THE STRESSFULNESS OF A COACTIVE SITUATION

BY

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Thomas A. Fish

This thesis is dedicated to my parents, whose support throughout the years has encouraged me to explore my own potentialities. I thank them for my independence.

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ABSTRACT

One purpose of the present thesis was to determine whether rivalry with coaction was more stressful than rivalry without coaction. Another purpose was to determine whether these effects would be greater for a more action-involving form-board task than for a digit-letter task involving less noise and action. Sixty-four introductory psychology students (32 female and 32 male) were assigned randomly to one of four groups resulting from crossing the two different tasks with the absence or presence of coaction. All subjects performed seven practice trials of the assigned task. Subjects were then told that the eighth trial was to be a competition. A competitor was introduced to the subject and following a relaxation period, the critical trial began. Half the subjects performed the critical trial while the competitor was in another room and half performed the critical trial in the presence of the competitor. The major dependent variables were change scores from the seventh to the eighth trial for performance, heart rate, and estimated level of arousal. Heart rate data and performance data from the digit-letter task tended to support the hypothesis that rivalry with coaction was more stressful than rivalry without coaction. No evidence was obtained to support the contention that the stressfulness of rivalry involving coaction would be greater for a more conspicuous task.

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Triplett in 1897 was one of the first psychologists to express interest in the effects of the presence or absence of others on an individual's task performance (Triplett, 1897). He observed that the presence of others facilitated performance. However, he failed to differentiate between two factors which may have been involved in his experiments: the possibility of a cognitive desire to out-perform others and the mere presence of others performing the same task. In a competition, where if one person reaches a particular goal another may not; most people will likely have a cognitive desire to out-perform others, though some may not. This cognitive desire has been labelled rivalry, while the sights and sounds of a person making the same movements was labelled social facilitation (Allport, 1924). Allport identified rivalry as being emotional in character, representing the individual's struggle to assert his needs and interests (Allport, 1924). He further believed that the effects of social facilitation arose from a cognitive component:

> The individual is conscious of specific facilitating stimuli, such as the tapping of pencils, shuffling of feet, sounds of attentive respiration, peripheral vision of the speed, pauses, and degrees of progress of one's neighbors. (Allport, 1924, p. 279).

This facilitation consciousness was perceived as increasing the discharge of motor impulses under stimulation by the presence and similar movements of one's fellows. Allport also believed that this consciousness would be:

> greater for work requiring overt and conspicuous movement than for the more intellectual tasks, which both demand

closer concentration and afford fewer stimulations from the behavior of one's co-workers. (Allport, 1924, p. 279).

Social Facilitation Research

Since Allport's work and prior to Zajonc's (1965) contributions, numerous studies appeared on social facilitation. This interest was maintained up until the beginning of World War II, when research in the area quiesced. Travis (1925) found that the presence of an audience facilitated performance on a pursuit-rotor task. Dashiell, a major contributor during this time, found a similar effect of an audience on a simple multiplication task (Dashiell, 1930). Research concerning the presence of coactors during this period was often done in animal laboratories. Results due to coaction indicated that rats eat more (Harlow, 1932) and ants work more (Chen, 1937). In an early study, Allport (1920) found that humans write more in a coactive setting. Zajonc (1965) also refers to research which shows a decrease in learning for cockroaches (Gates & Allee, 1933), parakeets (Allee & Masure, 1936), and greenfinches (Klopfer, 1958). He interpreted these discrepant findings as indicating that social facilitation produces an increment in performance but an impairment to learning (Zajonc, 1965). In his well known paper, Zajonc also reorganized the research on social facilitation into two basic areas: audience and coaction effects (Zajonc, 1965). Audience effects referred to the effects on an individual of being observed by others. Coaction effects referred to the effects on an individual of the presence and simultaneous performance of others on the same task. Zajonc's (1965) paper initiated a multitude of research in this area which has been recently reviewed (Geen & Gange, 1977). Generally speaking, both

audience and coactive situations have been reported as being stressful (Allport, 1924; Becker & Franks, 1975; Chapman, 1973; Chapman & Chapman, 1974; Cottrell, Rittle, & Wack, 1967; Criddle, 1971; Geen, 1971, 1973; Gurnee, 1939; Hillery & Fugita, 1975; Hunt & Hillery, 1973; Martens, 1969; Martens & Landers, 1969).

The Concept of Stress

The word stress is commonly used in our everyday language. Almost everyone will state that they know what stress is, though so few have operationally defined the term. Stress may be the response to the sudden appearance of a long lost friend, a passionate embrace, a sad movie, or even to the death of a loved one. What these situations have in common is that they increase the demand of the environment on the human organism. Thus, stress has been defined as "the nonspecific response of the body to any demand" (Selye, 1976, p. 1). Anything which causes stress is described as a stressor. This nonspecific approach would include both pleasant and unpleasant events as being stressful, though the intensity may vary. Stress is not merely nervous tension since stress reactions reportedly occur in lower animals which have no nervous system (Selye, 1973). Also, it is obvious that different stressors will have very unique and specific effects on the human organism. However, all stressors make some increased demand on the organism to respond in an adaptive manner to the stressor (Selye, 1973). "This demand is nonspecific; it requires adaptation to a problem, regardless of what that problem may be" (Selye, 1973, p. 693). This broad conceptualization has much to offer the social sciences since its implementation would avoid the accumulation of situation specific experimental results and concentrates on the general or total response

system of the human organism. For example, many experiments have reported both increments and decrements in performance in coactive or audience settings. Following Selye's nonspecific approach, we would identify both changes in performance as being examples of a stress response. With the aid of physiological and self-report measures, we now have the tools to establish general principles concerning the response to stressful situations without being overly concerned about specific responses related to the idiosyncratic nature of a particular task or experimental setting.

Empirically speaking, a stressor may be viewed as creating a state of generalized physiological arousal with an appropriate cognitive reaction (Selye, 1974). Others have argued against such a position, indicating that different stressors may produce increments in some physiological measures and decrements in others, thus negating the validity of a general activation approach (Lacey & Lacey, 1970). However, evidence supporting the independence of various physiological measures was often provided by lesioned or drugged humans and infrahumans (Bradley, 1958; Mirsky & Cardon, 1962; Wikler, 1952), lending doubt to the generalizability to normally functioning humans. Lacey (1967) did report that normally functioning humans evidenced a deacceleration in heart rate coinciding with a rise in palmar skin conductance during attentive observation of the environment. However, the majority of his statements were made on the basis of phasic heart rate changes. These measures are miniscule by nature and do not represent an accurate picture of an individual's tonic response (Elliott, 1972). Lacey also stated that low correlations among various physiological measures when exposed to a stressor discredit

the general arousal theories, which he says would predict much higher correlations (Lacey, 1967). However, the important thing to remember is that the correlations were positive, though often low. A stressful situation may increase the tonic heart rate of an individual to a substantial degree, while galvanic skin response increases remain minimal, thus accounting for the low correlation. Another individual may respond to the same situation with a large increase in galvanic skin response while heart rate increases remain minimal. In either case, there appears to be no contradiction to Selye's nonspecific approach which classifies a stressor as creating a state of generalized physiological arousal (Selye, 1974). The specific differences may be due to certain genetic predispositions to certain stressors, or to factors such as age, sex, temperament, or even to the personality structure of the individual (Selye, 1973). It may be said that differences lie only in the pattern of the stress response. Finally, in defence of the physiological measure used in the present thesis, the present author is unaware of any studies which have shown that tonic heart rate decreased or exhibited no change when subjects were being exposed to a stressor of increasing intensity.

Stress brought about by another person or other people is referred to as psychosocial stress (Evans, Cox, & Jamieson, 1977). Rivalry, audience, coaction, and social comparison settings are examples of different psychosocial stressors. These situations need not result in an increment in performance to be called stressful. Whether the effect of these stressors is facilitative, negligible, or detrimental to performance depends on a

variety of factors. The nature and complexity of the task should be considered as well as the dominant response characteristics of the performer (Zajonc, 1965). The relative enjoyment or boredom experienced while performing the task is another factor to be reckoned with (Korman, 1974). Also, the arousal levels tested in a particular experimental setting could influence the obtained performance results (Korman, 1974). Therefore, taking the view that an increment in performance is required before a particular situation may be considered stressful, is unrealistic in the present author's view. Again, a more accurate picture is likely achieved by considering the total response system of the individual, including physiological, behavioural, and self-report measures.

Research on rivalry can be interpreted as involving stress (Allport, 1924; Church, 1962; Evans, 1971; Lloyd & Voor, 1973; Wankel, 1972). Stressful effects were reported even when competitors performed in separate rooms (Evans & Bonder, 1973), thus eliminating any effects of coaction. In terms of performance, these effects were usually facilitative, thought negligible and detrimental results were reported by Evans (1971) and Lloyd and Voor (1973), respectively. Rivalry, being a psychosocial stressor, has been shown to have a facilitating effect on physiological arousal in terms of muscle activity (Lloyd & Voor, 1973), palmar skin conductance (Church, 1962), and tonic heart rate (Evans, 1971, 1972; Wankel, 1972). Research utilizing self-report measures again shows rivalry as being stressful in regard to ratings of alertness (Church, 1962; Wankel, 1972).

Evaluation of Research on Coaction

There is also evidence suggesting that the presence of coactors is stressful. Allport's (1924) work identified coaction as stressful for word associations, comparative judgements, multiplication, vowel cancellation, and reasoning tasks. Gurnee (1939) discovered that subjects learning in a group setting exhibited fewer performance errors compared to subjects who learned in isolation, while Martens and Landers (1969) reported that subjects in quadrads performed significantly better than subjects in dyads or alone on a muscular endurance task. Thayer and Moore (1972) demonstrated an effect of coaction for self-reported activation in a moderate anxiety condition, while Hunt and Hillery (1973) found that coaction facilitated dominant responses in maze learning. Also, Chapman (1973) has shown the stressfulness of coaction on the laughter response in children, while Hillery and Fugita (1975) found that performance on manual and finger dexterity sections of the General Aptitude Test Battery (GATB) improved concomitantly with an increasing number of coactors. In the animal world, Becker and Franks (1975) have shown that coaction facilitated short-cut responses with maze-running albino rats.

As noted earlier, coaction has been shown to be stressful numerous times in research with animals. Studies done with infrahumans do not appear to possess the inherent problems found in research with humans. Although anything is possible, it seems unlikely that a rat, a cockroach, or a greenfinch have a cognitive desire to out-perform others. Operating under this assumption, Becker and Franks (1975) among many others, have demonstrated the stressful effects of coaction. Albino rats were tested

in a maze situation either alone, in pairs, or in groups of three. Performance of short-cut responses increased concomitantly with the number of coactors and increased further when the coactors were trained. These results, which suggest the validity of coaction as a psychosocial stressor with infrahumans, have encouraged the search for comparable results with human beings.

Various researchers have attempted to demonstrate that the stressful effects of coaction are independent of the effects of rivalry in a competitive situation. However, in the present author's view, no one to date has successfully demonstrated this independence with human subjects.

In an early experiment, Allport forbade subjects to compare results and further emphasized the absence of any competition in order to isolate the stressful effects of coaction (Allport, 1924). When compared to an alone condition, a stressful effect of coaction was demonstated for word associations, comparative judgements, multiplication, vowel cancellation, and reasoning tasks. However, the mere statement that a competition was not involved is no guarantee that the participants did not entertain rivalrous cognitions. People have the capacity for imagination which may serve to eliminate the effectiveness of such verbal requests.

Gurnee (1939) conducted an experiment which showed that subjects who learned in a group setting were superior to isolated learners in performance on a bolt-head maze and a numerical task. Prior to the critical trial, subjects in both conditions gave their responses orally,

while during the critical trial responses were written. Superior performance on the critical trial may be due in part to a cognitive desire to out-perform others of the group on the critical trial. Thus, the stressful effects of coaction were not successfully isolated from the effects of rivalry in this study. To his credit, Gurnee did in fact propose this factor as possibly accounting for his findings (Gurnee, 1939).

Martens and Landers (1969) also presented data suggesting that coaction is stressful. Subjects who were 8, 13, and 18 years of age performed a muscular endurance task either alone, in dyads, or in groups of four. A significant effect of coaction was demonstrated for quadrads. However, no differences were detected between the dyad and alone conditions, though the means indicated a tendency for subjects in dyads to perform better than those in the alone condition. Again, Martens and Landers simply informed their subjects that they were not to compete with each other. It is therefore quite possible that the effects attributed to the coaction manipulation may have been influenced by the natural tendency for subjects to have rivalrous cognitions. As Allport states, "a certain degree of rivalry seems natural to all co-activity" (Allport, 1924, p. 285).

Utilizing the Activation-Deactivation Adjective Check List to measure self-reported activation levels along with instruction-induced anxiety, Thayer and Moore (1972) reported that ratings of activation were higher in a coactive situation for the moderate anxiety condition. The low and high anxiety groups reported more activation in an alone

condition. However, by manipulating a person's anxiety level and thus his level of stress, Thayer and Moore have introduced a variable which may have had a powerful influence on their results. It is impossible to delineate from their findings, whether or not the stressful effect of coaction for the moderate anxiety condition was simply an artifact of the anxiety manipulation or a true effect of coaction. Also, the fact that the induced-anxiety instructions and coaction manipulations did not significantly affect performance and were not checked for effectiveness by the use of physiological measures of arousal, lends doubt to the validity of their findings.

In another study, Hunt and Hillery (1973) demonstrated that coaction was stressful in facilitating dominant responses in maze learning. They found that coaction enhanced performance on a simple maze but not on a complex maze. In fact, subjects performed better in the alone condition on the complex maze. However, the experimenters failed to control for the stressfulness of rivalry. In the coactive condition, the fact that subjects could see each other may have aroused rivalrous cognitions which are known to be stressful and as a result be wrongly attributed to the effects of coaction.

Hillery and Fugita (1975) found that performance on the manual and finger dexterity sections of the General Aptitude Test Battery (GATB) increased concomitantly with an increase in the number of coactors. Again, rivalry rears its head as a possible confounding factor in their results. It is entirely possible that by increasing the number of coactors, one increases the intensity of the desire to out-perform others,

thereby facilitating the stress response.

Chapman (1973) utilized a different approach to the problem by studying the stressfulness of coaction in a seemingly non-competitive atmosphere. His studies reveal quite clearly that children in coactive dyads laughed more than those in an audience condition, who in turn laughed more than isolated subjects while listening to amusing stories and songs (Chapman, 1973). He also found that the quantity of one's laughter is somewhat dependent on the amount of laughter elicited by one's coactive companion (Chapman & Chapman, 1974). It appears that Chapman's work does not fall prey to the criticisms directed at previously mentioned studies. The participants were told that they were helping to select material for a children's library and it is likely that rivalrous cognitions to out-laugh one's companion were minimized. Subjects may have utilized the laughter of their coactors as a cue to the appropriateness of their own laughter, or as a guide for a conforming response; or both. Regardless of the specific interpretations accounting for the coaction effects, Chapman's work does support the contention that coaction is an identifiable psychosocial stressor in a non-competitive situation. One criticism of Chapman's work is that behavioural measures of laughter were the only index of the stressfulness of coaction. The inclusion of physiological and self-report measures of arousal would have greatly enhanced our knowledge of the actual stressfulness of the situation.

It has been suggested, that in order to gain confidence in exper-

imental results, one should utilize a variety of dependent measures (Freedman, Carlsmith, & Sears, 1970). If two or more dependent measures exhibit the same effect, one's confidence in the results will increase accordingly. This is especially vital for research dealing with stress, since its effect should be reflected by the total response system of the organism. Thusfar, examination of the stressfulness of coaction has yielded many conflicting results which may be due in part to this problem. Few experiments have looked at the physiological, behavioural, and cognitive aspects of coaction in the same study. If coaction can be described as a psychosocial stressor which places an increased demand on the organism, its effects should be evident on all three measures (Selye, 1974). If this is not the case, one must question the concept of co-action as a psychosocial stressor or critically examine the validity of the dependent measures used.

In order to determine whether coaction is stressful, it seems one must try to demonstrate that rivalry involving coaction is more stressful than rivalry alone. It appears illogical to attempt to eliminate rivalry in co-active situations because rivalrous cognitions seemingly occur in most situations involving coactivity. Instead of attempting to eliminate rivarly, the present study utilized a design whereby subjects in all conditions received rivalrous instructions, while the type of task and the presence or absence of coaction, were varied. Analyses were done in terms of three dependent measures which served as indicators of a stressed state: performance,

a physiological measure of arousal, and a self-report measure.

Major Hypotheses

It was predicted that each dependent measure would be influenced by the rivalrous instructions. Also, previous research has indicated that these effects should be additionally stressful in the coactive group if coaction is in fact a psychosocial stressor. Finally, it was predicted that coaction would prove to be more stressful for subjects performing a form-board task in contrast to subjects performing a digit-letter task. This was predicted on the basis of Allport's suggestion that social facilitation effects should be greater for overt and conspicuous movement and less for tasks of a quieter, intellectual variety (Allport, 1924). The form-board task used in this study requires more conspicuous movement by the participants and provides more noise during execution than the digit-letter task.

METHOD

Subjects

Subjects were recruited from introductory psychology classes at Lakehead University (n = 64). Participation by subjects was voluntary and a credit was given to each subject toward their final mark in introductory psychology. Two booklets were handed out to various classes in order that participants could sign up for preferred times. One booklet was designated for female volunteers, while the other was designated for male volunteers. Participation in the experiment was limited to 32 females and 32 males.

Design

The basic design of the experiment was a 2 x 2 factorial design. A digit-letter task versus a form-board task and no coaction versus coaction were the two main factors in the design. The conditions were identical for all subjects prior to the critical trial. Following random assignment, the conditions for the critical trial were: No Coaction/Digit-Letter (NC/D-L), No Coaction/Form-Board (NC/F-B), Coaction/Digit-Letter (C/D-L), and Coaction/Form-Board (C/F-B). Eight females and eight males were in each of the above conditions.

All subjects performed the critical trial of the experiment in a competitive situation. Subjects in the NC/D-L and NC/F-B groups performed the critical trial with the knowledge that their scores were to be compared with a competitor's score. In these conditions the competitor performed the critical trial in a different room from the subject. The competitor

was a confederate of the experimenter and was introduced to subjects in all groups as another introductory psychology student prior to the commencement of the critical trial. The experimenter employed two introductory psychology students to serve as competitors for this study. The competitors were informed of the basic nature of the research and were paid $50 each for their efforts. The female competitor was employed to compete with female subjects, while the male competitor was employed to compete with male subjects. Competitors were instructed to keep their performance relatively constant throughout the experiment. Subjects in the C/D-L and C/F-B groups also performed the critical trial with the knowledge that their scores were to be compared with the competitor's score. In these conditions the competitor performed the critical trial in the same room as the subject.

Apparatus and Materials

The study was conducted in two separate experimental rooms at Lakehead University. Only one room was utilized for the C/D-L and C/F-B groups. Subjects in the no coaction conditions sat at one side of a table in the experimental room. During the critical trial of the NC/D-L and NC/F-B groups, the competitor performed the task in a separate room, linked to the subject's room by a buzzer which signified the start of the critical trial for both participants. Subjects in the coaction conditions also sat at one side of a table in the experimental room. Prior to the critical trial, the competitor was seated at the other side of the table allowing a clear view to the subject of his or her progress on the digit-letter or form-board task.

The digit-letter task is similar to the WAIS digit-symbol task except that the symbols are replaced with letters. Eight different forms of the task were used to measure performance. The eighth form was duplicated for the competitor's use during the critical trial. Appendix A presents a copy of the eighth form of the digit-letter task.

The form-board task consisted of eight unique boards with twenty-four different pieces of varying shapes for each board. The eighth form-board was duplicated for the competitor's use during the critical trial. Each piece had a particular slot in it's respective form-board. Appendix B presents a photograph of the eighth form of the form-board task. All digit-letter and form-board trials were timed with a stop watch.

Heart rate was measured by a Gilson M5P Finger Pickup Transducer Model FP6 dynograph. A plethysmograph was attached to the subject's index finger on the least preferred hand which recorded heart rate on the recorder. The dynograph was equipped with a marker pen with which the experimenter marked the heart rate record at appropriate times. The recording paper moved at a speed of 150 millimeters per minute.

Estimated level of arousal was measured using a magnitude estimation procedure patterned after a procedure used by Ekman and his associates who measured subjective estimates of alcohol intoxication (Ekman, Frankenheuser, Goldberg, Bjerber, Jarpe, & Myrsten, 1963). Instructions were given to each subject concerning how to estimate one's level of arousal. Subjects were told to assign a 10 to their everyday level of arousal. If they thought they were half as aroused as usual they were told to assign a 5, if only 25 percent as aroused as usual they were told

to assign a 2.5, if they thought they were twice as aroused as usual they were told to assign a 20. Each subject was then tested to see if he or she understood the procedure. Subjects were told to assign a zero to their estimated level of arousal if they fell asleep.

Two rating scales were also used to determine the extent to which subjects thought about being in a competition prior to and during the critical trial of the experiment. The rating scales were composed of a four point scale concerning how much subjects thought about being in a competition. The choices ranged from 0-- "not at all" to 3-- "to a great degree" for both scales. The two rating scales appear in Appendix Ca and Cb of this thesis.

Procedure

Prior to the arrival of the subject, the experimenter randomly determined the task the subject would perform. The experimenter reached into his pocket and pulled out a marble to decide the task to be performed. The marbles were of different colours; one representing the digit-letter task, the other representing the form-board task. This was done in a manner which ensured that one replication of the experiment was accomplished before going on to the next. For example, if the first two females were randomly assigned to the digit-letter task, the next two females would automatically be assigned to the form-board task. The same procedure was also used with male subjects.

Subjects were greeted by the experimenter and then led into the experimental room. Once seated, subjects were told that a record of their heart rate would be kept during the experiment. The plethysmograph

was then placed on the index finger of the subject's least preferred hand. A brief description of how the plethysmograph works was given while emphasizing that the plethysmographed finger must be kept still if the recording apparatus was to function properly. The experimenter then instructed the subject on the meaning of one's level of arousal. Subjects were informed that the concept of perceived level of arousal referred to how hard they thought their body was working at a particular time. They were told that if they ran quickly up a long flight of stairs or if they had to give a talk to a large group of people, their level of arousal would go up. They were also told that it was likely that they could perceive this increase in arousal since they would feel their heart beating faster and they may have started to perspire. Subjects were further informed that since participating in this experiment was a new experience for them, their level of arousal was probably higher than usual. Following this, subjects were instructed concerning how to estimate their level of arousal. Then, subjects were instructed to relax for five minutes. The experimenter marked the beginning and end of the relaxation period on the heart rate record. After the relaxation period, subjects were asked to estimate their level of arousal. The first digit-letter or form-board task was then placed in front of the subject with appropriate instructions and a demonstration on how to perform the task. The experimenter told each subject that they had one minute to do the task as well as they could while reminding them that the plethysmograph was to be kept still during the entire experiment. The subject was instructed to begin and stop on the sound of the buzzer.

The buzzer was sounded, a mark was automatically made on the heart rate recording paper, and the experimenter started the stop watch. At the end of one minute the buzzer was again sounded and the heart rate recording paper marked. The subject was then asked to estimate his or her level of arousal. The experimenter then corrected and recorded the subject's performance score in the subject's presence. Once accomplished, the second task was placed before the subject. The above procedures were identical for the first seven trials of the experiment.

After completion of the seventh trial, subjects were randomly assigned to a group. The experimenter reached into his pocket and pulled out a marble which determined the group a subject would be in. The marbles were of different colours; one representing the coaction condition, the other representing the no coaction condition. This was done in a manner which ensured that one replication of the experiment was accomplished before going on to the next. For example; if two females had already been assigned to the NC/D-L and NC/F-B conditions, the next two females were automatically placed in a coaction situation. The same procedure was also used with male subjects.

Subjects in the no coaction condition were introduced to the competitor. Both participants were informed that they would be engaging in a competition and that a comparison of their performance would follow. It was also made clear that the participants would be competing in different rooms. They were told that they would get to relax for one minute prior to the competition. The confederate was sent to the other room for the relaxation period. Immediately following the relaxation period, subjects

were asked to estimate their level of arousal. Subjects were then given the first rating scale which asked them to rate the degree to which they thought about being in a competition during the relaxation period. After subjects had completed the first rating scale, the final form of the digit-letter or form-board task was placed before them. On the buzzer, subjects completed the task until the buzzer sounded again to signify the end of the trial. The trial commenced on the sound of the buzzer and the same recording procedure applied as in the previous seven trials. On completion of the task, subjects were asked to estimate their level of arousal. Subjects were then given the second rating scale which required them to rate the degree to which they thought about being in a competition during the last trial. The experimenter then recalled the confederate to the subject's room.

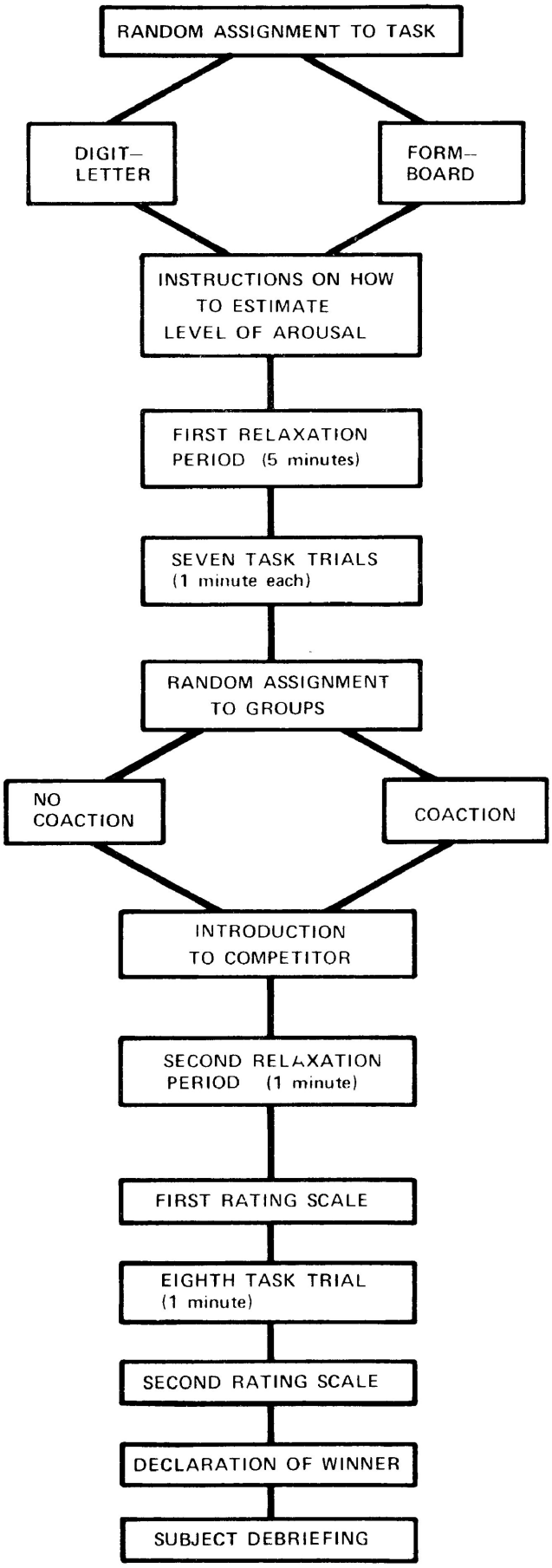
Subjects in the coaction condition were also introduced to the confederate. Both participants were informed that they would be engaging in a competition and that a comparison of their performance would follow. It was also made clear that the participants would be competing directly across from one another. Procedures for a relaxation period were identical to those in the no coaction condition. After the subject had completed the first rating scale, the other competitor was then called back into the subject's room. A plethysmograph was attached to the index finger of the competitor's least preferred hand. Identical forms of the digit-letter or form-board task were placed in front of the participants along with competitive instructions to try and do better than the other person. On the buzzer, subjects completed the task until the buzzer

sounded again to signify the end of the trial. Recording procedures were the same as in the no coaction condition. On the completion of the final trial, subjects were asked to estimate their level of arousal during the last trial. Both participants then filled out the second rating scale which was identical to that given in the no coaction condition. Subjects were asked to do these tasks prior to seeing how well they did in relation to the other person.

After subjects in both the no coaction and coaction group had completed the second rating scale, they were completely debriefed concerning the experimental manipulations. Subjects in all groups were asked if they had any knowledge of the experimental manipulations beforehand as well as being asked not to divulge information about the experiment to potential subjects. It should be noted that in all conditions, the experimenter was in the same room as the subject during the entire experiment. One experimental session lasted about 45 minutes. A schematic representation of the entire experimental procedure appears in Figure 1.

Figure 1

FLOW CHART OF EXPERIMENTAL PROCEDURE



RESULTS

Performance data were obtained from the seventh and eighth trials of the digit-letter and form-board tasks. Tonic heart rate and estimated level of arousal data were obtained from the last minute of the first relaxation period, the minute during the second relaxation period, and from the seventh and eighth trials of the experiment. Data from the first rating scale were collected immediately after the second relaxation period. Finally, data from the second rating scale were obtained immediately after the eighth trial of the experiment. The means and standard deviations for these measures are presented in Appendix D.

The dependent variables in this experiment were: performance change on the digit-letter and form-board tasks from trial seven to trial eight of the experiment (ΔP), heart rate change from the first to the second relaxation period (ΔRHR), heart rate change from the seventh to the eighth trial (ΔHR), estimated level of arousal change from the first to the second relaxation period (ΔRELA), estimated level of arousal change from the seventh to the eighth trial (ΔELA), and scores obtained from the first (R1) and second (R2) rating scales. The means and standard deviations for these measures are presented in Table 1.

Performance

Separate analyses were done for each task because of the different nature of the tasks and also because the digit-letter task has a possible perfect score of 200 while the form-board task has a possible perfect score of 24.

A separate randomized groups analysis of variance for four different

Table 1

Means and Standard Deviations For All Dependent Measures

Group	n	ΔP		ΔRHR		ΔHR		ΔRELA		ΔELA		R1		R2	
		M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Digit-Letter															
No Coaction	16	4.25	3.42	-3.25	3.89	10.69	9.11	2.41	3.22	2.53	7.08	1.25	1.06	1.88	.96
Females	8	3.00	3.55	-5.38	2.50	5.63	7.48	2.25	4.27	1.56	9.56	1.00	.76	1.63	1.06
Males	8	5.50	2.98	-1.13	3.98	15.75	7.96	2.56	1.99	3.50	3.74	1.50	1.31	2.13	.83
Coaction	16	7.19	5.08	-2.94	7.34	22.38	12.63	2.53	2.36	2.94	5.17	1.94	.85	2.63	.62
Females	8	8.75	3.54	-3.88	6.53	17.00	7.96	3.38	2.00	3.50	2.73	2.00	1.07	2.75	.46
Males	8	5.63	6.09	-2.00	8.42	27.75	14.57	1.69	2.52	2.38	7.01	1.88	.64	2.50	.76
Form-Board															
No Coaction	16	.19	2.88	-1.13	4.75	9.56	6.39	2.66	2.89	3.56	4.56	1.63	.96	2.13	.81
Females	8	-.38	2.67	-1.63	4.75	9.13	7.12	2.25	3.37	4.13	3.00	1.13	.83	1.88	.99
Males	8	.75	3.15	-.63	5.01	10.00	6.02	3.06	2.48	3.00	5.90	2.13	.83	2.38	.52
Coaction	16	.94	3.62	-.44	6.93	17.81	12.69	4.56	4.90	2.75	4.68	1.50	.97	2.00	.73
Females	8	1.75	3.06	-2.38	6.44	16.25	9.10	3.13	4.85	1.88	4.70	1.38	1.06	2.00	.76
Males	8	.13	4.16	1.50	7.27	19.38	16.02	6.00	4.80	3.63	4.81	1.63	.92	2.00	.76

groups did not reveal any significant differences among scores on the seventh trial of the experiment for either the digit-letter or form-board tasks. Appendix E contains a summary of these analyses.

A 2 X 2 factorial analysis of variance with the two factors being no coaction/coaction and female/male was done on performance change scores (ΔP). This was the dependent variable used to determine whether performance was influenced by the experimental manipulations. For the digit-letter task, results due to coaction very nearly reached the conventional level of significance, $F(1, 28) = 3.89$, $p < .06$. Performance improved more for the coaction group ($\Delta M = 7.19$) than for the no coaction group ($\Delta M = 4.25$). No significant sex differences were found in this analysis, though a nearly significant coaction X sex interaction, $F(1, 28) = 3.56$, $p < .07$ indicated that female performance ($\Delta M = 8.75$) increased more than male performance ($\Delta M = 5.63$) in the coaction groups for the digit-letter task, while in the no coaction groups the difference between females ($\Delta M = 3.00$) and males ($\Delta M = 5.50$) was in the opposite direction. Appendix F contains a summary of this analysis. For the form-board task, no significant differences were found for performance for either coaction or sex. Appendix F contains a summary of this analysis.

Heart Rate

Randomized groups analyses of variance for eight different groups, did not reveal any significant differences for heart rate during the last minute of the first relaxation period or for the seventh performance trial. Appendix G contains a summary of these analyses.

A 2 X 2 X 2 factorial analysis of variance with the three factors

being digit-letter/form-board, no coaction/coaction, and female/male was done on the change in heart rate scores from the first to the second relaxation period (ΔRHR). This was the dependent variable used to determine whether resting heart rate was influenced by the experimental manipulations. No significant differences were detected for task or for coaction. A result approaching significance was obtained for sex, $F(1, 56) = 3.49$, $p < .07$) suggesting a tendency for females to show a greater decrease in heart rate ($\Delta M = -3.31$) than males ($\Delta M = -.56$) from the first to the second relaxation period. Appendix H contains a summary of this analysis.

A 2 X 2 X 2 factorial analysis of variance utilizing the same three factors was also done on heart rate change from trial seven to trial eight of the experiment (ΔHR). This was the dependent variable used to determine whether heart rate was influenced by the experimental manipulations. No significant differences were detected between tasks. A highly significant result was obtained for the coaction manipulation, $F(1, 56) = 15.49$, $p < .001$ indicating that heart rate increases were greater in the coaction conditions ($\Delta M = 20.09$) than in the no coaction conditions ($\Delta M = 10.13$). A significant effect of sex was also detected, $F(1, 56) = 6.03$, $p < .05$ indicating a greater increase in heart rate for males ($\Delta M = 18.22$) than for females ($\Delta M = 12.00$). Appendix I contains a summary of this analysis.

Self-Report Measures

A randomized groups analysis of variance for eight different groups, did not reveal any significant differences among groups in estimates of

level of arousal for the end of the first relaxation period or for the seventh trial of the experiment. Appendix J contains a summary of these analyses.

A 2 X 2 X 2 factorial analysis of variance with the factors being digit-letter/form-board, no coaction/coaction, and female/male was done on changes in estimates of arousal from the first to the second relaxation period (ΔRELA). This was the dependent variable used to determine whether resting estimated level of arousal was influenced by the experimental manipulations. No significant differences were detected. Appendix K contains a summary of this analysis.

A 2 X 2 X 2 factorial analysis of variance utilizing the same three factors was also done on changes in estimated level of arousal from trial seven to trial eight (ΔELA). This was the dependent variable used to determine whether estimated level of arousal was influenced by the experimental manipulations. Again, no significant differences were found. Appendix L contains a summary of this analysis.

A 2 X 2 X 2 factorial analysis of variance with the factors being digit-letter/form-board, no coaction/coaction, and female/male was done on scores from the first rating scale. This scale asked subjects to rate the degree to which they were thinking about being in a competition during the second relaxation period. Results indicated no significant differences in regard to task or coaction. One result approaching significance was found for the sex factor, $F(1, 56) = 2.94$, $p < .09$ suggesting that males ($M = 1.78$) tended to think more about being in a competition than females ($M = 1.38$) during the second relaxation period. Another result approaching

significance was found for the task X coaction interaction, $F(1, 56) = 2.94$, $p < .09$. This result is considered uninterpretable by the present author and will not be referred to again. Appendix M contains a summary of this analysis.

A 2 X 2 X 2 factorial analysis of variance with the same three factors was done on scores from the second rating scale. This scale asked subjects to rate the degree to which they were thinking about being in a competition during the critical trial of the experiment. Results indicated no significant main effects for any of the three factors. A significant task X coaction interaction was found, $F(1, 56) = 4.90$, $p < .05$, indicating that subjects performing the digit-letter task in the no coaction condition thought less about being in a competition ($M = 1.88$) than those performing the digit-letter task in the coaction condition ($M = 2.63$). For subjects performing the form-board task, this pattern was reversed. Subjects in the no coaction condition thought more about being in a competition ($M = 2.13$) than subjects in the coaction condition ($M = 2.00$). To investigate this interaction further, a Newman-Keuls test for post-hoc pairwise comparisons was utilized to compare each of these four means with the other three. Using the .05 level for significance, the only significant difference to emerge was that between the mean for the digit-letter no coaction group ($M = 1.88$) and the digit-letter coaction group ($M = 2.63$). Appendix N contains a summary of this analysis.

Correlations

In an attempt to gain information regarding the relationships among performance, heart rate, and estimated level of arousal changes; inter-

correlations were computed among the following change scores: performance change from the seventh to the eighth trial of the experiment (ΔP), resting heart rate change from the first to the second relaxation period (ΔRHR), heart rate change from the seventh to the eighth trial (ΔHR), resting estimated level of arousal change from the first to the second relaxation period (ΔRELA), and estimated level of arousal change from the seventh to the eighth trial of the experiment (ΔELA). These correlations are presented in Table 2. Intercorrelations were also computed separately for each task to determine the contributions made by each task group towards the overall correlations. Table 3 and Table 4 present the correlation matrices for the digit-letter and form-board tasks.

Table 2

Overall Correlation Matrix For Five Dependent Measures

	ΔP	ΔRHR	ΔHR	ΔRELA	ΔELA
ΔP		-.197	.293*	-.022	.173
ΔRHR			.155	.266*	.106
ΔHR				.175	.175
ΔRELA					.064
ΔELA					

*$p < .05$

A significant overall relationship was found between performance and heart rate change scores, $r(62) = .293$, $p < .05$ indicating that heart rate increases correlated positively with performance increases. When

taken separately, a significant correlation was found for the digit-letter task, $r(30) = .488$, $p < .01$ but not for the form-board task.

Table 3

Correlation Matrix For The Digit-Letter Task Group

For Five Dependent Measures

	ΔP	ΔRHR	ΔHR	ΔRELA	ΔELA
ΔP		-.056	.488**	.062	-.039
ΔRHR			.014	.396*	.095
ΔHR				.296	.139
ΔRELA					.324
ΔELA					

*$p < .05$

**$p < .01$

Table 4

Correlation Matrix For The Form-Board Task Group

For Five Dependent Measures

	ΔP	ΔRHR	ΔHR	ΔRELA	ΔELA
ΔP		-.146	.138	.119	.382*
ΔRHR			.336	.023	.106
ΔHR				.093	.209
ΔRELA					-.225
ΔELA					

*$p < .05$

The overall correlation between performance change and estimated level of arousal change from the seventh to the eighth trial of the experiment was positive, though not significant. When taken separately, a non-significant correlation was found for the digit-letter task, while a significant correlation was found for the form-board task, $\underline{r}(30) = .382$, $\underline{p} < .05$.

An overall correlation between resting heart rate change and resting estimated level of arousal change was found to be significant, $\underline{r}(62) = .266$, $\underline{p} < .05$. When taken separately, a significant correlation was found for the digit-letter task, $\underline{r}(30) = .396$, $\underline{p} < .05$ but not for the form-board task.

DISCUSSION

Generally, the present findings tend to support the hypothesis that rivalry involving coaction was more stressful than rivalry without coaction.

Performance

The obtained performance data will be treated as indicating that coaction did facilitate performance on the digit-letter task but not on the form-board task. Technically, the difference in performance change between the no coaction and coaction groups on the digit-letter task only approached statistical significance. However, the achieved level of significance ($p < .06$) was extremely close to the conventionally accepted level of significance ($p < .05$). Furthermore, utilizing the formula for eta^2, it was found that 11% of the total variability for performance change on the digit-letter task was associated with the coaction factor (Nie, Hull, Jenkins, Steinbrenner, & Bent, 1975). With a slight increase in sample size, the present author is confident that the obtained performance differences between the no coaction and coaction groups for the digit-letter task would reach a statistically acceptable level. Also, the difference between the no coaction and coaction groups for the form-board task did not even approach statistical significance ($p > .99$). In fact, only 1% of the total variability for performance change on the form-board task was associated with the coaction factor. Thus, from this point on, the obtained performance data for the digit-letter task will be discussed as if it had reached the conventional level of significance for the coaction factor. The performance data for the form-board task will be

treated as being nonsignificant in terms of the coaction factor.

The differing results obtained for the two tasks may be due in part to the nature of the tasks themselves. Performing the digit-letter task seemingly requires more skill by the participant than does the form-board task, with luck being relatively unimportant. The letters and numbers used with the task appear to be equally complex. Also, the sequential execution by all subjects was identical for each trial of the digit-letter task. Thus, considering the results obtained in this study with eight different forms of the task, the first six forms being used for practice and the last two forms being utilized in the final analysis; it appears that performance on the digit-letter task is systematically influenced by stressful manipulations. Previous research utilizing a digit-symbol task has also shown that increases in performance reflect increases in stress (Evans, 1974; Evans & Bonder, 1973). The form-board task on the other hand, is one in which performance seemed to depend largely upon a luck component which would likely mask any experimental effects. To check this possibility, Pearson Product-Moment correlations were calculated among performance scores for the seven trials of the digit-letter and form-board tasks. The intertrial correlations for the digit-letter task ranged from .73 to .89, while the correlations for the form-board task ranged from -.20 to .51. Out of a possible total of 21 correlations, 21 were significant at the .001 level for the digit-letter task. For the form-board task, only 7 correlations were significant. Of these correlations, only one correlation was significant at the .001 level. These results tend to support the presence of a luck component when performing the form-board

task. How one performs on one particular trial is not strongly related to how one performs on other trials. These results also support the notion that not as much luck is involved when performing the digit-letter task. The shapes used in the form-boards ranged from simple rectangles to more complex figures such as five pointed stars. A subject's score would be influenced by the proportion of simple and complex shapes attempted during a particular trial. Also, each shape used could only fit one way in its respective form-board. If a subject was lucky enough to discover the correct placement in a short time, his or her score would likely be higher on that trial. Considering the results obtained in this study with eight different forms of the task, the first six forms being used for practice and the last two forms being utilized in the final analysis; it is evident that performance on the form-board task is not systematically influenced by stressful manipulations. This may be due in part to the luck component involved in performing the task. Previous research using the form-board task with rivalry as the independent variable, has also arrived at similar results though only one form of the task was used for both practice trials and trials included in the final analysis (Evans, 1971).

The second hypothesis using Allport's (1924) suggestion that the stressful effects of social facilitation should be greater for overt and conspicuous movement and less for tasks of a quieter, intellectual variety was not supported in this study by the performance data. Subjects in the coaction condition improved their performance on the digit-letter task more than those subjects in the no coaction condition. Performance change on the more conspicuous form-board exhibited little difference between

the coaction and no coaction groups. However, not much can be based on this negligible result because of the luck component involved in doing the form-board task which would negate the detection of effects due to the task's conspicuousness.

Heart Rate

The hypothesis that the presence of others performing the same task in the same room would prove more stressful than the effects of rivalry without coaction was further supported by the heart rate data. The obtained tonic heart rate data clearly indicate the stressfulness of coaction. Subjects in the coaction condition exhibited a significantly higher heart rate increase than subjects in the no coaction condition. Individuals appeared to be stressed more by a seen competitor than an unseen competitor in this experiment.

The second hypothesis that the stressful effects of coaction should be less for the digit-letter task and greater for the form-board task was not supported by the heart rate data. The difference between subjects' heart rate increases in the no coaction and coaction conditions was not significantly higher for the form-board task. However, this does not necessarily mean that Allport's suggestion is incorrect. It is quite possible that his hypothesis could be confirmed if a variety of tasks ranging from very quiet mental operations to very noisy and conspicuous tasks were utilized. Also, since performance on the form-board task involves a certain amount of luck, it is possible that the additional stress provided by the more conspicuous task may have been reduced by subject recognition of this luck component. Further research utilizing

tasks which minimize the effects of luck will likely clarify this issue. Thus, even though the heart rate data provide little evidence to support Allport's contention that the stressfulness of coaction should be greater for more conspicuous tasks, the present author feels that extreme caution should be employed in accepting an alternative position.

Self-Report Measures

Data from subjects' estimated levels of arousal failed to support the hypothesis that rivalry with coaction was more stressful than rivalry without coaction. Since results approaching significance were found for performance on the digit-letter task, and highly significant results were obtained for heart rate due to the coaction factor; the estimation procedure utilized appears suspect as a valid self-report measure for this kind of work. Subjects showed high variability in the range of estimations. One subject may have limited his estimations to between 5 and 15; while another may utilize a much larger range, say 10 to 75. The open-endedness of the procedure seems to have added a considerable amount of variability to the results. It was also noted by the experimenter, that numerous subjects had difficulty in grasping the concept of estimating their level of arousal.

The second hypothesis that the stressfulness of coaction would be greater for subjects performing the form-board task was also not supported by the self-report measure. Again, the validity of this finding is debatable since the validity of the estimation procedure used is highly questionable.

Looking at the data from the first rating scale we can see that there

is no evidence that the groups differed in terms of the degree to which they were thinking about the impending competition during the second relaxation period. Data from the second rating scale indicate that the groups did differ in terms of the degree to which they were thinking about being in the competition during the critical trial. However, differences were only found to be significant with the digit-letter task, indicating that subjects in the digit-letter coaction group thought more about being in the competition during the critical trial than subjects in the digit-letter no coaction group. A number of possible explanations may be offered to explain this finding. Subjects performing the form-board task may have perceived the luck component involved in performing the task and may have thought less about being in the competition. However, the present thesis provides no evidence for this contention and the reasons for obtaining this result remain the task of future investigations. It is quite possible that this finding represents the commitment of a Type I error of rejecting the null hypothesis when it may in fact be true.

Correlations

Supporting the view that as stress increases, so does performance on simple tasks; was a significant overall correlation between performance change and heart rate change. However, when taken separately, one can see that performance change was significantly related to heart rate change for the digit-letter task but not for the form-board task. This result provides further support for the contention that performance on the digit-letter task is a valid index of the stressfulness of a psychosocial

stressor. This result also suggests that performance on the form-board task is not sensitive to changes in stress level. Thus, subjects perform a well learned simple task requiring a certain level of skill and a minimal amount of luck, better with increasing stress. This result has been demonstrated previously with a virtually identical task (Evans, 1974; Evans & Bonder, 1973).

A nonsignificant overall correlation was found between performance change and estimated level of arousal change. However, when looking at the tasks separately, the correlation is significant at the .05 level for the form-board task but approaches zero for the digit-letter task. Since the form-board has not been shown to be a valid index of psychosocial stress, and the validity of the estimation procedure used is questionable; no attempt will be made to explain this correlation.

Finally, a significant overall positive correlation was found between resting heart rate change and resting estimated level of arousal change. Again, since the validity of the estimation procedure used is questionable, no attempt will be made to explain this correlation.

Sex Differences

The effects of the coaction manipulations appear to be different for females and males.

A near significant coaction X sex interaction indicated that the coaction factor was more effective in facilitating female performance than male performance on the digit-letter task. In fact, male performance increases were almost identical for the no coaction and coaction groups. Males were apparently more stressed during the critical trial

as evidenced by a significantly higher heart rate change than females for both the no coaction and coaction conditions. In fact, heart rate change for females in the coaction condition was close to that for males in the no coaction condition. The increase in performance for females doing the digit-letter task due to the coaction manipulation is concomitant to their increased stress levels as indicated by heart rate change scores. The lack of increase in performance for males due to the coaction manipulation suggests that an optimal stress level may have been achieved by the rivalry factor, leaving further increases in the intensity of the stressor ineffective in terms of performance change on the digit-letter task. It had occurred to the present author that male performance on the digit-letter task may have evidenced an inverted U pattern if further increases in the intensity of the stressor were used. This inverted U function suggests that performance will decrease once an optimal level of stress has been passed (Malmo, 1959). To check this possibility, the present author plotted heart rate and performance scores for the critical trial of the experiment. Although in some cases male performance appeared to have reached an asymptote, no evidence was obtained to support the suggestion that male performance on the digit-letter task had decreased with an increase in the intensity of the stressor. It is the present author's view that further increases in the intensity of the stressor would likely produce performance decrements with the digit-letter task. However, future investigations will likely clarify this issue.

Resting heart rate data from the second relaxation period indicate

a tendency for females to relax more prior to the competition. Also, a near significant result indicated that males reported thinking more about being in a competition during the second relaxation period than females. These results suggest that males were perhaps "getting up" for the competition earlier than females. A significantly higher heart rate change for males during the critical trial further suggests that the effects of the competition were more stressful for males.

This study provides suggestive evidence that the variables manipulated in this investigation differentially influenced females and males. Although the majority of the evidence only approaches statistical significance, the overall pattern of the results indicates that one should be cognizant of possible sex differences in this type of research. Also, the results of this study were obtained with a male experimenter. The possible influence of this factor is unanalyzable in this particular investigation. Further research should attempt to isolate or control the effects of the experimenter's sex on the eventual results.

Conclusion

In sum, this experiment appears to have demonstrated that rivalry with coaction was more stressful than rivalry without coaction. This conclusion is supported by a performance increase approaching significance on the digit-letter task, along with a highly significant tonic heart rate increase for the coaction manipulation.

The hypothesis following Allport's (1924) suggestion that the stressful effects of social facilitation should be greater for overt and conspicious movement and less for tasks of a quieter intellectual variety was not supported in the present study. However, since the form-board task involves

a luck component and the validity of the self-report procedure used is questionable, the results from these two measures will not be considered as evidence opposing Allport's hypothesis. Also, even though the heart rate data did not support Allport's suggestion, we cannot accept the null hypothesis and say that Allport's hypothesis is incorrect. It is quite possible that the hypothesis could be confirmed if a variety of tasks were used ranging from very quiet mental operations to very noisy and conspicuous tasks.

Some important theoretical questions remain to be answered. Why is a rivalrous situation involving coaction more stressful than a rivalrous situation without coaction? A number of possible explanations have been suggested (Geen & Gange, 1977). Allport (1924) proposed that social facilitation effects are influenced by cognition, in that the individual is conscious of numerous stimuli in the situation. Others have suggested that the effects of coaction may be due to an increase in the intensity of rivalry (Cottrell, 1972). Some support for this explanation was obtained with the second rating scale. Subjects performing the digit-letter task in the coaction condition reported thinking more about being in a competition than subjects performing the task in the no coaction condition. However, it should be noted that this difference was not found with the form-board task. Still others have suggested that coaction effects may be the result of an increase in emotional arousal accompanying evaluation apprehension and fear of failure (Geen & Gange, 1977). However, in the present author's view it is likely that coaction effects may be due to a combination of all these factors. For one person, an increase

in the intensity of rivalry may be the major factor. For another, coation may intensify the individual's fear of failure. Thus, it is felt that individual differences may play a role in determining why rivalry involving coaction is more stressful than rivalry without coaction.

It is suggested that future investigations concerning the effects of coaction and other psychosocial stressors do not abandon the search for reliable self-report measures for this kind of work. Future researchers should also be cognizant of possible sex differences in their results and attempt to isolate the variables responsible for these discrepancies. Finally, it is suggested that the effects of the experimenter's sex be controlled for in order to identify the possible influence it may have on the results.

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LIST OF APPENDICES

Appendix A

The Digit-Letter Task

0	1	2	3	4	5	6	7	8	9
L	V	T	A	E	N	W	X	H	K

5	1	0	6	6	2	0	6	9	9	2	9	7	5	9	5	3	2	0	5	7	7	3	4

6	9	8	2	6	6	2	2	4	2	4	0	1	5	9	6	7	4	9	0	7	5	8	9

5	0	1	4	9	0	9	6	6	3	3	6	7	4	6	9	0	9	6	3	3	4	8	8

1	9	9	8	0	8	5	2	8	2	6	3	7	2	9	2	9	2	3	6	5	0	2	6

6	6	7	0	0	0	2	2	1	5	0	1	9	3	9	9	5	9	1	6	2	3	7	7

1	3	0	1	3	5	7	4	2	8	3	6	3	6	7	3	0	5	8	8	7	2	2	9

8	7	4	8	3	1	4	4	6	8	0	2	3	7	3	1	2	5	2	9	6	3	6	7

6	2	3	0	4	8	2	9	6	3	8	3	5	2	2	3	8	1	6	6	4	0	9	4

Appendix B

The Form-Board Task

Appendix Ca

Rating Scale, #1

To what degree were you thinking about being in a competition during the relaxation period?

0 ... Not at all

1 ... To a slight degree

2 ... To a moderate degree

3 ... To a great degree

Answer

Appendix Cb

Rating Scale #2

To what degree were you thinking about being in a competition during the last trial?

0 ... Not at all

1 ... To a slight degree

2 ... To a moderate degree

3 ... To a great degree

Answer

Appendix D

Means and Standard Deviations For Raw Data

Digit-Letter

Group	n	P1		P2		RHR1		RHR2		HR1		HR2	
		M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
No Coaction	16	52.38	7.81	56.63	8.90	79.50	14.45	76.25	14.78	84.19	17.05	94.88	17.55
Females	8	56.00	8.40	59.00	11.06	82.63	15.22	77.25	13.47	88.38	18.94	94.00	16.66
Males	8	48.75	5.50	54.25	5.87	76.38	13.90	75.25	16.86	80.00	14.98	95.75	19.51
Coaction	16	52.94	4.04	60.13	6.34	79.19	9.97	76.25	7.51	83.38	8.82	105.75	13.87
Females	8	53.63	3.46	62.38	5.58	79.88	11.13	76.00	7.46	84.00	8.54	101.00	12.58
Males	8	52.25	4.68	57.88	6.60	78.50	9.38	76.50	8.07	82.75	9.63	110.50	14.23
		RELA1		RELA2		ELA1		ELA2		R1		R2	
No Coaction	16	9.13	4.96	11.53	6.56	21.53	15.97	24.06	13.04	1.25	1.06	1.88	0.96
Females	8	9.13	6.27	11.38	9.23	27.19	21.38	28.75	16.88	1.00	0.76	1.63	1.06
Males	8	9.13	3.68	11.69	2.66	15.88	4.01	19.38	5.37	1.50	1.31	2.13	0.83
Coaction	16	9.47	3.70	12.00	3.29	17.06	5.66	20.00	4.87	1.94	0.85	2.63	0.62
Females	8	7.50	3.21	10.88	2.85	15.50	4.04	19.00	4.00	2.00	1.07	2.75	0.46
Males	8	11.44	3.20	13.13	3.48	18.63	6.84	21.00	5.71	1.88	0.64	2.50	0.76

Form-Board

Group	n	P1		P2		RHR1		RHR2		HR1		HR2	
		M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
No Coaction	16	12.19	2.99	12.38	2.96	77.63	13.43	76.50	12.05	87.31	14.00	96.88	14.24
Females	8	12.50	2.20	12.13	2.70	77.38	9.59	75.75	9.45	86.38	9.59	95.50	9.96
Males	8	11.88	3.76	12.63	3.38	77.88	17.16	77.25	14.85	88.25	18.05	98.25	18.20
Coaction	16	12.06	2.41	13.00	2.88	73.00	11.99	72.56	10.20	84.56	12.17	102.38	18.08
Females	8	12.13	1.96	13.88	2.10	75.25	13.60	72.88	11.76	86.63	11.16	102.88	18.61
Males	8	12.00	2.93	12.13	3.40	70.75	10.55	72.25	9.18	82.50	13.52	101.88	18.80
		RELA1		RELA2		ELA1		ELA2		R1		R2	
No Coaction	16	7.91	3.13	10.56	4.19	17.00	6.48	20.56	8.08	1.63	0.96	2.13	0.81
Females	8	8.50	2.56	10.75	4.37	15.00	7.31	19.13	8.79	1.13	0.83	1.88	0.99
Males	8	7.31	3.69	10.38	4.31	19.00	5.24	22.00	7.62	2.13	0.83	2.38	0.52
Coaction	16	7.03	3.89	11.59	5.84	17.06	8.29	19.81	9.78	1.50	0.97	2.00	0.73
Females	8	6.63	4.31	9.75	4.62	18.75	9.69	20.63	12.20	1.38	1.06	2.00	0.76
Males	8	7.44	3.68	13.44	6.63	15.38	6.84	19.00	7.39	1.63	0.92	2.00	0.76

Code	Variable
P1	Performance score for the seventh trial
P2	Performance score for the eighth trial
RHR1	Heart rate for the first relaxation period
RHR2	Heart rate for the second relaxation period
HR1	Heart rate for the seventh trial
HR2	Heart rate for the eighth trial
RELA1	Estimated level of arousal for the first relaxation period
RELA2	Estimated level of arousal for the second relaxation period
ELA1	Estimated level of arousal for the seventh trial
ELA2	Estimated level of arousal for the eighth trial
R1	First rating scale
R2	Second rating scale

Appendix E

A Randomized Groups Analysis of Variance For Performance Scores on the Seventh Trial of the Digit-Letter Task

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROBABILITY
BETWEEN GROUPS	3	220.375	73.4583	2.181	.111
WITHIN GROUPS	28	942.875	33.6741		
TOTAL	31	1163.250			

A Randomized Groups Analysis of Variance For Performance Scores on the Seventh Trial of the Form-Board Task

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROBABILITY
BETWEEN GROUPS	3	1.750	0.5833	0.074	.968
WITHIN GROUPS	28	219.750	7.8482		
TOTAL	31	221.500			

Appendix F

A 2 X 2 Factorial Analysis of Variance on Performance Change Scores For the Digit-Letter Task

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO
COACTION	1	69.031	69.031	3.886*
SEX	1	.781	.781	.999
COACTION X SEX	1	63.281	63.281	3.562*
ERROR	28	497.373	17.763	
TOTAL	31	630.467		

*$p < .10$

A 2 X 2 Factorial Analysis of Variance on Performance Change Scores For the Form-Board Task

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO
COACTION	1	4.50	4.50	.412
SEX	1	.50	.50	.046
COACTION X SEX	1	15.125	15.125	1.385
ERROR	28	305.749	10.920	
TOTAL	31	325.874		

Appendix G

A Randomized Groups Analysis of Variance For Resting Heart Rate During the Last Minute of the First Relaxation Period

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROBABILITY
BETWEEN GROUPS	7	677.750	96.8214	.587	.765
WITHIN GROUPS	56	9236.375	164.9353		
TOTAL	63	9914.125			

A Randomized Groups Analysis of Variance For Heart Rate During the Seventh Trial of the Experiment

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROBABILITY
BETWEEN GROUPS	7	509.125	72.7321	.395	.902
WITHIN GROUPS	56	10316.625	184.2254		
TOTAL	63	10825.750			

Appendix H

A 2 X 2 X 2 Factorial Analysis of Variance on Heart Rate Change Scores From the First to the Second Relaxation Period

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO
TASK	1	85.563	85.563	2.466
COACTION	1	4.000	4.000	.115
SEX	1	121.000	121.000	3.487*
TASK X COACTION	1	0.563	0.563	.016
TASK X SEX	1	1.563	1.563	.045
COACTION X SEX	1	0.250	0.250	.007
TASK X COACTION X SEX	1	27.563	27.563	.794
ERROR	56	1943.244	34.701	
TOTAL	63	2183.744		

*$p < .10$

Appendix I

A 2 X 2 X 2 Factorial Analysis of Variance on Heart Rate Change Scores From the Seventh to the Eighth Trial

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO
TASK	1	129.391	129.391	1.26
COACTION	1	1590.016	1590.016	15.488***
SEX	1	618.766	618.766	6.027**
TASK X COACTION	1	47.266	47.266	.460
TASK X SEX	1	284.766	284.766	2.774*
COACTION X SEX	1	8.266	8.266	.081
TASK X COACTION X SEX	1	2.641	2.641	.026
ERROR	56	5749.051	102.662	
TOTAL	63	8430.160		

*$p < .10$

**$p < .05$

***$p < .001$

Appendix J

A Randomized Groups Analysis of Variance For Resting Estimated Level of Arousal During the Last Minute of the First Relaxation Period

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROBABILITY
BETWEEN GROUPS	7	130.8398	18.6914	1.190	.323
WITHIN GROUPS	56	879.5313	15.7059		
TOTAL	63	1010.3711			

A Randomized Groups Analysis of Variance For Estimated Level of Arousal During the Seventh Trial of the Experiment

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROBABILITY
BETWEEN GROUPS	7	902.4336	123.9191	1.360	.240
WITHIN GROUPS	56	5307.0938	94.7695		
TOTAL	63	6209.5273			

Appendix K

A 2 X 2 X 2 Factorial Analysis of Variance on Estimated Level of Arousal Change Scores From the First to the Second Relaxation Period

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO
TASK	1	20.816	20.816	1.723
COACTION	1	16.504	16.504	1.366
SEX	1	5.348	5.348	.443
TASK X COACTION	1	12.691	12.691	1.050
TASK X SEX	1	25.629	25.629	2.121
COACTION X SEX	1	0.004	0.004	.000
TASK X COACTION X SEX	1	16.504	16.504	1.366
ERROR	56	676.652	12.083	
TOTAL	63	774.148		

Appendix L

A 2 X 2 X 2 Factorial Analysis of Variance on Estimated Level of Arousal Change Scores From the Seventh to the Eighth Trial

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO
TASK	1	2.848	2.848	.091
COACTION	1	0.660	0.660	.021
SEX	1	2.066	2.066	.066
TASK X COACTION	1	5.941	5.941	.189
TASK X SEX	1	0.035	0.035	.001
COACTION X SEX	1	0.035	0.035	.001
TASK X COACTION X SEX	1	35.254	35.254	1.123
ERROR	56	1757.212	31.379	
TOTAL	63	1804.052		

Appendix M

A 2 X 2 X 2 Factorial Analysis of Variance on Scores From the First Rating Scale

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO
TASK	1	0.016	0.016	.017
COACTION	1	1.266	1.266	1.407
SEX	1	2.641	2.641	2.936*
TASK X COACTION	1	2.641	2.641	2.936*
TASK X SEX	1	0.766	0.766	.851
COACTION X SEX	1	1.891	1.891	2.102
TASK X COACTION X SEX	1	.016	.016	.017
ERROR	56	50.375	.900	
TOTAL	63	59.609		

*$p < .10$

Appendix N

A 2 X 2 X 2 Factorial Analysis of Variance on Scores From the Second Rating Scale

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO
TASK	1	0.563	0.563	.900
COACTION	1	1.563	1.563	2.500
SEX	1	0.563	0.563	.900
TASK X COACTION	1	3.063	3.063	4.900*
TASK X SEX	1	0.063	0.063	.100
COACTION X SEX	1	1.563	1.563	2.500
TASK X COACTION X SEX	1	0.063	0.063	.100
ERROR	56	35.000	0.625	
TOTAL	63			

*$p < .05$