# THE EFFECT OF ABSENCE OF VISUAL STIMULATION ON PERFORMANCE IN AN AUDITORY VIGILANCE TASK

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Richard Edward Manley

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ABSTRACT

THE EFFECT OF ABSENCE OF VISUAL STIMULATION ON PERFORMANCE IN AN AUDITORY VIGILANCE TASK

by Richard Edward Manley

The Problem

This experiment was designed to determine the effect of absence of visual stimulation on performance in an auditory vigilance task. From the point of view of the arousal theory this can be considered as a reduction of total afferent stimulation and, as such, may be expected to produce a lower level of arousal and, consequently, a reduction in vigilance efficiency.

From the viewpoint of the filter theory, it may be argued that the absence of visual stimulation reduces a major source of distracting stimuli to which the filter might become more favorably disposed as the vigil wears on. This reduction of an important source of potential distraction might result in improved performance. In order to check on the possibility of sex differences in vigilance, the following groups were tested:

1. Sighted males (N=22).
2. Sighted females (N=22).
3. Blindfolded males (N=22).
4. Blindfolded females (N=22).

An investigation of some subjective variables related to vigilance is also included in this study.

Procedure

During the vigilance task the subjects were seated in cubicles which afforded semi-isolated conditions. The vigilance task consisted of picking out and recording signals (sequences of three digits, all different, in the order odd-even-odd) from a series of taped digits delivered at the rate of one every second. The digits were presented continuously for 48 minutes. For the purpose of analysis the tape could be broken into three separate periods, each containing six of the total 18 signals. The inter-signal intervals varied from 25 seconds to about seven minutes. At the end of the vigilance task the subjects were asked to complete an Adjective Check-List.

Results

The signal-detection performance may be summarized as follows:

1. There was a significant decremental trend in performance.
2. No significant difference was found for the sighted-blindfolded variable.
3. The females' performance was significantly superior to that of the males.
4. There was a significant interaction between the sighted-blindfolded variable and sex. Blindfolded males were significantly superior to sighted males. Sighted females were slightly superior to blindfolded females.

Four separate analyses of the retrospective data were made. These comparisons may be summarized as follows:

1. High and low signal-detection performers; high performers reported having felt more vigilant than low performers.
2. Sighted-blindfolded groups; the blindfolded group reported having felt more vigilant than the sighted group.
3. Sighted and blindfolded males only; the blindfolded males reported having felt more vigilant than the sighted males.
4. Males and females; the males reported having felt more vigilant than the females.

Approved Paul Baker

Date 8/30/61

# THE EFFECT OF ABSENCE OF VISUAL STIMULATION ON PERFORMANCE IN AN AUDITORY VIGILANCE TASK

By

Richard Edward Manley

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# INTRODUCTION

In recent years there has been an increased interest in the study of vigilance. During World War II a need for better selection of monitoring personnel arose. Men were needed who could stand long watches as sentries, radarmen, or sonarmen; men who could remain alert over fairly long periods of time looking for barely perceptible signals which could appear at any time.

The military needs for the vigilant man still exist. Along with this the industrial need for man as a monitor has also increased. The post war trend toward increased automation has lessened the need for a man's muscle in industry and increased the need for man's vigilance. Both in machine control and in inspection the human is expected to watch for and react to infrequent and often weak signals occurring over a fairly long period of time.

The importance of noticing the signal may be very great, as in the case of the radarman monitoring his set on the early warning line in Alaska or the inspector looking for flaws in brake drums or jet engines as they come off the production line.

During the war Mackworth (1950) initiated a series of studies to discover the optimum length of a radar watch. He developed the Clock Test in order to distil the practical problem to one which could be studied in the laboratory. His display consisted of a clock hand going around a blank dial in discrete jumps. One-hundred jumps

constituted a complete revolution of the dial. Mackworth's subjects were to watch for and detect double jumps of the clock hand. The signals (double jumps) occurred irregularly and infrequently, and when they occurred they were hard to detect. This incorporates the essentials of a vigilance task in a laboratory setting. When the frequency of signal detection was plotted against time for a two-hour watch, Mackworth found a decremental trend in performance with the greatest decrement occurring between the first and second half-hour periods.

Since Mackworth's study (1950) there have been many investigations in the vigilance area. Many of these studies have been attempts to define the environmental variables affecting vigilance performance. Experiments have been contrived to test for the effects of changes in noise level (Broadbent, 1953, 1954; Jerison, 1957-C, 1957-A; Loeb & Jeantheau, 1958), temperature (Loeb & Jeantheau, 1958; Mackworth, 1950), duration of watch (Mackworth, 1950; Jerison, 1957-B), single vs. multiple displays (Jerison, 1957-A, 1957-B), signal intensity (Mackworth, 1950; Adams, 1956), signal duration (Adams, 1956), rate of signal presentation (Jenkins, 1958; Kappauf & Powe, 1959; Nicely & Miller, 1957), and inter-signal interval (Baker, 1959). Other experiments have been designed to investigate the effects of task and subjective differences. Among these we find studies of knowledge of results (Holland, 1957; Mackworth, 1950),

drugs (Mackworth, 1950), reinforcement (Holland, 1957, 1958), and rest periods (Mackworth, 1950).

## THEORIES OF VIGILANCE

Four different theoretical approaches have been advanced to explain the empirical findings in the vigilance area. They are:

1. Inhibition (Mackworth, 1950).
2. Expectancy (Deese, 1955).
3. Attention (Broadbent, 1957, 1958).
4. Arousal (Hebb, 1955; Lindsley, 1957, 1961).

### Inhibition

Mackworth (1950) proposes that inhibition accounts for many of the empirical findings in this area. Briefly, conditioning takes place during the practice trials; the double jump of the clock hand is the conditioned stimulus, the experimenter's "now" is the unconditioned stimulus, and the subject's key-press to the double jump is the conditioned response. Repeated trials without the experimenter's "now" lead to extinction of the key-press. As further evidence that the vigilance decrement is caused by inhibition, Mackworth points out that when the experimenter provides the subject with knowledge of results the performance decrement is eliminated. This constitutes reinforcement in classical terms. Mackworth also reports that when a telephone message is interjected into the task the subject's performance level returns to the level of a fresh subject. This is sighted as evidence of disinhibition. Bakan (1952), McGrath et. al. (1959) and Deese

(1955) point out that this telephone message may not be a neutral stimulus since it is a message from the experimenter telling the subject to do better. In fact, it is more likely to be motivational or to imply to the subject that his performance is less than satisfactory.

There are several inadequacies in the ability of the inhibition theory to handle the vigilance phenomena. Increased signal rate should lead to more rapid extinction of this response. Jenkins (1958) found the opposite to be true. Signal detection performance does not completely break down as classical conditioning would predict, i.e., total experimental extinction. Mackworth's subjects' performance stabilized at about the 70-75% level of detection. This leads Mackworth to hypothesize that a state of self-instruction partly replaces the unconditioned stimulus as reinforcement.

Expectancy

Deese (1955) put forth an expectancy model to account for the decrement found in the vigilance experiments. His view is that the observer's expectancy level is determined by his previous experience with the task. The observer's prediction about the task (in this case the occurrence of the next signal) is based on his averaging of his previous experience with the task. From this, Deese would expect that the probability of detecting the next signal would be a function of the mean inter-signal interval. For an inter-signal interval considerably shorter than the mean

the probability of detection would be low. The probability of detection would increase as the mean interval was reached. The subject's expectancy level determines, at least in part, his vigilance performance. There are individual differences which Deese feels should be measured and used to predict the levels of performance which may be expected from a particular observer.

The expectancy theory would predict that signal-rate and inter-signal interval would be directly related to the detection of a signal. Jenkins (1958) has found the former to be true, but the latter has not yet been effectively demonstrated. Deese also indicates that the characteristics of the vigilance task may lead to decreased sensory input and, hence, to a decrement in vigilance performance. He recommends that more investigation between vigilance performance and the maintainance of a background sensory input be carried out.

Attention

Broadbent (1957, 1958) has laid the groundwork for an attention or filter theory. Only part of the stimuli which impinge on the sensory organs will actually be taken into the system. Much of the stimulation is blocked by a hypothetical sensory filter. What is taken in is determined, at first, by the instructions relevant to the task; but there is a system bias. This bias is for novel stimulation. The filter theory predicts that as time on watch progresses the observer is more apt to select stimuli from

his environment which are irrelevant to his task. These irrelevant stimuli may be either internal or external but, in either case, as time progresses they will become more preferred.

Attending even briefly to these non-task stimuli at the time when task stimuli (signals) are presented will cause the observer to miss the signal. It must be remembered that the signals in the typical vigilance design are of near-threshold intensity, occur at unpredictable intervals, and are highly transitory in nature. Increased preference for stimuli of a non-task nature as a function of time on task will cause the customary vigilance decrement.

Broadbent indicates that the filter theory primarily accounts for an increase in the tendency to momentarily miss the individual signal. Overall level of performance, i.e., task difficulty and/or individual differences, must be inferred from one or several of the other theories.

Arousal

Hebb (1955) indicates that there are two functions of stimuli. Stimuli may serve as cues, as in the classical afferent pattern of stimulation following a relatively discrete sensory pathway to the specific projection area within the cortex, or they may serve a motivational function. The latter concept of stimulus function is based upon the recent discovery of the reticular formation and its apparent arousal or activating function.

Lindsley (1957, 1961) describes the reticular formation as necessary for perception. The ascending reticular activation system (ARAS) receives its stimulation from regular sensory pathways (there is also speculation that it can be activated by the cortex via a feedback system) and, in turn, activates the cortical areas. Direct stimulation of the reticular areas causes a change in the cortical EEG pattern from sleep-like (Alpha Rhythm) to waking (desynchronized). In cases where the ARAS is occluded by surgery or barbiturates, specific potentials can be recorded in the sensory projection areas of the cortex as a result of stimulation, but neither behaviorally nor in terms of the EEG patterns does the animal respond to the stimulation.

The ARAS is seen by Lindsley as a monitor of both afferent and efferent activity which is capable of becoming adapted to certain levels of stimulation. This adaptation allows the ARAS to seek a response level or to set a pace, so to speak. If the ARAS is deprived of its sensory input it attempts to adjust. This adjustment may lead to many of the unusual features described in the literature of sensory deprivation.

Hebb (1955) postulates that efficiency is dependent on cortical stimulation and that the organism's level of activity is ultimately dependent, via the reticular system, upon external stimulation. If there is not enough stimulation the activity level lowers and this is

accompanied by a drop in response efficiency. It is also postulated that there is an optimal level of stimulation and if stimulation is either too high or too low response efficiency will be lowered.

## THE PROBLEM

The experiment reported below is probably most closely related to the arousal theory. The main variable is the presence or absence of visual stimulation during an auditory vigilance task. Reduction of visual stimulation can be considered as a reduction in the total afferent stimulation. This reduction in stimulation can be expected to produce a lower level of arousal and, consequently, bring about a reduction in vigilance efficiency.

From the point of view of the filter theory, it might be argued that the absence of visual stimulation reduces a major source of distracting stimulation to which the filter might become more favorably disposed as the time on task increases. The reduction of an important source of potential distraction might result in improved performance.

The present study represents an exploration of the sighted-blindfolded variable in an auditory vigilance task. It is also designed to check on the possibility of sex differences in vigilance since an earlier study by Bakan (1953) has suggested the presence of sex differences in vigilance performance. An investigation of some subjective variables related to vigilance is also included in the present study.

## PROCEDURE

### Selection of Subjects

Subjects were obtained through the sign-up program in the General Psychology course. Each student enrolled in the General Psychology course is expected to participate as a subject in one or more experiments. Lists are posted in a convenient area and the students may select one of several lists which they will sign.

Those subjects enrolling for this experiment were telephoned by the experimenter on the eve of their test session to remind them that they had signed up and to arrange a meeting place and transportation to the testing site. Subjects met at the Psychology Building (B-3) on South Campus and were driven to the Experimental Psychology Laboratory or to Quonset No. 76 where cubicles were present such that several subjects could be tested under conditions of semi-isolation.

The subjects were initially seated together in the main corridor for the purpose of general instruction and practice. Wrist watches were taken and the subjects were asked to refrain from smoking, chewing gum, etc. for the duration of the experiment. Instruction sheets were given to each subject (see Appendix). The experimenter read the instructions aloud and the subjects were told to follow the text. Questions were answered at several points or whenever a subject indicated confusion.

Practice

At the end of the instruction sheet there is a series of 63 digits. The subjects were told to go through this series looking for sequences of three successive digits, all different, in the order of odd-even-odd. They were to write such sequences on a practice sheet provided for that purpose. When they were finished the experimenter told them what signals there were and corrected any of the misconceptions expressed at this time.

The instruction sheets were taken up and the subjects were assigned to cubicles. These were arranged in such a way that the subjects in the cubicles could not see one another. Each cubicle was provided with a chair and a work table. Each table held a pasteboard shoe box, several practice cards and an information card. The subjects were asked to fill out the information card which provided the experimenter with data about their name, age, sex, scholastic year, and hearing. The subjects were next asked to listen to the tape and to record any "good signals" (sequence of three digits, all different, in the order of odd-even-odd) which they might hear. A few seconds after the occurrence of a signal the experimenter repeated it aloud.

Two auditory practice sessions were given the subjects. The first was about five minutes in duration and contained two signals. The second lasted for about ten minutes and had three signals. At the end of each

practice run the tape was stopped and the experimenter checked with each subject to see that he understood the task, and to answer any questions he might have.

After the second auditory trial-run the subjects were given a five-minute break during which they could leave the cubicle, smoke, relax, and talk with one another. When the break ended the subjects returned to their cubicles.

In order to obtain information about sighted and blindfolded subjects, and about males and females, four groups were set up:

1. Sighted males.
2. Sighted females.
3. Blindfolded males.
4. Blindfolded females.

An equal number of males and females were tested under each of two conditions--sighted or blindfolded. Only one experimental condition was run at any one time. Sighted and blindfolded subjects were never tested during the same test session; males and females were, however, tested together. The number of subjects run at one time varied from two to six.

The sighted subjects were supplied with a pack of test cards (blank 3" x $2\frac{1}{2}$" white cards), a pencil, and a pasteboard shoe box with a slot cut in the top through which they were to drop the cards after they had recorded a signal. The slotted boxtop was used on the sighted

subjects so they would not have more knowledge as to signal frequency than did the blindfolded subjects. The cards contained code numbers which enabled the experimenter to put them into correct order if they became mixed in the box. The subjects were asked not to change the order of the cards.

The blindfolded subjects were outfitted with blindfolds which were set up to insure total blindness and an optimal amount of comfort over a long testing period. Close fitting Army surplus goggles were used. The eye pieces were filled with foam rubber. The foam rubber was cut thick enough so that when the goggles were worn it exerted enough pressure against the eyelids to keep them closed. Fresh sterile gauze was placed between the subject's eyes and the foam rubber pads to guard against any irritation or undue discomfort. The blindfolded subjects also had a test pack of blank cards and a pasteboard shoe box. For the blindfolded subjects the top of the box was removed so that they might have less trouble dropping their recorded signals into it.

Before the test was begun the experimenter emphasized that this was the real thing and pointed out that the signals would not be repeated as they had on the previous test runs.

The Test Environment

The tape recorder was placed in a central position and the volume was adjusted so that all of the subjects

could hear it from their cubicles. The test period was 48 minutes long. The tape was arranged in such a way that it could be analyzed in three separate 16 minute periods. Subjectively, it consisted of a continuous series of digits, delivered one every second in the same tone of voice and lasted for 48 minutes. The entire test contained 18 signals, six occurring in each of the three periods. The time between signals was 107, 71, 154, 25, and 418 seconds. This series of inter-signal intervals was repeated for each of the three periods although the actual signals differed. At the end of the listening period the subjects were asked to complete an Adjective Check-List.

Adjective Check List

While still in their cubicles the subjects were given a 50 item check-list designed for use in this experiment. This list contained many adjectives seemingly relevant to feelings during a vigilance task. The subjects were told to respond on a seven-point scale bounded by "not" and "very" with regard to how well the adjective described the way they felt during the experiment. Instructions for using the scale and an example item were included on the questionnaire. (See Appendix.)

When a subject completed the check-list his watch was returned, he was given a credit slip for his participation, and he was released with the request that he not discuss the experiment with other students.

## RESULTS

### Signal-Detection Performance

The basic data in terms of mean signal-detection performance for each of the four groups, and for various combinations of these groups, is presented numerically in Table 1 and graphically in Figures 1, 2, and 3. The following summary is based on an inspection of the data:

1. For all subjects combined there is a decremental trend in performance from Period I to Period III.
2. Sighted and blindfolded subjects start out at approximately the same level, but as time on task progresses the sighted subjects show more decrement. For the blindfolded subjects there is actually a slight improvement in performance between the first and second periods.
3. The overall signal-detection performance of females is superior to that of the males. This difference, however, is due to the inferior performance of the sighted males. Mean signal-detection performance for males and females is the same in the blindfolded condition.

The data were subjected to a $\sqrt{x + .5}$ transformation suggested by Edwards (1950) for use when the means of

Table 1. Signal Detection Performance for Male and Female Subjects in Sighted and Blindfolded Groups

| Group | No. in Group | Period I | Period II | Period III | Total |
|---|---|---|---|---|---|
| Sighted Males | 22 | 4.04 | 3.50 | 3.09 | 10.63 |
| Sighted Females | 22 | 4.82 | 4.77 | 4.04 | 13.63 |
| Blindfolded Males | 22 | 4.32 | 4.59 | 4.09 | 13.00 |
| Blindfolded Females | 22 | 4.59 | 4.59 | 3.82 | 13.00 |
| Sum of Sighted S's | 44 | 4.43 | 4.14 | 3.57 | 12.14 |
| Sum of Blindfolded S's | 44 | 4.45 | 4.59 | 3.95 | 12.99 |
| Sum of Male S's | 44 | 4.18 | 4.04 | 3.59 | 11.81 |
| Sum of Female S's | 44 | 4.70 | 4.68 | 3.93 | 13.31 |
| Total Sample | 88 | 4.44 | 4.36 | 3.76 | 12.56 |

Figure 1. Mean Signal-Detection Performance for Sighted and Blindfolded Subjects Over Periods

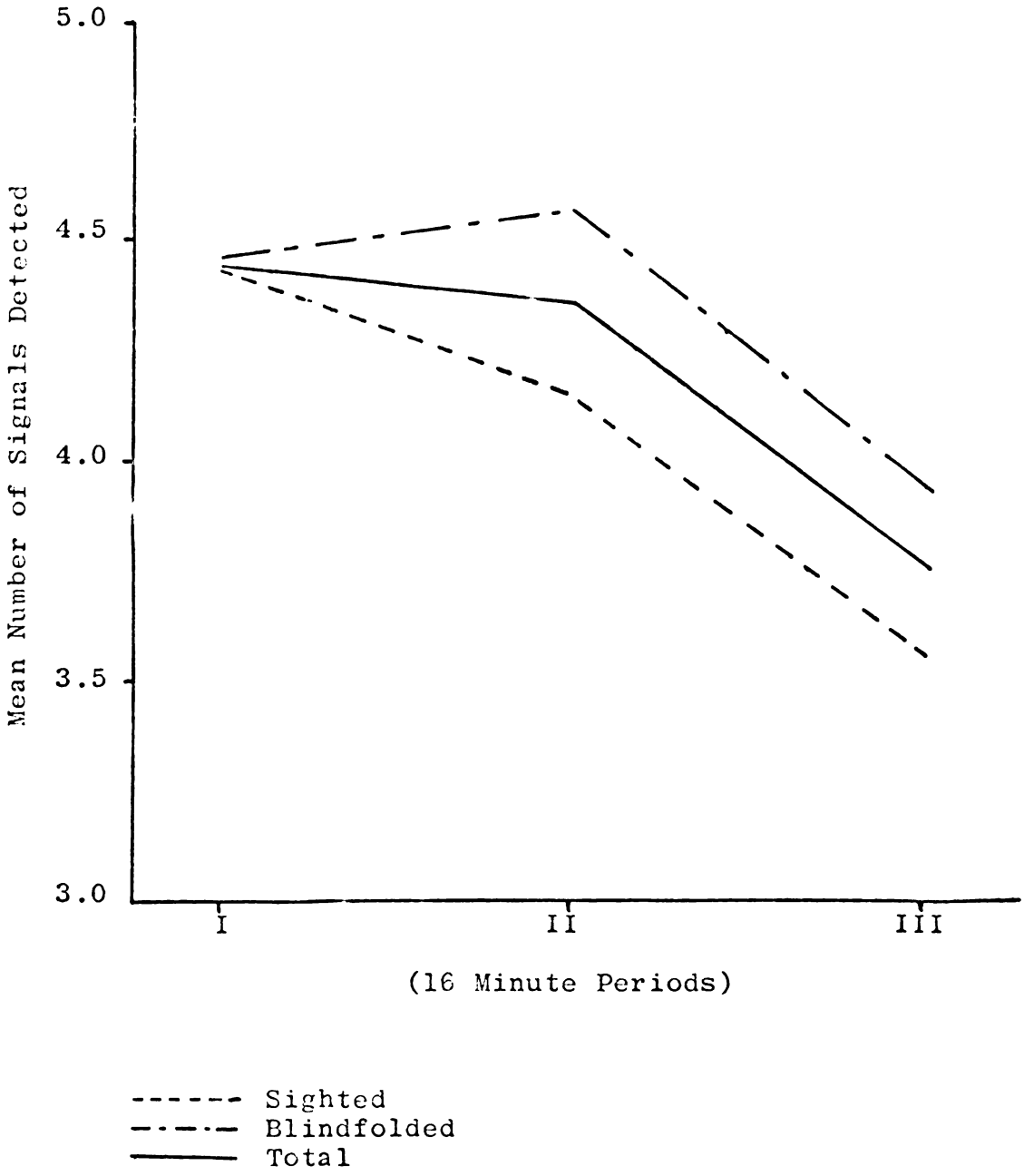


Figure 2. Mean Signal-Detection Performance for Males and Females Over Periods

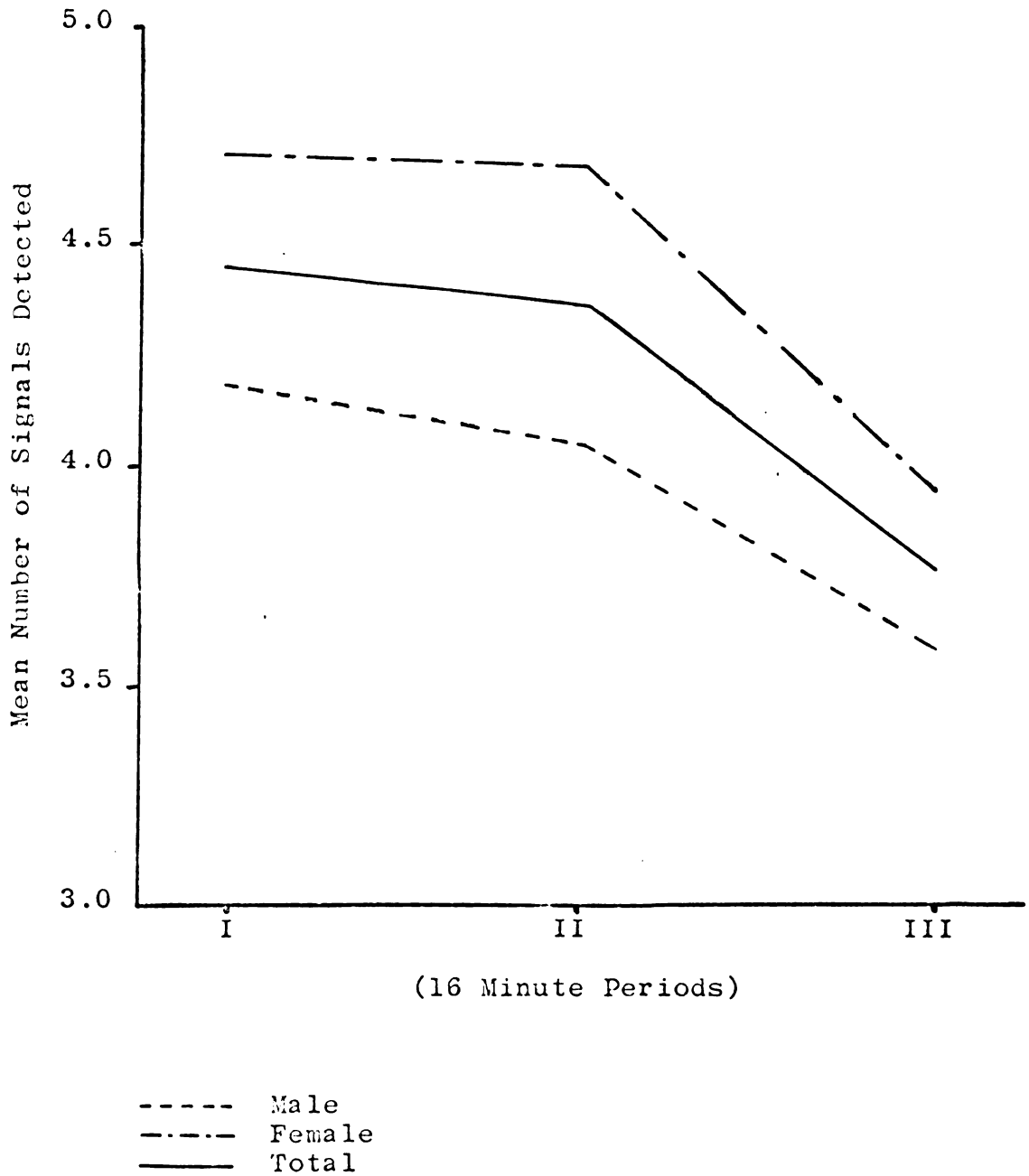
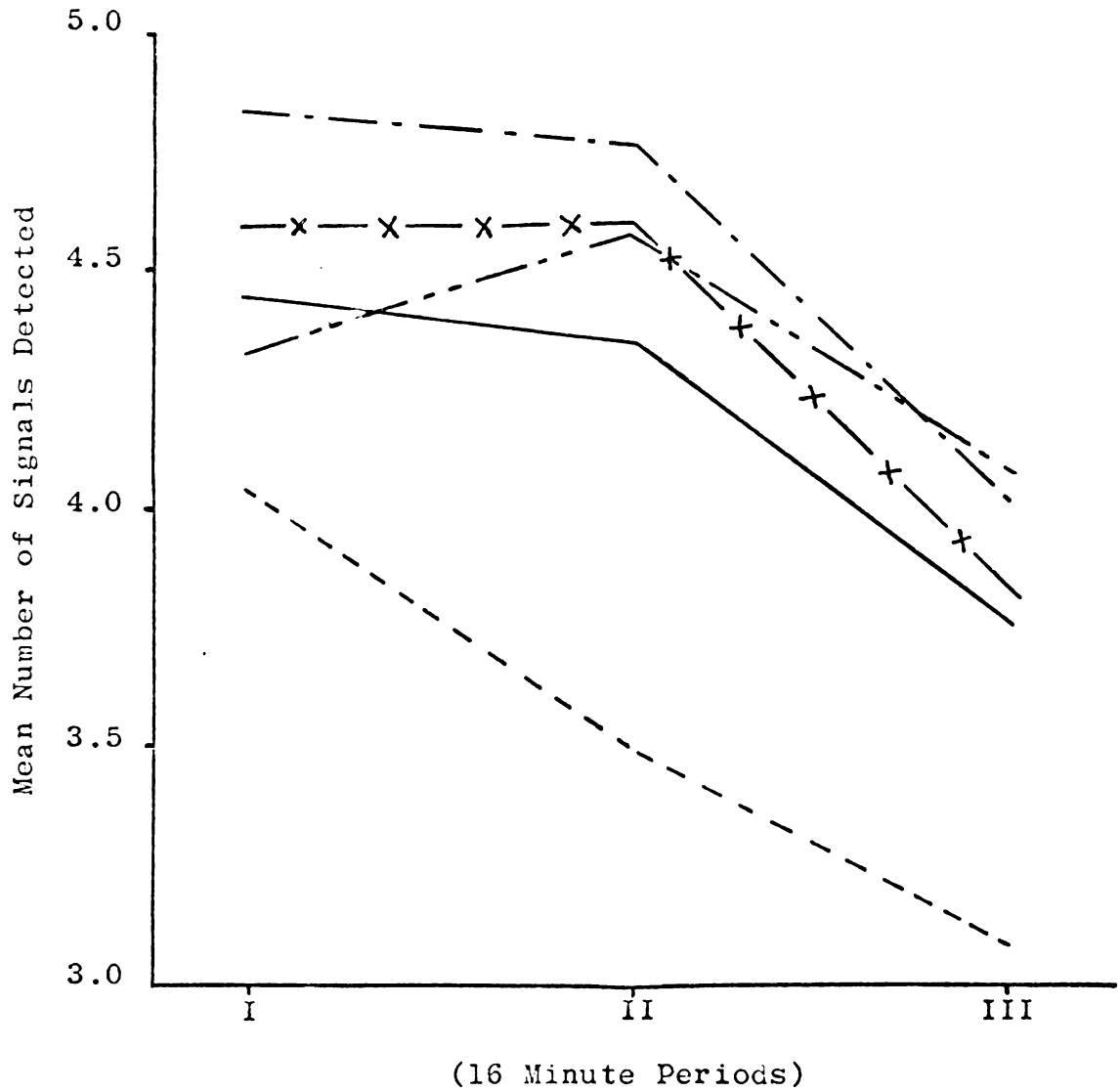


Figure 3. Mean Signal-Detection Performance for Sighted and Blindfolded Males and Females Over Periods



the various groups are small and an analysis of variance was carried out. A test for homogeniety of variance (Bartlett) was carried out and the data was found to be homogeneous. The analysis is modeled after that suggested by Edwards for repeated measurements of independent groups. A summary of the analysis is presented in Table 2. This analysis may be summarized as follows:

1. The overall decremental trend is significant at the 1% level (between periods).
2. None of the interactions involving period (the course of signal-detection over time) were statistically significant.
3. The overall difference between sighted and blindfolded conditions was not statistically significant.
4. The difference between males and females was significant at the 5% level of confidence. This difference must be considered in conjunction with the interaction between the sighted-blindfolded variable and sex which was also significant at the 5% level.
5. The significant interaction between the sighted-blindfolded variable and sex is clarified by an inspection of Table 3.

An inspection of Table 3 shows that the sighted-blindfolded variable influences the performance of males, producing impaired performance for males in the sighted

Table 2. Analysis of Variance of Transformed Signal-Detection Scores

| Source of Variation | Sum of Squares | Degrees of Freedom | Mean Squares | F | p |
|---|---|---|---|---|---|
| Between Subjects | 20.22 | 87 | | | |
| Between Conditions (sight-blindfold) | .57 | 1 | .57 | 2.78 | NS |
| Between Sex (male-female) | 1.14 | 1 | 1.14 | 5.56 | .05 |
| Interaction (condition X sex) | 1.28 | 1 | 1.28 | 6.24 | .05 |
| Between Subjects in Same Group (Error Term) | 17.23 | 84 | .205 | | |
| Within Subjects | 26.76 | 176 | | | |
| Between Periods | 1.78 | 2 | .890 | 6.10 | .01 |
| Periods X Conditions | .16 | 2 | .080 | .55 | NS |
| Periods X Sex | .03 | 2 | .015 | .10 | NS |
| Periods X Conditions X Sex | .23 | 2 | .115 | .79 | NS |
| Residual(Error Term) | 24.56 | 168 | .146 | | |
| TOTAL | 46.98 | 263 | | | |

Table 3. Sighted-Blindfolded X Male-Female Interaction (Mean Overall Signal-Detection Performance)

| | Sighted | Blindfolded | t | p |
|---|---|---|---|---|
| Male | 10.63 | 13.00 | 2.49 | .02 |
| Female | 13.63 | 13.00 | .61 | NS |

condition. For the females there is a slight difference between the sighted and blindfolded condition favoring the sighted condition. Apparently males and females are not reacting in the same way to the sighted-blindfolded variable. The differences between the means were tested with the t-test and it was found that the mean difference for the males was significant at the 2% level while the mean difference for the females was not significant.

Errors of Commission

The previous analysis has been concerned with signals which have been presented to the subject and which have not been reported by him. This type of error is called an error of omission. Subjects also make commission errors, i.e., reports of signals when they do not occur. It is necessary to be explicit about the criteria for errors of commission.

In order to guard against including "good signals" which have been mishandled by the subject, the following criteria have been adopted:

1. Only signals which are basically correct, i.e., three digits, all different, and in the order of odd-even-odd will be considered. Signals of other forms (1-4-1 or 4-3-6, etc.), if accepted, would reflect a misunderstanding of the task and not necessarily errors of commission.

2. Signals containing two out of three correct signal digits (recording 3-4-9 for 3-4-5) will not be counted as errors of commission.
3. Signals constituting a transposition of correct signal digits (recording 5-4-1 for 1-4-5) will not be counted as errors of commission.

There is a difference between the incidence of errors of commission for sighted and blindfolded subjects. Sighted subjects averaged 2.82 errors of commission while blindfolded subjects averaged 4.23 errors. This difference appears to be caused by a decreased number of errors of commission during Periods II and III exhibited by the sighted subjects as opposed to the fairly stable number of errors of commission throughout the entire task exhibited by the blindfolded subjects. The difference between the means of these groups (these data were not transformed) was tested with the t-test and was not found significant.

In order to further investigate this trend, the number of subjects making commission errors (disregarding the number made by each subject) under the sighted and blindfolded conditions during each of the three periods was tabulated. The results of this tabulation may be seen in Table 4. The data of Table 4 indicates that fewer sighted subjects make errors of commission during the last period than blindfolded subjects. In order to test this trend a two x two Chi-Square, corrected for continuity, was

Table 4. Number of Sighted and Blindfolded Males and Females Making Errors of Commission During Each Period

| Condition | Period I | Period II | Period III |
|---|---|---|---|
| Sighted Males | 12 | 12 | 7 |
| Sighted Females | 15 | 13 | 8 |
| Blindfolded Males | 13 | 10 | 9 |
| Blindfolded Females | 15 | 13 | 12 |
| Sum of Sighted | 27 | 25 | 15 |
| Sum of Blindfolded | 28 | 23 | 21 |
| Total | 55 | 48 | 36 |

computed between the number of sighted and blindfolded subjects making more errors in Period I than in Period III and making fewer errors in Period I than in Period III. This Chi-Square was not significant. Table 5 shows the results of this tabulation.

Retrospective Data

The adjective check-list was included in this design in order to explore the relationship between signal-detection and some subjective variables. Subjective differences between sighted and blindfolded subjects and between males and females were also investigated. Four separate analyses were performed. These were designed to provide comparisons of retrospective descriptions of feelings during the task for the following groups:

1. Performance (high or low signal-detection groups).
    a. The high signal detection group consisted of the five subjects from each group attaining the highest overall signal-detection score (N=20).
    b. The low signal-detection group consisted of the five subjects from each group attaining the lowest overall signal-detection score (N=20).
2. Experimental conditions (sighted-blindfolded).
3. Conditions (sighted-blindfolded) for males only. This analysis is included in view of the significant interaction between the sighted-blindfolded variable and sex, and

Table 5. Number of Sighted and Blindfolded Subjects Making More Errors of Commission in Period I than in Period III and Making Fewer Errors of Commission in Period I than in Period III

| | More Errors in Period I than in Period III | Fewer Errors in Period I than in Period III | Total |
|---|---|---|---|
| Sighted | 22 | 6 | 28 |
| Blindfolded | 14 | 10 | 24 |
| Total | 36 | 16 | 52 |

the significant difference between sighted and blindfolded males.

4. Sexes (male-female).

The check-list was composed of 50 adjectives. The subjects were told to respond to each adjective on a seven-point scale (0 to 6) bounded by "not" and "very". Item scores (the sum of the values checked for each item) and item means were computed for each group tested. A t-test of significance was performed between the various groups when the mean difference and variance warranted it. Table 6 serves as an introduction to the adjectives used, and also indicates those items which resulted in a significant difference between the various groups.

Table 7 presents the data for all adjectives for which there was a difference between the high and low signal-detection groups significant at the 10% level or better.

The analysis of sighted and blindfolded groups with respect to their retrospective data is summarized in Table 8. This table shows the adjectives which discriminate between sighted and blindfolded subjects at the 10% level of confidence.

Table 9 presents those adjectives which discriminate between sighted males and blindfolded males at the 10% level of significance.

Table 10 presents those adjectives which discriminate between males and females at the 10% level.

Table 6. Adjectives Used on the Retrospective Check-List and Those Comparisons Resulting in a Difference Significant at the 10% Level or Better

| Item Number | | Comparisons Resulting in Significant t |
|---|---|---|
| 1. | Alert | |
| 2. | Deaf | |
| 3. | Silly | Condition, Sex, Male (S-B)* |
| 4. | Mindless | Performance |
| 5. | Bored | Condition, Male (S-B) |
| 6. | Emotional | Performance |
| 7. | Spry | Sex |
| 8. | Dreamy | Male (S-B) |
| 9. | Weary | Sex |
| 10. | Enthusiastic | Sex |
| 11. | Lost | Performance |
| 12. | Dull | |
| 13. | Active | |
| 14. | Upset | |
| 15. | Drowsy | |
| 16. | Lively | |
| 17. | Inattentive | |
| 18. | Fatigued | |
| 19. | Industrious | Sex |
| 20. | Calm | Condition |
| 21. | Sharp | |
| 22. | Blind | Condition, Male (S-B) |
| 23. | Tired | Sex |
| 24. | Dismal | Performance |
| 25. | Passive | |

*Male (S-B) refers to the comparison made between sighted and blindfolded males only.

(Table continued on next page)

Table 6 (continued)

| Item Number | | Comparisons Resulting in Significant t |
|---|---|---|
| 26. | Quick | |
| 27. | Nervous | |
| 28. | Apathetic | Condition |
| 29. | Sluggish | |
| 30. | Intent | |
| 31. | Exhausted | |
| 32. | Angry | |
| 33. | Vigilant | |
| 34. | Lifeless | |
| 35. | Wakeful | |
| 36. | Cooperative | |
| 37. | Vigorous | Sex |
| 38. | Careless | |
| 39. | Wide-Awake | Sex |
| 40. | Excited | |
| 41. | Restless | |
| 42. | Alive | |
| 43. | Relaxed | Condition |
| 44. | Energetic | Sex |
| 45. | Gone | Performance, Male (S-B) |
| 46. | Frisky | Sex, Performance |
| 47. | Depressed | |
| 48. | Brisk | Sex |
| 49. | Fidgity | |
| 50. | Watchful | Performance |

Table 7. Retrospective Check-List Adjectives Which Differentiate Between the High and Low Performance Groups Significant at the 10% Level

| Item Number | Mean of High | Mean of Low | t | p (2 tailed) |
|---|---|---|---|---|
| 4. Mindless | 1.70 | 3.05 | 3.49 | .01 |
| 6. Emotional | 4.10 | 1.75 | 4.93 | .01 |
| 11. Lost | 2.10 | 2.95 | 2.00 | .05 |
| 24. Dismal | 2.40 | 3.35 | 1.86 | .10 |
| 45. Gone | 1.30 | 2.35 | 2.17 | .05 |
| 46. Frisky | 1.10 | 1.90 | 1.86 | .10 |
| 50. Watchful | 3.65 | 2.80 | 1.81 | .10 |

Table 8. Retrospective Check-List Adjectives Which Differentiate Between the Sighted and Blindfolded Groups Significant at the 10% Level

| Item Number | Mean of Sighted | Mean of Blindfolded | t | p (2 tailed) |
|---|---|---|---|---|
| 3. Silly | 1.00 | .38 | 2.35 | .05 |
| 5. Bored | 3.95 | 2.65 | 4.11 | .01 |
| 20. Calm | 3.27 | 4.12 | 2.07 | .05 |
| 22. Blind | 1.07 | 3.97 | 6.77 | .01 |
| 28. Apathetic | 2.72 | 1.68 | 3.17 | .01 |
| 43. Relaxed | 2.55 | 3.29 | 1.85 | .10 |

Table 9. Retrospective Check List Adjectives Which Differentiate Between Sighted Males and Blindfolded Males Significant at the 10% Level

| Item Number | Mean of Sighted Male | Mean of Blindfolded Male | t | p (2 tailed) |
|---|---|---|---|---|
| 3. Silly | 1.45 | .54 | 2.02 | .10 |
| 5. Bored | 4.54 | 2.68 | 3.15 | .01 |
| 8. Dreamy | 4.23 | 3.00 | 2.32 | .05 |
| 22. Blind | 1.00 | 4.45 | 5.85 | .01 |
| 45. Gone | 2.62 | 1.64 | 2.09 | .05 |

Table 10. Retrospective Check-List Adjectives Which Differentiate Between Males and Females Significant at the 10% Level

| Item Number | | Mean of Male | Mean of Female | t | p (2 tailed) |
|---|---|---|---|---|---|
| 3. | Silly | 1.00 | .38 | 2.32 | .05 |
| 7. | Spry | 1.68 | .91 | 2.46 | .02 |
| 9. | Weary | 3.66 | 4.34 | 1.79 | .10 |
| 10. | Enthusiastic | 2.45 | 1.66 | 2.37 | .05 |
| 19. | Industrious | 2.23 | 1.48 | 2.39 | .05 |
| 23. | Tired | 3.36 | 4.11 | 1.98 | .05 |
| 37. | Vigorous | 2.29 | 1.55 | 2.26 | .05 |
| 39. | Wide-Awake | 2.48 | 1.77 | 1.98 | .05 |
| 44. | Energetic | 2.14 | 1.39 | 2.42 | .05 |
| 46. | Frisky | 1.64 | .98 | 2.54 | .05 |
| 48. | Brisk | 2.00 | 1.23 | 2.65 | .01 |

# DISCUSSION

## Signal Detection Performance

There is a decrement in signal-detection performance present for all groups in this study. Sighted and blindfolded subjects have nearly the same score at the end of Period I (after 16 minutes spent on the task). Between Periods I and II the sighted performance level drops while the performance for the blindfolded subjects increases slightly. Between Periods II and III both groups show a substantial drop in signal-detection performance.

Two other studies (Belton, 1958; Toth, 1960) using this same task to investigate individual differences in vigilance have obtained performance decrements of a similar nature. This indicates that this task produces a decremental trend similar to that found in other vigilance studies. Generally the decremental trend found here is in agreement with other studies finding decrement, i.e., the onset of decrement takes place within the first hour of watch. For the total group in this study it may be seen that decrement is present at least at the end of the first period (16 minutes).

The data suggest there is a delay in the onset of the decremental trend for the blindfolded subjects as compared to the sighted subjects, though this differential trend is not statistically significant. The analysis of variance indicates there are no significant interactions between

period and any of the other variables. It is interesting to speculate, however, that the blindfolded subjects have in some way delayed the onset of the vigilance decrement.

The overall signal-detection performance of the females is superior to that of the males in this task. This must be explained by the inferior performance of the sighted males. Both blindfolded groups (males and females) attained the same overall mean score on this task. It must be pointed out here that there was a significant interaction between the sighted-blindfolded variable and sex. The males are affected by the sighted-blindfolded variable which produces impaired performance for males in the sighted condition. The difference in performance between sighted and blindfolded males is significant at the 2% level. Females, on the other hand, perform slightly better sighted than blindfolded. This difference was not found significant.

In terms of distractibility, the males appear more distractible than the females. The males' overall performance is depressed significantly under the sighted condition (sighted males compared with blindfolded males) while the overall performance of the females improves slightly in the sighted condition. The males' performance in this task is in line with the predictions that might be made from the filter theory. It would appear that as time on task progresses the males tend to seek new stimulation. The sighted males have more visual stimulation in their

environment than do the blindfolded males. The filter theory suggests that as time on task progresses the filter becomes biased toward novel stimulation, hence, those subjects with more irrelevant stimuli in their environment should show greater decrement in performance.

The data for female subjects performing in this vigilance task is not supportive of either of the theories (filter or arousal). It may be seen that while there is a slight trend toward increased decrement in signal-detection performance as a result of being blindfolded, this is not significant. The most that can be said is that females and males react differently to the sighted-blindfolded variable.

Errors of Commission

In the result section it was pointed out that a trend existed for blindfolded subjects to commit more errors of commission than sighted subjects. This difference was tested and not found to be statistically significant. This difference is largely due to a few blindfolded subjects who make a large number of errors of commission. It was noted in making the computations for the t-test that the variance was much smaller for the sighted subjects than for the blindfolded subjects (6.34 as compared to 26.05). It may be said then that the blindfolded group is much more variable regarding its commission error behavior than is the sighted group.

In order to reduce the effects of a few subjects in

the blindfolded condition making a great number of errors of commission, a two X two Chi-Square was computed for the number of sighted and blindfolded subjects making more errors in Period I than in Period III and for those making fewer errors in Period I than in Period III. The Chi-Square, corrected for continuity, for this data was not significant.

This may suggest an explanation for the seemingly delayed onset of the performance decrement for the blindfolded subjects. It may be that one of the things that at least some of the blindfolded subjects do to keep their performance up is to invent signals. This suggestion would be in line with a two-factor theory of vigilance proposed by Bakan (1959). Briefly, this theory states that the stimulation level of the usual vigilance task is so low that subjects have a tendency to go to sleep. This tendency is in conflict with the instructions they are usually given. In order to stay awake subjects use various methods of self-stimulation (daydreaming, reciting to themselves, thinking over the day, etc.). It may be that some of the blindfolded subjects, being deprived of some of the distracting stimuli, focused upon the vigilance task as a means of self-stimulation. This would not have the effect of decreasing their signal-detection performance as in the case of sighted subjects who focused upon elements of the stimulus environment irrelevant to the vigilance task.

It would appear, in view of the significant difference between sighted and blindfolded males in signal-detection performance, that this means of self-stimulation is most used by males; or that it is used by both males and females, but that the males' performance is much more affected by distracting stimuli than the females'. The latter formulation seems more reasonable in view of the errors of commission data. Both the male and female groups made more errors of commission in the blindfolded condition than in the sighted condition (88-63 for males and 99-61 for females), and more males and females in the blindfolded condition made errors of commission in Period III than those in the sighted condition (9-7 males and 12-8 females). Certainly, this is only a suggestion and further investigation is necessary before any conclusions can be drawn.

Retrospective Data

The analysis of the retrospective data with respect to the high and low signal-detection performers indicates that, generally, there is a relationship between performance and the check-list attitudes. It would be expected that the good performer would report having felt more alert, more watchful, etc. on the check-list than would the poor performer. Conversely it would be expected that the low performer would report having felt more dreamy, more fatigued, etc. than the high performer. This, generally, is what was found. The items for which the

difference was significant are listed in Table 7. The item means for all of the groups for which analyses were performed will be found in the Appendix. It was found that high signal-detection performers felt significantly less mindless, more emotional, less lost, less dismal, less gone, less frisky, and more watchful. The only significant item which constitutes a reversal of what might be expected is frisky, though this might be a predisposing state to distractibility.

The retrospective data for the sighted and blindfolded groups was compared and it was found that, generally, blindfolded subjects have a better attitude toward the task. This is in line with the fact that blindfolded subjects have a higher overall signal-detection score than sighted subjects do. This may also tend to support the suggestion that blindfolded subjects, deprived of external stimulation, are able to use the vigilance task as a source of self-stimulation and, in so doing, may show less of a performance decrement as a result of time on task. If the subject can use the vigilance task it seems reasonable that he may have a better attitude toward it.

Since there was a significant interaction between the sighted and blindfolded variable and sex, and in view of the significant difference between sighted and blindfolded males, it was decided that a comparison of the retrospective data for the sighted and blindfolded males should be made. This analysis shows that the sighted

males felt significantly more silly, more bored, more dreamy, less blind, and more gone. In addition to the items which proved statistically significant it may be seen that sighted males described themselves in terms which were more similar to those found among the low performers. In nearly all of the adjectives which would be thought to describe good vigilance attitudes or feelings the sighted males scored higher than the blindfolded males. In other words, the sighted males described themselves as having attitudes and feelings less conducive to vigilant behavior than those described by the blindfolded males. Here again, it may be seen that the retrospective attitudes and feelings described by the subject are related to their performance on the vigilance task. Those groups of subjects which reported feeling less vigilance-oriented generally performed worse than groups of subjects reporting feelings more readily construed as vigilant.

The final analysis of retrospective data was made between males and females. In this analysis it appears that the males have "superior" retrospective feelings toward the task. They feel more spry, more enthusiastic, less weary, etc.

The retrospective data presented in this experiment may well have many facets. It has been found that for all of the analyses except the male-female analysis, the retrospective data had been a good postdictor for group

performance. There may well be social differences which overshadow the effects of a test of this kind which would cloud the general effect. It may be that males are used to thinking of themselves as more active than females, and that a questionnaire like this taps this kind of feeling. Nevertheless, the retrospective data indicates that males report feeling more vigilance-oriented.

The items used in this check-list are of a nature to tap feelings about the vigilance task. Primarily, it must be assumed that the feelings present at the end of the task are due, at least in part, to the task. The blindfolded and sighted males were very different in their signal-detection performance and in their retrospective data. It is improbable that the differences observed were caused by group differences present before the onset of the task. It is assumed (at the 2% level of confidence) that the change in their performance is a result of the task conditions. This also forces the assumption that their attitudes prior to the task had a negligible effect on their performance and that the task, or their performance on the task, influenced their feelings toward the task. Certainly, this does not imply that attitudes and feelings do not have a part in vigilance. The types of items used in this check-list were rather specifically related to the task. It would be expected that these would tap feelings stemming from the task itself.

This study has been primarily interested in group

retrospective data. No attempt has been made to analyze the data for the individual subject. Certainly, differences could be found which would be pertinent to individual performance level in such an analysis. Many of the individual differences are lost in a group trend.

## SUMMARY AND CONCLUSIONS

### The Problem

This experiment was designed to determine the effect of absence of visual stimulation on performance in an auditory vigilance task. From the point of view of the arousal theory this can be considered as a reduction of total afferent stimulation and, as such, may be expected to produce a lower level of arousal and, consequently, a reduction in vigilance efficiency.

From the viewpoint of the filter theory, it may be argued that the absence of visual stimulation reduces a major source of distracting stimuli to which the filter might become more favorably disposed as the vigil wears on. This reduction of an important source of potential distraction might result in improved performance. In order to check on the possibility of sex differences in vigilance, the following groups were tested:

1. Sighted males (N=22).
2. Sighted females (N=22).
3. Blindfolded males (N=22).
4. Blindfolded females (N=22).

An investigation of some subjective variables related to vigilance is also included in this study.

### Procedure

During the vigilance task the subjects were seated in cubicles which afforded semi-isolated conditions. The

vigilance task consisted of picking out and recording signals (sequences of three digits, all different, in the order odd-even-odd) from a series of taped digits delivered at the rate of one every second. The digits were presented continuously for 48 minutes. For the purpose of analysis the tape could be broken into three separate periods, each containing six of the total 18 signals. The inter-signal intervals varied from 25 seconds to about seven minutes. At the end of the vigilance task the subjects were asked to complete an Adjective Check-List.

Results

The signal-detection performance may be summarized as follows:

1. There was a significant decremental trend in performance.
2. No significant difference was found for the sighted-blindfolded variable.
3. The females' performance was significantly superior to that of the males.
4. There was a significant interaction between the sighted-blindfolded variable and sex. Blindfolded males were significantly superior to sighted males. Sighted females were slightly superior to blindfolded females.

Four separate analyses of the retrospective data were made. These comparisons may be summarized as follows:

1. High and low signal-detection performers;

high performers reported having felt more vigilant than low performers.

2. Sighted-blindfolded groups; the blindfolded group reported having felt more vigilant than the sighted group.
3. Sighted and blindfolded males only; the blindfolded males reported having felt more vigilant than the sighted males.
4. Males and females; the males reported having felt more vigilant than the females.

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# APPENDIX

1. Instruction Sheet.

2. Adjective Check-List.

3. Retrospective Check-List Adjectives and the item means of groups for which analyses were performed.

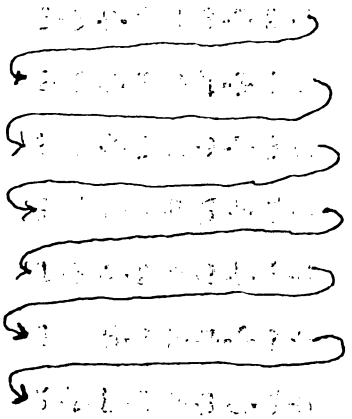
4. Raw signal-detection data and raw errors of commission data.

[illegible] in the box before you

in the box.

first

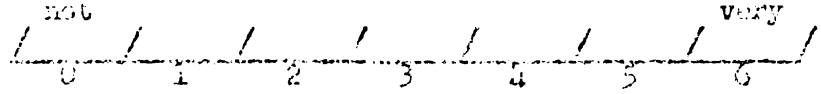
looking



This short list is designed to find out how you felt while you were involved in this listening task. You are to check the degree to which each of the words listed below describes the way you felt during the experiment.

Consider the adjective happy as an example.

Happy



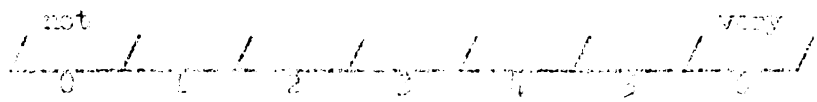

If during the task you did not feel at all happy you should place a check in space 0. If you felt very happy you should place a check in space 6.

You are to think of each scale as representing a dimension from not to very and to place your check anywhere between 0 and 6 according to your feelings during the task.

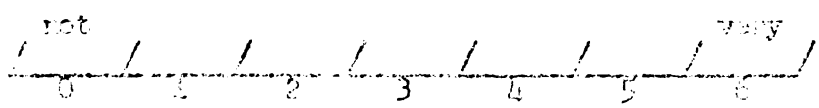
If your degree of happiness during the task was somewhere between sad and happy you would place your check somewhere along the scale corresponding to your degree of happiness.

You are to be sure that all of the adjectives given below describe the way you felt during the task. Usually your first reaction is the best one.

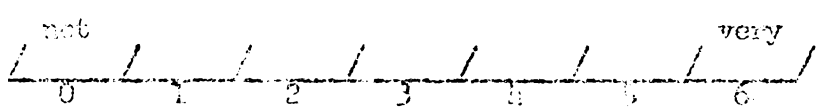
1. Tired



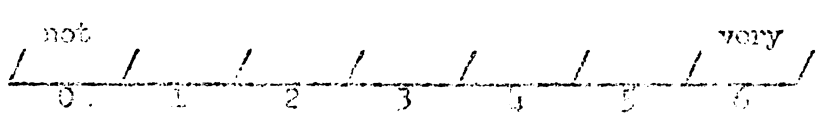

2. Hurt



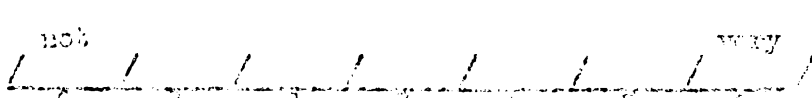

3. Silly



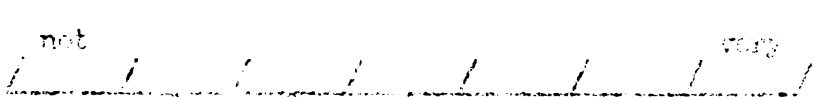

4. Mindless

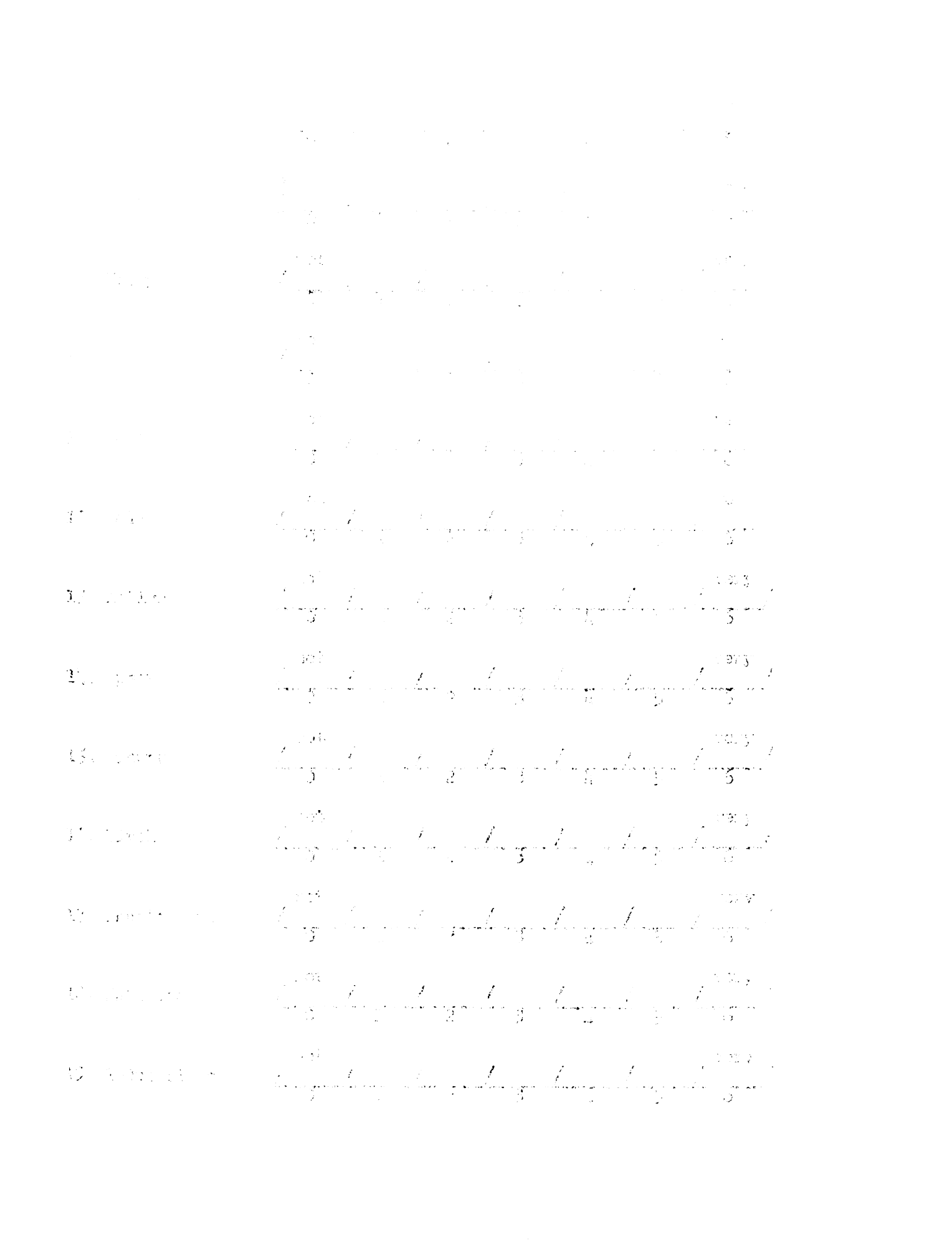


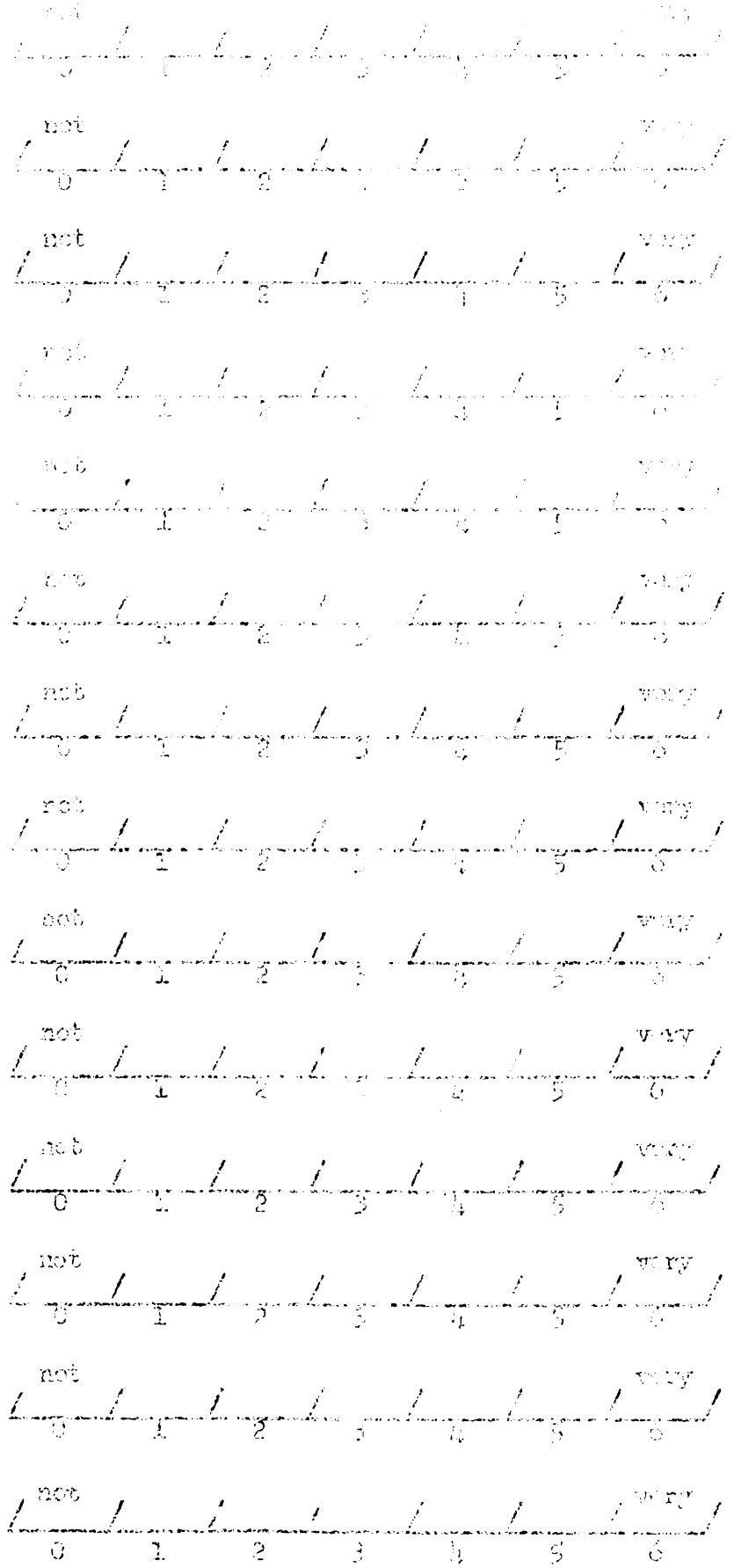

5. Jovial



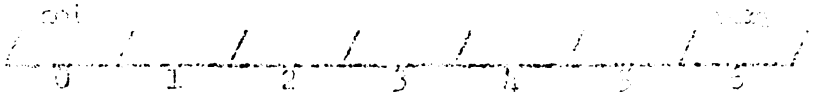

6. Awkward



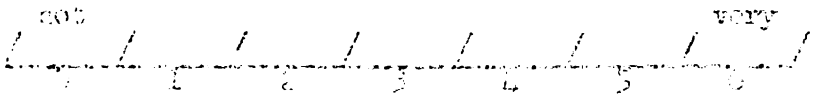




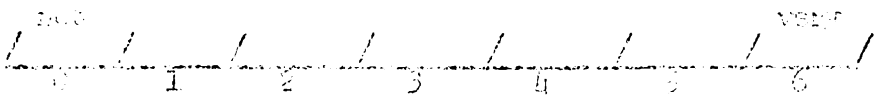
48. Rain




49. Fidelity




50. Wisdom



Intercorrelations (Coefficients of Multiple and Net Partial Correlation) of Crops for which Irrigation Data Available

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 2. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 3. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 4. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 5. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 6. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 7. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 8. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 9. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 10. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 11. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 12. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 13. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 14. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 15. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 16. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 17. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 18. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 19. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 20. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 21. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 22. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 23. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 24. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 25. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

(continued on next page)

Intercorrelations (Chi-Square Adjusted) (continued)

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 26. | [illegible] | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 27. | [illegible] | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 28. | [illegible] | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 29. | [illegible] | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 30. | [illegible] | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 31. | [illegible] | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 32. | [illegible] | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 33. | [illegible] | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 34. | [illegible] | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 35. | [illegible] | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 36. | [illegible] | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 37. | [illegible] | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 38. | [illegible] | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 39. | [illegible] | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 40. | [illegible] | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 41. | [illegible] | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 42. | [illegible] | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 43. | [illegible] | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 44. | [illegible] | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 45. | [illegible] | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 46. | [illegible] | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 47. | [illegible] | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 48. | [illegible] | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 49. | [illegible] | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 50. | [illegible] | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

## SIGHTED MALES

| Subject Number | Signal Detection Raw Data | | | | Errors of Commission Raw Data | | | |
|---|---|---|---|---|---|---|---|---|
| | Per. I | Per. II | Per. III | Total | Per. I | Per. II | Per. III | Total |
| 1 | 5 | 3 | 1 | 9 | 0 | 1 | 0 | 1 |
| 2 | 3 | 3 | 0 | 6 | 0 | 3 | 0 | 3 |
| 3 | 6 | 5 | 4 | 15 | 2 | 1 | 0 | 3 |
| 4 | 3 | 4 | 4 | 11 | 1 | 0 | 1 | 2 |
| 5 | 6 | 3 | 1 | 10 | 3 | 0 | 0 | 3 |
| 6 | 6 | 4 | 5 | 15 | 0 | 0 | 0 | 0 |
| 7 | 4 | 6 | 5 | 15 | 0 | 0 | 0 | 0 |
| 8 | 1 | 5 | 1 | 7 | 0 | 0 | 0 | 0 |
| 9 | 5 | 6 | 4 | 15 | 1 | 0 | 0 | 1 |
| 10 | 5 | 0 | 2 | 7 | 0 | 0 | 0 | 0 |
| 11 | 5 | 5 | 6 | 16 | 0 | 1 | 2 | 3 |
| 12 | 3 | 3 | 5 | 11 | 4 | 2 | 2 | 8 |
| 13 | 2 | 2 | 1 | 5 | 1 | 0 | 0 | 1 |
| 14 | 5 | 6 | 5 | 16 | 0 | 0 | 0 | 0 |
| 15 | 4 | 3 | 6 | 13 | 4 | 2 | 1 | 7 |
| 16 | 6 | 5 | 1 | 12 | 1 | 0 | 0 | 1 |
| 17 | 3 | 2 | 1 | 6 | 3 | 0 | 1 | 4 |
| 18 | 5 | 0 | 3 | 8 | 3 | 3 | 4 | 10 |
| 19 | 4 | 3 | 0 | 7 | 1 | 2 | 0 | 3 |
| 20 | 1 | 3 | 4 | 8 | 1 | 3 | 0 | 4 |
| 21 | 5 | 5 | 5 | 15 | 0 | 1 | 3 | 4 |
| 22 | 2 | 1 | 4 | 7 | 0 | 3 | 0 | 3 |

## SIGHTED FEMALES

| Subject Number | Signal Detection Raw Data | | | | Errors of Commission Raw Data | | | |
|---|---|---|---|---|---|---|---|---|
| | Per. I | Per. II | Per. III | Total | Per. I | Per. II | Per. III | Total |
| 1 | 4 | 5 | 3 | 12 | 1 | 2 | 2 | 5 |
| 2 | 6 | 6 | 6 | 18 | 0 | 0 | 0 | 0 |
| 3 | 6 | 2 | 2 | 10 | 4 | 2 | 2 | 8 |
| 4 | 3 | 4 | 2 | 9 | 0 | 0 | 0 | 0 |
| 5 | 6 | 3 | 6 | 15 | 1 | 0 | 0 | 1 |
| 6 | 6 | 6 | 4 | 16 | 0 | 1 | 1 | 2 |
| 7 | 3 | 1 | 0 | 4 | 3 | 3 | 2 | 8 |
| 8 | 6 | 5 | 5 | 16 | 2 | 1 | 0 | 3 |
| 9 | 6 | 6 | 6 | 18 | 1 | 2 | 0 | 3 |
| 10 | 5 | 6 | 5 | 16 | 0 | 0 | 0 | 0 |
| 11 | 5 | 6 | 4 | 15 | 1 | 1 | 1 | 3 |
| 12 | 2 | 5 | 5 | 12 | 4 | 2 | 0 | 6 |
| 13 | 3 | 5 | 6 | 14 | 0 | 0 | 1 | 1 |
| 14 | 4 | 4 | 3 | 11 | 2 | 2 | 0 | 4 |
| 15 | 6 | 6 | 6 | 18 | 1 | 1 | 0 | 2 |
| 16 | 5 | 4 | 3 | 12 | 2 | 0 | 1 | 3 |
| 17 | 5 | 6 | 4 | 15 | 1 | 2 | 1 | 4 |
| 18 | 5 | 5 | 6 | 16 | 2 | 0 | 0 | 2 |
| 19 | 6 | 6 | 2 | 14 | 1 | 0 | 0 | 1 |
| 20 | 2 | 4 | 3 | 9 | 3 | 0 | 0 | 3 |
| 21 | 6 | 5 | 3 | 14 | 0 | 1 | 0 | 1 |
| 22 | 6 | 5 | 5 | 16 | 0 | 1 | 0 | 1 |

## BLINDFOLDED MALES

| Subject Number | Signal Detection Raw Data | | | | Errors of Commission Raw Data | | | |
|---|---|---|---|---|---|---|---|---|
| | Per. I | Per. II | Per. III | Total | Per. I | Per. II | Per. III | Total |
| 1 | 4 | 3 | 2 | 9 | 2 | 0 | 5 | 7 |
| 2 | 4 | 3 | 1 | 8 | 0 | 0 | 0 | 0 |
| 3 | 3 | 4 | 6 | 13 | 7 | 2 | 6 | 15 |
| 4 | 5 | 4 | 4 | 13 | 1 | 0 | 0 | 1 |
| 5 | 4 | 4 | 4 | 12 | 2 | 0 | 0 | 2 |
| 6 | 4 | 4 | 5 | 13 | 0 | 0 | 0 | 0 |
| 7 | 5 | 6 | 3 | 14 | 0 | 0 | 0 | 0 |
| 8 | 3 | 6 | 4 | 13 | 0 | 0 | 0 | 0 |
| 9 | 5 | 6 | 3 | 14 | 0 | 1 | 0 | 1 |
| 10 | 5 | 1 | 4 | 10 | 1 | 4 | 1 | 6 |
| 11 | 6 | 5 | 3 | 14 | 0 | 0 | 0 | 0 |
| 12 | 6 | 4 | 2 | 12 | 0 | 1 | 0 | 1 |
| 13 | 6 | 6 | 6 | 18 | 0 | 3 | 0 | 3 |
| 14 | 5 | 6 | 4 | 15 | 1 | 4 | 1 | 6 |
| 15 | 4 | 3 | 6 | 13 | 4 | 7 | 6 | 17 |
| 16 | 3 | 6 | 3 | 12 | 5 | 4 | 3 | 12 |
| 17 | 2 | 5 | 6 | 13 | 1 | 0 | 0 | 1 |
| 18 | 5 | 6 | 5 | 16 | 2 | 1 | 6 | 9 |
| 19 | 4 | 4 | 5 | 13 | 1 | 0 | 0 | 1 |
| 20 | 4 | 3 | 4 | 11 | 2 | 0 | 1 | 3 |
| 21 | 5 | 6 | 6 | 17 | 1 | 1 | 0 | 2 |
| 22 | 3 | 6 | 4 | 13 | 0 | 0 | 1 | 1 |

## BLINDFOLDED FEMALES

| Subject Number | Signal Detection Raw Data | | | | Errors of Commission Raw Data | | | |
|---|---|---|---|---|---|---|---|---|
| | Per. I | Per. II | Per. III | Total | Per. I | Per. II | Per. III | Total |
| 1 | 4 | 5 | 6 | 15 | 0 | 0 | 0 | 0 |
| 2 | 5 | 6 | 3 | 14 | 2 | 1 | 1 | 4 |
| 3 | 5 | 3 | 4 | 12 | 9 | 6 | 7 | 22 |
| 4 | 4 | 6 | 5 | 15 | 0 | 0 | 0 | 0 |
| 5 | 6 | 6 | 3 | 15 | 0 | 0 | 0 | 0 |
| 6 | 5 | 4 | 5 | 14 | 1 | 4 | 0 | 5 |
| 7 | 6 | 6 | 5 | 17 | 0 | 0 | 0 | 0 |
| 8 | 3 | 0 | 1 | 4 | 2 | 3 | 2 | 7 |
| 9 | 3 | 4 | 3 | 10 | 1 | 0 | 1 | 2 |
| 10 | 6 | 6 | 4 | 16 | 1 | 1 | 1 | 3 |
| 11 | 6 | 3 | 6 | 15 | 1 | 0 | 0 | 1 |
| 12 | 6 | 3 | 2 | 11 | 1 | 3 | 2 | 6 |
| 13 | 5 | 6 | 3 | 14 | 1 | 0 | 0 | 1 |
| 14 | 5 | 5 | 6 | 16 | 0 | 2 | 0 | 2 |
| 15 | 5 | 6 | 5 | 16 | 2 | 1 | 0 | 3 |
| 16 | 5 | 4 | 5 | 14 | 2 | 5 | 4 | 11 |
| 17 | 2 | 5 | 1 | 8 | 1 | 0 | 0 | 1 |
| 18 | 4 | 5 | 4 | 13 | 2 | 0 | 1 | 3 |
| 19 | 3 | 3 | 3 | 9 | 0 | 1 | 1 | 2 |
| 20 | 3 | 3 | 2 | 8 | 2 | 2 | 5 | 9 |
| 21 | 5 | 6 | 4 | 15 | 0 | 2 | 3 | 5 |
| 22 | 5 | 6 | 4 | 15 | 3 | 5 | 4 | 12 |