AUDITORY VIGILANCE AS A FUNCTION OF INTROVERSION-EXTROVERSION

Thesis for the Degree of M. A.
MICHIGAN STATE UNIVERSITY

John Charles Toth

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By

JOHN CHARLES TOTH

A THESIS

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ABSTRACT

There are many life situations which require prolonged vigilance. Vigilance is a state of readiness to perceive and respond to stimuli occurring at irregular and often infrequent intervals. It has been found that there are wide individual differences in performance on vigilance tasks. A relationship between personality variables and performance in vigilance tasks has been suggested. Bakan found that performance in a vigilance task was related to a measure of introversion-extroversion in a group of British sailors. Belton's attempt to verify this for a group of American university students was inconclusive. He suggested that his testing of the subjects in groups confounded the study since introverts and extroverts might react differently in a group situation. The present study was an effort to clarify the relationship between introversion-extroversion and auditory vigilance under conditions of social isolation. In addition a retrospective questionnaire was administered to the subjects after the vigilance task. The purpose of this was to ascertain the subjective feelings of the subjects while taking the test and to improve experimental control.

The Maudsley Personality Inventory was administered to a large group of university students. Three groups (introvert, normal and extrovert) of subjects were selected on the basis of their scores on the introversion-extroversion continuum. The subjects engaged in a 48 minute auditory vigilance task while sitting alone in a room.

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They listened to a continuous series of digits coming from a tape recorder at the rate of one per second. Their job was to record irregularly occurring odd-even-odd digit sequences. The vigil was divided into three equivalent 16-minute periods for the purpose of analysis. Each period contained six odd-even-odd signals. Performance was measured by the number of signals omitted. After the vigil a retrospective questionnaire was administered.

Analysis of variance of the data showed a significant performance decrement over time for the groups as a whole. There was no significant difference between the introverts and extroverts total performance or performance over time (group x period interaction). However, there was a tendency towards greater decrement for the extrovert group. The performance of the normal group was closer to that of the extrovert group than to the performance of the introvert group. The questionnaire results showed that extroverts were more likely to feel sleepy, have the smoking habit, dislike being isolated, and to hear voice changes in the tape, than introverts. Also the extroverts estimated the length of the vigilance task to be longer than did the introverts.

Since the present study was similar to Belton's, except for the social isolation variable, it was possible to combine the data from both studies and reanalyze it. The following conclusions were drawn from the combined analysis.

1. Testing the subjects in isolation did not significantly change performance.
2. There was no significant difference between introverts and extroverts in overall performance.
3. There was a significant decrement over time for the groups taken as a whole.
4. There was a significant group x period interaction. Extroverts had more decrement over time than the introverts.

It was suggested that the large individual differences necessitated the larger sample of the two studies combined to produce a significant group x period interaction. Theoretical implications were discussed. The combined results were found to be consistent with Bakan's two-factor theory and Eysenck's theory of differential inhibition.

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INTRODUCTION

Vigilance is an important aspect of human behavior. It involves the problem of sustained efficiency while performing repetitive or otherwise boring and monotonous perceptual tasks. Vigilance is a state of readiness to perceive and respond to stimuli occurring at irregular and often infrequent time intervals.

There are many real life situations which require prolonged states of vigilance. Some examples are radar look-outs watching for visual changes in the radar-scope, sonar operators listening for changes in auditory signals, assembly-line inspectors checking for defective products, school teachers correcting papers, and automobile drivers looking for traffic hazards. Increasing automation continually expands the need for human monitoring of equipment.

It was the great need for accurate radar monitoring during World War II that prompted Mackworth (1950) to study vigilance under controlled conditions. He developed the Clock test which embodied characteristics of radar-scope vigilance. It incorporated the following features which were also characteristic of many subsequent studies including the present study.

1. The vigil was performed in isolation.
2. No proficiency checks or knowledge of results were available to the subjects.
3. The task was relatively difficult.

4. The signals were irregular and infrequent in time.
5. There was a limited time for a response.
6. The task was monotonous and boring.
7. No immediate consequences resulted if an error was made.
8. Learning reached asymptotic level during the practice period before the vigilance task.

The Clock test consisted of a black six inch pointer which rotated over a white dial like a second hand of a large clock. The pointer jumpted 1/100 of the dial scale every second. At irregular intervals the hand jumped two divisions instead of the usual one at which time the subjects pressed a key. The subjects were given a five minute practice period prior to the vigilance task. Mackworth found that over a two-hour period the frequency of signal detection decreased with time. The greatest decrement in performance occurred between the first and second half-hour periods. See Figure 1.

Mackworth found that the decline could be prevented by alternating watches every half hour, or by supplying knowledge of results, or by administering 10 mg. of benzedrine (amphetamine sulfate) one hour prior to the task. Briefing the subjects beforehand, "to watch very carefully," did not affect the results. No end spurt was obtained because the time estimation of the subjects was very poor and most of them imagined that there was still time left. Mackworth also used an auditory vigilance task and obtained similar results. He concluded that vigilance decrement must be a function of some central

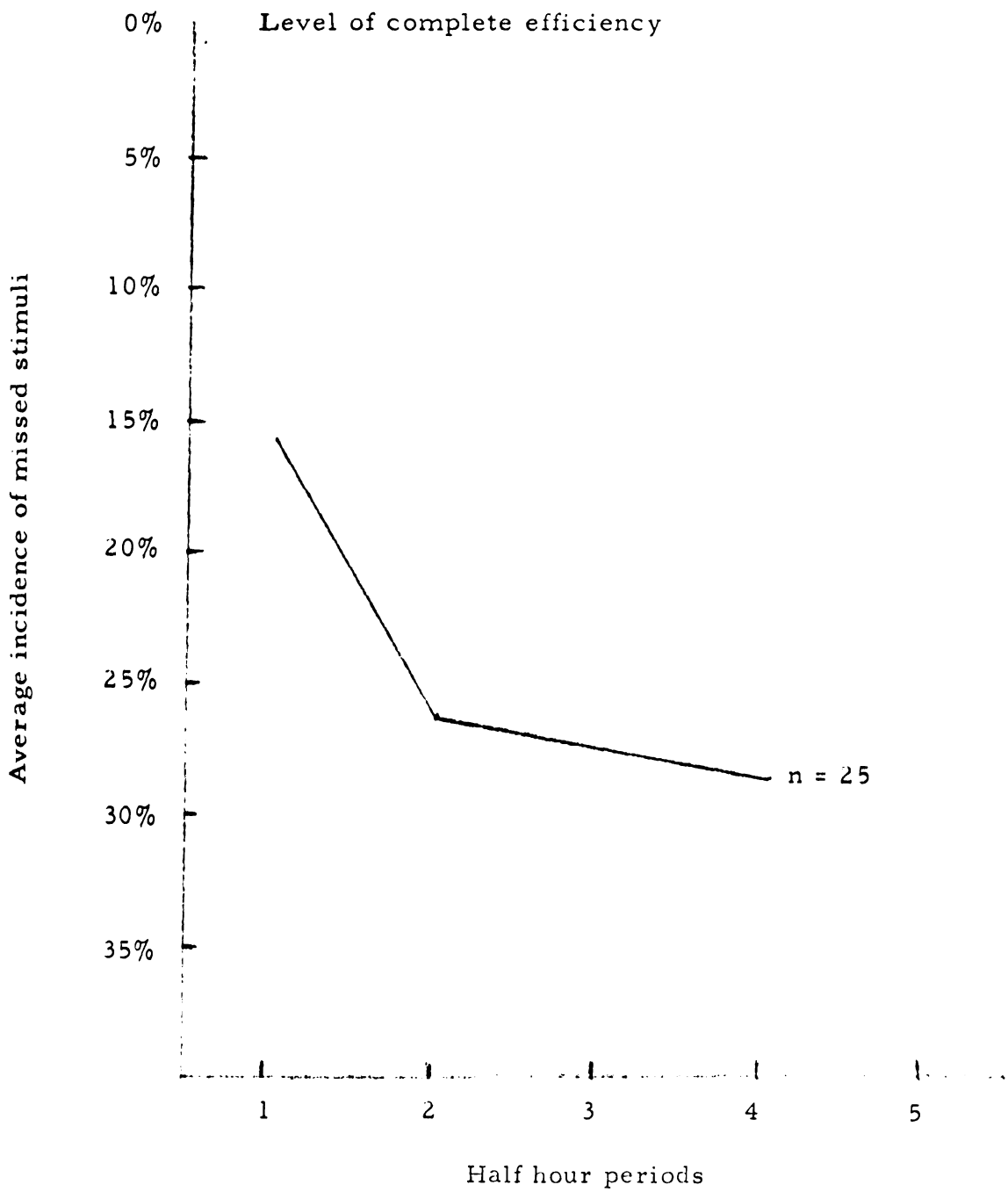

Fig. 1. Mackworth Clock Test performance. Two hour vigil.

cerebral process rather than peripheral mechanisms. Mackworth noted marked individual differences and he stated that, "people differ greatly in their ability in the Clock test, but this is not related either to visual acuity or to group intelligence test scores. There is no known reason for these differences."

Bakan (1955) performed an experiment in which he measured performance decrement by the subject's increase in discrimination threshold over time. Subjects were asked to view an illuminated test area which flashed on for one second every other second. The test area flashed at basal brightness (2.1 ft. L.) for 1/3 of a second and then increased to standard brightness (3.1 ft. L.) for the remaining 2/3 second. Occasionally the standard intensity was increased at which time the subject was instructed to push a button. If the subject did not perceive the increase the intensity was increased to a higher level the next second. The test stimuli ranged from 3.2 to 4 ft. L. in nine log steps. Bakan found a significant increase in threshold over time. The stimulus threshold was 25% higher at the end of the 1 1/2 hour task than it was at the beginning. He also found significant individual differences in performance. There was an overall difference between subjects as well as a difference between subjects over time. It was these large individual differences such as found by Mackworth and Bakan that has suggested the exploration of personality variables as possible factors in performance on vigilance tasks.

However, most of the studies on vigilance have been aimed

primarily at environmental variables or conditions rather than individual differences. Studies have been designed to evaluate the effects of temperature (Mackworth, 1950; Loeb & Jeantheau, 1958), noise (Eysenck, 1957; Loeb & Jeantheau, 1958), signal brightness (Bakan, 1955), and addition of secondary stimulus (Bakan, 1957). Other studies have involved the effect of drugs (Mackworth, 1950), rest periods (Mackworth, 1950), knowledge of results (Mackworth, 1950; Holland, 1957) and reinforcement (Holland, 1958).

One of the most consistent findings in vigilance experiments are the large individual differences in performance. As mentioned above most of the work performed in vigilance was not primarily concerned with individual differences but nevertheless large individual differences were always found to be present. The relationship between personality factors and vigilance appears to be a logical approach to understanding these differences. Personality correlates have theoretical as well as practical implications.

Numerous tentative theories have been proposed to explain and predict behavior displayed during vigilance tasks. Since the currently available data seems varied and even paradoxical, no single theory has as yet been able to engross all of the facts. Broadbent (1958) summarized the four main theoretical contenders and he maintained that all or at least parts of each theory were required to explain vigilance behavior. The present study can adequately be explained by applying the theories put forth by Bakan (1957) and Eysenck (1957).

Bakan proposed a two-factor theory to account for vigilance performance decrement over time. He outlined a sleep factor and a self-stimulation factor. Sleep is on a continuum and there are varying degrees of wakefulness between the extremes. There is a degree of adaptation to the incoming stimuli which results in monotony and monotony is a pre-condition for sleep. A person asleep is relatively insensitive to stimuli. A stimulus performs at least two functions within the organism. It directs behavior and it maintains a state of arousal. The arousal center is thought to be located in the reticular formation of the brain stem. Bakan explains that the monotonous conditions of vigilance performance provide a low level of afferent stimulation or change of stimulation. This results in a decrease in sensitivity to the environmental stimuli brought about by a decrease of the arousal reaction. The tendency to go to sleep and the motivational state to perceive the stimuli result in a conflict situation. One way of resolving the conflict is for the subject to reduce the monotony of the situation through self-stimulation. The self-stimulation makes up for the inadequate environmental stimulation and helps the subject to stay awake. This self-stimulation may take a variety of forms, including body movements, singing, humming, whistling, anticipating signals, and daydreaming. Some of these activities may be more detrimental to performance on a vigilance task than others. Bakan's theory predicts a performance decrement over time and individual differences in a vigilance task.

Eysenck proposed a modified Hullian system to account for differential performance on a vigilance task by introverts and extroverts. The theory was based upon Hull's reactive and conditioned inhibition and Pavlov's work on conditioning. Eysenck used a modified Hullian system because Pavlov neglected motivation but he retained Pavlov's centralistic view. According to the theory performance is a function of drive and habit and decrement is due to inhibition. Personality types differ with respect to the build up of inhibition in monotonous or repetitive tasks. Eysenck suggests a difference between introverts and extroverts in the tendency to build up inhibition. Extroverts are presumed to develop inhibition faster than introverts. Consequently extroverts should show an earlier decline in performance on vigilance tasks. Eysenck hypothesized the following:

> Human beings differ with respect to the speed with which excitation and inhibition are produced, the strength of the excitation and inhibition produced, and the speed with which inhibition is dissipated. These differences are properties of the physical structures involved in making stimulus-response connections.
>
> Individuals in whom excitatory potential is generated slowly and in whom excitatory potentials so generated are relatively weak, are thereby predisposed to develop extroverted patterns of behavior and to develop hysterical-psychopathic disorders in cases of neurotic breakdown; individuals in whom excitatory potential is generated quickly and in whom excitatory potentials so generated are strong, are thereby predisposed to develop introverted patterns of behavior and to develop dysthymic disorders in case of neurotic breakdown. Similarly, individuals in whom reactive inhibition is developed quickly, in whom strong reactive inhibitions are generated, and in whom reactive inhibition is dissipated slowly, are thereby predisposed to develop extroverted patterns of behavior and to develop hysterical-phychopathic disorders in case of neurotic breakdown; conversely, individuals in

> whom reactive inhibition is developed slowly, in whom weak reactive inhibitions are generated, and in whom reactive inhibition is dissipated quickly, are thereby predisposed to develop introverted patterns of behavior and to develop dysthymic disorders in case of neurotic breakdown.

Bakan (1957) investigated the possible relationship of personality variables to auditory (verbal) vigilance performance. In this study Bakan tested 40 Royal Navy men under two conditions. The first condition involved listening to a tape recording of digits spoken at the rate of one digit each second. Subjects were instructed to listen for and record groups of three successive odd digits which were all different. The second condition was the same as the first except that a secondary stimulus was introduced. The subjects were asked to press a key every time they heard the digit 6, i. e., the secondary stimulus. The subjects were alone in an isolation cubicle during the vigilance task. The odd-odd-odd sequences were randomly dispersed (time between signals ranged from 15 to 185 seconds) throughout the vigilance period which lasted 80 minutes. For scoring purposes the continuous 80 minute task was subdivided into five 16-minute subperiods. Each subperiod contained 10 primary signals. The secondary stimulus was presented on the average of once every 10 seconds. The primary scores were used for analysis.

Measures of intelligence, neuroticism and introversion-extroversion were obtained for each subject. The Heron Personality Inventory was used for the introversion-extroversion measure. No significant relationship was found between performance and neuroticism or intelligence.

An introvert and an extrovert group was formed by dividing the 40 subjects at the median score on the introversion-extroversion continuum. No significant difference was found between these two groups in either intelligence or neuroticism. The relevant data in regard to the present study was the significantly better performance of the introverts (total and over time) compared to the extroverts. See Figure 2.

Belton (1958) performed a study similar to Bakan's except for the following modifications.

1. Subjects were American college students.
2. The Maudsley Personality Inventory was used for the introversion-extroversion measure.
3. Groups ranging from two to eight subjects were tested simultaneously. The subjects had physical isolation during the actual test but they were aware of each other's presence. Social interaction was permitted before and after the test.
4. No discrimination as to sex. Bakan's subjects were all males.
5. Twice as many subjects were used by Belton. Each experimental group contained 44 subjects.
6. Vigilance task was 48 minutes long. Three 16-minute subperiods were used in analysis.
7. Subjects were chosen from the extreme ends of the introversion-extroversion continuum (top and bottom 15%).

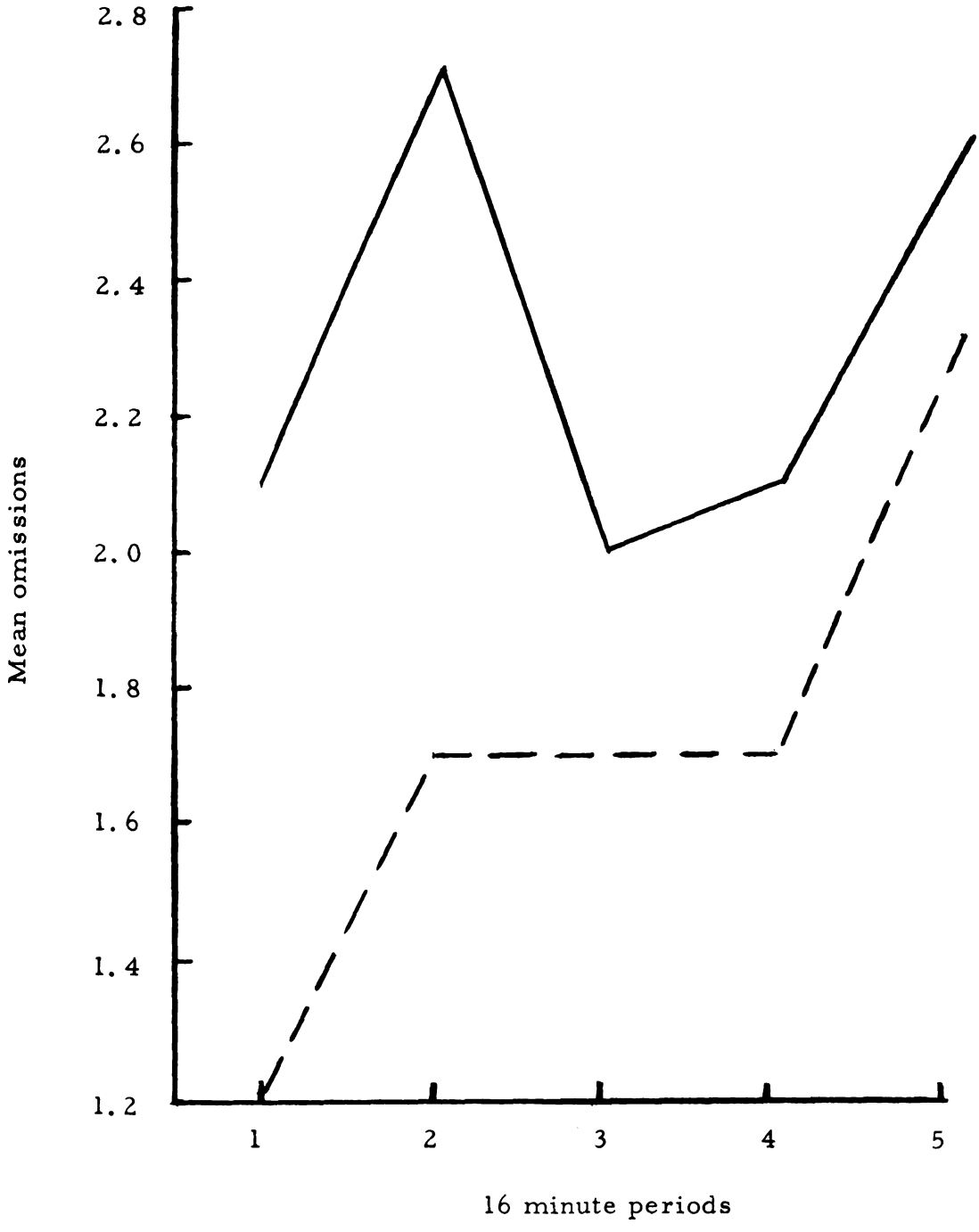

Fig. 2. Auditory vigilance task performance Bakan, 1957.

——— Extroverts — — — Introverts

8. Six signals were presented to the subjects during each 16-minute subperiod.

Belton obtained the following results from his study:

1. There was no significant difference between introverts and extroverts in overall performance (between groups variance).
2. There was no significant difference in performance over time (period x group interaction).
3. There was a significant decrement over time for the total group (between periods variance).

These results are contrary to the results obtained by Bakan. However, Belton's data did show a definite tendency towards greater decrement for the extrovert group. See Figure 3. The introvert group's performance increased the second period and then decreased for the last period. Their performance for the last period was approximately equal to the first period. The extrovert group showed definite decrease with time. Their performance was lower than the introvert's during the last period despite the fact that the extroverts had a much higher performance for the first period. One of the major differences between the Bakan and Belton studies was the isolation factor. Bakan's subjects performed in complete isolation but Belton's did not. In view of the fact that extroverts are characteristically sociable and gregarious, Belton hypothesized that the lack of complete isolation confounded the study. The social interaction may have increased the extroverts' level of performance and in this way reduced

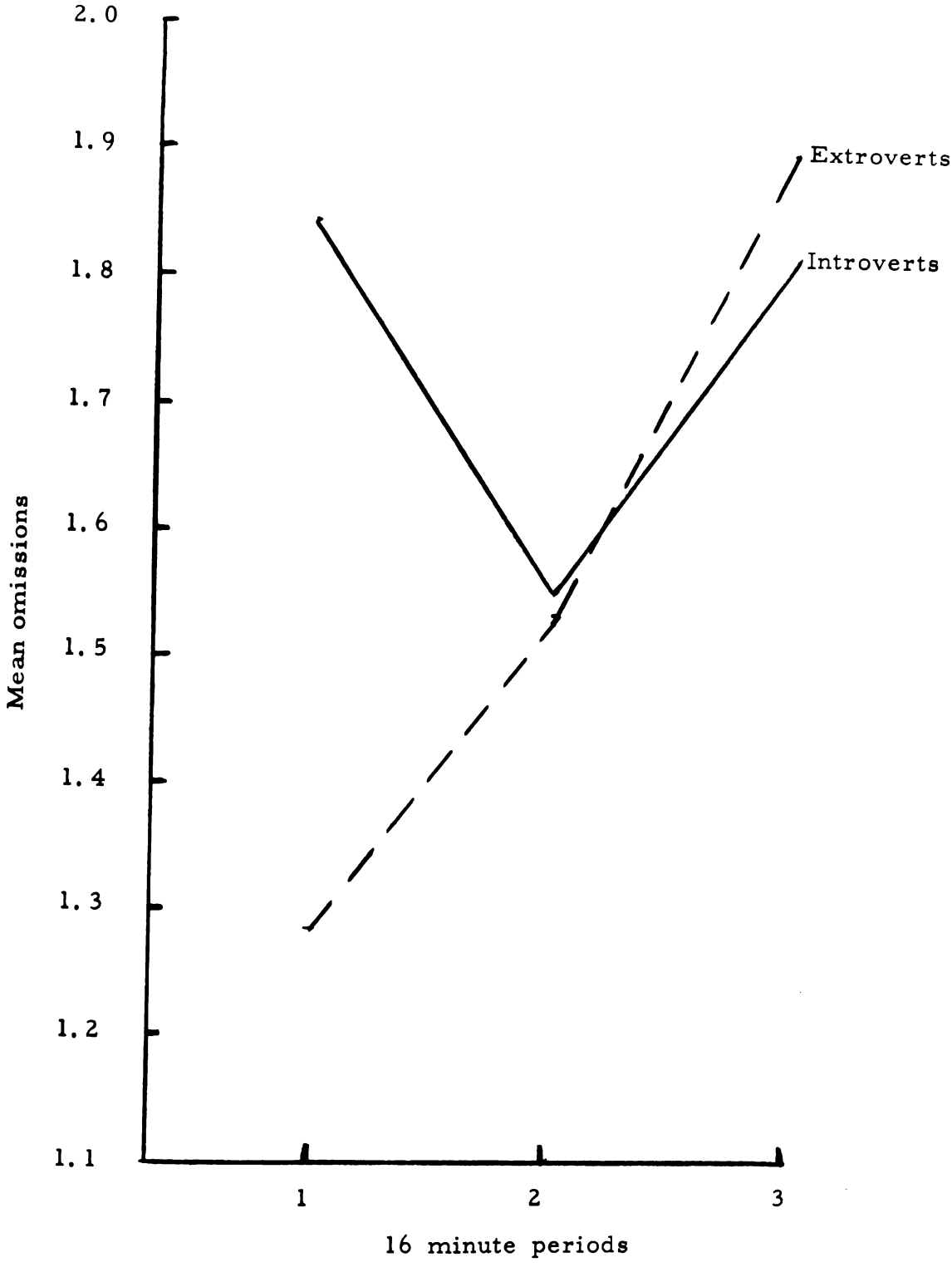

Fig. 3. Auditory vigilance task performance.

Belton, 1958.

the differences between the experimental groups.

The present study evolved in the light of the above contradictions. It was designed similar to the Belton study except for the following modifications.

1. The experimental groups each had an n of 33 instead of 44.
2. A middle "normal" group was added.
3. The subjects performed the vigilance task in complete physical and psychological isolation.
4. Experimental conditions were designed to eliminate all extraneous stimuli.
5. All of the subjects in the three experimental groups were matched for neuroticism.
6. The retrospective questionnaire administered to each subject after the vigilance task was modified. In addition to new items the questionnaire contained six "control" items. These questions were designed to improve the experimental control of the study.

The primary objectives of the present study were four-fold:

1. To obtain data comparable to Belton's in order that a combined analysis may be made.
2. Determine other relevant variables influencing performance.
3. To determine the relative performance of "normal" subjects as compared to introverts and extroverts.

4. Check on Belton's findings and thereby determine the relationship, if any, between introversion-extroversion and auditory vigilance.

METHOD

Subjects

The subjects used in this study were elementary psychology students of both sexes enrolled at Michigan State University. They were all relatively naive about experimental situations since most had had no previous experience or studies of a psychological nature.

The course instructors gave each student in their sections a slip of mimeographed paper asking for the following information:

NAME _____

SEX ___ DATE OF BIRTH: Month _____ Day _____

Year _____ INSTRUCTOR _____ SECTION ____

MSU GRADE AVERAGE _____ MAJOR _____

SUBJECT _____ CLASS: Freshman _____

Sophomore _____ Junior _____ Senior _____ PLACE

OF BIRTH: City _____ State _____

PREVIOUS PSYCHOLOGY COURSES _____

_____

The students filled out these forms as a matter of general information for their instructors. These slips were then turned over to the experimenter without the knowledge of the students.

About one week later the experimenter administered a "Biographical Survey" (Maudsley Personality Inventory) to each of the

students. The experimenter was introduced as a graduate student doing research on the attitudes and opinions of college students. They were instructed not to put their names on the questionnaires but to write down their sex, birth date and subject major. This information was asked for on the contention that it was necessary for the analysis of the opinions and attitudes obtained. No time limit was imposed on the students filling out the questionnaires. They were instructed not to deliberate too long on the questions but to answer them as quickly as practicable. The questionnaires were then machine scored for introversion-extroversion, neuroticism and lie scales.

Two extreme groups and a middle group were picked from the introversion-extroversion distribution for this study. The bottom 14% (from 0-19 inclusive on the introversion-extroversion continuum) were assigned to the introvert group and the top 14% (40-48 inclusive) were assigned to the extrovert group. The normal group was picked from the middle range of 27 to 32 inclusive.

After the groups were selected on the basis of introversion-extroversion scores the subjects were identified by matching information on sex, birth date and major with that given the instructors earlier in the term. Then by referring to the student directory it was possible to obtain each address and telephone number.

All of the individuals in the groups were matched for neuroticism; a latitude of five points was used for matching the individuals of one group with those of the others.

Thirty-three subjects were assigned to each group without regard to sex. The basis of selection was not revealed to the subjects; they were told that they were part of a random sample picked from all of the elementary psychology students. Table A in the Appendix shows the introversion-extroversion and neuroticism scores of the subjects and their sex.

The Personality Measure

The instrument used for obtaining personality measures was the Maudsley Personality Inventory (MPI). The MPI was developed by Eysenck as a questionnaire measure of introversion-extroversion and neuroticism (Jensen, 1958; Eysenck, 1955 and 1957). The I-E scale is a measure of social extroversion or sociability and the N scale is a measure of neurotic tendency.

The introversion-extroversion and neuroticism scales of the MPI were derived from other personality inventories by the use of item and factor analyses. Many of the items were taken from the Guilford Inventory and the Maudsley Medical Questionnaire.

The two scales (I-E and N) have a high "construct validity" i. e. the items of the scales are highly correlated with the factor they are said to measure and they have insignificant correlations with other factors. The items have been selected to minimize correlation between the I-E scale and neuroticism.

The MPI consists of 24 I-E scale items, 24 N scale items 20 Lie scale items and 12 buffer items which help to disguise the

purpose of the questionnaire. In scoring, the keyed responses are given two points, indecisive responses receive one point. Therefore the range of the I-E and N scales is from 0 to 48. The extreme extrovert and neurotic should theoretically receive 48 on each of the scales.

No correlations have been found between age, sex, or intelligence and the MPI scales, although there is a slight tendency for women to score about one point higher than men on both of the scales.

The split-half reliability was found to be .82 for the I-E scale and .87 for the N scale (Jensen, 1958).

Because of the brevity of the scales, high reliability, orthogonality in normal populations, high correlations with similar tests and negligible correlation with non-personality variables such as age, sex and intelligence the MPI is generally considered to be one of the best questionnaire measures of introversion-extroversion and neuroticism available at the present time (Jensen, 1958). A copy of the Maudsley Personality Inventory and the scoring key is included in the Appendix B.

The Vigilance Task

The vigilance task consisted of listening to a tape recording of digits spoken at the rate of one per second. The subjects were asked to record signals consisting of odd-even-odd sequences of different digits heard during the vigil. The task was performed in complete isolation in a sound-insulated room. Subjects were in isolation from

52-54 minutes during which time they were presented with 18 odd-even-odd signals. The actual scored task was 48 minutes in length and was divided into three 16-minute periods. Each 16-minute period contained six signals and the distribution of the signals over time was the same in each period, although the actual signals differed. The time between signals was 107, 71, 154, 25, 185 and 418 seconds. To the subjects the task seemed continuous and uninterrupted with randomly dispersed signals throughout the entire 48-minute period.

The experiment was carried out in a sound treated room, 8 ft. wide, 12 ft. long and 9 ft. high. Illumination was provided by a single 15 watt white light bulb inside of a large white frosted globe attached to the ceiling directly above the subject's head. The subject sat at a table in a chair facing a tape recorder, a small paper box (about 3 x 3 x 6 inches) with a slot cut in top, a stack of 52 index cards (3 x 5 inches) and pencils for recording the signals heard onto the cards. The backs of the cards were coded to enable the experimenter to discern the order in which the various signals were recorded onto the cards. There was a chair and a 12 inch electric fan behind the subject. The chair was used to store books, coat etc. brought in by the subjects and the fan provided circulation in the room.

The tape was constructed so that each digit was pronounced the same way (spliced construction) each time it was repeated in the tape. There were additional numbers before the 48-minute period, which were used for the practice periods before beginning the vigilance task.

The study was done during the winter term and the room temperature ranged from about 66° to 70° F. which proved quite comfortable for most of the subjects.

Procedure

Most of the selected subjects were contacted by telephone. A few were contacted by seeing them after their psychology classes or by sending them a postal card. A definite appointment was made with each subject and appointments were scheduled for two-hour intervals. The subjects were given an opportunity to schedule their appointments for any convenient time.

All elementary psychology instructors required their students to participate in a given number of experiments as part of the course requirement. Each subject received research credit for participating in this study. However, since this study ran for a full term many of the subjects had already obtained the necessary credit. All such subjects (save one) were very cooperative and agreed to participate on a voluntary basis.

Invariably every subject asked how long the task would take. It was explained that the exact length could not be revealed prior to the task but that the entire experiment would take less than two hours.

When the subject arrived for the task he was given a set of instructions to read. These were generally read in an adjacent room with adequate lighting and the subject could take as long as needed to

read the instructions. The following instructions were given to each subject.

Instructions for Vigil
Experiment

There are many situations in life where a person is required to maintain a prolonged state of vigilance or attention. These situations require the person to be alert at all times as it is generally not known when an important signal may be received. Examples of such situations are the jobs of radar operators watching for "pips" on a radar screen, sonar operators listening for signals denoting submarines, factory inspectors looking for defective parts, school teachers correcting papers, and many others.

This experiment was designed to study some aspects of human behavior under sustained vigil conditions. You are to listen to a series of one digit numbers from 1 through 9. These shall be presented to you by a voice tape recording at the rate of approximately one each second, e. g. 7 - 4 - 5 - 9 - 3 - 6 - 3 - 9 - etc. The series will be continuous i. e. without breaks or irregularities.

Your job is to listen for and then record any odd-even-odd sequences of three numbers. They must be all different and in the order of odd-even-odd. You are to write each three number sequence on a card and drop it in the box provided. The odd-even-odd sequence may come at any time; there are no periodic intervals of presentation. The only way to notice them is to be on guard at all times.

Each sequence must meet the following requirements:

1. The numbers must come one after the other.

2. The numbers must be all different.

3. The order must be odd-even-odd.

Always remember the last digit heard if it is odd since any odd digit may be the start of an odd-even-odd sequence.

The odd digits are: 1 - 3 - 5 - 7 - 9. Remember these!

For example you may hear: 9 - 2 - 9 - 8 - 2 - 6 - 3 - 3 - 7 - 4 - 8 - 9 - 2 - 7 - 4 - 2 -

You should write 927 on a card and drop it in the box. The sequence 929 does not meet the requirements.

REMEMBER! ALL DIFFERENT: ODD-EVEN-ODD.

After studying these instructions you shall receive two practice sessions during which time you may familiarize yourself with the actual task.

Look through the following series of numbers and write the odd-even-odd signals upon a separate sheet of paper.

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

Now ask the experimenter to give you the three number odd-even-odd signals contained in the above numbers. Compare your results with these.

If you are ready you may now start your first practice period. The experimenter shall call out the signals just after they appear during the two practice periods.

After the subject finished the instructions, his answers were checked for accuracy and he was encouraged to ask any questions pertinent to the task that may not have been entirely clear. The subject was then taken to the experimental room, seated and given a piece of blank paper on which to write the practice signals. The subject's watch was removed for the duration of the vigilance task by the experimenter. The tape recorder was turned on and the volume was adjusted to a fixed level, which was easily audible. The first practice period lasted 3.5 minutes and contained two signals. Each time a

signal occurred the experimenter called it out. After this initial practice period the subject was again asked if there were any questions concerning the task. The signals written down were checked and any irregularities discussed. There was a four minute rest period toward the end of which the following instructions were read to the subject:

> You will receive one more practice period before the actual task. When the actual task begins, pick up the top card from the pack and place it in front of you. Wait until you hear an odd-even-odd sequence and then write the signal on the card. Pick up the card immediately and place it in the box. Then take another card from the top of the pack and repeat the process until I come in and tell you that the task is over. Always take the top card because they are marked with the reversed alphabet on the backs.

The second practice period was 6.5 minutes long and contained three odd-even-odd signals. The experimenter again called out the signals after they occurred. This was followed by a six-minute rest period. During the rest period the subjects were permitted to walk about the room but not to leave the room or smoke. The following instructions were read to the subjects toward the end of the six-minute rest period.

> We are now ready to begin the experiment. The last number of one signal is never the first number of the following signal. While listening for signals make believe that you are working at a boring job. Your job is to listen for and record these odd-even-odd signals. This experiment will have no bearing whatsoever upon your school work or status. Please do not walk around the room, smoke or chew gum. Just sit in the comfortable chair and work naturally while listening to the tape.

After these instructions the experimenter advanced the tape to a predetermined setting whence the 48 minute period began.

After starting the tape recorder the experimenter picked up all instruction sheets, etc., closed the top on the tape recorder and left the room. The first sequence did not arrive until after the experimenter was out of the room. When the time was up the experimenter entered the room and turned off the recorder.

Retrospective Questionnaire

After the vigilance task had terminated the subjects were given a retrospective questionnaire which asked about the subject's activities, attitudes and emotional reactions to the task. It was hypothesized that the differences in responses between introverts and extroverts to the questionnaire items might improve understanding of any differences between groups in vigilance performance. A copy of the retrospective questionnaire may be found in Appendix C. The questionnaire contained 24 questions which had to be answered yes or no. These questions may be classified into four categories:

1. Subjective feelings during performance.

   Questions: 1 - 2 - 5 - 7 - 12 - 15 - 21 - 22

2. Subjective feelings and attitudes about test and test situation.

   Questions: 3 - 4 - 8 - 11 - 14 - 16 - 17 - 19 - 23

3. Control questions.

   Questions 6 - 9 - 10 - 13 - 18 - 20

4. Task time estimation.

   Question: 24 (5 choice)

All of the above are self explanatory except perhaps the control questions. These were designed to check the influence of uncontrolled variables upon the experimental variable.

Question #6 was used to check if the subjects were equally prepared for the vigilance task, and to see that if learning had been reduced to a minimum. Questions #9 and #13 had to do with the subject's smoking habits. It was considered feasible that subjects who smoke and who are prohibited from smoking may show performance changes not otherwise contemplated. Question #10 asked if the subjects averaged seven or more hours of sleep at night. It was hypothesized that extroverts being more outgoing socially may have built up a sleep debt which may account for some performance decrement. Question #18 asked if the subjects had any feelings of claustrophobia. If the experimental groups do not differ significantly in regard to this variable, apprehensions created by claustrophobia may be disregarded as a relevant variable. The last control question (#20) asked if the subject had eaten a meal within two hours prior to the task. Since there is a physiological basis for lethargy to occur after a meal, it also was considered a possible variable influencing performance if significant differences were found to exist between the experimental groups. One half of the introvert and extrovert groups were given the questionnaire orally while the rest of the subjects answered them on IBM answer sheets. After having answered the questions the subjects were asked not to reveal the details or the length of the experiment to other students

and were given a credit slip for participating in the experiment. The following is a summary of the experimental procedure.

1. Orientation and instructions.
2. Three and one-half minute practice period.
3. Four minute rest period.
4. Six and one-half minute practice period.
5. Six minute rest period.
6. Forty-eight minute vigilance task.
7. Retrospective questionnaire.

Scoring

The MPI administered to the various sections of elementary psychology students were machine scored. The questionnaires of the subjects selected for the experiment were scored again by hand.

The results of the vigilance task were hand scored for omissions. The omissions scores represented the number of signals missed by the subjects. Since the sequence cards were coded in a definite order it was possible to break up the results of each subject into three equivalent 16 minute subdivisions.

Separate scores were obtained for each of the 16 minute subdivisions (designated: A = B = C) in addition to the total scores for each of the subjects.

In addition to the omissions scores, the MPI answer sheets were machine scored for the lie scale. The suggested criterion for identifying a falsified MPI questionnaire was used (Jensen, 1958),

i. e. to exclude any subject from the experiment who scored higher than 20 on the lie scale.

The retrospective questionnaires were first scored by machine (item analysis) and then by hand. The resultant scores indicated how many subjects of each experimental group answered "yes" or "no" to the various items of the retrospective questionnaire.

RESULTS

Signal Omissions and Introversion-Extroversion

The data were analyzed to determine whether there were differences between introverts and extroverts with respect to the following:

1. Overall group differences in signal omissions during the vigilance period.
2. Experimental group differences in performances over time.

The mean omissions of the experimental groups by periods have been compiled in Table 1 and graphically presented in Figure 4. Table 1 shows the prime variable with which this study was concerned. Inspection of these data indicated that:

1. There are no differences between the groups in omissions during the first period.
2. There is an overall performance decrement in direct proportion to the degree of extroversion. Extroverts missed more signals than the introverts. The normal group fell between the introvert and extrovert groups but somewhat closer to the extrovert group's performance.
3. The extroverts showed the greatest decrement over time. The normal group's decremental trend was similar to the extrovert's but it was of a lesser degree. The introvert

Table 1

Mean Signal Omissions by Periods

for Experimental Groups

	Period A	Period B	Period C	Total
Introverts	1.61	1.24	1.61	1.48
Normals	1.61	1.67	2.18	1.82
Extroverts	1.61	1.79	2.42	1.94
Total	1.61	1.57	2.07	1.75

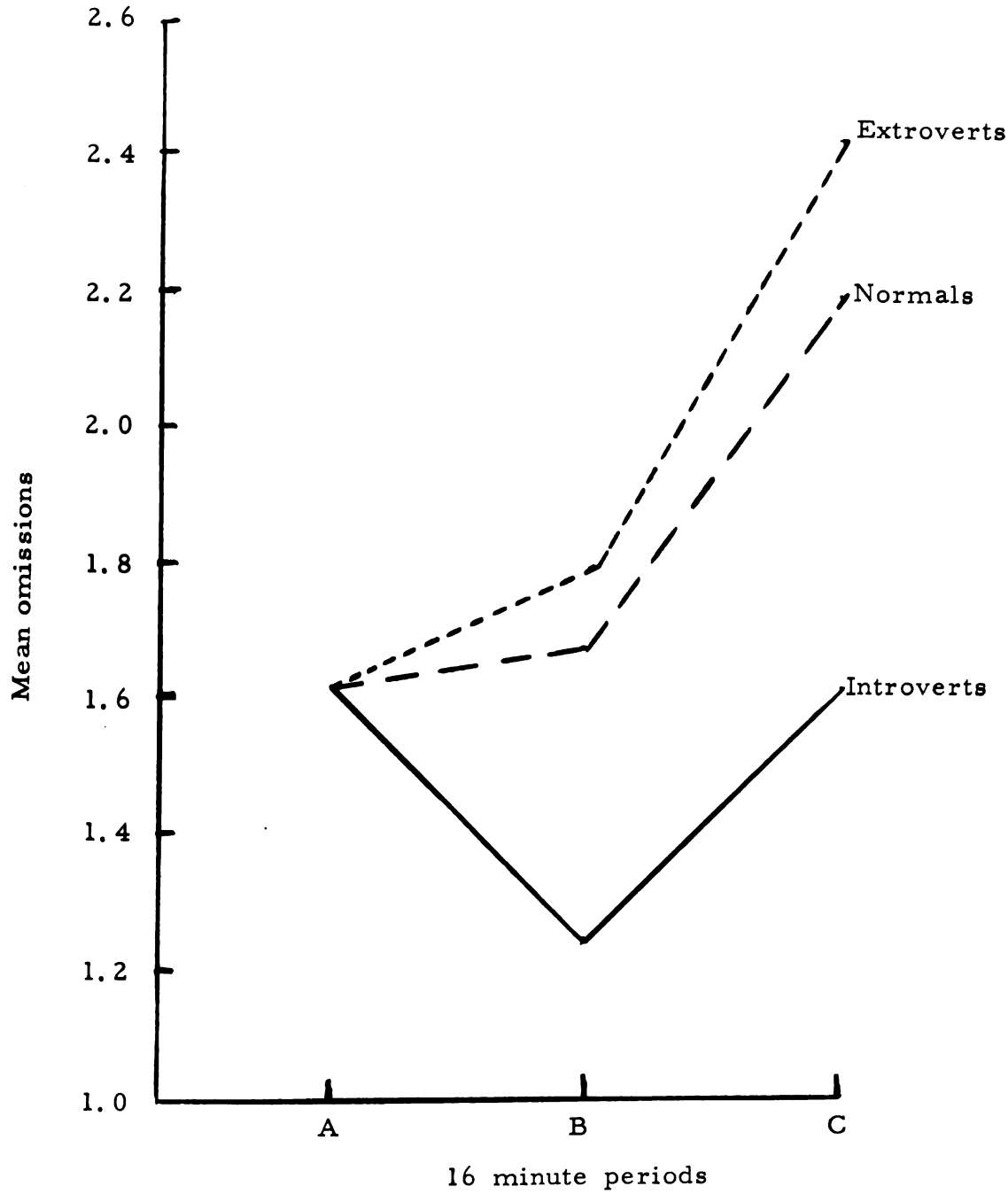

Fig. 4. Performance by periods for introvert, normal and extrovert groups.

group did not have a decrement over time during the 48 minute vigilance task.

It can generally be stated that as time at work and degree of extroversion increase the number of omission errors also increase. The highest omission score was obtained by the extroverts during the last period (C). The introvert group showed a decrease in omissions for the second period after which it started to increase as the other two groups but at a lesser rate. The introverts' mean omission score increase from period B to period C was .37 as compared to .51 and .63 for the normal and extrovert groups respectively.

The data were subjected to an analysis of variance of repeated measurements on independent groups as outlined by Edwards (1950). The results of these analyses are presented in Table 2.* The following conclusions have been drawn from the above analysis of variance.

1. There are no significant differences between introvert, normal and extrovert groups in overall performance (between groups variance).
2. There was a definite performance decrement over time for the groups taken as a whole (significant between periods variance).
3. Performance differences between the three experimental groups over time were found to be insignificant (groups x trials interaction).

Table 2

Analysis of Variance of Omissions for Introverts (I), Normals (N) and Extroverts (E)

Variation	df	SS	MS	F
Between subjects	98	397.87	-----	-----
Between I, N, E groups	2	10.96	5.480	1.360
Between subjects in the same group	96	386.91	4.030	-----
Total within	198	232.19	-----	-----
Between periods	2	15.59	7.795	7.112**
Periods x I-N-E	4	6.11	1.528	1.394
Error	192	210.49	1.096	-----
Total SS	296	630.06	-----	-----

**Significant at the 1% level.

*The analysis of variance was carried out on the untransformed data despite the fact that the assumption of homogeneity of variance could not be made on the basis of Bartlett's test ($p < .05$). Attempts to transform the data so as to produce homogeneity of variance were not successful.

Despite the fact that the between groups variance and the groups x trials interaction were found to be insignificant the data show a definite tendency of differential decrement in performance between the experimental groups. Extroverts show a higher performance decrement than the normals or introverts. Some "t" tests were computed on selected points (on the basis of theoretical predictions) in an effort to pin-point performance differences. A "t" test computed between the introverts and extroverts last periods was found to be significant, $p < .05$. A similar test between the first and last periods of the extroverts showed a significant performance decrement for the extrovert group, $p < .05$.

A nonparametric test was performed as a distribution-free check on the frequencies of increments and decrements in the introvert and extrovert groups. A decrement was defined as a higher omission score for the last period (C) as compared to the first period (A). An increment was the converse of a decrement. These frequencies are shown in Table 3.

A sign test (Edwards, 1954), was performed between the first and last periods of the extrovert group. The resulting probability ratio was .16 corrected for continuity. The extroverts had considerably more decrements than increments. The introvert group had a near equal number of increments and decrements. These results are in complete agreement with Belton's (1958) study. He found a near significant ($p < .10$) decrement trend for the extroverted

Table 3

Direction of Change (Frequency Data) from Period A to Period C for the Experimental Groups

	Increment	Decrement	No change	Total
Introverts	15	10	8	33
Normals	7	16	10	33
Extroverts	7	17	9	33
Totals	29	43	27	99

group and approximately equal numbers of increments and decrements for the introverted group.

A chi-square (2 x 2 contingency table) corrected for continuity was computed for the relationship of introversion-extroversion and decrements. The resulting probability was found to be less than .06. All of these calculations support the hypothesis of differential performance over time as a function of introversion-extroversion.

Signal Omission Analysis of the Present Study Combined with Belton's Study

As pointed out in the introduction the present study is similar to Belton's (1958) study. The major difference between the two studies was the complete isolation (both physical and psychological) of the subjects during the vigilance task in the present study.

Belton's results with respect to decrement over time were similar to those obtained in the present study. Both studies showed a greater decrement tendency for the extroverts as compared to the introverts. The fact that this trend showed up in two independent experiments and that there were large individual differences within the various experimental groups suggests that the failure to obtain a statistically significant groups x periods interaction may be due to an insufficient number of subjects.

Pursuant to the above, the data from the two experiments were combined and reanalyzed. Since Belton did not have a normal

group, the data from the normal group in the present study were not used in the combined analysis. Belton had 31 introverts and 31 extroverts matched for neuroticism while the present study used 33 subjects in each group. In order to equalize the group sizes between the two studies, two subjects were randomly eliminated from each group of the present study. Table 4 shows the group by period means of the two experiments and Figure 5 is a graphic presentation of the data. A factorial design (Lindquist, 1953) was used to analyze the combined data. This design afforded an evaluation of the variance between experiments. The following major conclusions may be drawn from the analysis of variance of the combined studies. See Table 5.

1. The variance between studies was nowhere near statistical significance. This direct comparison between experiments suggests that the procedural difference of the group or individual testing of the subjects was of no major importance. This lack of significance between studies also lends support to the rationale of combining the two experiments for analysis.
2. The between periods variance was found to be highly significant. There was an overall performance decrement.
3. The group x period interaction, which was suggestive but not significant in either experiment taken separately, was statistically significant beyond the .05 level. The results of the combined experiments indicate that there is

Table 4

Mean Correct Signal Scores by Periods of

the Two Experiments Taken Separately

	Period A	Period B	Period C	Total
Toth introverts	4.42	4.71	4.32	4.48
Belton introverts	4.16	4.42	4.19	4.26
Combined means	4.29	4.56	4.26	4.37
Toth extroverts	4.45	4.29	3.64	4.13
Belton extroverts	4.71	4.48	4.10	4.43
Combined means	4.58	4.38	3.87	4.28

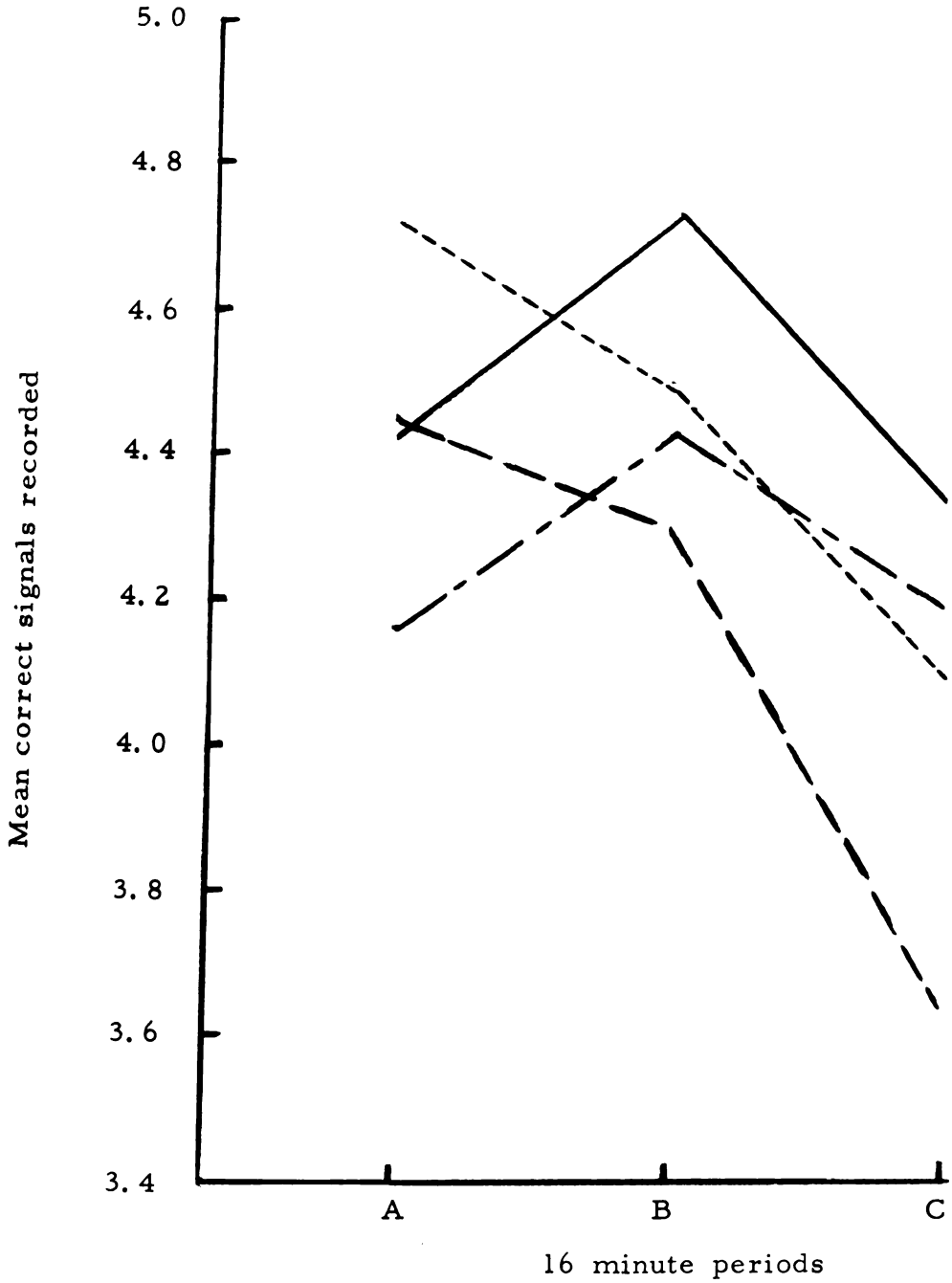

Fig. 5. Mean correct signals received each period for the Belton and Toth studies.

———— Toth introverts (n = 31)

— — — — Toth extroverts (n = 31)

—— - —— - —— Belton introverts (n = 31)

---------- Belton extroverts (n = 31)

Table 5

Analysis of Variances of the Toth and Belton Studies Combined

Variation	df	SS	MS	F
Between subjects	123	532.06	-----	-----
Between I-E groups	1	.77	.770	.176
Experiments	1	.13	.130	.030
I-E x experiments	1	6.46	6.460	1.478
Error	120	524.70	4.370	-----
Total within	248	279.58	-----	-----
Between periods	2	12.74	6.370	5.914**
Periods x I-E	2	7.47	3.735	3.468*
Periods x experiments	2	.75	.375	.348
Periods x I-E x experiments	2	.03	.015	.014
Error	240	258.59	1.077	-----
Total SS	371	811.64	-----	-----

** $p < .005$.

* $p < .05$.

a difference between introverts and extroverts in performance on a vigilance task over time.

A nonparametric test was made of the increments and decrements comparing the first period (A) with the last (C). Results indicated a significant ($p < .05$) difference in increments and decrements between introverts and extroverts.

Retrospective Questionnaire

The retrospective questionnaire was given in order to explore relationships between the introversion-extroversion continuum and the subjective reports of the subjects. As mentioned above, approximately one-half of the subjects were given the questionnaire orally while the other half read the questions and answered them on IBM answer sheets. No significant differences were found between the two methods of answering the questionnaire. The data were combined for further analysis as presented in Table D in the Appendix. Corrected chi-square values were computed between introversion-extroversion and the questionnaire responses. The results of these analyses are presented in Table 6. Five of the retrospective questionnaire items were found to be significant at the 5% level or better (this includes item number 24 which was a multiple choice question).

Retrospective questionnaire item number one, "Did you feel sleepy at any time?" was found to be significant at the 2% level. Eighteen introverts, 32 normals and 28 extroverts said yes to this item.

Table 6

Chi-Square Values Obtained from Contingency Tables between Introversion-Extroversion and Yes-No Responses to Questionnaire Items

Item No.	Response directions	Chi-square
1.	Extroverts--yes	5.810**
2.	Introverts--no	.183
3.	Extroverts--no	.142
4.	Extroverts--no	.076
5.	Extroverts--yes	.742
6.	Extroverts--yes	.183
7.	Introverts--yes	5.070*
8.	Introverts--no	.065
9.	Introverts--no	8.857***
10.	Introverts--yes	1.586
11.	Introverts--no	1.745
12.	Introverts--no	.246
13.	Introverts--no	1.650
14.	I & E both--no	.000
15.	Extroverts--yes	.316
16.	Extroverts--no	.550
17.	Extroverts--no	1.533
18.	I & E both--no	.000
19.	Introverts--no	.984
20.	Extroverts--yes	.243
21.	Introverts--no	5.070*
22.	Extroverts--no	.687
23.	I & E both--no	.000

*Significant at 5% level.

**Significant at 2% level.

***Significant at 1% level.

More extroverts felt sleepy during the vigilance task than introverts. The normal group answered this item the same as the extrovert group. Item number 7, "Did you like being alone?" was found to be significant at the 5% level. Twenty-nine introverts, 27 normals and 20 extroverts answered "yes" to this question. Introverts liked being alone during the vigilance task more than the extroverts. The normal group's responses were similar to those of the introverts. Item number nine, "Do you have the smoking habit?" was significant at the 1% level. Eight introverts, 12 normals and 21 extroverts claimed to have the smoking habit. Extroverts tended to smoke more than the introverts while the normal group was somewhere in between these two extremes. Item 21, "Did the sound of the voice change?" proved significant at the 5% level. Four introverts, four normals and 13 extroverts said that the recorded voice changed during the vigilance task. Extroverts perceived more distortion than the introverts or normals. The normal group's response frequencies to this item were identical to those of the introverts.

The last question, found to be significant, on the retrospective questionnaire was the subject's own subjective estimate of the actual length of the vigilance task. This question was of the five-multiple choice type and the possible answers ranged from 15 minutes to one hour and 15 minutes with 15 minute increments. Table 7 shows the introvert, normal and extrovert response frequencies for the five possible alternatives. Thirteen introverts and ten normals judged the task to be 15 minutes long while only one extrovert made this

Table 7

Response Frequencies to Retrospective Question Number 24

Question: "How Long Was the Task?"

Minutes	Introvert	Normal	Extrovert
15	13	10	1
30	13	11	13
45	5	8	14
60	0	4	5
75	2	0	0
Total	33	33	33
Mean minutes	29.09	32.73	40.45

judgment. The independence of these time estimates were tested and significant differences were found between introversion-extroversion and time estimation. A chi-square computed between the experimental groups and the question alternatives (3 x 5 contingency table) resulted in a probability ratio of less than .01. Extroverts perceived the vigilance task to be longer than the introverts. The normal group's judgments were similar to the introverts' but the differences between the normal and extrovert groups did not reach statistical significance.

Six of the questions on the retrospective questionnaire were designed to help establish experimental control. These were analyzed in order to ascertain their influence upon vigilance performance.

Question number six checked the pre-task preparations for the subjects. Results indicate that a negligible number of subjects felt that the instructions and/or practice prior to the task were inadequate. Questions nine and 13 were designed to check the possible effect of smoking upon vigilance performance. As pointed out above, significantly more extroverts have the smoking habit. Question 13 asked if the smokers thought they would have done better if they had been allowed to smoke. Answers to this item indicate that deprivation of smoking had an insignificant effect upon performance as subjectively reported by the subjects. On the basis of these subjective findings the experimenter felt justified in dismissing smoking as a factor affecting performance in a 48 minute vigilance task. Responses to item ten showed that introverts tended to get somewhat more sleepy than normals

or extroverts but the difference was not statistically significant. Therefore, the possibility of a decrement in performance due to sleep debt was discounted. There were no significant differences between groups in regard to question 18. Therefore claustrophobia was not a factor in differential performance on the vigilance task. The last control question (#21) explored the possibility of lethargy, as caused by recent eating, influencing performance. No significant differences were found between groups.

DISCUSSION

The present study investigated auditory vigilance as a function of the personality dimension introversion-extroversion. The Maudsley Personality Inventory was used as the personality measure. This questionnaire also gave a measure of neurotic tendency. This measure was considered a relevant variable and was therefore held constant by matching all three groups for neuroticism. The lie scale of the MPI was used to check for falsified questionnaires. The three groups chosen for the experiment consisted of two extreme groups on the introversion-extroversion continuum and a control group of normals picked from the middle range. The experimental paradigm used for the experiment was the conventional design of repeated measurements of (three) independent groups. This design afforded the multi-variant comparisons of introversion, normal, extroversion, vigilance performance totals and performance over time. A retrospective questionnaire was given each subject at the conclusion of the vigilance task. The intent of the questionnaire was to increase experimental control and to ascertain the subjective feelings of the subjects and relate these reports to introversion and extroversion.

Introversion-Extroversion and Vigilance Performance

The crux of the present experiment was to refute or confirm the results obtained by Belton (1958) and his contradiction with Bakan's

(1957) study. Belton hypothesized that the extroverts would show poorer performance than the introverts. However, he found no significant difference between them in overall signals detected or in the course of performance over time. The data were highly suggestive since the extroverts started out better than the introverts but they showed a greater decrement over time.

These results were contrary to Bakan's findings which showed worse performance for the extroverts especially during the early part (periods 1 and 2) of the vigilance task. Belton reviewed the differences between the two studies in an effort to determine the reason for the discrepencies. He attributed the cause to a difference in the administration of the vigilance task. Belton did not provide complete isolation (both physical and psychological) for the subjects during the vigilance task as Bakan did in his study. He hypothesized that there may have been an interaction between the introversion-extroversion variable and the social isolation variable. The lack of social (psychological) isolation may have caused the extroverts to show a spuriously high performance. Extroverts may do better when other people are around than when they are working alone. In the Bakan study the extroverts did worse then the introverts whereas in the Belton study the extroverts did slightly better than introverts in overall performance. Belton documents his isolation hypothesis by referring to a study by Fraser (1953) who made a comparison between vigilance performance of subjects alone and with the experimenter

present. Fraser found significantly more signals missed with the experimenter absent than with the experimenter present.

Belton also concludes that the results of his experiment were inconsistent with Eysenck's theory of inhibition. Eysenck's theory suggests that the introverts build up less inhibition in a continuous task than extroverts, therefore, introverts should show less performance decrement on a vigilance task. Belton further states that Eysenck's theory would not predict superior performance for the extroverts during the first period of the vigilance task nor would it suggest a social factor interacting with the introversion-extroversion variable.

The present study did not find any significant differences between the experimental groups in overall performance. The performance differences between the three experimental groups over time were also found to be insignificant. The performance decrement over time for the groups taken as a whole was significant beyond the 1% level. These results were generally in agreement with Belton's study. The introverts' performance improved and then deteriorated until their final period score was the same as their first. The extroverts' performance began to decline immediately after the task was begun and they had an even greater decrement towards the end of the vigil. As in Belton's study the results were not statistically significant but they were nevertheless highly suggestive. In both studies the introverts indicated better performance over time than the extroverts.

In the present study each subject was tested in complete isolation. It may be noticed that the initial scores of the extroverts were lower than those found by Belton (see Figure 5). Therefore, we may assume that the isolation variable may have been a factor but not a significant one, or the extroverts' superiority may have been due to chance. The combined analysis did not show a significant variance between studies. If we lower the extrovert curve of the Belton study until the first period coincides with that of the present study, the two look remarkably similar.

If socialization during performance is an influential factor it would only raise the extroverts' curve since they are characteristically gregarious by criterion. Further research needs to be done in this regard. One-half of the introverts could be tested in isolation while the other half under sociable conditions and the same could be done with the extrovert group.

In the combined analysis it became evident that the isolation factor was of no significant importance but the group x period interaction was significant. This indicates a difference in vigilance performance between the introverts and extroverts over time. Since this interaction was insignificant in the separate studies we may hypothesize that the samples used in each study were not large enough. Since the groups were too small the large individual differences within each group caused the statistical sensitivity of the experiment to be reduced. Combining the two studies almost doubled the number of subjects in

each group. The triple interaction (periods x I-E x experiments) was not found to be statistically significant. After analyzing the above studies it becomes permissible to make the following conclusions:

1. The high performance of the extrovert group during the first vigilance period in the Belton study was probably due to chance factors.
2. The isolation factor was not a significant variable influencing vigilance performance.
3. There was no significant difference between introverts and extroverts in overall performance.
4. There was a highly significant decrement over time for the groups taken as a whole.
5. Extroverts had significantly more decrement over time than the introverts (I-E x period interaction).
6. The above data support Bakan's two-factor theory which predicts individual differences and performance decrement over time in monotonous tasks. The studies showed significant decrement over time as a whole and large individual differences within each experimental group. These individual differences may be a function of the particular self-stimulation processes employed by the various subjects.
7. Eysenck's theory of differential performance was generally supported by the above studies. Extroverts built up significantly more inhibition (measured by performance

decrement) than introverts over time. Eysenck's theory postulates differential excitation as well as inhibition between introverts and extroverts. However, he speaks of differential performance as being a function of inhibition. Therefore, one would not look for differential performance until the cumulating inhibition has had time to create one. The insignificant between groups variance is not necessarily inconsistent with Eysenck's theory. Perhaps if the vigilance task would have been longer the between groups variance as well as the group x period interaction would have been more pronounced.

Retrospective Questionnaire Analysis

The retrospective questionnaire was given in an attempt to gain better experimental control and to determine whether the trait of introversion-extroversion was related to the questionnaire responses. The analysis involved looking for differences in the responses of the subjects as a whole and as a function of the introversion-extroversion dimension.

As mentioned above some of the subjects answered the questions orally while others marked their answers on IBM answer sheets. Analysis showed no significant differences between the two methods of obtaining retrospective data. The frequency trend of the responses was invariably in the same direction.

Five of the items (including the last question on time estimation) were found to be significantly related to introversion-extroversion. The extroverts felt sleepy and disliked being alone more than the introverts during the vigil. Significantly more extroverts had the smoking habit than introverts and extroverts thought that the sound of the voice on the tape recording changed during the vigilance task. Lastly the extroverts estimated the length of the vigilance task to be considerably longer than did the introverts.

Since the extroverts felt the sleepiest and judged the length of the task to be the longest, one may assume that they perceived the task to be more monotonous than the normal or introvert groups. Bakan's two-factor theory states that performance decrement is directly related to the monotony of the task. Therefore, according to Bakan's theory the extroverts may be expected to have a higher performance decrement than the other two groups.

The overall response trends indicated that the subjects generally experienced lethargy but only seven actually dozed off. There was a tendency to daydream and become more restless as time lapsed. A significant number felt that this task could lead to an emotional breakdown and that they could not learn to do this type of work for a living. The subjects generally did not like the task and felt that they did not do very well on the vigilance task.

SUMMARY

There are many life situations which require prolonged vigilance. Vigilance is a state of readiness to perceive and respond to stimuli occurring at irregular and often infrequent intervals. It has been found that there are wide individual differences in performance on vigilance tasks. A relationship between personality variables and performance in vigilance tasks has been suggested. Bakan found that performance in a vigilance task was related to a measure of introversion-extroversion in a group of British sailors. Belton's attempt to verify this for a group of American university students was inconclusive. He suggested that his testing of the subjects in groups confounded the study since introverts and extroverts might react differently in a group situation. The present study was an effort to clarify the relationship between introversion-extroversion and auditory vigilance under conditions of social isolation. In addition a retrospective questionnaire was administered to the subjects after the vigilance task. The purpose of this was to ascertain the subjective feelings of the subjects while taking the test and to improve experimental control.

The Maudsley Personality Inventory was administered to a large group of university students. Three groups (introvert, normal and extrovert) of subjects were selected on the basis of their scores on the introversion-extroversion continuum. The subjects engaged in a 48 minute auditory vigilance task while sitting alone in a room.

They listened to a continuous series of digits coming from a tape recorder at the rate of one per second. Their job was to record irregularly occurring odd-even-odd digit sequences. The vigil was divided into three equivalent 16-minute periods for the purpose of analysis. Each period contained six odd-even-odd signals. Performance was measured by the number of signals omitted. After the vigil a retrospective questionnaire was administered.

Analysis of variance of the data showed a significant performance decrement over time for the groups as a whole. There was no significant difference between the introverts and extroverts total performance or performance over time (group x period interaction). However, there was a tendency towards greater decrement for the extrovert group. The performance of the normal group was closer to that of the extrovert group than to the performance of the introvert group. The questionnaire results showed that extroverts were more likely to feel sleepy, have the smoking habit, dislike being isolated, and to hear voice changes in the tape, than introverts. Also the extroverts estimated the length of the vigilance task to be longer than did the introverts.

Since the present study was similar to Belton's, except for the social isolation variable, it was possible to combine the data from both studies and reanalyze it. The following conclusions were drawn from the combined analysis.

1. Testing the subjects in isolation did not significantly change performance.
2. There was no significant difference between introverts and extroverts in overall performance.
3. There was a significant decrement over time for the groups taken as a whole.
4. There was a significant group x period interaction. Extroverts had more decrement over time than the introverts.

It was suggested that the large individual differences necessitated the larger sample of the two studies combined to produce a significant group x period interaction. Theoretical implications were discussed. The combined results were found to be consistent with Bakan's two-factor theory and Eysenck's theory of differential inhibition.

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TABLE OF APPENDICES

Appendix A

Sex, Introversion-Extroversion and Neuroticism Scores of Introvert, Normal and Extrovert Groups

Subject	Introvert			Normal			Extrovert		
	I-E	N	Sex	I-E	N	Sex	I-E	N	Sex
1	17	12	F	28	13	M	40	13	M
2	12	32	F	29	32	M	42	32	M
3	11	38	M	30	40	M	40	40	F
4	11	43	M	30	44	F	40	42	F
5	18	12	M	30	12	F	44	10	F
6	18	6	M	27	7	F	44	6	F
7	17	29	M	29	29	M	40	29	M
8	14	22	M	41	22	M	30	22	F
9	18	34	M	31	33	F	43	34	F
10	10	38	F	31	38	M	40	38	F
11	18	23	F	27	24	F	42	24	M
12	12	32	M	29	33	M	40	34	F
13	17	31	F	29	31	F	40	32	F
14	16	14	F	30	15	M	42	14	F
15	16	31	M	28	30	M	40	30	M
16	13	23	M	31	24	M	40	24	M
17	7	35	F	32	33	M	40	32	M
18	19	38	M	32	36	M	42	36	M
19	18	36	M	31	34	M	44	34	F
20	9	21	M	32	20	M	40	20	M
21	18	41	M	29	44	F	40	42	F
22	5	18	F	30	18	M	42	18	M
23	16	20	F	28	17	F	46	20	F
24	18	18	F	29	16	M	41	17	F
25	8	20	F	29	20	F	41	20	F
26	19	18	M	27	22	F	44	23	M
27	19	28	M	32	28	M	41	24	M
28	18	11	F	32	11	M	41	10	M
29	13	8	F	31	9	F	41	4	F
30	16	26	M	28	26	F	48	26	M
31	16	38	F	30	38	M	41	40	M
32	12	18	M	28	16	M	40	18	F
33	2	30	M	28	29	M	42	34	M
Means	14.27	25.58	14F	29.61	25.58	13F	41.58	25.52	16F

APPENDIX B

BIOGRAPHICAL SURVEY

INSTRUCTIONS: Please answer each question by filling in one of the spaces on the answer sheet next to the number corresponding to the question number on the survey sheet.

If your answer is yes fill in the first space. If your answer is no fill in the second space. If you simply cannot make up your mind for a question fill in the third space.

Work quickly and do not ponder too long about the exact shade of meaning of each question. There are no right or wrong answers, and no trick questions.

All your answers should appear on the answer sheet. Do not make any marks on the sheet with the questions.

Do not put your name on the answer sheet.

REMEMBER TO ANSWER EACH QUESTION.

1. Are you inclined to limit your acquaintances to a select few?
2. Do you prefer action to planning for action?
3. Do you nearly always have a "ready answer" for remarks directed at you?
4. Are your daydreams frequently about things that can never come true?
5. As a child, did you always do as you were told, immediately and without grumbling?
6. Are you inclined to be quick and sure in your actions?
7. Do you have difficulty in making new friends?
8. Do you sometimes put off until tomorrow what you ought to do today?
9. Are you inclined to take your work casually, that is, as a matter of course?
10. Do you often feel disgruntled?
11. Are you inclined to ponder over your past?
12. If you say you will do something, do you always keep your promise no matter how inconvenient it might be to do so?
13. Do you like to mix socially with people?
14. Are you inclined to be shy in the presence of the opposite sex?
15. Do you sometimes get cross?
16. Do you often experience periods of loneliness?

17. Are you touchy on various subjects?

18. Do you often find that you have made up your mind too late?

19. Are you completely free from prejudice of any kind?

20. Are you inclined to be overconscientious?

21. Do you often "have the time of your life" at social affairs?

22. Do you ever change from happiness to sadness, or vice versa, without good reason?

23. Do you like to play pranks upon others?

24. Do you sometimes laugh at a dirty joke?

25. Does your mind often wander while you are trying to concentrate?

26. Would you rate yourself as a tense or "high-strung" individual?

27. After a critical moment is over, do you usually think of something you should have done but failed to do?

28. Would you much rather win, than lose a game?

29. Do you find it easy, as a rule, to make new acquaintances?

30. Do you ever have a queer feeling that you are not your old self?

31. Do you ever take your work as if it were a matter of life or death?

32. Are you frequently "lost in thought" even when supposed to be taking part in a conversation?

33. Do you always feel genuinely pleased when a bitter enemy achieves a merited success?

34. Do you derive more real satisfaction from social activities than from anything else?

35. Do ideas run through your head so that you cannot sleep?

36. Do you sometimes boast a little?

37. Can you usually let yourself go and have an hilariously good time at a gay party?

38. Do you like to indulge in a reverie (daydreaming)?

39. Have you often felt listless and tired for no good reason?

40. Are <u>all</u> your habits good and desirable ones?

41. Are you inclined to keep quiet when out in a social group?

42. Are you sometimes bubbling over with energy and sometimes very sluggish?

43. Do you always answer a personal letter as soon as you can after you have read it?

44. Would you rate yourself as a talkative individual?

45. Do you occasionally have thoughts and ideas that you would not like other people to know about?

46. Would you be very unhappy if you were prevented from making numerous social contacts?

47. Are you happiest when you get involved in some project that calls for rapid action?

48. Do you spend much time in thinking over good times you have had in the past.

49. Do you sometimes talk about things you know nothing about?

50. Have you ever been bothered by having a useless thought come into your mind repeatedly?

51. Do other people regard you as a lively individual?

52. Do you sometimes gossip?

53. Do you usually keep in fairly uniform spirits?

54. Are your feelings rather easily hurt?

55. At times, have you ever told a lie?

56. Do you generally prefer to take the lead in group activities?

57. Would you rate yourself as a happy-go-lucky individual?

58. Have you money worries at times?

59. Do you have periods of such great restlessness that you cannot sit long in a chair?

60. Are you usually a "good mixer"?

61. Would you rate yourself as a lively individual?

62. Have you ever been late for an appointment or work?

63. Do you ever feel "just miserable" for no good reason at all?

64. Are you often troubled with feelings of guilt?

65. Are you inclined to be moody?

66. Do you like to have many social engagements?

67. Once in a while, do you lose your temper and get angry?

68. Do you sometimes feel happy, sometimes depressed, without any apparent reason?

69. Is it difficult to "lose yourself" even at a lively party?

70. Are you ordinarily a carefree individual?

71. Do you have frequent ups and downs in mood, either with or without apparent cause?

72. Would you always declare everything at the customs, even if you knew that you could never be found out?

73. Do you like work that requires considerable attention to details?

74. Are there times when you seek to be alone and you cannot bear the company of anyone?

75. Are you inclined to keep in the background on social occasions?

76. Have you often lost sleep over your worries?

77. Of all the people you know are there some whom you definitely do not like?

78. Do you usually feel disappointments so keenly that you cannot get them out of your mind?

79. Do you usually take the initiative in making new friends?

80. Do you enjoy participating in a showing of "Rah Rah" enthusiasm?

Extroversion: Keyed Responses

NAME ______ LAST ______ FIRST ______ MIDDLE ______ DATE ______ AGE ______ SEX ______ M OR F

STUDENT NUMBER ______ MICHIGAN STATE COLLEGE ______ DATE OF BIRTH ______ INSTRUCTOR ______

NAME OF COURSE ______ COURSE NO. ______ SECTION ______ NAME OF TEST ______ FORM ______

DIRECTIONS: Read each question and its numbered answers. When you have decided which answer is correct, blacken the corresponding space on this sheet with the special pencil. Make your mark as long as the pair of lines, and move the pencil point up and down firmly to make a heavy black line. If you change your mind, erase your first mark completely. Make no stray marks; they may count against you.

SAMPLE:
1. Chicago is
1—1 a country
1—2 a mountain
1—3 an island
1—4 a city
1—5 a state

SCORES

BE SURE YOUR MARKS ARE HEAVY AND BLACK.
ERASE COMPLETELY ANY ANSWER YOU WISH TO CHANGE.

Circled (keyed) responses: 1—2, 2—1, 3—1, 6—1, 9—1, 13—1, 14—2, 20—2, 23—1, 31—2, 37—1, 41—2, 44—1, 46—1, 47—1, 51—1, 56—1, 57—1, 61—1, 66—1, 69—2, 73—2, 75—2, 79—1

DATE OF BIRTH

Extroversion: Keyed Responses

NAME _____ LAST _____ FIRST _____ MIDDLE _____ DATE _____

STUDENT NUMBER _____ MICHIGAN STATE COLLEGE

NAME OF COURSE _____ COURSE NO. _____

DIRECTIONS: Read each question and its numbered answers. When you have decided which answer is correct, blacken the corresponding space on this sheet with the special pencil. Make your mark as long as the pair of lines, and move the pencil point up and down firmly to make a heavy black line. If you change your mind, erase your first mark completely. Make no stray marks; they may count against you.

SCORES

DATE OF BIRTH _____ AGE _____ SEX _____ M OR F

SECTION _____ INSTRUCTOR _____

NAME OF TEST _____ FORM _____

SAMPLE: 1. Chicago is
1—1 a country
1—2 a mountain
1—3 an island
1—4 a city
1—5 a state

	1	2	3	4	5
1			●		
2			●		
3			●		
4					
5					
6			●		
7					
8					
9			●		
10					
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13			●		
14			●		
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20			●		
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23			●		
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BE SURE YOUR MARKS ARE HEAVY AND BLACK.
ERASE COMPLETELY ANY ANSWER YOU WISH TO CHANGE.

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DATE _____ DATE OF BIRTH _____

Neuroticism: Keyed Responses

SCORES

NAME ______ LAST ______ FIRST ______ MIDDLE ______ DATE ______ DATE OF BIRTH ______ AGE ______ SEX ______ M OR F

STUDENT NUMBER ______ MICHIGAN STATE COLLEGE ______ SECTION ______ INSTRUCTOR ______

NAME OF COURSE ______ COURSE NO. ______ NAME OF TEST ______ FORM ______

DIRECTIONS: Read each question and its numbered answers. When you have decided which answer is correct, blacken the corresponding space on this sheet with the special pencil. Make your mark as long as the pair of lines, and move the pencil point up and down firmly to make a heavy black line. If you change your mind, erase your first mark completely. Make no stray marks; they may count against you.

SAMPLE:

1. Chicago is
1—1 a country
1—2 a mountain
1—3 an island
1—4 a city
1—5 a state

1 2 3 4 5

1	31	61	91	121
2	32	62	92	122
3	33	63	93	123
4	34	64	94	124
5	35	65	95	125
6	36	66	96	126
7	37	67	97	127
8	38	68	98	128
9	39	69	99	129
10	40	70	100	130
11	41	71	101	131
12	42	72	102	132
13	43	73	103	133
14	44	74	104	134
15	45	75	105	135

BE SURE YOUR MARKS ARE HEAVY AND BLACK.
ERASE COMPLETELY ANY ANSWER YOU WISH TO CHANGE.

16	46	76	106	136
17	47	77	107	137
18	48	78	108	138
19	49	79	109	139
20	50	80	110	140
21	51	81	111	141
22	52	82	112	142
23	53	83	113	143
24	54	84	114	144
25	55	85	115	145
26	56	86	116	146
27	57	87	117	147
28	58	88	118	148
29	59	89	119	149
30	60	90	120	150

SCORES

DATE OF BIRTH _____ AGE _____ SEX _____ M OR F

Neuroticism: Keyed Responses

NAME ______ LAST FIRST MIDDLE DATE ______ AGE ______ SEX ______ M OR F

STUDENT NUMBER ______ MICHIGAN STATE COLLEGE DATE OF BIRTH ______

SECTION ______ INSTRUCTOR ______

NAME OF COURSE ______ COURSE NO. ______ NAME OF TEST ______ FORM ______

DIRECTIONS: Read each question and its numbered answers. When you have decided which answer is correct, blacken the corresponding space on this sheet with the special pencil. Make your mark as long as the pair of lines, and move the pencil point up and down firmly to make a heavy black line. If you change your mind, erase your first mark completely. Make no stray marks; they may count against you.

SAMPLE:

1. Chicago is 1—1 a country 1—2 a mountain 1—3 an island 1—4 a city 1—5 a state

1 2 3 4 5

Answer spaces for items 1–150, each with choices 1 2 3 4 5.

BE SURE YOUR MARKS ARE HEAVY AND BLACK.
ERASE COMPLETELY ANY ANSWER YOU WISH TO CHANGE.

APPENDIX C

Retrospective Questionnaire

Please answer the following statements as quickly as practicable. Mark 1 for Yes and 2 for No. Please use the extreme right side of the answer sheet.

1. Did you feel sleepy at any time?
2. Did you actually doze off at any time?
3. Were you "nervous" about taking this test?
4. Did you like the test?
5. Did you daydream?
6. Were the instructions and practice for this task adequate?
7. Did you like being alone?
8. I think I did well on the test.
9. Do you have the smoking habit?
10. I average seven or more hours of sleep at night.
11. I think the task was too controlled.
12. The task was depressing.
13. I would have done better if I would have been allowed to smoke.
14. I think I could learn to do this for a living.
15. I became noticeably more restless as time passed.
16. I was "ego" or "personally" involved in the task.
17. A continued task like this could lead to an emotional breakdown.
18. Do you have a tendency to dislike closed places?
19. Were there enough sequences given?
20. Have you had a meal to eat within two hours before the test?
21. Did the sound of the voice change?
22. Did the numbers "blur" or "run together" at times?
23. I think this was a rather silly task.
24. How long was the task?

    (1) 15 minutes (2) 30 min. (3) 45 min. (4) 1 hour (5) 1 hour 15 min.

APPENDIX D

Total Retrospective Questionnaire Response Frequencies

Item No.	Introvert		Normal		Extrovert	
	True	False	True	False	True	False
1	18	15	32	1	28	5
2	2	31	1	32	4	29
3	5	28	2	31	3	30
4	10	23	12	21	8	25
5	23	10	23	10	27	6
6	29	4	32	1	31	2
7	29	4	27	6	20	13
8	11	22	9	24	13	20
9	8	25	12	21	21	12
10	23	10	18	15	17	16
11	3	30	0	33	8	25
12	13	20	15	18	16	17
13	1	32	2	31	5	28
14	4	29	5	28	4	29
15	23	10	28	5	26	7
16	17	16	12	21	13	20
17	24	9	23	10	29	4
18	6	27	3	30	6	27
19	12	21	22	11	17	16
20	16	17	21	12	19	14
21	4	29	4	29	13	20
22	11	22	12	21	7	26
23	6	27	3	30	6	27

APPENDIX E

The following table presents the raw data obtained during the vigilance task for each subject. The first number under each experimental group represents one subject's omission score for the first 16 minute period (A) of the vigilance task. The second number across is for period B and so on. The last (fourth) number is the particular subject's total omission score.

The numbers used to identify subjects are the same as those used in the table in Appendix A. Therefore, by referring to Appendix A, it is possible to obtain each subject's sex, introversion-extroversion and neuroticism scores.

Total and Periodic Omission Scores of Each Subject in the Experimental Groups

Subject	Introvert	Normal	Extrovert
1	2-0-1-3	4-2-3-9	2-3-6-11
2	2-0-3-5	1-3-2-6	0-2-2-4
3	2-0-1-3	1-0-1-2	3-0-3-6
4	0-0-0-0	2-2-5-9	4-6-6-16
5	0-2-2-4	1-1-3-5	1-2-2-5
6	2-3-4-9	0-1-1-2	1-1-1-3
7	0-1-1-2	0-3-4-7	2-3-5-10
8	3-0-1-4	1-2-0-3	2-4-4-10
9	2-4-6-12	1-2-0-3	2-0-1-3
10	1-1-3-5	1-0-1-2	1-3-0-4
11	0-1-0-1	4-2-3-9	5-2-4-11
12	1-1-1-3	2-1-4-7	0-1-4-5
13	2-3-2-7	1-3-2-6	1-0-1-2
14	1-1-1-3	1-2-3-6	3-6-5-14
15	2-0-0-2	1-2-3-6	0-0-0-0
16	3-1-2-6	3-3-3-9	4-2-5-11
17	3-1-2-6	2-2-4-8	1-1-0-2
18	2-2-1-5	4-2-4-10	1-4-3-8
19	2-3-3-8	0-1-1-2	1-3-1-5
20	1-1-1-3	1-2-2-5	0-0-0-0
21	4-5-3-12	0-3-0-3	2-0-2-4
22	1-1-3-5	3-1-3-7	0-2-1-3
23	0-1-0-1	2-0-2-4	5-3-4-12
24	1-0-0-1	0-2-3-5	3-2-4-9
25	1-4-4-9	3-1-3-7	2-3-4-9
26	1-0-2-3	4-2-0-6	1-0-3-4
27	1-1-1-3	3-2-2-7	1-1-0-2
28	2-1-1-4	4-4-5-13	0-1-2-3
29	1-0-0-1	0-1-2-3	0-0-0-0
30	3-1-1-5	1-2-0-3	0-2-2-4
31	4-2-3-9	0-0-0-0	2-0-1-3
32	2-0-0-2	0-0-1-1	1-0-1-2
33	1-0-0-1	2-1-2-5	2-2-3-7