PSYCHOLOGICAL EFFICIENCY:
AN EMPIRICAL EVALUATION OF WISHNER'S THEORY OF EFFICIENCY

by

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A DISSERTATION

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FIGURES

TABLES

PSYCHOLOGICAL EFFICIENCY

AN EMPIRICAL EVALUATION OF WISHNER'S THEORY OF EFFICIENCY

If a dictionary meaning of efficiency is adhered to, then efficiency refers to the effectiveness of an operation or activity "as measured by a comparison of production with cost in energy" (Webster's Dictionary, 1951). A similar meaning is given in the Dictionary of Psychology (Chaplin, 1968) which refers to efficiency as "the ratio of the amount of energy expended to the effect or result obtained." Physical scientists seem to use the term accordingly. Psychologists, however, have more often used efficiency synonomously with productivity (Thorndike & Woodworth, 1901; Ruger, 1910; Bills, 1943; Cofer & Appley, 1964). For example, a greater amount of material learned by one student over another might be called more efficient learning when the only measure involved might be the amount of learned material. If equal time for learning is given to both students, then one might assume that equal effort has been expended by both students. In such a case the measure of productivity can indeed be equated with efficiency.

The above assumption, however, can be challenged on the basis of an equally tenable assumption. It can be assumed that people differ in the amount of irrelevant or wasted

effort they expend during a work period. If one student wastes more effort than the other, then the assumption of equal effort by both students is untenable. One student may indeed show greater productivity than another. However, if that same student expends more irrelevant or wasted effort then he may be no more efficient than the less productive student. In terms of efficiency of effort or behavioral efficiency he may be even less efficient. Wishner (1955) has argued that mere measures of productivity omit the all important wasted behavior and that measures of productivity alone are not adequate respresentations of the notion of efficiency.

Wishner (1955) proposed a theory of psychological efficiency which attempts to relate measures of productivity and measures of wasted effort or wasted behavior. A machine analogy serves as a model for the theory of efficiency. Ordinarily the efficiency of a machine is determined by comparing the energy input to the amount of energy exerted in useful work (input/output ratio). If, however, the input is unknown, the efficiency of the machine can still be determined by comparing how much of the output is utilized in useful work and how much is wasted as heat, friction, etc. (output/output ratio). Similarly, if an organism's behavioral output can be partitioned into "focused behavior" (relevant to task demands, or useful, productive behavior) and "diffuse behavior" (irrelevant, inappropriate or wasted behavior), then the organism's efficiency can be defined

with an output/output ratio. Efficiency is, therefore, defined as "some function of the ratio of focused to diffuse behavior (E=f (F/D) where focused behavior is that behavior directly relevant to the task requirements in a controlled situation, and diffuse behavior is all other behavior excluding behavior, or energy output, required for the proper maintenance of life processes." (Wishner, 1964, p. 1).

The theory attempts, therefore, to clarify the meaning of psychological or behavioral efficiency by relating measures of productive behavior (focused behavior) to measures of wasted behavior (diffuse behavior). It seems important to determine empirically whether measures of both focused behavior and diffuse behavior remain constant or change under varying conditions. For instance, in the equation E=F/D, if D remains constant under several or all conditions, then only measures of F are necessary for statements about changes in E. An analagous argument can be made for D if F remains constant. Changes in E, however, might well be produced by changes in both F and D. If such is the case, as Wishner's theory suggests, then efficiency must not be equated with productivity but must incorporate measures of F and D as particular conditions may require.

There are numerous conditions which might have differential effects on efficiency by influencing focused or diffuse behavior or both. Wishner (1955; 1965) has suggested that efficiency decreases as a function of self-preoccupation, as

a function of stress, and as a function of psychopathology. Self-preoccupation, which is induced by instructions and which Wishner calls self centering, is the chief independent variable in this study. These self centering instructions may be viewed as stress inducing instructions or they may be viewed more objectively as simply instructions designed to direct attention to the self, the effect of which is to be determined empirically.

The relationship of psychopathology to efficiency was considered so intimate by Wishner at one time (1955) that the efficiency concept was employed as a definition of psychopathology. It was thought that as psychopathology increased then efficiency decreased in a nearly perfect, inverse relationship. The productive or focused behavior was viewed as becoming inappropriate to or inadequate to task demands as psychopathology increased. If these speculations hold true, it means that measures of focused behavior should show a decrease as psychopathology increases. This general notion of an inverse relationship between efficiency and psychopathology is still retained by Wishner but without the assertation that the relationship is one to one (Wishner, 1965). Therefore, a second independent variable, i.e., a measure of psychopathology, will be related to efficiency to further investigate this relationship.

Since efficiency has been abandoned as a definition of psychopathology (it is now considered only a correlate) efficiency is now regarded as ". . . a complicated form of

psychological activity . . . related to what is ordinarily conceived of as psychopathology." (Wishner, 1965, p. 137). In this respect efficiency can be considered to be a class of complex responses or a type of individual difference or most appropriately, a personality characteristic. Individual differences in efficiency were demonstrated by Fishbein (1965) and by Wishner, Peastrel and Fishbein (1964). Wishner went on to assert that ". . . among the interesting psychological problems is the question of how general efficiency will turn out to be as a measure of important individual differences." (Wishner, 1965, p. 152). He even proposed that eventually he expects to characterize with a number a person's general efficiency and to make practical applications of the theory to actual work situations. Further examination of this possibility will be conducted by measuring efficiency in a task that will have implications as to whether efficiency is, indeed, a general personality characteristic.

Of the numerous other variables that could be related to efficiency, sex is particularly pertinent because a previous study (Wishner, 1962) and pilot studies connected with this project have suggested tentatively that it influences efficiency. Sex, therefore, is to be the third independent variable in this study.

REVIEW OF STUDIES IN EFFICIENCY

As already indicated, efficiency is expected to vary as a function of self preoccupation. The focus of the following four studies was on self preoccupation as induced by instructions. Self preoccupation, when induced by these particular instructions, is what Wishner refers to as "self centering." Wishner (1955) and Niebuhr (1955) had hypothesized that productive work would be contingent on the ability to make one's task the center of attention and to resist making one's self the center of attention. Consequently they investigated a dichotomous independent variable which they refer to as self centering versus other centering (i.e., task centering). The technique they used for inducing self centering was to tell subjects that they were being measured for neuroticism. (The experimental procedures were then presented to subjects ostensibly as a measure of neuroticism.) Other centering was induced by some general instructions to concentrate on the experimental task and to help the experimenter in his work by cooperating.

Niebuhr (1955) studied measures of muscle action potentials of right and left arms as a function of practice and of task centering versus self centering. The muscle action potentials were taken while the subjects participated in a reaction time task which was presented as the alleged test of neuroticism. This study exemplifies one

approach at measuring efficiency by measuring the focused and diffuse behavior.

Niebuhr used two groups of student nurses with 20 subjects in each group, a self centered group versus an other centered group. Self centering was induced by the instructions described above. Other centering was induced by requesting the cooperation of the subjects in an important work involving five years of scientific investigation and the outcome of a doctoral dissertation. The experimental procedure was as follows: subjects were instructed to press down on a telegraph key with the middle finger of the right hand. Immediately thereafter a ready signal was given by flashing a light. Then a reaction time signal was given (a white light) with an interval between ready signal and reaction signal varying between three and seven seconds. Subjects were instructed to release the key as rapidly as possible after onset of the reaction signal. They were also told to keep their left hand flat and relaxed on the arm of the chair. Muscle action potentials from each arm were measured during the entire procedure. Subjects were tested on three successive days with 100 trials per day.

In the above situation muscle action potentials from the right arm represent focused activity since the instructed behavior required action in the right arm. The action potentials from the left arm represent a sample of diffuse

activity since the instructions required that the left arm muscles remain inactive.

The data indicated that the reaction times (simple behavioral productivity) for the two groups do not differ significantly. However, measures of action potentials for the left arms during the first three seconds of the preparatory response time are significantly higher ($p < .001$) for the self centered group than for the other centered group. In addition, muscle action potentials for the right arms during the same period of time are also significantly higher for the self centered group. Taken alone these findings might suggest merely that the self centered group was more tense than the other centered group. However, when the ratio of right arm action potentials to left arm potentials (i.e., F/D measures) during preparatory time for self centered group was compared to the same measure for the other centered group, then the other centered group was found to be significantly greater ($p < .001$). This result suggests that the other centered group was more efficient (i.e., had relatively more focused to diffuse activity).

A study by Wishner (1962) relating GSR conditioning to the self centered-other centered variables received its impetus from two studies by Welch and Kubis (1947a; 1947b) which dealt with GSR conditioning as a function of anxiety. Welch and Kubis found the rate of conditioning of the GSR to be greater for more anxious subjects than for less anx-

ious subjects. They had instructed all of their subjects to relax and to pay no attention to noises which might occur in the room during the experiment. Thus the more rapid conditioning of the highly anxious subjects to an auditory CS suggests that these subjects did not follow instructions well, that they formed association in definace of the instructions to relax and disregard noises. In terms of meeting task requirements, it seems that the more anxious subjects performed poorer than the less anxious subjects even though they conditioned faster. In effect, the anxious subjects were arbitrarily forming associations quickly and conceivably were behaving more diffusely by doing irrelevant things. Since greater amounts of diffuse behavior implies lower efficiency, the highly anxious group may have been less efficient.

Wishner's (1962) GSR conditioning experiment investigated the ability of other centered subjects versus self centered subjects to resist forming arbitrary associations and to form associations only as called for by experimental instructions. In the experiment efficiency was not based on direct measures of focused and diffuse behavior. The behavioral productivity of the two groups (SC versus OC) was measured under two conditions. These conditions called for subjects either to produce or not to produce associative responses. If one group showed higher productivity than the other group under instructions not

to produce then this result was interpreted as suggesting that the high production group behaved more diffusely (i.e., did things irrelevant to the instructions). If one group showed lower productivity than the other group under instructions to produce, then this result might imply that the lower group behaved diffusely. An assumption underlying this implication was that if they were not producing as instructed, they were not only doing little or nothing, but quite possibly they were doing irrelevant things. Now, if under these two conditions (produce or don't produce) the "diffuse" groups happen to be one and the same (e.g., self centered) then it would suggest that that particular group was less relevant in behavioral output, more diffuse in output and therefore, less efficient. The experimental procedures below and Figure 1 further describe this approach to inferring efficiency. This approach gives an indirect measure of efficiency without the direct measures that would give the efficiency ratio. Furthermore, this approach to measuring efficiency is one which Wishner refers to as making the same activity productive or focused under one condition and diffuse under a different condition.

Independent variables were the instructional sets of self centering versus other centering and instructions designed to produce orientations toward relaxation or problem solving activity. Instructional set was produced by the usual self centering or other centering instructions.

Orientation toward relaxation was produced by instructions to relax and disregard noises (which of course would be the CS). Thus the relax instructions meant that subjects should not produce associative responses. Orientation toward problem solving was produced by instructions to solve a problem during the experiment. Consequently, four experimental groups were involved: self centered relaxed, self centered problem solving, other centered relaxed and other centered problem solving. The dependent variable was the trials to criterion of conditioning.

Experimental predictions were set forth as statistical interactions between the principle independent variables. Efficiency theory predicted that the difference in trials to criterion between self centered relaxed and self centered problem solving groups would be in a direction different from the difference between other centered relaxed and other centered problem solving groups. Of course since the self centered subjects are theoretically less efficient, they should constitute the group that produces highly under relax or low production instructions, and they should produce lower under problem solving or high production instructions. Figure 1, adapted from Wishner's study, shows graphically the predicted results (see page 12).

The results supported the prediction in a statistically significant manner ($p < .05$). Self centered relaxed

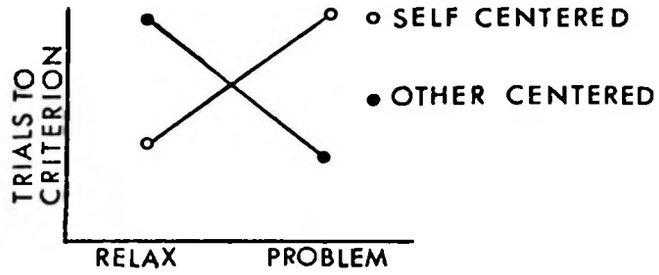

Figure 1. Interaction of SC-OC groups in trials to criterion of conditioning. Adapted from Wishner (1962).

subjects conditioned faster than other centered relaxed subjects while self centered problem solving subjects conditioned slower than other centered problem solving subjects.

Two studies were conducted by Letchworth and Wishner (1962; 1963) involving efficiency and verbal conditioning. The second study was a replication of the first with some methodological refinements. Again the independent variables were the self centering or other centering instructions and the relax or solve a problem instructions. The dependent variable was conditioned verbal behavior. The self centered and other centered groups were subdivided into a relax group who received instructions to relax and pay no attention to what the experimenter did and a problem solving group who received instruction to try to say words which would make the experimenter rap his pencil. Again, four experimental groups were involved: self centered relaxed; self centered problem solving; other centered relaxed; and other centered problem solving.

The essentials of the experimental procedure were as follows: each subject was given a stack of cards on which were typed three words. One word on each card ended in "s". The subject was asked to say one of the words on each card and then to go to the next card. An operant level was established by counting the "s" words emitted on the first 20 trials. From trial 21 to 70 the experimenter rapped a pencil on the desk every time the subject said an "s" word.

From the standpoint of efficiency theory, the important aspect of the experiment was the acquisition phase, trials 21 to 70. During this phase of the experiment, efficiency theory predicted that self centered relaxed subjects would produce a greater percentage of "s" words than other centered relaxed subjects. Also, it was predicted that self centered problem solving subjects would produce a smaller percentage of "s" words than other centered problem solving subjects.

These predictions were based on reasoning analogous to that explained in the preceeding study (Wishner, 1962). The reasoning was that if a particular group (e.g., self centered relaxed) showed greater productivity under instructions not to produce (i.e., relax) than did another group (e.g., other centered problem sovling) which was told to produce (i.e., solve a problem), then it suggests that the high production group (self centered group) is behaving

more diffusely or not as relevantly as the low production group. Also, if a particular group (e.g., self centered problem solving) shows less productivity under instructions to produce than another group (e.g., other centered problem solving), this result suggests that the low production group (self centered group again) is behaving less relevantly or more diffusely than the high production group. If these "diffuse" groups are one and the same, at least in respect to independent variables, then this "diffuse" group probably is less efficient than the other group. Efficiency theory predicted that these "diffuse" groups would be the same in respect to instructional set, namely the self centered group. Refer again to Figure 1 for graphic representation of an analogous expectation. The predictions in the two studies were confirmed at statistically significant levels (t test, $p < .025$).

Wishner, Peastrel and Fishbein (1964) investigated the relation between efficiency measures and GSR conditioning. The measure of efficiency was similar to Niebuhr's 1955 technique using muscle action potentials obtained in a reaction time task. It was predicted that subjects found to be more efficient by the action potential measures in the reaction time task would condition slower under instructions to relax in the GSR conditioning procedure than less efficient subjects. Under instructions to solve a problem in the GSR conditioning situation, the more efficient sub-

jects should condition faster. This result was expected because the more efficient subjects (as determined empirically by the muscle action potentials) should be able to follow instructions better, to behave more relevantly and less diffusely by relaxing when told to relax. They should, therefore, not form associations so readily as the less efficient subjects. Under instructions to solve a problem, they should behave more relevantly and less diffusely by forming associations quickly.

Efficiency theory also predicted a positive correlation between efficiency measures in the reaction time task and trials to criterion in the GSR conditioning situation under relax instructions. A negative correlation was predicted under problem solving instructions. These predictions were based on the notion that increasing numbers of trials to criterion in conditioning demonstrates slower formation of associations. Slower formation of associations is the relevant thing to do if told to relax as contrasted with instructions to solve a problem. Under instructions to relax, the slower formation of associations is expected if the subjects behave according to instructions (i.e., relevantly). Therefore, those subjects who are more efficient should show more trials to criterion or less productivity under relax conditions. Hence, as measured efficiency increases in subjects, trials to criterion should increase (i.e., positive correlation should result). Under

problem solving instructions, greater efficiency is reflected by forming associations as rapidly as possible. Therefore, the more efficient subjects should have fewer trials to criterion (i.e., between efficiency and trials there should be a negative correlation).

The results supported the first three predictions. For the fourth prediction a negative correlation in the predicted direction was obtained but not at a statistically significant level.

Fishbein (1965) related efficiency to inhibition of eyelid conditioning. He used the efficiency measure referred to above as developed by Wishner, Peastrel and Fishbein (1964), and he also used an experimental design analogous to the one they used. Efficiency theory predicted that relatively high efficient subjects instructed to inhibit blinking (i.e., refrain from blinking as much as possible) in the eyelid conditioning situation would produce fewer conditioned responses than subjects lower in efficiency. Under "passive" instructions (i.e., remain relaxed and do not "try to control the natural responses of the eye") relatively high efficient subjects should produce fewer conditioned responses than low efficient subjects. The results were consistent with these predictions.

Efficiency measures have been related to schizophrenia (Peastrel, 1964; Wishner, 1965) and are considered to have potential for extension into other areas of psychology such as concept formation, cognition and artistic judgements

(Wishner, 1965). However, investigation into some basic issues seems warranted at this time.

PROBLEMS

The studies cited suggest that efficiency can be measured and that Wishner's theorizing about it is valid. However, empirical evaluations of efficiency have too often involved indirect measures of the efficiency concept. The measures of focused and diffuse behavior, which define the efficiency concept, have not been isolated as dependent variables in most of the studies cited. Therefore, when any change occurs in efficiency for any person or group, it remains uncertain as to whether the change is attributable to changes in focused behavior while diffuse behavior is constant or vice versa or to change in both focused and diffuse behavior. Consequently there is a need for empirical evidence which demonstrates how measures of diffuse and focused behavior vary under different conditions.

A new task is proposed in which one activity yields a measure of the focused behavior. A different activity, which is irrelevant to the task as instructed, is to serve as a sample of diffuse behavior. From these activities, direct measures of focused and diffuse behavior will be available so that their relative contributions to the efficiency ratio can be observed under varying conditions. This study, therefore, is to incorporate three dependent

variables: focused behavior, diffuse behavior and efficiency which is defined as F/D.

The instructional sets of self centering versus other centering seemingly influenced efficiency on a number of tasks. These findings suggest that the effects of self centering versus other centering may be generalized across many tasks. The present study is designed to determine the effect of instructional set plus other independent variables on yet another task. It is, of course, an empirical issue whether these results generalize to any given task. Wishner (1965) has acknowledged that people's efficiency may be specific to certain tasks. However, he has expressed hope that efficiency in people can be characterized by a number. It may be that just as other individual differences or personality characteristics can be characterized by a number, then efficiency can be similarly expressed. If Wishner's theory holds up empirically in another task, then its plausibility as a personality characteristic would be enhanced. The present task will be considerably different from tasks used previously and should, therefore, be a reasonable test of whether the efficiency concept is applicable to another task.

Since self centering and other centering instructions have been used successfully as determinants of efficiency, these operations are to serve as the main independent variables. Efficiency theory predicts that other centering produces greater efficiency than self centering in the new

behavioral task.

The relevance of another variable to efficiency has been suggested by pilot studies connected with this project and by one of Wishner's studies also (Wishner, 1962). Furthermore certain aspects of the theory of efficiency suggest some lines of investigation. Some of these matters will be explored in a cursory manner and some more thoroughly, making the entire project a hypothesis seeking study as well as a hypothesis testing study.

For instance, Wishner's theory implies that psychopathology or gross maladjustment should be related to efficiency. Specifically, efficiency theory predicts that greater psychopathology leads to lower efficiency as a result of either lowered focused behavior scores or increased diffuse behavior scores or both. Though this project was planned for a normal population (college students), the behavior of some subjects in the pilot studies has suggested that maladjustment of even moderate proportions may effect efficiency as measured herein. This possibility will be explored by relating a measure of neuroticism (Eysenck, 1962; Eysenck & Eysenck, 1963) to efficiency. Neuroticism is to be the second independent variable under consideration. It is predicted that a higher neuroticism group will show less efficiency than a lower neuroticism group. On the basis of efficiency theory the correlation between neuroticism and efficiency is expected to be a negative one. Furthermore, efficiency theory would lead one to expect a

negative correlation between neuroticism and focused behavior and a positive correlation between neuroticism and diffuse behavior. These correlations will be investigated.

On the basis of pilot studies associated with his published work, Wishner (1962) suggested that sex might be a variable influencing efficiency and therefore included sex of subject as an independent variable. Though his results did not show great enough differences to be statistically significant, they suggested that males are more efficient than females. Other studies related to the generality of efficiency have used subjects of only one sex (Niebuhr, 1955; Letchworth & Wishner, 1962; 1963; Wishner, Peastrel & Fishbein, 1964) or have used random sampling and have avoided the issue (Fishbein, 1965). Pilot work on the present task has suggested that males are more efficient than females, at least under the conditions specified. For the third independent variable, this study is to evaluate the influence of sex on efficiency. On the basis of the literature, it is predicted that males are more efficient than females.

GENERAL METHODS

Task Equipment

The proposed measure of efficiency occurs in a vigilance like task utilizing the equipment described below (for a description of the programming and recording equipment see appendix A). Figure 2, page 23 is a picture of the experimental set up.

A black panel 315 by 255 mm (milimeters) at its face and 115 mm deep is mounted above a work bench. Two signal lights (28 volt aircraft beacon type bulbs) are mounted in the panel side by side, 40 mm from center to center. They are separated by an opaque partition and are mounted behind a milk glass cover. Overlaying the milk glass is a black cover into which are cut two square apertures, one in front of each light, 20 by 20 mm in size and 20 mm apart. Narrow bands 5 mm wide are cut at the top of and to one side of each aperture. These allow an inverted "L" shaped rim of light to accompany each aperture light. The horizontal bands at the top of each aperture are 60 mm above the apertures and extend outward from the partition for 140 mm. The vertical bands are 110 mm to either side of the apertures and extend from the outer edge of the horizontal band downward for 145 mm. (These lighting sizes and arrangements were selected after preliminary trials with various sizes and arrangements of lights. This combination seemed to produce less fatigue and to keep the

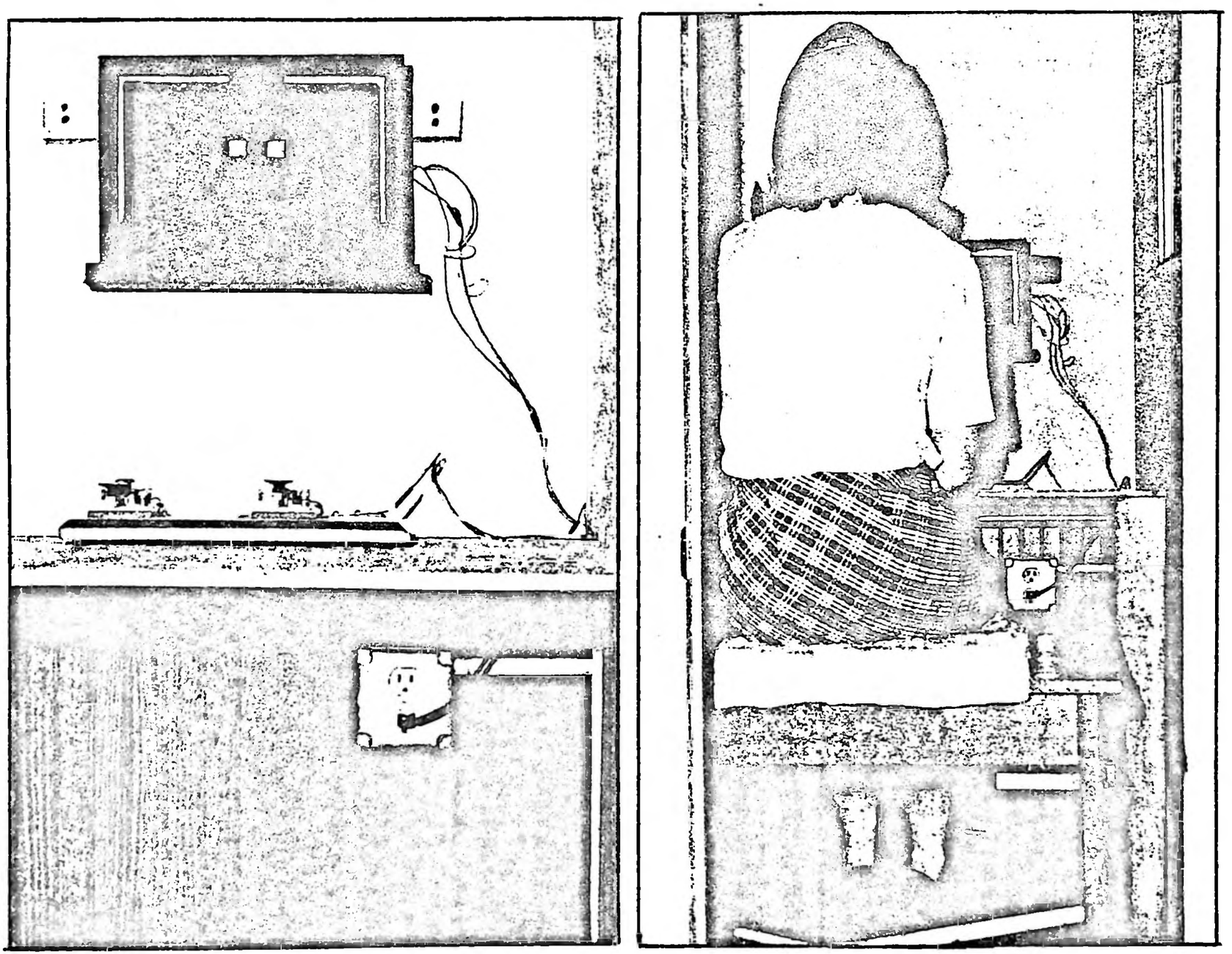

Figure 2. Task equipment in subject's work area.

subjects' eyes fixed on the lights better than other arrangements.)

The work bench top is 40 inches from the floor and is 48 inches long and 20 inches wide. The panel is mounted 10.5 inches above the top at the back side of the bench so that when a subject sits at the bench, the panel is approximately at eye level.

The subject sits on an elevated seat consisting of a foam rubber cushion mounted on top of a small table. The table rides on casters to allow for easy positioning. This seat is 32.5 inches from the floor and insures that the subject's legs hang freely with feet off the floor and off any other support.

On the bench beneath the panel is a board on which are mounted two telegraph keys with 155 mm between the center of the finger positions. The keys serve as switches that close electrical circuits which provide pulses of current for recording hand movements. These keys have set screws which allow variation in the amount of vertical movement of the key and variation in the mechanical resistance to operate the key. The keys are set and maintained at their settings for all subjects by locking the set screws with lock nuts.

A pair of small transducers (about the size of a nickel) are mounted on the wall in front of the subject but are concealed from view under the work bench. They are

34 inches above the floor and six inches below the work bench. This locates them about 8 to 10 inches in front of and slightly above the subject's knees and about 25 to 30 inches above the feet (distance varies with subjects). The transducers are part of an ultra sonic activity recording device (see appendix A and Peacock & Williams, 1962). On pilot studies IV and V, the transducers were mounted to the right and rear of the subject's ankles.

Task Description

The task requires that the subject respond to the signal lights by pressing and releasing the keys as the lights go on and off. As long as a light is on, the key below it should be pressed, but whenever the light is off, the key should be released. The subject's task is essentially to remain on target with key responding with both keys. For a specified number of trials both lights go on and off simultaneously with both on and off durations being 1.000 seconds. Consequently a rhythmic pattern of responding with both hands is established. A stepper switch and the relays used to program and record the events emit clicks which occur simultaneously with the lights and which can be heard by the subject. Presumably these clicks enhance a tendency toward rhythmic responding. This rhythmic pattern of events continues for 25 trials which constitutes the warm-up period.

For the actual test task session (180 trials) the rhy-

thmic presentation of signal lights is changed so that one third of the trials have a special arrangement. On these special trials the right light remains on 1.500 seconds. Thus both lights continue to come on together, but the right light stays on .500 seconds longer than the left light. These special trials occur randomly and, as noted, for about 33 % of the total trails.

The task requires that on these special trials subjects must resist releasing the right key prematurely. In holding the right key down the extra .500 seconds, subjects must release the left key at its appropriate time and must resist holding it down in coordination with right hand activity. Furthermore, on two thirds of the trials, subjects must not hold down the right key beyond the 1.000 second on period of the right light. In brief, subjects must resist a rhymthmic, coordinated activity which seems to occur easily and "naturally" and must perform according to instructions (i.e., appropriately). The task involves doing two things at once, each of which tends to influence the other but neither of which necessarily forces the other. Thus a person can do them both, and except for reaction time limits, subjects conceivably can do them perfectly.

This rather elaborate task was devised with a variety of purposes intended, some of which do not pertain to the present study. Its advantages include the provision for flexibility in manipulating variables such as stress

or task demands. The task requirements were made rather demanding with the assumption that if a subject tried to perform the task at all, then he would be enticed to try very hard. Hopefully these efforts would maintain motivation at peak levels for all subjects.

Measure of Efficiency (Dependent Variables)

The measure of focused behavior is the time on target of the left hand. This left hand activity is relevant to the task, it is in accordance with task instructions, and it is productive in terms of what the task requires. As such it coincides with the theoretical definition of focused behavior.

The measure of diffuse behavior is obtained from the activity of the subject's feet and legs. Foot and leg movement is not only irrelevant to the task demands but also is in defiance of instructions to relax and remain still except for arm and hand movements. Consequently these movements fit the theoretical requirements of diffuse behavior and are a sample of diffuse behavior. The ultra sonic activity recorder gives a measure of total amount of foot and leg movement.

The efficiency measure is the ratio of focused to diffuse behavior (F/D). Certain adjustments in the diffuse measure are required, but these are explained in pilot study V.

General Procedures and Instructions

In the pilot studies some of the procedures were varied as needed (primarily the instructions). From these pilot studies standard procedures were developed which fulfilled the requirements of the project.

In the experimental task, each subject was seated on the elevated seat in the task area (in pilot studies I through III where diffuse measures were not taken, the work bench and seat were not elevated so that subjects' feet were on the floor). The experimenter stood beside the subject while reading all of the instructions except for the stance taken behind or to the side of the subject in pilot study I. Some refinements in the standard instruction were made from time to time over the course of the pilot studies. For pilot studies I through V the self centering or other centering instructions were read first, followed by the standard instructions. For subsequent pilot studies and for the main experiment, the standard instructions were read first.

Self centering instructions.

> The work task I am going to give you to do is a test of neuroticism and when completed I can tell how neurotic you are. This test may seem unusual to you, but as you may know psychologists have been able to develop very simple tests to determine basic personality structure. In this test your behavior is being evaluated. I cannot tell you how the test works now, but I will explain it later. (Following the standard instructions, these subjects were given this additional comment:) Remember that how poorly you do tells how neurotic you are, so do your best.

Other centering instructions.

> The experiment in which I have asked you to

participate is part of a research project. This study is the culmination of several years of research and reading, and its success or failure will affect the entire project. As you can see we have a lot involved in terms of time and work, and I hope that you will give me all the assistance you possibly can by doing your best. Following the standard instructions these subjects were given this additional comment: Remember that the entire project depends on this part of the study so please do your best.

Standard instructions.

I want you to sit naturally; do not cross your ankles or legs, but arrange yourself comfortably in a relaxed position so that you can press these keys with your fingers. The only activity you are to engage in is pressing the keys, and otherwise relax. You may use one or more fingers to press with. Always press the right key with your right hand and the left key with your left hand. We have found that you can work more comfortably by resting your forearms on the table. Since you will need to press and release the keys as quickly as you can, it will help you to arrange your fingers like this; put one or two or three fingers on the board beside the keys (experimenter gestures with three fingers beside the board) while you work the keys with your index fingers or any fingers you wish to use which are not on the board. This way you support your key fingers so that they remain on the keys at all times. Should you release a key very suddenly, your finger will not jump up far above the key but will remain right with it, and you are in position, ready to deliver your quickest response the next time you press.

Now practice pressing both keys a few times to get the 'feel' of it. (Let subject press both keys a few times.) Whenever you intend to hold down a key for a period of time, be sure you hold it down firmly enough so that contact will be maintained. (Point out contacts to subject and demonstrate how too light pressure breaks contact). You may move the board on which the keys are mounted to make the arrangement more comfortable if you wish.

The two lights in the panel in front of you will be going on and off periodically. Your task is to hold down the right key when the right light is on and let it remain up when the light is off.

Do the same with the left key in response to the left light. Always respond with right hand and right key to the right light and left hand and left key to the left light, regardless of what the other light is doing or of the noises you will be hearing. Your accuracy in doing this is determined by how quickly you respond in pressing and releasing the keys and, of course, by doing the correct thing at the right time with the appropriate key. You may anticipate when the light is coming on or going off and thus speed up your responses. But you must watch both lights and respond to each one with the appropriate key at the right time so that you are on target as much as possible.

Do you have any questions?

I will give you a series of trials which we call a warm-up series and then stop for a pause and start the final series of trials. We will be ready in a few minutes, at which time I will instruct you to put your fingers in position and hold down on the keys until the lights come on. This way you will have a perfect start with the keys already down as the lights come on, which marks the beginning of the task. Your next moves will then be to release the keys as the lights go off, press as lights come on and so forth. We will be ready in a few minutes.

(When ready to start, experimenter reads the following:) Now put your fingers in position and press down on both keys. Hold them down firmly so you will be on target when the lights come on. (Following the 25 warm-up trials, these preparatory instructions are repeated to begin the next phase.)

As already noted the content of the standard instructions was refined from time to time. The content of self centering and other centering instructions was the same for all subjects except for slight variations as specified in pilot study VI.

Preliminary Investigations: Summaries and Implications.

Investigation of efficiency in the manner outlined required a series of pilot studies. These studies were

conducted to deal with such issues as reliability of the equipment, the development and evaluation of the general procedures and instructions, and the reliability of the measures. They also explored the relationships between some variables. In the course of these studies some unexpected issues were confronted. A complete description of the seven pilot studies and the issues confronted are presented in detail in appendix B. A summary of the main issues and problems raised and resolved in these pilot studies is presented below.

Pilot studies I, II and III were concerned with establishing the reliability of the equipment and the reliability of the focused behavior measure. These studies also dealt with the development of the procedures and instructions. The procedures and instructions described in the preceding section (General Procedures and Instructions) evolved largely from pilot studies I, II and III. Reliability of the equipment was demonstrated without the occurrence of any significant malfunctions. The reliability of the focused behavior measure was demonstrated (test-retest, $r = .97$) after one precaution was taken. Subjects were questioned, and if they reported that they were significantly fatigued or sick at the time of testing, then they were rescheduled for testing at some time when they could report in without fatigue or sickness.

All subjects were questioned on these issues and were asked to return another time if they replied affirmatively.

Pilot study IV was concerned with an evaluation of the measure of diffuse behavior. It also was concerned with the effect of self centering versus other centering on efficiency, predicting that self centering would lead to lower efficiency scores. The measure of focused behavior proved to be so variable that though efficiency scores were in the direction predicted, the difference was not significant. Subsequent analysis of these efficiency scores utilizing a logarithmic transformation of diffuse scores as described in pilot study V did, however, result in a significant difference ($p < .001$).

Pilot study V was concerned primarialy with finding ways to reduce the variability of the diffuse scores and with a test-retest reliability check of both the focused and diffuse behavioral measures. This study also attempted to investigate the effects of three independent variables on the efficiency ratio. These independent variables were: instructional set (self centering versus other centering); ability level (high versus low scholastic aptitude test scores); and, sex (male versus female). Three techniques were found for reducing variability of the diffuse scores: transformation of raw scores to logs; rejection of subjects who qualify as "leg swingers" (see pilot study V for specifics); and rejection of Negroes as subjects. (Note: rejection of Negroes is a tentative step and even then is applicable probably only to certain people representing particular personality characteristics as found in those Negro students within the college population from which

samples for this project were drawn.) Test-retest reliability coefficients for diffuse measures were .73 for twenty of the forty subjects (those designated as self centered) and .67 for the other twenty (the other centered subjects). Reliability coefficients for the focused measures were .78 (twenty self centered subjects) and .60 (twenty other centered subjects). Males were found to be more efficient than females (F test, $p < .05$, one-tailed). Whatever effect on efficiency was produced by instructional set was masked by the variability, but after applying the techniques for reducing variability, the data suggested that other centered subjects are more (though not significantly more) efficient. The evidence obtained did not suggest that ability levels produce differences in efficiency.

Pilot study VI consisted of two experiments in which the effects of instructional set on efficiency were evaluated. Both experiments were also concerned with the effectiveness of the procedures already described for reducing variability, namely: omission of Negroes, rejection of "leg swingers," rescheduling for testing the sick and fatigued, and transformation of diffuse scores to logs. Furthermore, experiment I introduced a matching procedure on diffuse scores to help control for variability. Experiment II altered the procedures so that instructional set was given after the standard instructions, and an additional stress variable was added in hopes of influencing efficiency. Results from experiment I indicated that with the matching

procedure, other centering results in higher efficiency scores than self centering (Sandler's A test, $p < .025$, one-tailed). Moreover, the variability of the efficiency scores was considerably less than in previous pilot studies. In experiment II, results on efficiency from the additional stress variable were inconclusive because of disrupted behavior by the subjects. When instructional set was given after the standard instructions other centeredness lead to significantly greater efficiency ratios (Sandler's A test, $p < .01$, one-tailed). Moreover, this significant difference was obtained without recourse to matching procedures as done in Experiment I. Finally, the variability of efficiency scores was, again, encouragingly low.

Pilot study VII included two correlational studies which investigated the relationship between efficiency and neuroticism. In these two studies correlation coefficients between efficiency and neuroticism were obtained on four groups of subjects. These correlations were: -.25, -.72, -.85 and -.93. The latter two are significantly different from zero ($p < .05$ and $p < .01$ respectively, one-tailed, chart of critical values of r, Runyon and Haber, 1967). Correlations were also obtained for neuroticism and focused behavior and neuroticism and diffuse behavior on one group. These correlations of -.89 between neuroticism and focused behavior and +.78 between neuroticism and diffuse behavior are significantly different from zero ($p < .01$, one-tailed chart of critical values of r, Runyon and Haber, 1967). All

of these correlations fit theoretical expectations and were interpreted as encouraging to the notion that mild, as well as gross maladjustment (i.e., psychopathology) lead to reduced efficiency.

METHOD

This experiment dealt specifically with the issues described on pages 18 through 21. It incorporated the equipment, the measures of dependent variables, and the general procedures and instructions described on pages 22 through 30. It also incorporated the modifications in procedures, instructions, and treatment of data as suggested by the pilot studies. The specific modifications are specified below as they occur. In order to avoid restriction of the sample it was planned that a group of Negro subjects be studied. However, failure to obtain volunteers for this group forced cancellation of the plan.

An investigation of whether scores of focused behavior are related to diffuse behavior was also conducted. This relationship had not been reported in the pilot studies connected with this study, and even though very low corrlations between focused and diffuse scores had been obtained in some of the pilot studies, there was no systematic investigation of this relationship available. Knowledge of this relationship was sought because of the possibility that these dependent variables might be systematically related to one another. A high correlation between the two variables could suggest that they are not independent measures (i.e., one may influence the other or perhaps they could be measures of the same thing). There would be the possibility that one measure contaminates the other. A low correlation between focused and

diffuse behavior scores would support the assumption that they measure substantially different things.

Method

A two by two factorial design was used. Independent variables were the dichotomous variables of neuroticism, sex and instructional set. Dependent variables were focused behavior, diffuse behavior, and the efficiency ratio. The correlation between neuroticism and the three dependent variables was also investigated. Finally, the correlation between focused and diffused behavior scores was investigated.

Subjects. Subjects were selected from a group of volunteers solicited from introductory courses in psychology and sociology at Stetson University. The procedures and instructions used in soliciting volunteers and selecting subjects are described below in the procedure section. Two subjects were rejected as "leg swingers" in accordance with rejection criteria specified in pilot study V. Both subjects were female. One male subject was lost because after rescheduling for testing due to sickness (in accordance with rescheduling procedures specified in pilot study II), he failed to return. Counting these three subjects, a total of 43 subjects were selected to be tested for efficiency from a pool of 80 volunteers.

Forty subjects were used, five in each of the eight cells of the factorial design. High and low neuroticism groups were identified by testing the entire group of 80

volunteers for neuroticism on the Maudsley Personality Inventory (1962). The extra subjects were obtained to allow for rejection and loss of subjects as might be required. Those people falling in the upper and lower halves of the measure of neuroticism served as high neurotic and low neurotic groups. These groups were subdivided on a sex basis for male and female groups. Finally, the male and female groups were subdivided into self centered and other centered groups. This selection method gave an arrangement of groups as shown below:

High neuroticism:	Male :	Self centered
		Other centered
	Female:	Self centered
		Other centered
Low neuroticism:	Male :	Self centered
		Other centered
	Female:	Self centered
		Other centered

For high neuroticism subjects the mean neuroticism score was 32 with a range of 26 to 44. For low neuroticism subjects the mean neuroticism score was 15 with a range of four to 24.

Procedure. Before any volunteers were accepted, the students in the courses from which subjects came were given brief instructions about the project and about volunteering. These instructions, which are reproduced in Appendix D, included a statement to the effect that the procedures would be stressful and that anyone who wanted to do so could with-

draw from the project at any time. When each of the 80 volunteers came for the first testing session, the test for neuroticism, he or she was instructed individually about the stress involved in some of the procedures and was reminded that he or she sould withdraw at any time. These instructions are reproduced in Appendix D. No subjects withdrew from the experiment after volunteering except the one subject who failed to return after being rescheduled.

After being tested for neuroticism the subjects were subdivided into high and low groups as described above. They were then selected randomly from the eight groups (i.e., eight cells) for testing in the efficiency task. Each subject was tested for efficiency after being given the standard instructions and the appropriate self centering or other centering instructions following the warm up period.

After all subjects were tested for efficiency, all volunteers were invited to a group debriefing session. The content of this debreifing given by the experimenter is outlined in Appendix E.

RESULTS AND DISCUSSION

Results

Before statistical analysis of the results was conducted the diffuse scores were transformed to logarithms as called for in pilot study V. This transformation is necessary to normalize the diffuse data which tends to be positively skewed (see pilot study V).

The means and standard deviations for scores of efficiency, focused behavior and diffuse behavior are presented in Table I (page 41). These scores are shown as they occur as functions of neuroticism, sex and instructional set. Means that are significantly different (identified by parentheses and asterisks) were established as significantly different by the analyses of variance specified below.

Results of an analysis of variance for each of the dependent variables, i.e., efficiency, focused behavior and diffuse behavior, are presented in Tables 2, 3 and 4 (pages 42, 43 and 44). The results in each of these tables comes from a two by two by two analysis of variance based upon a Lindquist three dimensional design (Lindquist, 1953, pps. 220-228).

Focused behavior and diffuse behavior scores. The results of most immediate interest are those concerning focused behavior and diffuse behavior as shown in Table I. Scores of focused behavior show significant differences relative to neuroticism and to sex but not to instructional set. Scores of diffuse behavior show significant differences re-

Table 1

Means and Standard Deviations:

Dependent Variables as Functions of Independent Variables

Independent Variables:	Dependent Variables:		
	Focused Behavior Scores	Diffuse Behavior Scores	Efficiency Scores
Neuroticism:			
High neuroticism mean:	(279)*	210.8	(135.9)*
Low neuroticism mean :	(296)	202.3	(148.7)
High neuroticism S.D.:	21.3	22.59	21.3
Low neuroticism S.D. :	25.4	26.91	21.7
Sex:			
Male subjects, mean :	(296)*	(198.4)*	(152.9)**
Female subjects, mean:	(279)	(214.7)	(131.7)
Male subjects, S.D. :	18.8	20.24	18.5
Female subjects, S.D.:	27.4	26.97	21.0
Instructional Set:			
Self centered mean :	285	(215.5)*	(134.0)**
Other centered mean :	291	(197.6)	(150.7)
Self centered S.D. :	28.8	29.51	21.1
Other centered S.D. :	20.1	15.46	20.6

Note.— Efficiency scores and diffuse scores (which are log transformations) have been multiplied by 100 for computational purposes.

Groups of numbers in parentheses ( ) indicates means that are significantly different.

* $p < .05$

** $p < .01$

Table 2

Analysis of Variance: Efficiency Scores

Source	df	MS	F
Neuroticism (A)	1	1639	4.82*
Sex (B)	1	4495	13.22**
Instructional Set (C)	1	2790	8.20**
A x B	1	0	
A x C	1	0	
B x C	1	408	
A x B x C	1	18	

* $p < .05$
** $p < .01$

Table 3

Analysis of Variance: Focused Behavior Scores

Source	df	MS	F
Neuroticism (A)	1	3081	5.51*
Sex (B)	1	2976	5.32*
Instructional Set (C)	1	355	
A x B	1	3	
A x C	1	37	
B x C	1	554	
A x B x C	1	107	

* $p < .05$

Table 4

Analysis of Variance: Diffuse Behavior Scores

Source	df	MS	F
Neuroticism (A)	1	731	
Sex (B)	1	2673	4.84*
Instructional Set (C)	1	3222	5.84*
A x B	1	198	
A x C	1	81	
B x C	1	838	
A x B x C	1	21	

* $p < .05$

lative to sex and to instructional set but not to neuroticism. The directions of these differences are summarized as follows.

High neuroticism subjects have lower focused scores than low neuroticism subjects, but these two neuroticism groups have no significant differences in diffuse scores. Self centered subjects have higher diffuse scores than other centered subjects, but these two groups have no significant differences in focused scores. Male subjects have higher focused scores than females, and males also have lower diffuse scores.

Efficiency scores. Efficiency scores are derived from F/D, and therefore, the differences in efficiency scores for the three experimental groups are contingent on differences in focused and diffuse scores. For the efficiency scores, it can be seen in Table I that self centered subjects show lower efficiency than other centered subjects; females show lower efficiency than males; and high neuroticism subjects show lower efficiency than low neuroticism subjects.

Correlation results. The Pearson product-moment correlation between focused behavior scores and diffuse behavior scores is +.003. The scatterplot for this relationship (not shown herein) can be described as having extreme scattering of the points and as consistent with the low correlation.

Correlations between neuroticism scores and scores of the three dependent variables are presented below. Scatterplots for these three relationships are presented in Figures

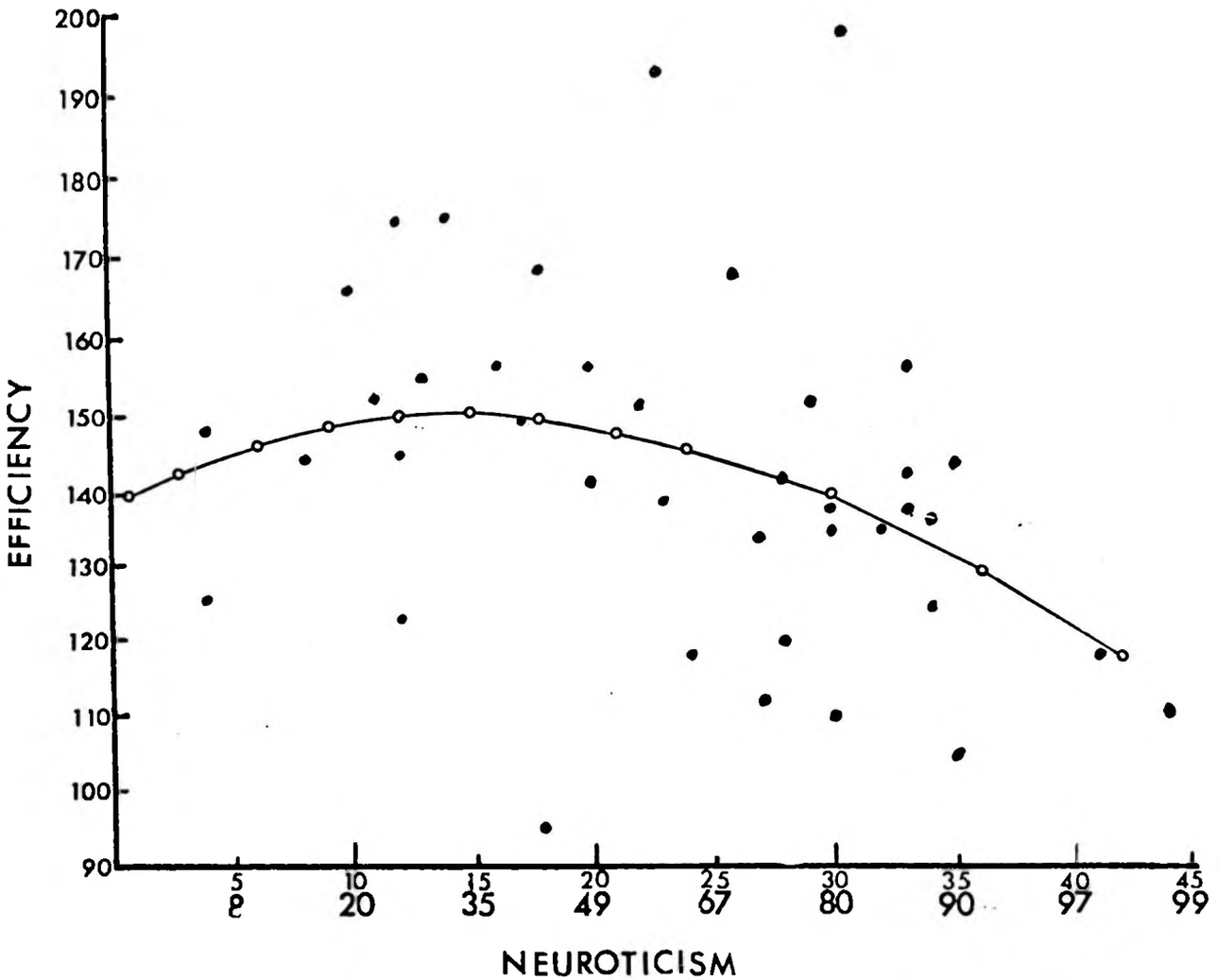

Figure 3. Scatterplot of efficiency scores as a function of neuroticism raw scores and centiles obtained on the Maudsley Personality Inventory (bottom row of numbers on the abscissa are centiles). Efficiency scores have been multiplied by 100 to eliminate decimals.

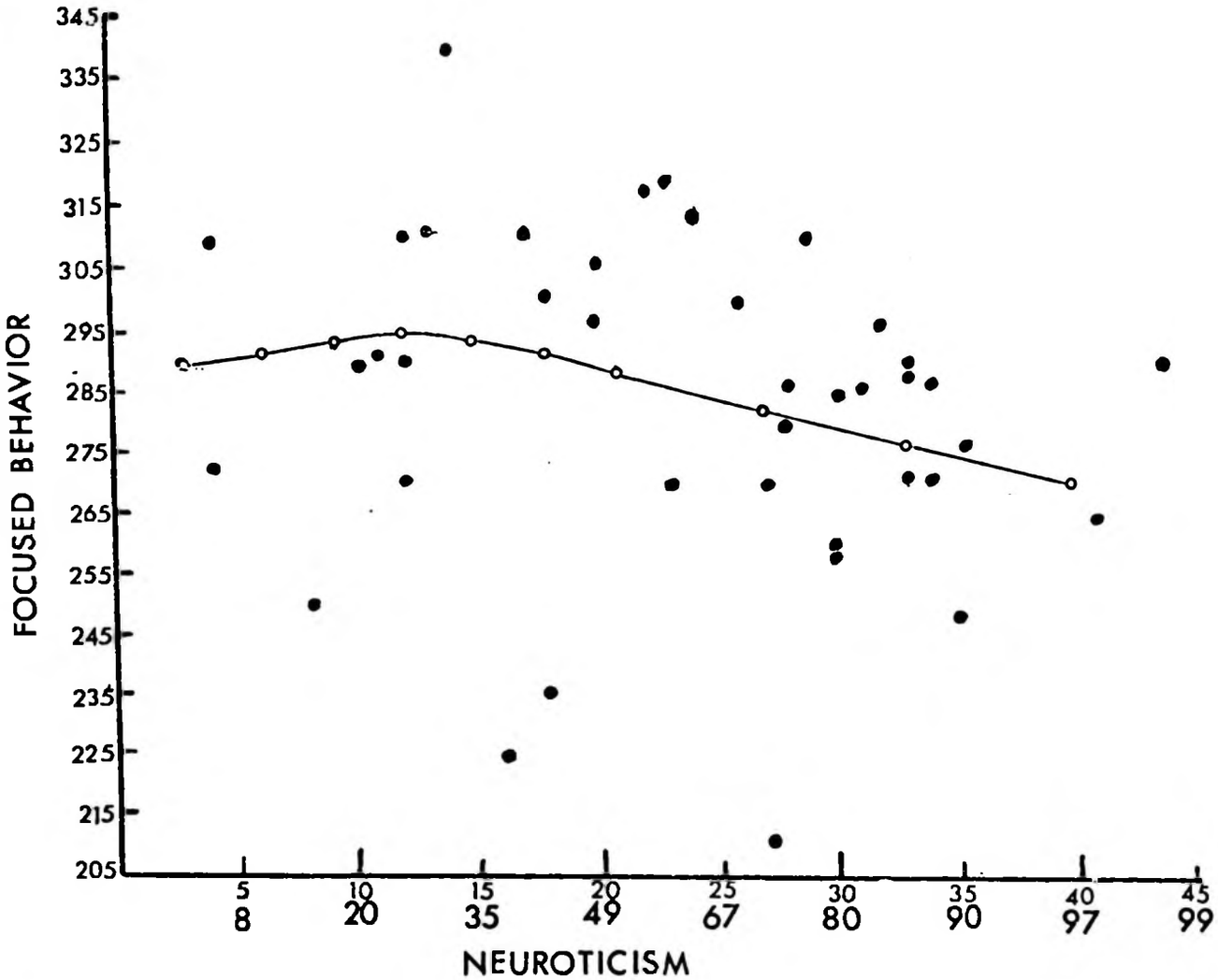

Figure 4. Scatterplot of focused behavior scores as a function of neurotism raw scores and centiles obtained on the Maudsley Personality Inventory (bottom row of numbers on the abscissa are centiles). Focused behavior scores are time on target in seconds.

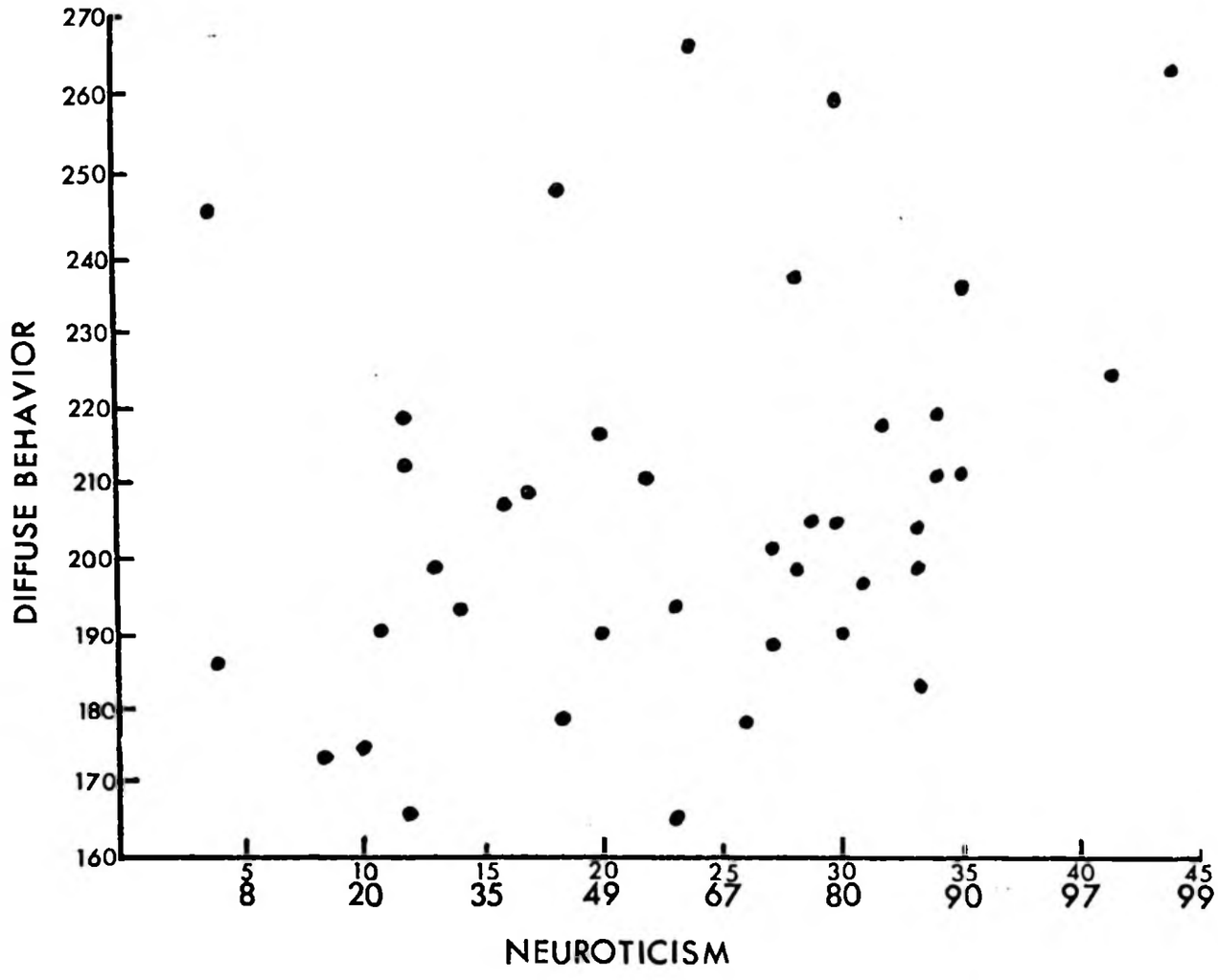

Figure 5. Scatterplot of diffuse behavior scores as a function of neuroticism raw scores and centiles obtained on the Maudsley Personality Inventory (bottom row of numbers on the abscissa are centiles). Diffuse behavior scores are log transformations of raw scores multiplied by 100 to eliminate decimals.

3, 4 and 5 (pages 46, 47, and 48) with curvilinear regression lines for both the efficiency scores and the focused behavior scores as related to neuroticism. Because a possible curvilinear relationship was suggested by these two scatterplots (see Figures 3 and 4), both linear and curvilinear relationships were investigated.

The following linear coefficients are Pearson product-moment correlation coefficients. The curvilinear correlation coefficients are coefficients obtained from second degree curves fitted to the data as suggested by Croxton and Cowden (1955).

Neuroticism and efficiency, r =-.29 (linear);

r = .37 (curvilinear);

Neuroticism and focused behavior, r =-.20 (linear);

r = .25 (curvilinear);

Neuroticism and diffuse behavior, r =+.30 (linear).

These coefficients were tested for significant differences from zero. Of the three linear coefficients, only the +.30 between neuroticism and diffuse behavior is significant at the .05 level (one tailed, chart of critical values of r, Runyon and Haber, 1967). F tests of significance from zero for the two curvilinear correlations (Croxton and Cowden, 1955) show that the r of .37 is significant, but only at the .10 level, and that the r of .25 is not significant even at the .10 level.

Tests of linearity as described by Hays (1963) were computed for the relationships between neuroticism and the

three dependent variables, efficiency, focused behavior and diffuse behavior. A *t* test of linearity for the neuroticism-diffuse measure relation yields a *t* value significant at the .10 level. Four *F* tests of linearity were computed for the other two relationships. Of these four, the only significant *F* value ($p < .05$) is for a linear relationship between neuroticism and efficiency. The *F* value is not significant ($p > .10$) for the curvilinear relationship between neuroticism and efficiency, and *F* values are not significant ($p > .10$) for either linear or curvilinear relationships between neuroticism and focused behavior.

Discussion

Implications of F and D scores for measures of efficiency. Table I shows that changes occur in both focused and diffuse behavior as a function of the three experimental conditions. With such changes taking place, one cannot safely assume that either focused behavior or diffuse behavior will remain constant under all conditions. If efficiency is to be expressed as $E=F/D$, one should not assume that F or D remains constant for any given condition until it is empirically demonstrated that it is constant. Therefore, the expression of efficiency by the ratio F/D will require that both F and D be accounted for under each given condition. The above data are interpreted as a demonstration that behavioral measures necessary to efficiency (as conceptualized by Wishner) are obtainable and necessary. Alternatives to these requirements for studying efficiency would entail an input/output ratio

or else indirect measures of efficiency as adopted in some of the studies reviewed earlier.

It should be noted that even if both F and D were found not to be significantly different as a function of some independent variables, then both measures might still have to be accounted for in the study of efficiency. It would still be possible for a significant difference in E to occur as a function of some variable if the difference in F was in one direction and the difference in D was in another direction. That is, if F is going up and D is going down, the E ratio could be significantly changed even though F and D individually are not significantly changed. Therefore, one should be leary of assuming that just because one variable in the F/D expression remains relatively constant (i.e., shows no significant changes) then a measure of the single other variable is all that is needed to show whether E changes.

Relationships between independent variables and dependent variables. A second group of findings concerns the effects of the independent variables on efficiency and on focused and diffuse behavior scores. The data from Table I shows that all three predictions concerning effects of the three independent variables on efficiency are supported. The effects of instructional set and neuroticism are especially interesting because of their close theoretical relationship to efficiency. The sex variable is somewhat parenthetical but adds meaning to the study.

As previously indicated self centering and other centering have played prominent roles in research on efficiency. Their effect on efficiency has been confirmed repeatedly so that a rather reliable S-R relationship has been established. The consistency of this S-R relationship adds to the reliability of the efficiency concept as a characteristic human behavior. The fact that this characteristic is revealed in this new and different task supports the notion that efficiency generalizes across tasks. In effect, added support is given to the possibility that efficiency is a general personality characteristic.

The relationship of sex to efficiency is consistent with previous suggestions that males are more efficient than females. However, the lack of experimental replications of this finding makes it less certain than the relationship between instructional set and efficiency. A final comment about the sex-efficiency relationship is in order. Though this relationship is not critical to efficiency theory, it is an interesting O-R relationship that adds meaning to efficiency as a personality characteristic.

The successful prediction that high neuroticism would lead to lower efficiency gives empirical support to an extension of Wishner's theorizing about psychopathology and efficiency. As noted earlier, Wishner considers efficiency to be a correlate of psychopathology and considers it as related to maladjustment and stress generally. The only

studies, however, which dealt specifically with these relationships were limited to the study of hospitalized psychiatric patients. The present findings can be considered to "bridge the gap" between studies of the relationship of efficiency to extreme psychopathology and to less extreme psychopathology.

The neuroticism-efficiency relationship can be considered from another point of view also. If neuroticism and efficiency are considered to be complex response patterns or personality characteristics, then their relationship stands as an interesting R-R relationship.

This relationship between neuroticism and efficiency is more precisely described by the focused and diffuse scores in Table I and by the correlation data and the graphs in Figures 3, 4, and 5. Efficiency theory suggested that higher neuroticism should lead to lower focused behavior scores and to higher diffuse behavior scores. These trends are obtained although when examined for significant differences the diffuse behavior scores are not significantly different.

Implications of correlational data. The extremely low correlation between focused behavior and diffuse behavior scores supports the assumption that two different and independent activities are being measured without one activity systematically influencing the other and, thereby, contaminating the measures.

The correlational relationships between neuroticism and the three dependent variables can be considered as generally consistent with efficiency theory even though they do not give strong support to the theory. Only the neuroticism to diffuse behavior relationship shows a statistically significant correlation (+.30) combined with a statistically significant trend (linear) which are both consistent with theoretical expectations. For the neuroticism to efficiency relationship, only the curvilinear correlation coefficient (.37) is statistically significant, and it is made suspect by the fact that only a linear trend is statistically significant and not a curvilinear trend. For the neuroticism to focused behavior relationship, the data offers no statistically significant support for theoretical expectations.

The fact that the correlations between neuroticism and the three dependent variables are low and that suggestions of curvilinearity appear are interpreted as raising additional problems for investigation. For example, the present sample of 40 subjects does not have enough representation at the lower range of neuroticism. Less than half of the subjects (16 of 40) fall at the 50th centile or below (based on college norms supplied with the test of neuroticism). Increasing the number of subjects and the range of neuroticism scores in a follow up study should give a better idea as to whether linear or curvilinear trends are evidenced. Such an extension may also change the cor-

relation coefficients. It is quite possible, however, that the dependent variables involved may be a function of so many other variables or of such powerful other variables that neuroticism may be obscured as a variable related to these dependent variables.

A question might be raised as to why the present correlations are much lower than most of those found in pilot study VII which investigated these same relationships. Also, the suggestions of curvilinearity are in contrast to the linear relationships obtained in pilot study VII. (These relationships were not presented graphically in that study, but the scatterplots have been retrieved for presentation below. Unfortunately, the raw data and the scatterplot for group C was lost and can not be shown.) These differences may be attributable to several factors, but an obvious possibility are some differences in ranges of neuroticism scores between subjects in pilot study VII and subjects in the present study.

The range of neuroticism scores for subjects in the present study is much greater than was obtained on subjects in pilot study VII. For the present study, the range of neuroticism scores was from four to 44 on the Maudsley test (expressed as 6th centile and 99th centile to make them comparable to neuroticism scores obtained on the Eysenck test).

The range of neuroticism scores for subjects in pilot study VII, experiment I, group A was from the 77th centile to the 95th centile (raw 29 to 38) on the Maudsley test.

For this same group the correlation between neuroticism and efficiency was -.85. The scatterplot presented in Figure 6 (page 57) suggests a linear relationship. For group B of the same experiment, the range of neuroticism scores was from the 27th centile to the 96th centile (raw, 6 to 18) on the Eysenck test. For this group the correlation between neuroticism and efficiency was -.72. Again, a linear relationship was suggested as shown in Figure 7 (page 57).

These ranges of neuroticism scores from the various groups in pilot study VII can be compared to the data in the present study by referring to the centile numbers on the abscissa of the scatterplot graphs. In Figure 3, consider only the plotted points between the centile scores of 77 and 95 for comparing group A and 34 and 96 for comparing group B. Within these ranges the relationship for neuroticism and efficiency in the current study is quite similar to the relationships obtained for groups A and B shown in Figures 6 and 7.

A similar comparison can be made for the group of ten subjects in experiment II of pilot study VII. In this group, neuroticism scores on the Maudsley test ranged from the 55th centile to the 95th centile (raw, 21 to 38). The correlations between neuroticism and efficiency and neuroticism and focused behavior were -.93 and -.89 respectively. For these data the scatterplots indicating linear relationships are shown in Figures 8 and 9 (pages 58 and 59). By comparing Figures 3 and 4 with 8 and 9 it can be seen that the

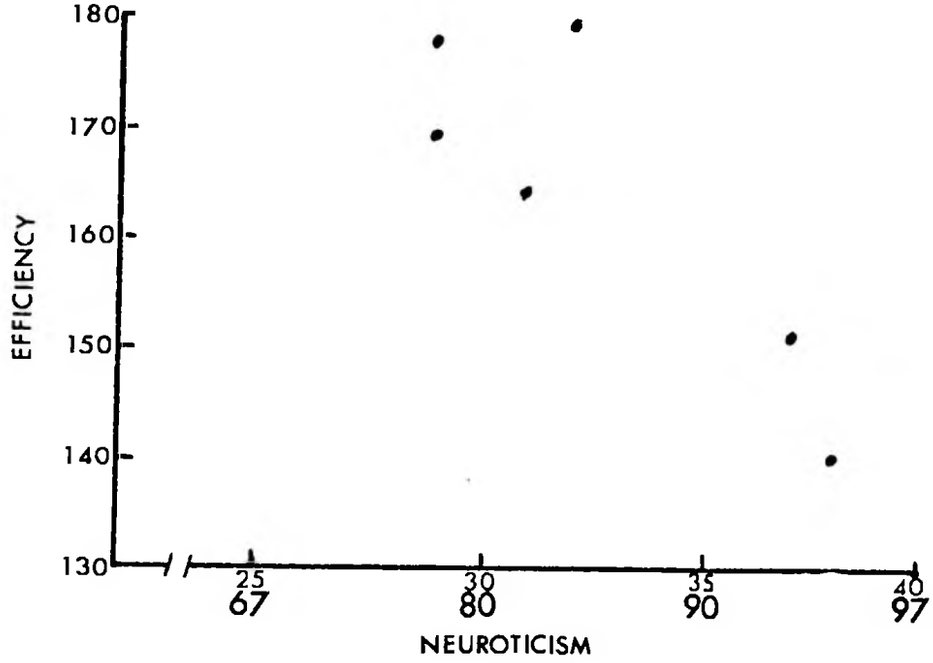

Figure 6. Scatterplot of efficiency scores as a function of neuroticism raw scores and centiles (centiles = bottom row of numbers) obtained on the Maudsley Personality Inventory . Efficiency scores have been multiplied by 100.

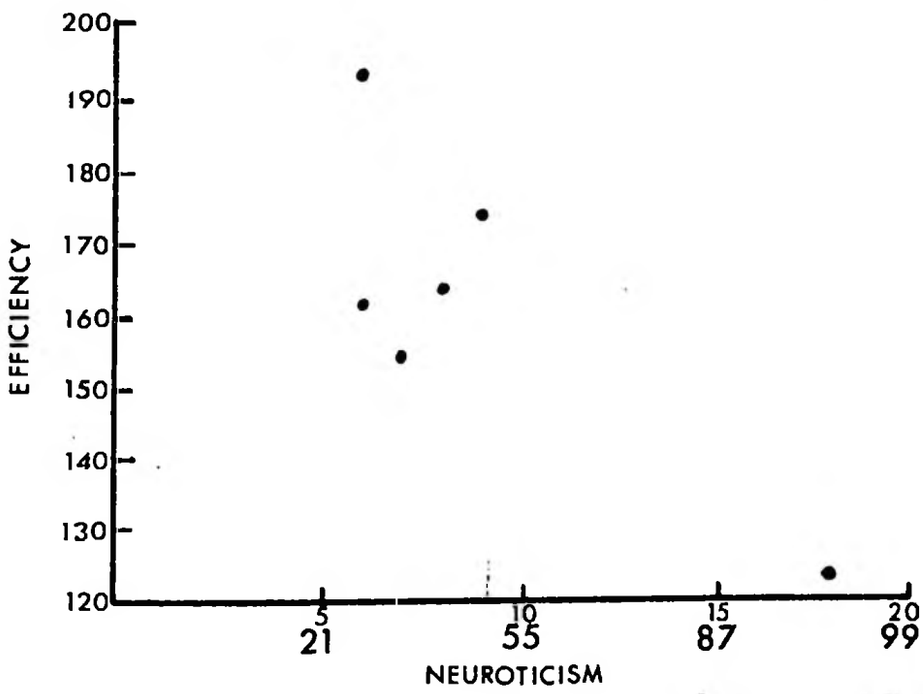

Figure 7. Scatterplot of efficiency scores as a function of neuroticism raw scores and centiles (centiles = bottom row of numbers) obtained on the Eysenck Personality Inventory. Efficiency scores have been multiplied by 100.

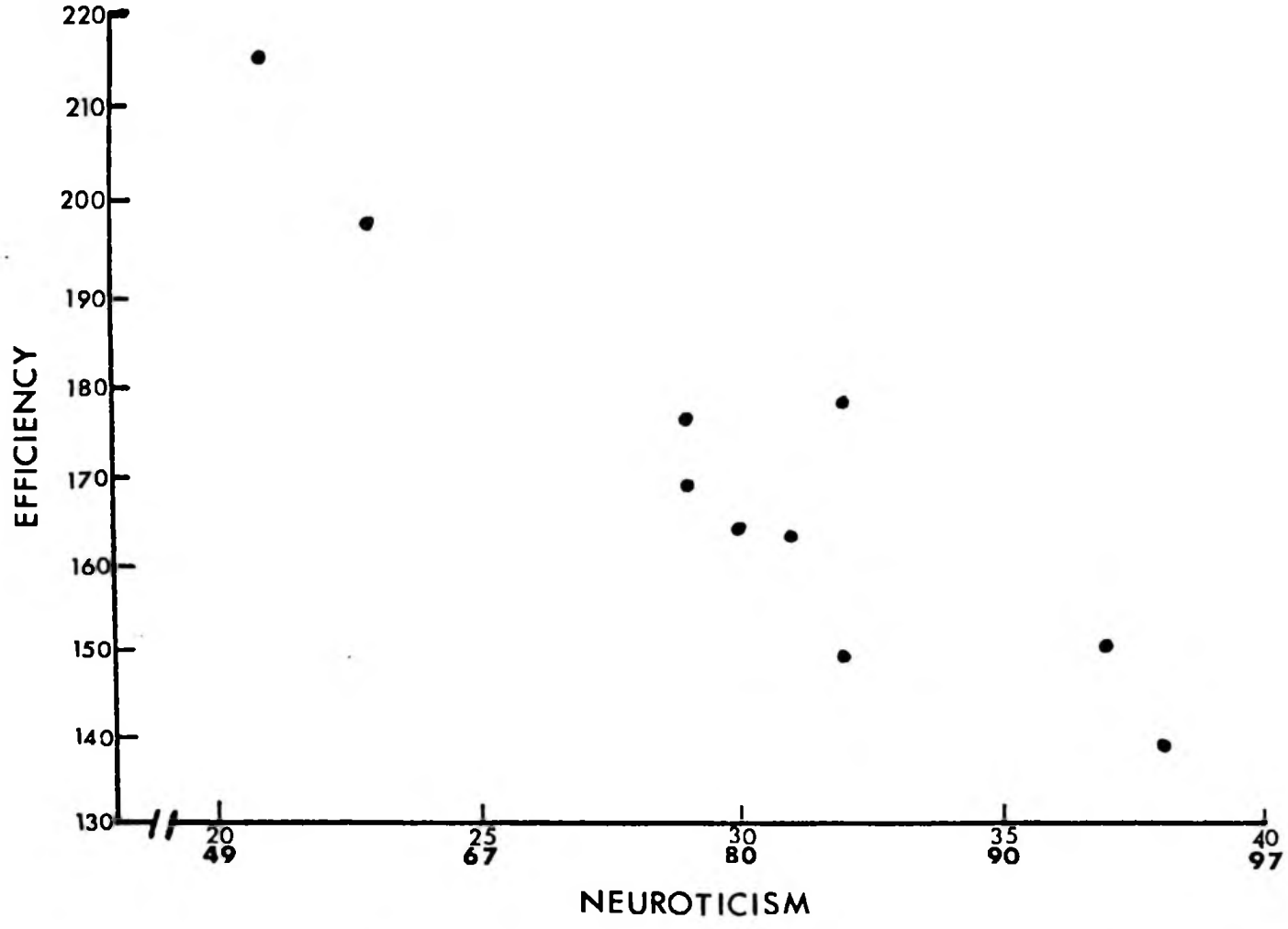

Figure 8. Scatterplot of efficiency scores as a function of neuroticism raw scores and centiles (centiles = bottom row of numbers) obtained on the Maudsley Personality Inventory. Efficiency scores have been multiplied by 100.

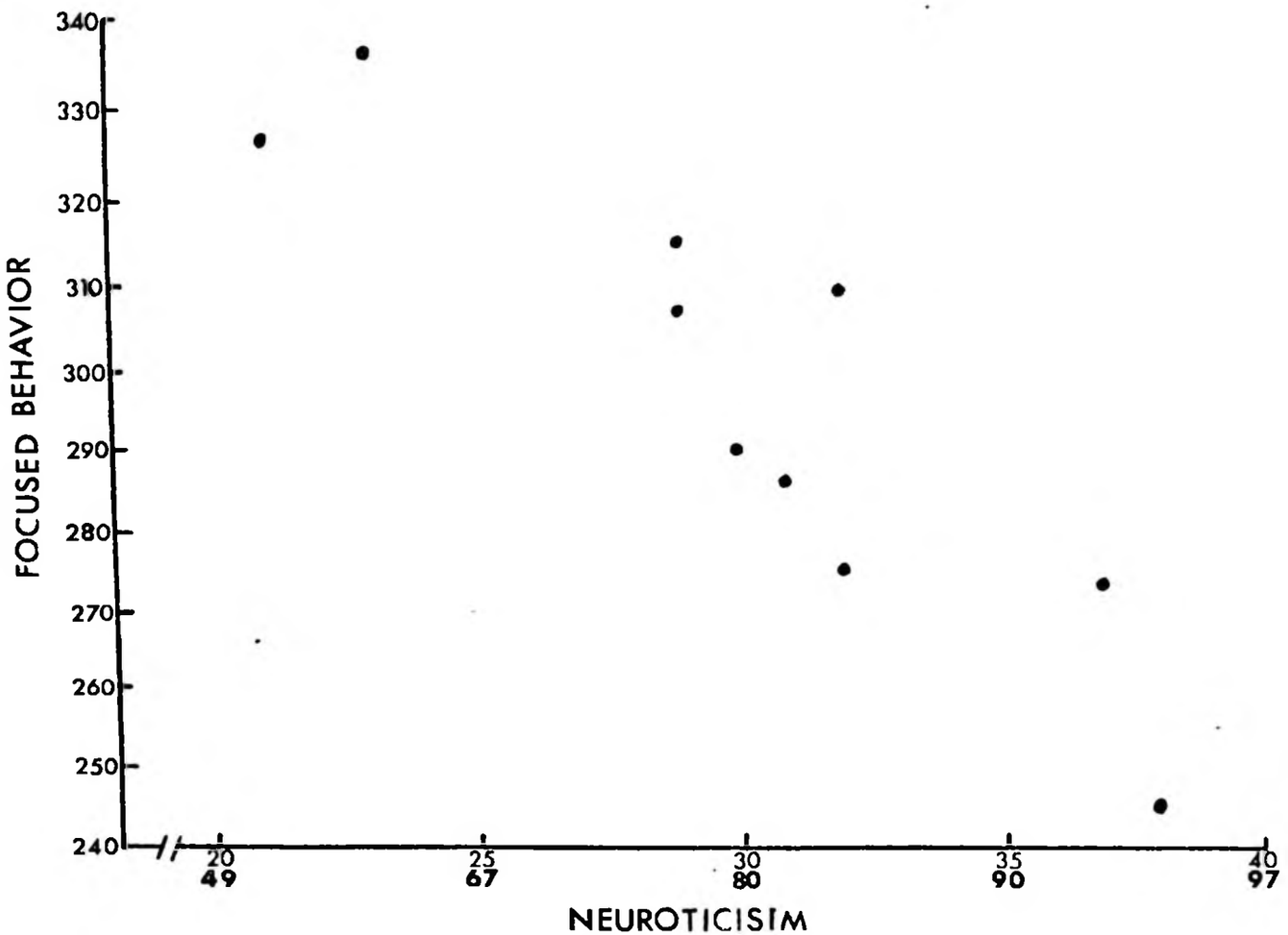

Figure 9. Scatterplot of focused behavior scores as a function of neuroticism raw scores and centiles (centiles = bottom row of numbers) obtained on the Maudsley Personality Inventory. Focused behavior scores are time on target in seconds.

points within the above centile range (55th to 95th) are consistent with the relationships obtained in experiment II, pilot study VII. The relationship of neuroticism to diffuse behavior in this study appears to be linear, making it consistent with data presented in Figure 5.

In group C of experiment I the correlation between Eysenck neuroticism scores and efficiency was -.25. Some approximation to linearity had been assumed because in spite of considerable scatter in the unreported scatterplot, groups A and B had already shown linear trends. The low correlation was attributed to various treatments given these ten subjects. The range of neuroticism scores for the group suggests another reason for the poor relationship. This range is from the 21st centile to the 91st centile (raw, 5 to 16). It can be seen in Figure 3 that this centile range spans that part of the scatterplot where the scatter is severe. Data contained within this range shows little relationship.

A final note is offered concerning the appropriateness of the diffuse measure. Since it is a sample of diffuse behavior, questions may arise as to how suitable or representative it is as a sample and how well does it relate to other possible samples of diffuse behavior. Only empirical data can answer definitely these questions. However, the fact that theoretical predictions about efficiency were confirmed while using this measure suggests indirectly that it is suitable. Moreover, the diffuse behavior scores them-

selves are consistent with theoretical expectations for neuroticism and instructional set. This result also tends to support the assumption that this measure of diffuse behavior is suitable.

SUMMARY

This study dealt with Wishner's concept of psychological efficiency which is defined as the ratio of focused to diffuse behavior (E=F/D), where F is behavior relevant to a task and D is irrelevant behavior. A preliminary question was whether F or D could be assumed to be constant and whether both measures were needed. The primary question of the study was whether efficiency is a concept applicable only to certain tasks or whether it is a general personality characteristic of humans. A study of these issues was carried out by relating the three dependent variables of E, F and D to three independent variables: neuroticism, sex and instructional set. On the basis of theoretical developments of the efficiency concept, it was predicted that efficiency would be higher for low neuroticism subjects than for high neuroticism subjects, higher for males than for females, and higher for other centered subjects than for self centered subjects.

Appropriate measures of F and D were developed, and these measures plus E were studied as functions of the three independent variables. The results were interpreted as indicative that measures of both F and D must be accounted for in studying E. For the primary question, the results suggested that efficiency is probably a general personality characteristic. All three of three of the predictions were sup-

ported by the results.

APPENDICIES

APPENDIX A

Programming and Recording Equipment

The requirements for programming entail the initiation of two events (two signal lights) simultaneously but with each event's on and off duration controlled separately. The on time and off time for each light will be equal on many trials but will be different on some trials. It is considered necessary to have the on-off controlling devices variable so that various on and off durations can be tried.

Requirements for recording include a system which records the on and off times of each signal light and the press and release times of each telegraph key. More importantly, the time during which left key and left light are simultaneously pressed and on and during which left key and left light are simultaneously released and off is needed to provide a time on target measure. This same type measure is needed for right key and right light actions.

These measures can be obtained on a graphic recorder which would supply a permanent record of each subject's performance. But time on target measures would have to be converted from linear graphic measures. Therefore, though a graphic event recorder is used to supply graphic representation of each signal event and each key event or response, a

system of timer clocks is tied to the graphic recorder so that at the end of each subject's session an immediate read out of the total time on target for left and right hand actions is available. Digital event counters record the number of each of the four events occurring. The time off target for the right hand actions is obtained by subtracting time on target from total task time.

Equipment and Equipment Housing.

Two 28 volt signal lights mounted in a panel.

Two telegraph keys mounted on a board (see p. 24 for a complete description of these items and how they are used).

Grayson-Stadler heavy duty power supply, 28 volt, model E783DA.

Grayson-Stadler digital counters, group of four, model E3700A.

Ralph Gerbrands four channel pen recorder, model P2-A.

Ralph Gerbrands two channel ratio programmer, model RP-2 (only one channel used as a stepper switch).

Hunter interval cycler, model 1245, series D.

Hunter decade interval timer, model 100c.

Two Lafayette clock timers, model 20225, ADW, calibrated to .01 seconds.

Four SPDT relays, 28 volts in coil.

One TPDT relay, 28 volts in coil.

One DPST hand operated switch.

One SPST hand operated switch.

One telegraph key serving as a SPST switch.

The equipment is housed in two adjacent cubicles. The signal lights and the telegraph keys are in subject's cubicle. These items are wired to the rest of the equipment which is mounted on a table in the adjacent experimenter's cubicle. The cubicles are enclosed except that subject's cubicle has no roof, and the walls are thin plywood allowing direct audio transmission between cubicles. There is also a 280 by 390 mm window between the cubicles, 1420 mm from the floor which allows the experimenter to stand and observe the subject but which is too high above the seated subject for reciprocal viewing.

Equipment lay outs and circuits for programming and recording the events are depicted in Figures 10 and 11 on pages 68 and 69.

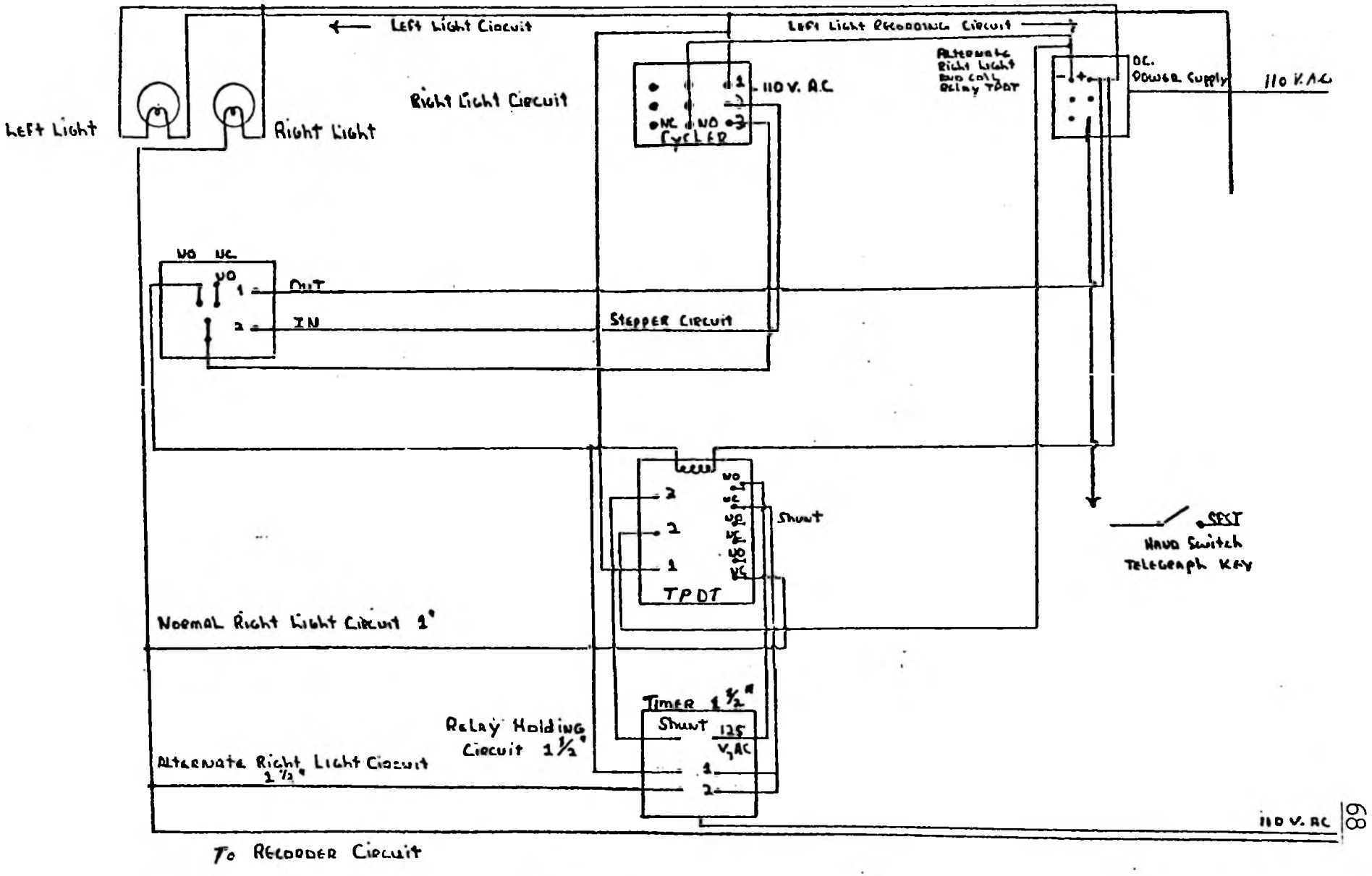

Figure 10. Programming circuits.

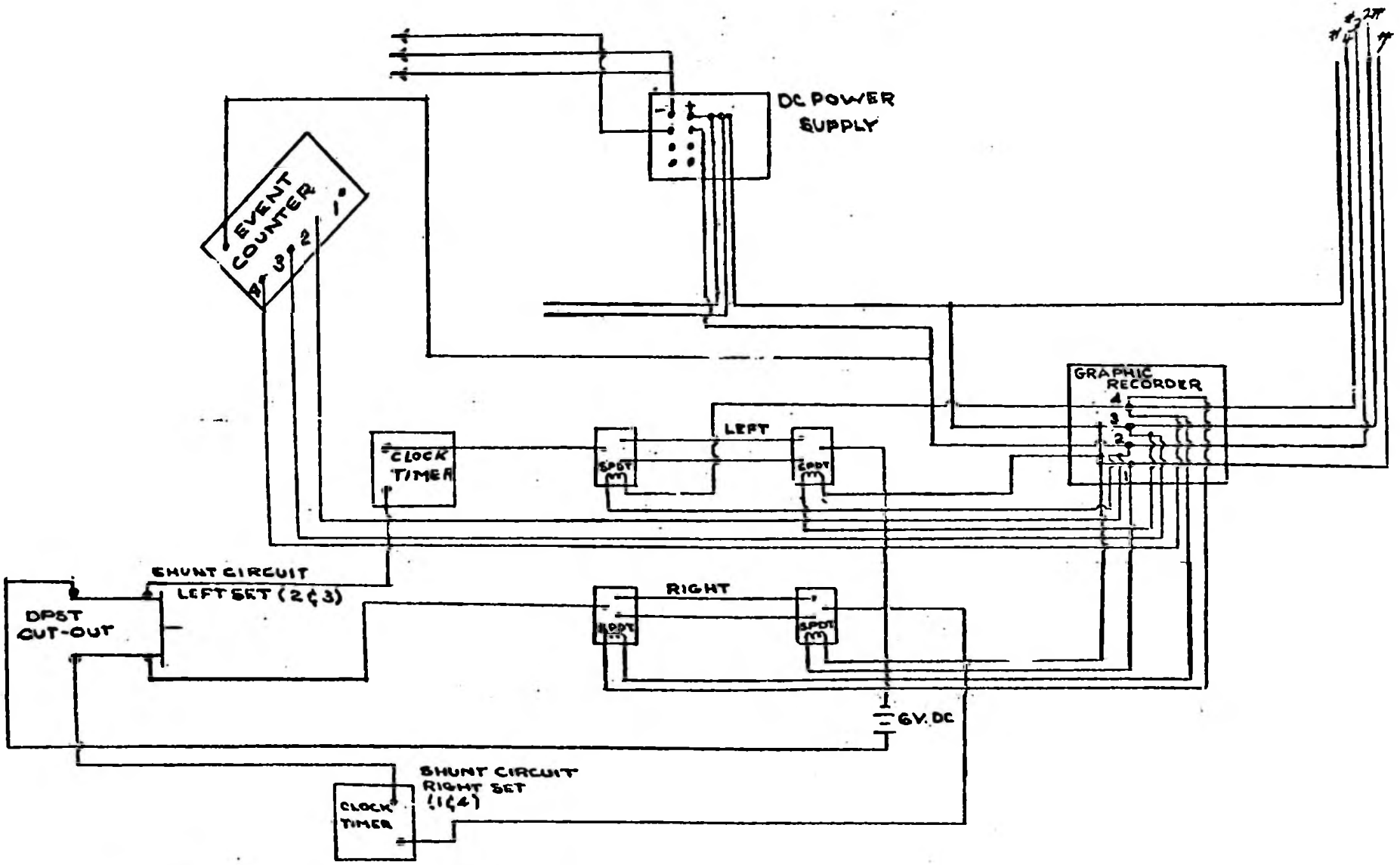

Figure 11. Recording circuits.

APPENDIX B

Pilot Studies

Investigation of efficiency in the manner outlined required a series of pilot studies. These studies were conducted to deal with such issues as the reliability of the equipment, the development and evaluation of general procedures and instructions and the reliability of the measures.

Pilot Study I

This first study was designed to check the effectiveness and reliability of the task equipment, to evaluate the subjects' reactions to the task, and to experiment with the equipment, the instructions and the procedures. No statistical treatments or data gathering was planned. The ultra sonic recorder was not used.

Method

Subjects. The subjects for the study consisted of 20 college students selected randomly from a general psychology class of 59 students.

Procedure. Each subject was welcomed to the testing room by the experimenter and instructed about the task (see p. 29 for the standard instructions which were developed from those used in this pilot study). Some subjects received slightly different instructions because post task

interviews with the subjects suggested that the instructions should be modified (see appendix B for the post task interview form). Also some subjects worked with certain equipment refinements made from time to time. The subjects worked on the task either three minutes, six minutes or ten minutes, receiving 90, 180 or 300 trials respectively. Before each task session each subject received the 25 warm-up trials.

Results. All of the equipment worked without mechanical malfunction. However certain refinements were made in the programming equipment, in the size and arrangements of the signal lights and in the procedures. On the basis of the post task interviews (presented in appendix B) and from observing the subjects' behavior during the task, it was concluded that subjects respond to the task requirements with cooperative efforts suggesting adequate motivation. Finally, the subjects' evaluation of and their report on the task suggests that the six minute period of work is preferable to the other two time periods. The shorter period does not give subjects time enough to adapt to the task. The longer period is considered undesirable because of various complaints of boredom, fatigue or other subject discomforts.

Pilot Study II

This study was conducted for a further evaluation of equipment, procedures and instructions. A test-retest reliability evaluation of the left hand time on target measure was also included. The ultra sonic recorder was not used.

Method

Subjects. Twenty-three college students were selected randomly from a general education science class of 489 students. The subjects included 11 males and 12 females whose ages ranged from 18 to 21 years. One male was discarded because of an equipment malfunction. One female was discarded because of failure to comprehend instructions, and one female was lost because of illness.

Procedure. Each subject was welcomed to the testing room by the experimenter, was seated at the working bench and given an early version of the standard instructions. All subjects received 25 warm-up trials and 180 test trials. The subjects were questioned in the post task interview. Approximately two weeks later they returned for a second identical testing session after which they were again interviewed.

Results. The equipment failure and the failure of one subject to comprehend instructions pointed to the necessity for some minor refinements in equipment and in instructions. The post task interviews suggested that most subjects responded cooperatively but with some variability in catching on to the task demands. The experimenter noticed that subjects' general physical health seemed to affect performance, and upon questioning some subjects, they agreed that lack of sleep, great fatigue or severe colds affected their performance.

The correlation between testing sessions for left hand measures was .52. The low correlation was attributed to

variations in how quickly subjects caught on to the task and to their variations in physical health.

Consequently some refinements in the instructions were made, and the following criteria were adopted for subjects: at time of testing they must report that they are not sick, that they feel good and that they had a good night's sleep. Subjects were then called back for a third test two weeks later. The refined instructions were used and the above criteria applied. The group was reduced to 17, but the correlation for left hand measures rose to .97.

Pilot Study III

In this third study the self centering and other centering instructions were introduced and scrutinized for problems.

Method

Subjects. The subjects were 27 students taken from an introductory psychology class of 63 students. They were selected and assigned randomly with ten subjects going to self centering and other centering groups each and with seven subjects going to a control group. The self centered and other centered groups had five males and five females, but one male was discarded from the self centered group because of a panic-like reaction he demonstrated in the task. The control group had three males and four females.

Procedure. The subjects were run in an alternating order with one or two from one group followed by one or two from another group and so forth. They were welcomed to the testing room by the experimenter and seated at the work

bench. They were given either the self centering, the other centering or no preliminary instructions, and then they were given the standard instruction.

Results. The focused behavior scores, which are reported as time on target in seconds, are given below for the three groups. Controls: mean, 304; range, 298 to 320; standard diviation, 6. Self centered: mean, 304, range, 264 to 330; standard deviation, 20.96. Other centered: mean 295; range, 240 to 315; standard deviation, 22.37.

No major procedural problems were encountered, but these results might raise some questions. For instance, the fact that other centered subjects show slightly less focused behavior than self centered subjects might suggest that these instructions are having effects just opposite from those predictable from efficiency theory. Actually these results are not necessarily contrary to theoretical expectations since the theory requires a ratio of focused to diffuse behavior. It would be reassuring, however, if these differences were found not to be significant.

An *F* test for these data indicated no significant differences at the .05 level of confidence. A *t* test between the self centered and other centered groups was not significant even at the .10 level (one-tailed test).

Pilot Study IV

Pilot Study IV was conducted in order to evaluate the measure of diffuse behavior and to study its relation to focused behavior in terms of efficiency theory. Efficiency

theory predicts that other centered subjects are more efficient than self centered subjects, i.e., have higher efficiency ratios (F/D).

Method

Subjects. Fourteen subjects were selected from an introductory psychology class of 32 students. They were selected and assigned randomly to self centered and other centered groups. One subject failed to come, leaving the self centered group with seven subjects (four male, three female) and the other centered group with six subjects (three male, three female).

Procedure. The subjects were welcomed to the testing room by the experimenter and seated in the usual manner. They were tested in an alternating pattern in which a self centered subject is followed by an other centered subject and vice versa. All subjects were first given either the self centering or other centering instructions, and then they were given the standard instructions.

Results. The efficiency ratios for the two groups are as follows: other centered group: mean, 6.43; standard deviation, 6.06. Self centered group: mean, 3.26; standard deviation, 1.30. The two groups differ in efficiency scores and in the predicted direction, but a *t* test for these two groups does not indicate a significant difference.

The diffuse measures are described by the following data: other centered group: mean, 64; range, 14 to 106; standard deviation, 29.41. Self centered group: mean, 108;

range, 62 to 133; standard deviation, 46.23. The variability in the above data may be masking any experimental effect. However, the difference in the group means is in the predicted direction, and in view of the great variability present, the results are interpreted as encouraging. (Subsequent analysis of the above data after a logarithmic transformation of diffuse scores as described in pilot study V results in a difference between means significant at the .001 level).

A search for methods of overcoming the problems posed by the variability seemed appropriate.

Pilot Study V

This study was conducted to explore several matters related to the assessment of efficiency. Special attention was to be given to the behavior of the subjects during testing in an effort to find some of the sources of variability in the data. A test-retest procedure was planned to check the reliability of the measures.

The introduction of several independent variables was planned. The instructional set and sex variables were to be introduced as planned earlier. Also, it seemed plausable that intellectually skilled people would grasp instructions better and thus would be more efficient than people having less ability in these respects. As an exploratory venture, it was decided to introduce a measure of ability as an additional independent variable. The skills measured by the Scholastic Aptitude Test of the College Board examinations

seem to be a reasonable measure of ability, especially ability to comprehend instructions, and since this measure was already available on the subject pool, it was used.

The experimental design for assessing the effects of these three independent variables on efficiency was a three dimensional two by two by two factorial design.

Method

Subjects. The subjects for this study were taken from among 95 college students in introductory psychology classes. All of the males and all of the females were rank ordered on the basis of their Scholastic Aptitude Test scores. These two groups were subdivided by matching a high score, male subject with a high score, female and then designating these two as self centered subjects. The same process was followed in procuring other centered subjects, with care taken to keep ability scores as closely matched as possible. Low scoring groups were obtained in the same general manner. This selection method produced eight subgroups (with five subjects each) as outlined below:

Other centered:	High score :	Female - cell 1 Male --- cell 2
	Low score :	Female - cell 3 Male --- cell 4
Self centered :	High score :	Female - cell 5 Male --- cell 6
	Low score :	Female - cell 7 Male --- cell 8

With five subjects in each cell, a total of forty subjects were used. The high ability scores ranged from 1200 to

1477 with a mean of 1277. The low ability scores ranged from 752 to 991 with a mean of 887.

Procedure. The subjects were welcomed to the testing session by the experimenter and seated in the usual manner. All subjects were given the self centering or other centering instructions first, and then they were given the standard instructions just before testing. Approximately two weeks later they returned for an identical testing session to complete the retest phase. Two subjects failed to return.

Results. Raw data for the diffuse measures was found to be positively skewed as indicated by Figure 12. The data was also highly variable as indicated by the following statistics: self centered group: range, 6 to 571; standard deviation, 83; and mean, 112. Other centered group: range, 17 to 351; standard deviation, 72; and mean, 103.

The focused behavioral data did not have the skewness or severe variability found in the diffuse data. For focused behavior the mean was 298, range was 222 to 346, and standard deviation was 35.

Before further statistical treatment of the data was practical, some preliminary steps seemed to be in order. A logarithmic transformation of the diffuse data (and multiplying by one hundred to eliminate decimals) produced the more normal distributions seen in figure 13. These distributions are described by the following statistics: self

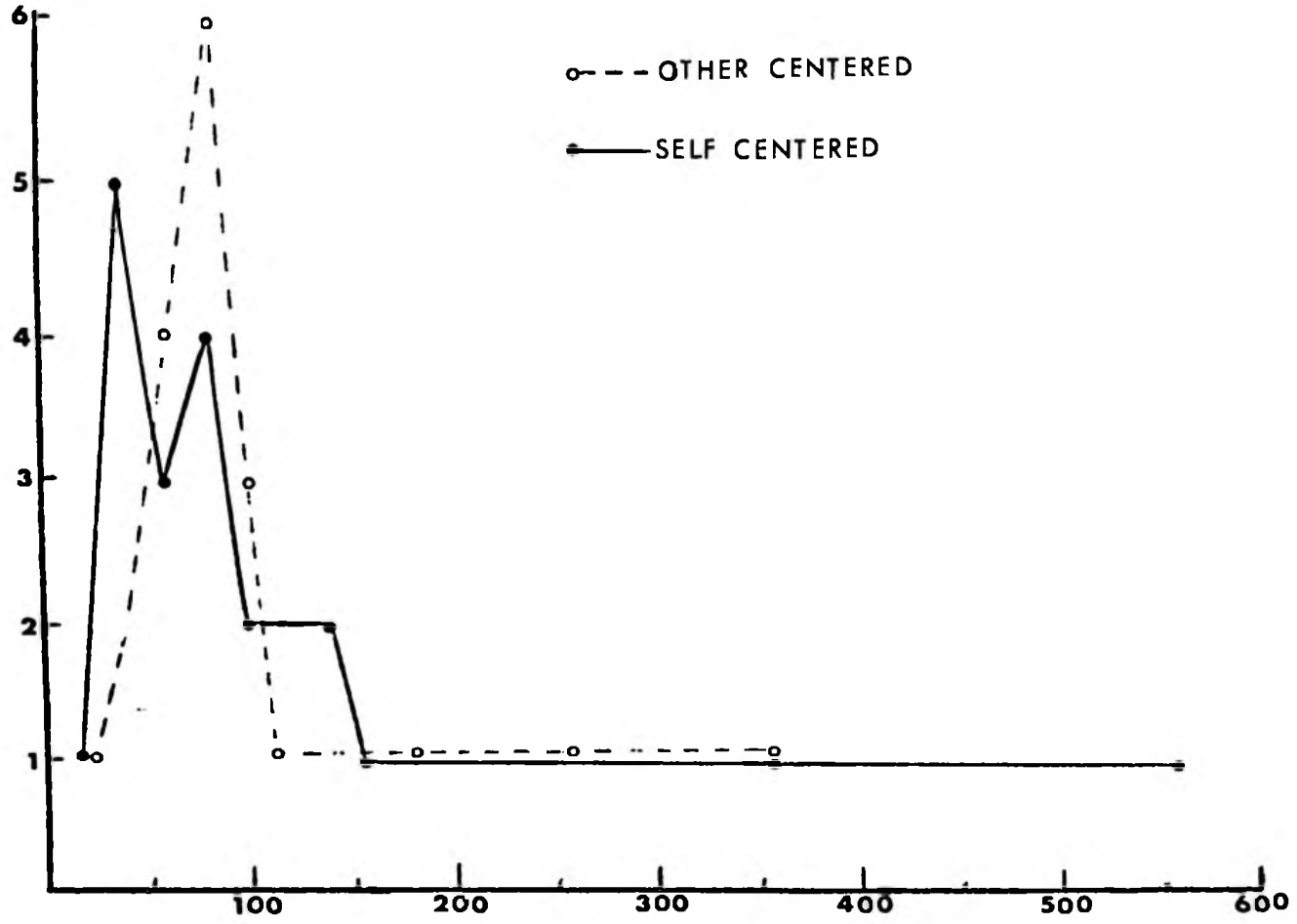

Figure 12. Frequency distribution of diffuse measures for other centered and self centered subjects.

centered group: range, 78 to 276; standard deviation, 40; and mean, 188. Other centered group: range, 123 to 255; standard deviation, 28; and mean, 193. (Hereafter, all references to data involving diffuse measures will be in terms of transformed data unless otherwise indicated.)

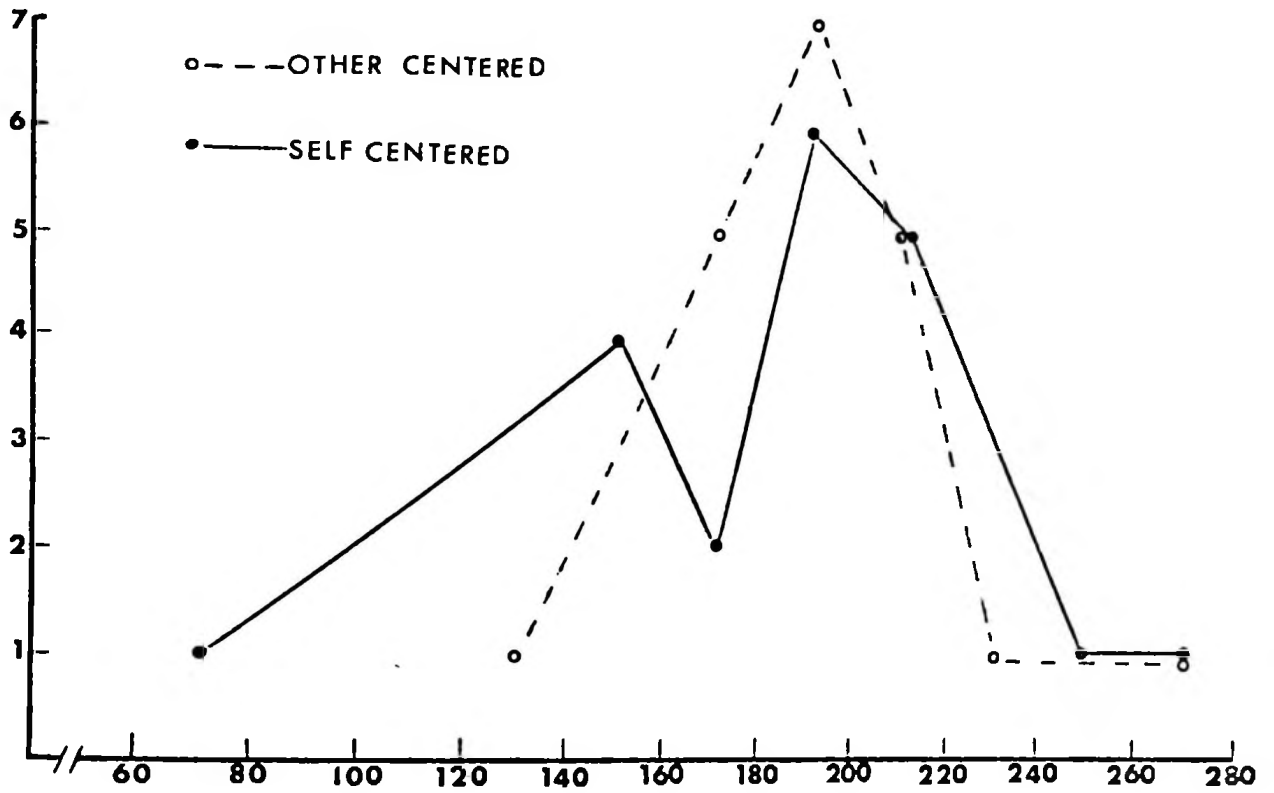

Figure 13. Frequency distribution of diffuse measures transformed to logs for other centered and self centered subjects.

A comparison of these two means does not give the expected result since efficiency theory would predict more diffuse behavior for self centered subjects. However, several problems with the measure were identified by a study of the subjects during testing. Correction of these problems could change the nature of the results.

The only Negro subject was a self centered, female. From the time of her arrival for testing she showed qualitatively different reactions from all other subjects. She showed none of the concern and expectancy of embarrassment that others did when read the self centering instructions. She seemed somewhat oblivious to the value system that implies shame if one is adjudged neurotic. In this sense she did not comprehend all the implications of the instructions even though she seemed to comprehend the task requirements per se. Overall her performance was atypical, and her diffuse score of six (untransformed) was so atypical that it seems preferable to eliminate her from the study (hereafter her scores are not included in the discussion of results).

The college population from which subjects are selected has only a small group of Negro students. Most of these Negro students are known personally by the experimenter. On the basis of this personal knowledge as well as information supplied by the college admissions office, it seems to the experimenter that these Negro students are quite similar on such characteristics as cultural background, personal values, ability and sophistication about American middle class values. It seems likely, therefore, that in this experiment these students would give performances similar to that given by the Negro student above. Because of this possibility, coupled with the difficulty of obtaining adequate representation from this small subgroup of students, Negroes will either be omitted from subsequent phases of the study, or

they will be dealt with in a separate group in an effort to determine empirically their reactions.

Several subjects demonstrated behavior which seems to artificially raise the count of diffuse behavior. The nature of the ultra sonic recorder is such that movement of an object in a steady, unitary direction tends to be counted slightly more than jerky movements involving frequent changes of direction, even if the latter movement is more vigorous. This characteristic of the measure is accentuated by a behavior found in some subjects who can be described as "leg swingers." These subjects start swinging their feet or legs in a rather fast (about one cycle per second) pendulum like fashion as soon as they are seated. Before any instructions are given they commence, and regardless of instructions or tasks given to them, they usually continue. Their behavior seems somewhat analogous to voluntary responders in eyelid conditioning studies. As in the case of voluntary responders, it seems appropriate to establish some criteria for discarding these "leg swingers" from the study.

The criteria which define a "leg swinger" best are as follows: subject commences swinging leg within ten seconds after being seated and continues swinging leg during time instructions are being read. Such subjects seem to be engaging in leg swinging disproportionate to the stress situation. By rejecting such subjects, some of the data distortion should be corrected. Furthermore, placement of the transducers to a position above and in front of the feet

seems to give a somewhat less biased count of foot and leg movement than the original placement to the right and rear of the ankles.

By applying the rejection criteria above, (eliminating four subjects) the variability of the data is considerably changed. The self centered group moves from a low score of 78 to a low of 156 and goes on up to 276, and the standard deviation changes from 40 to 30. The other centered group changes its range, keeping the original low of 123 but dropping to a high of 214, down from the previous high of 255. The standard deviation changes from 28 to 22. The means of the groups also change, with the self centered group going from 188 to 194 while the other centered group moves from 193 to 184. These changes are in keeping with efficiency theory.

The test-retest reliability check on the measures was completed but without two of the other centered subjects, who failed to return, and without two of the self centered subjects, the Negro girl and one subject whose test session was disturbed by intruders.

For the diffuse measures the following realiability coefficients were obtained: self centered group (N = 18), .73; other centered group (N = 18), .67. For the measure of focused behavior, the reliability coefficients were: self centered group, .78; other centered group, .60. These reliability figures support the reliability findings reported in pilot study II and seem to offer additional justification for

using the measures in this research project.

Though the data was inadequate in many respects for statistical inferences to be made about efficiency scores, some computations were completed to check possible trends. Since the main independent variable is instructional set, the data is reported in context of these groups.

For the self centered group (N = 19), the range of the ratios was .847 to 1.955, the standard deviation was .295, and the mean was 1.498. For the other centered group (N = 20), the range was .905 to 1.861, the standard deviation was .245, and the mean was 1.492. These results are contrary to theoretical expectations. However, by applying the rejection criteria even conservatively, the other centered data changes to the following: N becomes 17; range, 1.262 to 1.861; standard deviation, .209; and mean, 1.549. No change occurs in the self centered group even if the criteria are applied more generously, but a generous application of the criteria would change the other centered group to an N of 16 and a mean of 1.777.

Treatment by inferential statistics of such data where rejection occurs after-the-fact is of course unjustified. However, comparison by inspection of the means of the two groups as done above suggests that true differences can be found between these groups. For the high and low ability groups, however, the means actually move closer together when rejection criteria are applied. Before rejection of subjects, the means for high and low ability groups are 1.507

and 1.436 respectively with a difference of .071. After rejection, these means become 1.579 and 1.514 with a difference of only .065. Neither of these differences is impressive, and the trend would seem to be counter indicative of the notion that ability, as measured by the Scholastic Aptitude Test, relates to efficiency. However, greater extremes in ability levels might reveal some such relationship.

Effects of the sex variable were inferred from the analysis of variance. The males had higher efficiency ratios than the females with the difference a significant one ($F=5.88$; $df=1$, $p < .05$; one tailed test). All other variables and all interactions were not significant.

Pilot Study VI

One of the primary intentions of this study was the evaluation of the effectiveness of the several procedures designed to reduce variability in the dependent variable, thereby permitting the effects of independent variables to become apparent. A summary of these procedures include: rescheduling of inappropriate subjects including the sick and fatigued (see pilot study II), rejection of Negroes and leg swingers and transformation of diffuse measures to logs (see pilot study V).

This study also introduced several additional procedures which hopefully would help demonstrate the effects of instructional set on efficiency.

as follows: self centered: mean, 1.390; standard deviation, .245; range, .854 to 1.643. Other centered: mean, 1.562; standard deviation, .184; range, 1.271 to 1.816. Sandler's A test evaluation of these two sets of scores indicates a difference which is significant at the .025 level (one-tailed).

This significant difference between the two groups is encouraging for the overall purpose of the study. Of equal interest and encouragement is the reduction of variability in these efficiency scores as compared to scores in earlier pilot studies.

Experiment II of Pilot Study VI

Experiment II was concerned with altering the general procedures so that instructional set was delivered after the standard instructions rather than before. Also, an additional procedure was planned which, hopefully, would increase the effects of self centering. It was hypothesized that if subjects were told that they were being scrutinized in some manner by other people while they were being tested for neuroticism, then the disruptive effects of self centering would be magnified. There should then be an even greater loss in efficiency than occurred with the self centered group.

Therefore, three groups were planned: self centered, other centered, and accentuated self centered. A minimum of six subjects in all groups was planned.

Method

Subjects. Subjects were selected randomly from the 99

people remaining in the group of 115 indicated in experiment I until 24 had been tested in this experiment. One male and one female were rejected because they were leg swingers. The three groups were represented by sex as follows: other centered, four males, two females; self centered, four males, two females; accentuated self centered, three males, seven females.

Procedure. The subjects were received and treated by the experimenter in the usual manner. However, only the standard instructions were read at first, and then either the self centering or other centering instructions were read after the warm-up period (just prior to the 180 test trials). The experimenter stood behind the subject to deliver the instructions.

Because of the above changes the self centering and other centering instructions were condensed slightly. These instructions are reproduced below.

Other centering.

> We are now ready for the final series. This is the crucial part of the task and is the actual test part of the task. This is the final part of several years of research and though I cannot tell you how the test works now, I will explain it later. Our success or failure depends on how well you do your job now, so do your very best.

Self centering.

> We are now ready for the final series. This is the crucial part of the task and is actually a test of neuroticism. When completed I can tell how neurotic you are. The test may seem unusual to you, but psychologists have developed simple tests to determine basic personality structure. In this test your behavior is being evaluated,

> and though I cannot tell you how it works now, I will explain it later. How poorly you do tells how neurotic you are, so do your very best.

To the accentuated self centered subjects these additional remarks and procedures were given:

> We have you seated here so we can observe your reactions through this glass. I will remove the cover over this magnifying mirror so that we can get a more detailed view of your facial reactions during the neuroticism test.

The experimenter then removed a cloth which covered a circular magnifying mirror eight inches in diameter (a standard type shaving mirror). The mirror was mounted on the bench somewhat to the left of the signal lights and about 15 to 18 inches from the subject's face. Subjects could see their faces in the mirror by looking to their left slightly, and the sight was rather grotesque. Invariably the subjects would look at themselves in the mirror before returning their attention to the signal lights in preparation for the test trials.

Results. Few usable measures of efficiency could be obtained from the accentuated self centered subjects. Some subjects virtually froze their action and produced very little behavior. Some jammed their feet against the wall or a brace and produced average or even high focused measures. For these subjects, however, the diffuse measure was spuriously low, resulting in a spuriously high efficiency ratio. A few subjects talked aloud to themselves, repeating such phrases as "Oh boy!" or "Oh my God!"

After running 11 subjects and obtaining usable data on only three, this technique was terminated. In view of the above problems, it seems desirable to abandon this procedure for present considerations.

The efficiency ratios for the other two groups are as follows: Self centered: mean, 1.268; standard deviation, .149 range, 1.248 to 1.510. Other centered: mean 1.597; standard deviation, .219; range, 1.236 to 1.941. The difference between these two groups is significant as indicated by a t test (t=2.788, df=10, $p < .01$, one-tailed). Comparison of the groups by the matching technique described in experiment I and using the Sandler A test gives a similar difference ($p < .01$, one-tailed).

These procedural differences in handling instructional set produces differences in efficiency which give encouragement to the general intent of the study. This procedure is especially advantageous because it demonstrates that matching of subjects is not necessary.

Pilot Study VII

Pilot study VII incorporated two correlational studies designed to evaluate the relation between efficiency and a measure of maladjustment. Wishner's theory of efficiency implies that as maladjustment increases then efficiency should decrease. It has been noticed that in the pilot studies connected with this project some subjects have become extremely disorganized and inefficient under stressful conditions of the task. These considerations make it reasonable to hypothesize that there is an inverse correlation

between maladjustment and efficiency.

The measure of maladjustment selected is the neuroticism measure developed by Eysenck. Two standardized personality tests are available which measure this trait, the Maudsley Personality Inventory (Eysenck, 1962) and the Eysenck Personality Inventory (Eysenck & Eysenck, 1963). Both tests were selected for trial use. These tests, both developed by Eysenck, were selected because their high level of technical development (Buros, 1965; Knapp, 1962; Eysenck & Eysenck, 1963) gives them psychometric advantages over other tests purporting to give a single measure of maladjustment.

Experiment I of Pilot Study VII

Initial planning called for administering both the Maudsley Personality Inventory and the Eysenck Personality Inventory to the same ten or fifteen subjects, measuring their efficiency under neutral conditions (i.e., no instructional set or other experimental variable introduced), and then correlating efficiency scores with neuroticism scores from both the Maudsley and the Eysenck Inventories. However, some confusion in obtaining the test materials as well as time limitations and other practical problems combined to frustrate these plans. Eventually an ad hoc kind of procedure and selection of subjects was required.

Method

Subjects. A total of twenty-two subjects were finally acquired. Six of these (designated as group A) were newly

selected from the pool of subjects described in pilot study VI. The other six (group B) were the other centered subjects from experiment II of pilot study VI. These latter six were used because they were among the few available, and because of those subjects in prior experiments who were available, those under other centering conditions would seem to have their efficiency scores least effected by experimental variables. A final group of ten subjects (group C) were people who had been tested for efficiency under various conditions in which a variety of instructional sets of a self centering nature had been used.

Procedure. Groups B and C were given the Eysenck Personality Inventory while group A was given the Maudsley Personality Inventory. The subjects in group A were measured for efficiency by the usual procedures involving standard instructions but without the instructional set.

Results. For the six new subjects in group A the correlation between their neuroticism scores and their efficiency scores is -.85. For the six subjects in group B, the correlation between their neuroticism and efficiency scores is -.72. Both of these results fit theoretical predictions though only the former correlation coefficient is significantly different from a zero correlation ($p < .05$, one-tailed, chart of critical values of r, Runyon and Haber, 1967). These results are interpreted as encouraging to the hypothesis that maladjustment is related to efficiency as predicted by efficiency theory.

For the ten subjects in group C, the correlation between efficiency and neuroticism scores was -.25. Though this correlation gives only very limited support to the interpretation of the correlations above, it should be noted that the conditions under which these efficiency scores were obtained could easily interfere with the higher negative correlations that efficiency theory would predict.

Experiment II of Pilot Study VII

In order to check the trends suggested by the correlation in experiment I, additional correlation data was gathered.

Method

Subjects. Six subjects were selected from a special class of 13 college students. One subject was rejected because of interruptions during efficiency testing, and one was rejected because of foot swinging.

Procedure. The subjects were tested for neuroticism on the Maudsley scale and for efficiency with only the standard instructions. The data of the four usable subjects was then pooled with the data of the six subjects from group A in experiment I.

Results. From these 10 subjects, three correlation coefficients were obtained. The correlation between neuroticism and efficiency was -.93, an increase over the previous coefficient of -.85 when only six subjects were involved. The second correlation, between neuroticism and the measure of diffuse activity, was +.78. The same correlation on the

original six subjects, not reported before, was +.69. Finally, the correlation between neuroticism and focused behavior was -.89. All of these coefficients for the group of ten are significantly different from zero ($p < .01$, one-tailed, chart of critical values of r, Runyon and Haber, 1967).

APPENDIX C

Post Task Interview Outline

How tiring or boring is the task?

Did you get tired or bored?

Did your eyes get tired or strained? Arms or hands?

Could you have worked some more without much difficulty?

What strategy did you use if any?

Did you follow the rhythm or not?

Did you know what you were to do and did you try to do it?

Do you have any criticisms or observations to offer about the task?

APPENDIX D

First Briefing Session:

Read to Class when Soliciting Volunteers.

I am seeking volunteers who will serve as subjects in a psychological research project. If you are willing to serve as a subject please fill out the schedule sheet which will be passed out to you. You will be notified by mail of the time you are to come to participate in the research. You will be needed for two blocks of time of about 12 minutes each. During these times you will be tested for some personality characteristics and for other psychological characteristics. Some of the testing will be quite demanding and will be anxiety arousing.

If for some reason you wish to withdraw from the experiment you may do so at anytime. You may withdraw while being tested or before you arrive for testing. I will ask you, however, to notify me if you do not intend to keep an appointment for testing. You may miss an appointment because of withdrawing or because of some other reason, but please let me know before hand if you see that you will not be keeping an appointment.

Are there any questions?

Now fill out the schedule sheet when you receive it if you wish to volunteer as a subject.

Second Briefing Session:

Read at the First Testing Session.

Your participation in this research project will involve two testing periods, each one lasting about eight to twelve minutes. Some of your personality characteristics will be tested, and in the second test session you will have to learn a difficult task and perform on this task for about five minutes. The task is not harmful, but it is very difficult and trying.

If you feel that participation in such a project would be unpleasant then you may withdraw at any time including right now if you wish.

(Pause)

This test session involves a simple pencil and paper test. The test is self explanatory and takes about 10 minutes though there is no time limit. After you finish the test please see me so we can arrange a time for the next test.

APPENDIX E

Debriefing Session:

Outline of Debriefing Lecture.

I. Statement of appreciation to participants.

II. General nature of the research: an evaluation of a theory of efficiency by relating several variables to a measure of efficiency.

   A. Description of the measure of efficiency.

   B. Description of the other variables: neuroticism, sex and instructional set.

      For set variable, emphasize that it was not really a test of neuroticism but an experimental technique related to some measure of neuroticism and to other personality variables.

   C. General findings as suggested by the means of groups.

III. Conclude with an emphasis on the experimental nature of the measures and of the general findings.

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