of interest was that Type Bs who had lower HR performed better in the perceptual-motor task. This is similar to a previous finding (Andreassi and Juszczak, 1984) in which individuals with lower baseline HR performed better in a verbal learning task. At the time we suggested that a combination of factors may be involved in producing this type of result: 1) Individuals who were more relaxed performed better in the learning task, i.e., perhaps their level of arousal was compatible with optimal performance. 2) Perhaps they were more proficient learners to begin with and were less threatened by the task than were less accomplished persons.

The multiple R relating physiological responses to tracking performance suggested that lower HR, higher ST and higher EMG were related to better scores. The lower HR and higher ST indicate a more relaxed state while the higher EMG indicates greater muscle activity in the uninvolved forearm during tracking. These results would be interesting to follow up since they seem to suggest that a generally relaxed individual, but one whose skeletal muscle system shows appropriate increased response produces superior tracking performance.

The results of this present study and those of others suggest a follow-up to determine possible A-B differences according to the nature of the task. Namely, it is proposed that groups of Type A and B individuals be compared with respect to physiological activity and performance in a perceptual-motor task and a cognitive task.

Experiment II - Performance and Physiological Responses of Type A and Type B Individuals During a Cognitive and Perceptual Motor task

Method

Subjects: A total of 36 right-handed subjects affiliated with the City University of New York participated. They ranged in age from 18 to 31 years. Handedness, visual capacity, classification (A or B), cardiovascular history and recent medication were all determined as in Experiment I.

Apparatus and Procedure: The physiological measures were heart rate (HR), electromyogram (EMG), skin temperature (ST), and skin conductance (SC). The HR and EMG were recorded in the same manner as in Experiment I.

The ST and SC measurements were obtained with a J & J Thermal Model T-68. Temperature was recorded by a thermistor placed 2 cm on the ventral forearm lateral to the first EMG electrode recording site. The SC was measured with a J & J GSR Pre Amp Model IG-3 using two silver/silver chloride finger electrodes (SE-35) and were placed on the ventral surface of the second and third fingers of the left hand.

The EMG data were fed into a Cyborg Q700 data accumulator which provided 10 second averages of the EMG. The HR and EMG data were also fed into a Cyborg Q740 digital printer that printed out these values every 10 seconds.

The Thermal Model T-68 was connected via a J & J I-300 Interface to a Commodore 64 computer, which permitted the display of the ST and SC measures on a Comrex monochrome monitor (to the nearest .1 deg. farenheit and .1 umho for ST and SC respectively). Hard copies of these measures were provided by an Epson RX-80 dot matrix printer. These were printed at the same time intervals as HR and EMG (i.e., every 10 seconds).

A dual task method was employed in which subjects performed in either a simulated auto race (Pole Position) or a tonal memory task (Rebeep).Both tasks were performed simultaneously with a simple visual reaction time task. The auto race was presented via a Commodore 64 microcomputer and Comrex Color monitor and required that subjects compete with other cars as they completed a race track course under conditions of practice, qualify and race conditions (moderate level of difficulty). During Rebeep, subjects were required to repeat the exact sequence of tones generated by the Commodore computer. For example, the computer generated a tone and one of four boxes on the color monitor was briefly illuminated. The subject had to reproduce the tone by pressing the button on the keyboard which corresponded with the illuminated box. A second tone followed the first and the box on the monitor was illuminated. Subjects had to reproduce both tones by pressing the corresponding buttons in correct order. The length of the sequence increased until subjects failed to reproduce the correct sequence on two consecutive trials. The total number of tones correctly reproduced was recorded as the score. As was the case with the Pole Position task, there were practice and qualifying conditions and a condition of moderate difficulty. The level of difficulty for Rebeep was manipulated by presenting the tones at a faster presentation rate. The reaction time task simply required that subjects respond to a a randomly presented light while they were engaged in the auto race or tonal memory task. To illustrate, subjects were seated facing a Comrex color monitor. An RT apparatus (Lafayette Model 6302A) equipped with stimulus lights was placed 1 1/2 feet to the left of the color monitor. This enabled subjects to regard the response light peripherally while looking directly at the center of the color monitor. Subjects placed their left index fingers over the response key on the apparatus. The right hand was used to manipulate a joy stick which controlled the speed (foward-backward pressure) and direction (left-right pressure) of the race car. During Rebeep, the right hand was used to press the buttons on the computer keyboard. The instructions given to subjects were as follows:

> You will play the arcade game called Pole Position and the game called Rebeep. You will be given practice and qualifying periods before the actual games begin. At the end of each trial a score will appear in the upper left hand corner of the screen. Please do not look up to check your score. In fact, we request that you keep your eyes on the tasks throughout a trial. The Pole Position game will require that you complete a race track as fast as you can. The Rebeep game will require that you repeat the exact sequence of tones generated by the computer. For example, the computer will generate a tone and one of four boxes will light up on the monitor. You must repeat the tone by pressing the corresponding key. A second tone will follow the first and the corresponding box on the screen will light. You must repeat the sequence by pressing the appropriate keys. There will be another part to your task. At unpredictable times a small light will appear to the lower left of the video screen. You are to respond to the light by pressing a key with the tip of your left index finger. We will record how fast you respond so please respond as quickly as possible without missing any of the lights.

Subjects were reminded to restrict unnecessary body or arm movements. After a given trial, each lasting 90 seconds, the total score was recorded by the experimenter. Within that 90 second period a total of five visual stimuli (i.e., lights) were presented at random intervals (inter-stimulus-interval between 4 and 15 seconds). Reaction time was recorded to the nearest msec (Lafayette clock/counter Model 6302A). The subject started the second trial by pressing a "start" key on the Commodore computer. A given condition consisted of three trials. Thus, a condition lasted for four and a half minutes, with a total of 15 reaction time measures for each. Thus, the session consisted of a total of six conditions: Pole Position - Practice, Qualify, Moderate and Rebeep - Practice, Qualify, and Moderate.

The experimental session proceeded as follows: subjects were given three practice trials (Practice condition) to insure familiarity with the task, i.e., three practice trials for Pole Position and three for Rebeep. These practice trials were followed by three qualifying trials (Qualify condition). Subjects were told that in order to enter the main trials, i.e., the condition of moderate difficulty, their average qualifying score had to meet a criterion level.

At the beginning of the session three minute baseline HR, EMG, ST and SC measures were taken. This was accomplished by asking subjects to close their eyes, relax, and maintain a blank mind while these measures were printed out at 10 second intervals. After the last condition HR, EMG, ST and SC measures were taken during a final three minute rest period. All sessions began with an initial baseline period, followed by practice and qualifying conditions. A second session was repeated on another day. Half of the 36 subjects started with Pole Position in session 1, while the other half started with Rebeep. In session 2, the order was reversed, e.g., those who started with Pole Position in session 1 started with Rebeep in session 2.

Results

Performance -

The performance data were reaction time (RT), total race track score (Pole Position), and mean number of correctly reproduced tones (Rebeep). The data were subjected to a three-way Analysis of Variance in which Type, Task (Rebeep, Pole Position) and Conditions (Practice, Qualify, Moderate) served as main effects. Additional two-way ANOVAs (Subject X Task; Subject X Conditions) permitted a closer analysis of the data within each group and within each task separately. Prior to analysis, all raw data were log-transformed to insure conformity with the assumptions of homogeniety of variance and normality of distribution required by the ANOVA model (Winer, 1971). The raw RT and performance data are presented in Table 1 as a function of Type, Task and Conditions.

Table 1

Mean Reaction Time and Performance for the Type A and Type B Groups as a Function of Task and Conditions

	TYPE A				TYPE B			
	POLE POSITION		REBEEP		POLE POSITION		REBEEP	
	RT	SCORE	RT	SCORE	RT	SCORE	RT	SCORE
PRACTICE	557	9592	677	7.9	632	8979	746	7.3
QUALIFY	590	9956	597	8.2	608	9370	667	7.5
MODERATE	565	10150	633	8.8	729	9653	718	8.0

Reaction Time - The mean RTs computed for the Type As and Type Bs were compared using a three-way ANOVA (Type X Task X Condition). A significant Type effect (F=7.76 (1/215), p<.006) indicated that, across both tasks, the Type A subjects produced faster RT responses than did Type B subjects. Separate two-Way ANOVAs were conducted on the RT responses made during Pole Position and Rebeep separately (Type X Condition). It was found that the RT advantage for the As occurred during Rebeep (Rebeep - F=9.22 (1/107), p<.003). There were no differences in RT responses between these two groups during Pole Position (F=1.85 (1/107), p>.05). During Rebeep the mean RT for the As was 636 msec, while for the Bs it was 710 msec. The mean RT recorded from each group during Pole Position was 571 and 657 msec for Type As and Type Bs, respectively. Both Type A and Type B subjects, however, produced faster RT responses during Pole Position as compared to RT responses made during Rebeep. This was indicated in the three-way ANOVAs (Subject X Task X Condition) which compared RT responses made during Rebeep with those made during Pole Position for each group separately (Task effects : Type A - F=14.47 (1/17), p<.01; Type B - F=5.90 (1/17), p<.05). The RTs under the Practice, Qualifying, and Moderate Conditions for each Type and under the two tasks were examined with two-way (Subject X Condition) ANOVAs. During Pole Position, there were no significant differences in RT responses between the practice, qualifying, and moderate conditions with either the As or Bs (Condition effects, Type As - F=.69 (2/34); Type Bs - F=2.24 (2/34): p>.05 for both). Significant Condition effects were found during Rebeep with both the Type A and Type B subjects (F=6.94 (2/34), p<.01) and F=7.05 (2/34). p<.01 for Type A and Type B groups respectively). Newman-Keuls tests indicated that the As and Bs had faster RTs under the qualifying conditions as compared to RT responses made during the Practice condition (p<.01). There were no significant differences in RTs between Practice and Moderate, and between Qualifying and Moderate conditions (p>.05 for all comparisons). Figure 1 depicts the data for the As and Bs as a function of the three conditions in Pole Position. Figure 2 shows the data for the two groups under the three conditions of Rebeep.

Performance - Rebeep

The Two-way ANOVA (Type X Condition) which compared mean performance (across conditions) for the Type As and Bs revealed that the As reproduced a significantly greater number of tones than did Type B subjects (F=12.39 (1/107), p<.01 On the average, the As correctly reproduced 8.3 tones as compared to 7.6 tones for the Bs. Although there was an overall performance superiority with the Type A subjects, separate two-way ANOVAs (Subject X Condition) revealed that both As and Bs showed significant improvement in performance from qualifying to moderate conditions (Type A - F=8.54 (2/34), p<.01; Type B - F=3.60 (2/34), p<.05). Newman-Keuls tests indicated that subjects in each group did better during the moderate condition as compared to their performance during the qualifying condition, suggesting that subjects performance improved as a result of practice (p<.05). There were no differences in performance between practice and qualifying conditions with either of the groups. As shown in Table 1, the mean number of correctly reproduced tones were 7.9, 8.2, and 8.8 under practice, qualifying, and moderate conditions for the Type As and 7.3, 7.5, and 8.0 under practice, qualifying, and moderate conditions for the Bs.

Performance - Pole Position

The two-way ANOVAs (Type X Condition) which allowed for a direct comparison of overall performance between the Type A and Type B groups was non-significant with F=2.77 (1/102), p>.05 for Type effects. The non-significant Condition effect (Conditions - F=.80 (2/107),p>.05) revealed that there were no differences in race track scores with respect to practice, qualifying, and moderate conditions. A separate analysis of Type A and Type B performance

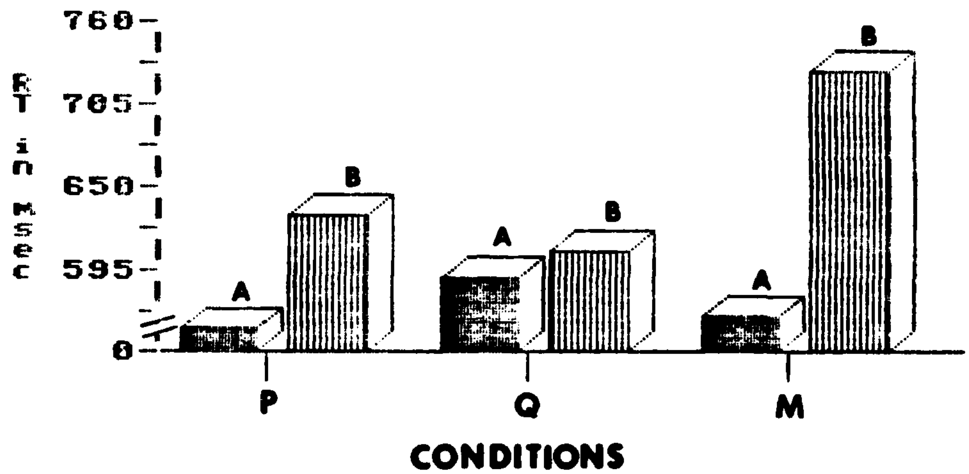

Figure 1 - Mean reaction time (in msec) for Type A and Type B subjects during the perceptual-motor (Pole Position) task. The letters P, Q, and M denote practice, qualify, and moderate conditions respectively.

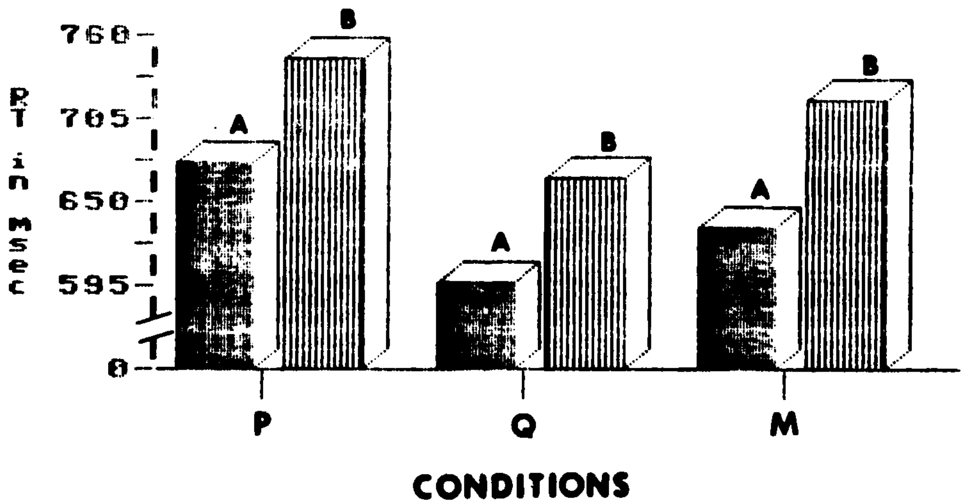

Figure 2 - Mean reaction time (in msec) for Type A and Type B subjects during the cognitive (Rebeep) task. The letters P, Q, and M denote practice, qualify, and moderate conditions respectively.

under the three conditions also showed that there was a tendency for peformance to improve from practice to qualifying conditions, but only for the Type A subjects (F=4.20 (2/34), p<.05). The Newman-Keuls test which examined this effect for the As indicated that the peformance during the moderate condition was significantly better than performance during practice (p<.05).

Physiological Responses -

Mean HR, SC, ST and EMG were computed for each subject as a function of the Baseline period, Rest period, Type, Tasks (Pole Position, Rebeep), and Conditions (Practice, Qualify, Moderate). A three-way ANOVA (Type X Task X Condition) was conducted on the log transformed HR, SC, and ST data (EMG data were incomplete). Again, separate two-way ANOVAs (Type X Condition; Subject X Condition) were performed to examine major effects within each Type and within each Task. The mean HR, SC, and ST data collected during the Baseline and Rest periods were subjected to separate one-way ANOVAs in which Type served as the main effect. With respect to EMG, some of the data were discarded due to artifact. The groups were thus compared using a t-test for uncorrelated data because of an unequal number of subjects. Table 2 contains the data recorded during Baseline, Task Conditions, and Rest for the Type As and Type Bs for Pole Position and Rebeep.

Heart Rate - The mean HR computed for each Type A subject during the three minute baseline period was compared with those computed for the Type B subjects using a one-way ANOVA model. The computed F ratio was non-significant with F=1.72 (1/35), p>.05. This indicated that during the baseline period there was no difference in HR between the Type A and Type B subjects. However, the three-way ANOVA (Type X Task X Condition) revealed a significant Type effect (F=4.13 (1/215), p<.04) Namely, under task conditions, Type A subjects had significantly higher HR than did Type B subjects. The mean HR, in BPM was 74.0 and 72.4 for the As and Bs

TABLE 2

Mean Heart Rate, Skin Conductance, Skin Temperature and Electromyogram for Type A and Type B under Task Type, Baseline, Rest, and Task Conditions.

	TYPE A				TYPE B			
	HR	SC	ST	EMG (N=13)	HR	SC	ST	EMG (N=7)
BASELINE	72.0	10.41	89.35	4.76	69.1	9.63	88.35	4.51
REST.	71.3	15.88	89.06	4.24	70.5	14.47	88.12	2.71
POLE POSITION								
Practice	73.6	14.96	89.27	6.91	71.6	13.57	87.89	6.31
Qualify	74.0	15.61	89.18	7.13	73.17	13.92	88.08	6.33
Moderate	74.2	16.04	89.19	6.98	73.6	14.30	88.15	6.81
REBEEP								
Practice	74.1	15.24	89.35	5.55	71.8	13.83	88.32	4.31
Qualify	74.7	15.89	89.29	5.83	72.1	14.42	88.22	4.86
Moderate	73.4	16.45	89.21	5.95	71.5	14.83	88.21	4.91

respectively. When the HR data were further analyzed with respect to the main effect of Task, there was no difference in HR activity between Rebeep and Pole Position with either the As or Bs (Type A - $F=.09$ $(1/17)$, $p>.05$: Type B - $F=2.22$ $(1/17)$, $p>.05$). The Type A subjects had higher HR than the Bs during Rebeep, but not during Pole Position. A significant F ratio was obtained in the two-way ANOVA (Type X Condition) which compared Type As HR with the Bs during Rebeep ($F=4.17$ $(1/102)$, $p<.04$). During Pole Position there were no differences in HR between the As and Bs (Type effect - $F=.75$ $(1/102)$, $p>.05$). Figure 3 graphs the findings concerning HR differences between the As and Bs within each task. Under Pole Position conditions of Practice, Qualify, and Moderate level of Difficulty, the Type B subjects showed a significant increase in HR from Practice, to Qualify and Moderate conditions ($F=10.42$ $(2/34)$, $p<.01$: Newman-Keuls multiple comparison test yielded significant differences ($p<.05$) between Practice and Qualify and between Practice and Moderate). During Rebeep, there were no differences in HR as function of the three conditions ($F=.53$ $(2/34)$, $p>.05$). The ANOVA conducted on the data recorded from the Type A subjects, on the other hand, showed a significant Condition effect during Rebeep ($F=3.50$ $(2/34)$, $p<.05$). The Newman-Keuls test indicated that HR increased from practice to qualify and decreased from qualify to moderate conditions ($p<.05$ for both comparisons). Conversely, there were no significant differences in HR under the three conditions with Pole Position ($F=.89$ $(2/34)$, $p>.05$). Figures 4 and 5 depict the HR data for the As and Bs as a function of the three conditions in Pole Position and Rebeep, respectively.

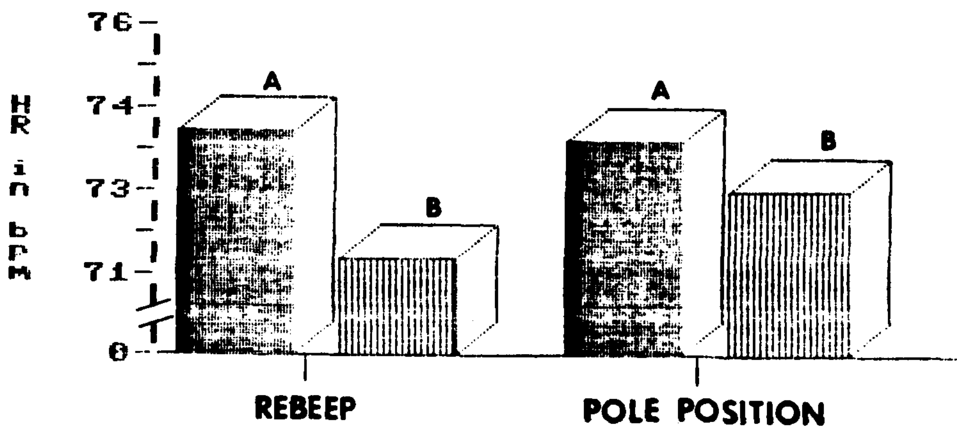

Figure 3 - Mean heart rate (in BPM) of Type A and Type B subjects during Pole Position and Rebeep.

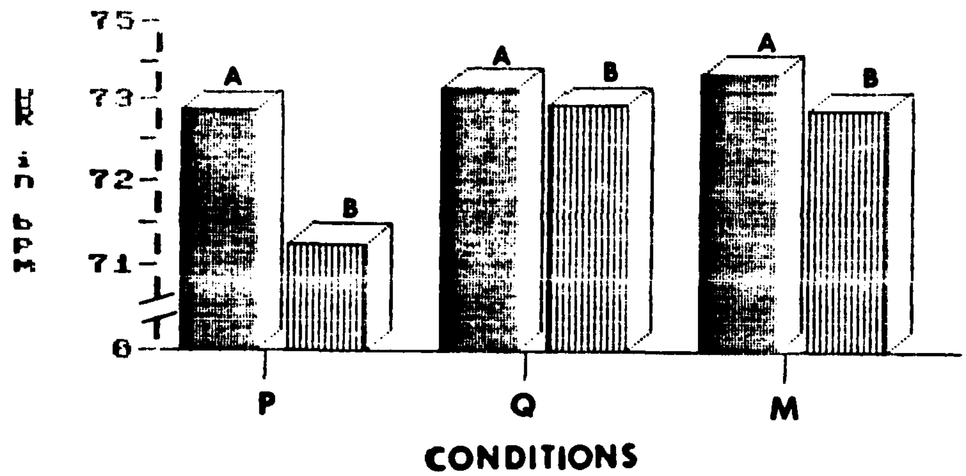

Figure 4 - Mean heart rate (in BPM) of Type A and Type B subjects under practice (P), qualifying (Q), and moderate (M) conditions during the perceptual-motor (Pole Position) task.

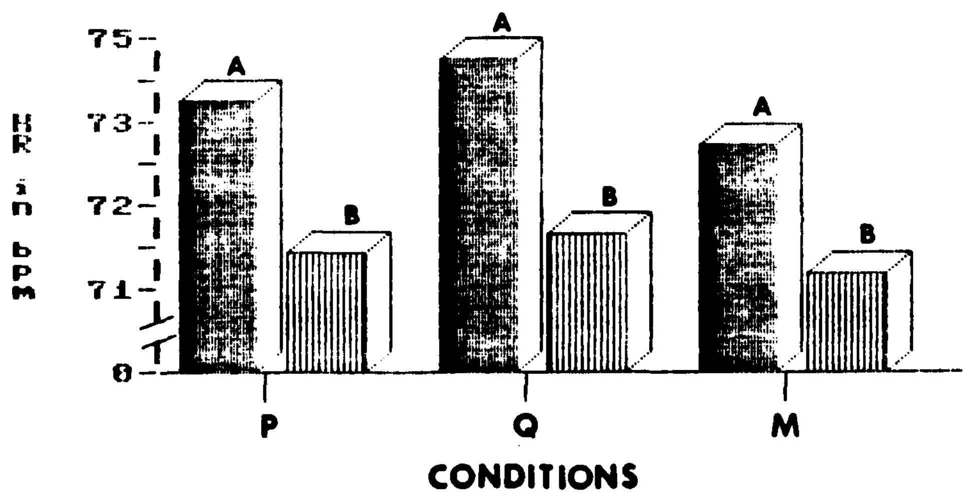

Figure 5 - Mean heart rate (in BPM) of Type A and Type B subjects under practice (P), qualifying (Q), and moderate (M) conditions during the cognitive (Rebeep) task.

The Baseline, Task, and Rest HR data were also examined in separate two-way ANOVAs (Subject X Condition) as a function of Task and JAS type. During Rebeep ,the Condition effect was significant for both groups (Type A - F=7.94 (2/34), p<.01; Type B - F=6.06 (2/34), p<.01). Further analysis indicated that both the As and Bs showed increases in HR activity from Baseline to Task conditions (p<.05 - Newman-Keuls test). Further, The As and Bs showed significant decreases in HR from Task conditions to Rest (p<.05). There were no significant differences in HR activity between the Baseline and Rest periods with either the As or Bs (p>.05). With respect to Pole Position, significant F ratios were obtained in the separate two-way ANOVAs (Subject X Condition) conducted on the Type A and Type B HR data. For the As it was, F=5.61 (2/34), p<.01, while for the Bs it was, F=9.21 (2/34), p<.01. The Newman-Keuls test indicated that HR increased from baseline to task conditions and decreased from task to rest period. This occurred for both Type A and Type B subjects (p<.05 for both As and Bs). The As and Bs were also compared with respect to the final three minute Rest period. The F-value was non-significant (F=.80 (1/35), p>.05) indicating no difference between the As and Bs during this period.

Skin Conductance - A one-way ANOVA revealed that the As and Bs did not differ with respect to baseline SC levels (Type effect - F=.37 (1/35), p>.05). However, a significant F value was obtained in the three-way ANOVA (Type X Task X Condition) which compared the As to Bs while they were engaged in the tasks (F=5.57 (1/215), p<.02). This indicated that across tasks and conditions, Type A subjects had higher SC levels than did Type Bs. When the SC data were analyzed within Pole Position and Rebeep separately, the two-way ANOVAs (Type X Condition) indicated that the main effect of Type was non-significant (Pole Position - F=3.13 (1/107), p>.05; Rebeep - F=2.47 (1/107), p>.05). This means that there were no differences in SC between the

Type A and Type B subjects within each task, but there was a generalized task effect. The SC responses of the As and Bs were also examined in separate three-way ANOVAs (Subject X Task X Condition). The Type A or Type B subjects did not show significant differences in SC as a function of task (Task effect : Type A - F=1.80 (1/17), p>.05; Type B - F=1.94 (1/17), p>.05). Separate two-way ANOVAs (Subject X Condition) were conducted to examine the SC levels of the As and Bs as a function of practice, qualifying and moderate conditions within each type of task. A significant Condition effect was obtained in the separate ANOVAs conducted on the Type A's SC responses recorded during Pole Position and Rebeep (Pole Position - F=33.52 (2/34), p<.001; Rebeep - F=22.70 (2/34), p<.001). Similar results were obtained in the separate ANOVAs conducted on the SC data for Type B subjects (Pole Position - F=12.70 (2/34), p<.001; Rebeep - F=18.65 (2/34), p<.001). The Newman-Keuls test revealed that in all situations, SC steadily increased from practice to qualify to moderate conditions (p<.01 for all comparisons). The SC levels of the As and Bs were also examined with respect to Baseline, Task, and Rest periods in separate two-way ANOVAs (Subject X Condition). During Rebeep, The F values for the Condition effect were: Type A - F=97.03 (2/34), p<.001 ; Type B - F=132.02 (2/34), p<.001. For Pole Position they were: Type A - F=88.31 (2/34), p<.001; Type B - F=113.77 (2/34), p<.001. The above mentioned significant effects reflect the finding that SC increased steadily from baseline to task to rest periods for both the As and Bs and within each task (P<.05 for all Newman-Keuls comparisons). There were no significant differences in SC levels between the As and Bs during the Rest period (F=2.22 (1/35), p>.05)

Skin Temperature - The one-way ANOVA indicated that there were no differences in ST between the As and Bs during the baseline period (F=3.15 (1/35), p>.05). During task conditions, however, the Type B subjects had significantly lower STs than the As, as indicated by the significant F value derived from the three-way (Type X Task X Condition) ANOVA (F=18.24 (1/215), p<.001). This was found to be the case with each task, i.e., The Type B subjects had lower STs than the As during Rebeep (F=7.87 (1/107), p<.006) and during Pole Position (F=10.61 (1/107), p<.001). There were no differences in ST with the As or Bs with respect to the two tasks, i.e., the separate three-way (Subject X Task X Condition) ANOVAs indicated that the Task effect was non-significant (Type A - F=.31 (1/17), p>.05; Type B - F=1.67 (1/17), p>.05). Further, there were no significant findings in ST for the As or Bs with respect to the practice, qualifying, and moderate conditions during Pole Position and Rebeep (p>.05 for all Condition Effects - Subject X Condition). The ST recorded from the As and Bs during Baseline, Task and Rest periods were also compared by separate two-way ANOVAs (Subject X Task). The computed F values were found to be non-significant (p>.05 for all Condition effects). We did find, however, that the Type B subjects had lower STs than the As during the Rest period as well (F=8.45 (1/35), p<.01)

Electromyogram - As mentioned previously, the EMG data were examined with t-tests (uncorrelated data). With respect to the Baseline period, there were no significant differences in EMG level between the As and Bs (t=.254, 18 df, p>.05). Further analysis of the EMG data indicated that the EMG levels of the As and the Bs during Pole Position and during Rebeep were similar (Pole Position - A vs B, t=.519, 18 df, p>.05: Rebeep - A vs B , t=.788, 18 df, p>.05). Both groups had significantly higher EMG during Pole Position as compared to EMG recorded during Rebeep. This was indicated in the significant t value for uncorrelated data which compared EMG levels in Pole Position with EMG levels in Rebeep Type A - t=7.04, 12 df, p<.01 two tailed; Type B - t=10.83, 6 df, p<.01 two tailed). With respect to EMG under the Practice, Qualify, and Moderate conditions within each task, the two way ANOVA (Subject X Condition) indicated that both groups of subjects did not show significant differences in EMG as function of the three conditions with Pole Position or Rebeep (p>.05 for Condition effects). The EMG data of the Type As (N=13) and Type B subjects (N=7) recorded during Baseline, Task, and Rest periods were subjected to separate two-way ANOVAs (Subject X Condition). A significant condition effect was found with the Type A subjects during Pole Position (F=15.77 (2/24), p<.01). The Newman-Keuls tests indicated that EMG increased from Baseline to Task Conditions, and decreased from Task to Rest period (p<.01 for all comparisons). In addition, Baseline EMG was significantly higher than EMG during Rest (p<.01). A similar ANOVA was conducted on the EMG data recorded during Rebeep, i.e., Baseline EMG was compared with Task and with EMG levels at rest. The F value was significant with F=8.17 (2/24), p<.01. Again, Newman-Keuls tests indicated that EMG increased significantly from Baseline to Task, and decreased from Task to Rest.

The separate ANOVAs conducted on the Type B subjects during Pole Position and Rebeep also yielded significant Condition effects (Pole Position - F=16.55 (2/12), p<.01; Rebeep - F=7.07 (2/12), p<.01). As was the case with the Type A subjects, EMG increased from Baseline to Task and decreased from Task to Rest period with both Pole Position and Rebeep (p<.05 for all comparisons). In addition, Rest EMG was significantly lower than Baseline EMG.

Multiple Correlations

Multiple Correlations were computed to determine relationships among performance and physiological data. For the Type A and B subjects combined there was a significant relationship between RT and HR (r=.46, 34 df, p<.01). When ST was added as a variable the multiple R was .58, 34 df, p<.01 and with SC added it was .58, 34 df, p<.05. The RT and HR correlation indicated that individuals with higher HR had longer RTs. The ST measure was negatively related to RT signifying that lower ST was related to longer RT. The SC variable had a positive weight such that increases in SC were related to longer RTs. The multiple Rs for tracking score and physiological relationships were all non-significant. Thus, while RT and physiological response relationships were found in this second experiment, the previously obtained relation between tracking scroes and HR, for Type Bs alone, was not observed in Experiment II. The performance-physiological patterning is similar to that observed in Experiment I, since it suggests that lower HR and higher ST was related better RT performance. Table 3 shows the values for these multiple Rs. Multiple correlations among the various Jenkins Activity Survey subscales (Type A, Factor S, Factor H) and performance yielded some interesting results. There was a significant correlation between Pole Position tracking score and Type A for the 36 subjects. The R of .38 was significant at $p<.05$ (34 df). The addition of the H scale (negative weight) led to a multiple R of .41, ($p<.05$, 34 df) while Factor S increases the multiple R to .42, it was not a significant addition. Thus, we have a relationship between tracking and behavior such that high Type A score combined with a tendency toward lower factor H score predicts better performance. When examining the Rebeep (tonal memory) correlations, Factor S was the most highly correlated of the three (R= .42, $p<.05$. 34 df). When Type A was added it rose to an R of .45 ($p<.05$, 34 df). and Factor H led to a multiple R of .52 ($p<.05$, 34 df) when it was included in the statistic. For the cognitive task a high Factor S and low Factor H scores were related to better performance. Perhaps the speed propensity help subjects process information quickly in performing the Rebeep (tonal memory) task. In both tasks Factor H is negatively weighted in relation to performance. Table 3 contains the multiple R and significance values for performance and Jenkins subscale scores.

TABLE 3

Multiple Correlation Results
for
Type A and B Combined

Reaction Time

VAR	MULTIPLE R	SIMPLE R	BETA	F	D.F.	*p*
HR	.46	.46	.53	9.11	1/34	.01
ST	.58	-.25	-.35	8.31	2/33	.01
SC	.58	.14	.07	5.48	3/32	.05

Tracking Scores

VAR	MULTIPLE R	SIMPLE R	BETA	F	D.F.	*p*
TYPE A	.38	.38	.36	5.66	1/34	.05
FACTOR H	.41	.10	-.15	3.31	2/33	.05
FACTOR S	.42	.37	.15	2.28	3/32	.05

Tonal Memory

VAR	MULTIPLE R	SIMPLE R	BETA	F	D.F.	*p*
FACTOR S	.42	.42	.10	7.39	1/34	.05
TYPE A	.45	.41	.54	4.21	2/33	.05
FACTOR H	.52	.00	-.34	3.92	3/32	.05

Discussion

In this second experiment the Type A subjects produced faster RT responses than the Type Bs, but only while engaged in the cognitive task (Rebeep). There were no differences in RT between these two JAS Types with the perceptual task. If one considers the cognitive task more demanding or stressful, then this finding is in agreement with the results of Contrada et al. (1984). They found faster RT responses with their group of Type A subjects, as compared to Bs, but only when they performed in a stressful situation (high frequency noise and shock). The notion that the cognitive task was more demanding was indicated in the observation that both Type A and Type B subjects in the present experiment produced slower RTs while performing the cognitive task. We also found that the As and Bs were equally proficient in the perceptual motor task, but the As outperfomed the Bs in the cognitive one. Moch (1984) found that Type As did better than Type Bs in a complex task under conditions of increasing stress (noise levels). Thus, under conditions of increased stress, which was induced in our study by having subjects simultaneously perform a reaction time and a cognitive task, the As clearly outperformed the Bs, i.e., the As had faster RTs and higher tonal memory scores. Perhaps the impatient, time urgent characteristic of Type A allows them to simultaneously perform two tasks with greater proficiency than Type Bs. Another finding was that the addition of another stressor such as the requirment to qualify resulted in faster RTs for the As but not the Bs. Namely, the Type As had significantly faster RTs from practice to qualifying conditions. There were no differences in RT with these two conditions for the

Bs. Further, the faster RT was observed only during the cognitive task.

The better performance (i.e., faster RTs and higher scores) found for Type As in the cognitive task apparently occurred at a greater physiological cost. We found that the Type As had significantly higher HR than the Bs. In addition, the As showed a significant increase in HR activity from practice to qualifying conditions. Again, both findings were observed only during the cognitive task. The findings of Contrada et al. (1984) are noteworthy since they found greater cardiovascular reactivity with their Type A subjects, relative to Type Bs, in their high stress condition (i.e., noise plus shock). Again, we propose Type As show greater responsivity or hyperarousal compared to Bs in situations that are demanding. Clearly, the As are more aroused and also perform better than the Bs since the addition of the cognitive task plus the requirment to qualify resulted in both faster RTs and higher HR activity for the As. The question that arises concerns the levels of stress and/or arousal required to induce greater physiological reactivity and performance decrement in Type As. This question has implications for examining the possible relationship between arousal theory (i.e., inverted U function) and the Type A construct.

With regard to skin conductance, the As showed greater responsivity than the Bs, i.e., their SC levels were higher. This difference was task related because baseline SC levels between the As and Bs were the same. However, unlike HR, the greater SC level was not related to the type of task since SC levels between the As and Bs within each task did not differ, i.e., it was an overall greater SC for Pole Position and Rebeep trials combined. Perhaps cardiovascular activity is a more sensitive index related to type of task than skin conductance. In any case, SC does indicate an overall difference in psychophysiological reactivity between As and Bs and is in agreement with the findings of Lovallo and Pishkin (1980). They found that Type As had higher SC levels than the Bs in a pattern task. In all of our situations SC steadily increased from practice to qualify to task conditions for both Pole Position and Rebeep.

As was the case in Experiment I, the As had higher skin temperature than the Bs for both tasks. This result is similar to that in Experiment I and with an entirely new sample of subjects. However, unlike Experiment I in which baseline ST for Bs was lower, there was no such difference in this experiment. Thus, the differences were task-related. We did not find any ST differences as a function of type of task or levels of difficulty with the As or Bs. An interesting finding here is that while SC is higher for As than Bs, skin temperature is also higher. Since an increase in SC indicates increased SNS response, while higher ST reflects relatively less SNS activity, these two indcators of SNS response appear to be reflecting opposite reactions, i.e., an increase and decrease in SNS response. We may be observing a special case of directional fractionation of physiological response as it relates to the Type A/B construct.

The interpretation of the findings concerning electromyogram activity are limited since for a number of subjects EMG data had to be discarded due to artifact contamination. However, EMG activity was at a higher level during Pole Position than Rebeep; most likely due to the fact that Pole Position involves greater over-all muscular activity even though EMG is measured from the non-engaged forearm. We did not replicate the finding in Experiment 1 in which Type As, overall, had higher EMG activity than their Type B counterparts, but this could be due to the limited EMG data in Experiment II.

Another question concerned whether Type A and Type B subjects would differ in terms of their physiological recovery, with the Bs showing significantly greater recovery (return to baseline) than the As. None of the physiological indices indicated any differences in recovery between the As and

Bs. The expectation that this would occur is logical, given the findings that As tend to be more sympathetically aroused than the Bs in a variety of task situations and that chronic and sustained sympathetic arousal leads to an increase in the amount of time for recovery to baseline or pre-task levels. Perhaps a rest period of three minutes is too brief to observe any possible differences. We propose that a follow up investigation include a longer post-task rest period (10 minutes).

The multiple R for performance-physiological response was similar in Experiments I and II. It was found that lower HR, and higher ST were related to faster RTs. In Experiment I the performance variable was tracking score, not RT, but the fact that the pattern was similar is of interest and suggests a pattern of physiological response in which lower activity level is related to better performance.

Tracking scores were also related to Jenkins subscale scores in such a manner that indicated superior performance for those high in Type A behavior, but not for those high in hard-driving competitive (H scale) subscale scores since the latter factor was negatively weighted. This subscale pattern is difficult to interpret, but suggests that the Type A factor and H factor are tapping different aspects of a behavior-performance relationship. Jenkins subscale scores were also related to tonal memory (Rebeep) in a manner suggesting that those high in speed and impatience (S scale) performed better. Type A and Factor H also related to memory scores, but not as highly as S,and again a negative weigting for Factor H indicated that those who scored lower performed better. Perhaps the speed aspect of that factor helped subjects to process information more quickly, a desirable characteristic in the tonal memory task since items are presented at a rather quick rate and there is a time limit in making responses. The negative weighting for H scale responses suggests that high scores in this factor may be reflective of behavior that disrupts performance in the kinds of tasks used in the present study.

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