EXTRAVERSION-INTROVERSION AND SPIRAL AFTER-EFFECTS

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ABSTRACT

Extraversion-introversion and Spiral After-effects

By Alan Spivak

Eysenck, via a typological approach to the study of personality, has derived by factor analytic techniques two continua of personality on which all individuals normal and abnormal are said to lie, namely, "extraversion-introversion" and "neuroticism." In searching for causal agents to account for these dimensions, Eysenck borrowed the Hullian notion of reactive inhibition. Using this concept as a point of departure, he proposed a postulate of individual differences which states that human beings differ with respect to their capacity to accumulate reactive inhibition. Furthermore, individuals in whom this capacity is strong are, thereby, predisposed to develop extraverted patterns of behavior and individuals in whom this capacity is weak should exhibit introverted characteristics.

Since reactive inhibition is also said to underlie such behavioral events as conditioning and reminiscence, a number of investigations have been carried out attempting to link these phenomena to the extraversion-introversion continuum. In an effort to prove his theory is not limited to the area of learning and conditioning, however, Eysenck has offered predictions concerning behavior in the perceptual field as well, placing particular emphasis on figural after-effects. Maintaining that reactive

inhibition and the Kohler-Wallach concept of satiation are identical constructs, he asserts that extraverts should develop greater after-effects than introverts.

The present study is concerned with an event termed the "spiral-square" after-effect, an illusion which differs from the more commonly observed "spiral-spiral" after-effect in that S reports changes in the size of a square, consequent upon inspection of a rotating spiral, rather than changes in the motionless spiral itself. Since no systematic investigation of the phenomena has been undertaken, it was deemed appropriate to examine both the time course of the after-effect and its relation to Eysenck's typological postulate.

While the research was in progress, a study by Lynn was discovered which reported significant correlations between extraversion and measures of duration and decline of the spiral-spiral after-effect over massed trials. As the spiral-square after-effect experiment found no such relationship, a second experiment was performed similar to the first, with the exception that the apparatus employed was the spiral-spiral after-effect.

When a correlational analysis of the data from Expt. I was performed, no relationship was found between the temporal measures of after-effect and degree of extraversion-introversion as determined by the Maudsley Personality Inventory. When extreme groups of extraverts and introverts were compared, the only significant t-ratio obtained was from the measure of size displacement of the square; once more the significance was in the opposite direction

predicted. The results of Expt. II likewise indicate no significant correlations or t-ratios among the temporal variables concerned, thereby contradicting Lynn's findings.

The fact that a significant difference between introverts and extraverts was obtained on the size displacement measure agrees with a corresponding observation made by Eysenck in the kinesthetic modality.

Not only do the results contradict Eysenck's theory of personality differences in temporal measures of after-effects but it is also apparent that there are contradictions in the theory itself. In kinesthetic after-effect experiments, for example, Eysenck predicts for extraverts after-effects of larger size due to a greater build up of satiation during inspection. Conversely, in the visual modality an after-effect of shorter duration is predicted which is allegedly a product of a more rapid accumulation of satiation during either the test period (Eysenck, 1957), or during the test period and the inspection period (Eysenck, 1960). The author's reformulation of the theory is an attempt to account for these inconsistencies.

The conclusion to be drawn from the present study is that differences among people with respect to the magnitude of spiral after-effect may be related to extraversion. Differences in the duration of spiral after-effect or its change over time do not appear to be related to extraversion.

Approved Paul R. Farnsworth Date October 30, 1961
Major Professor

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INTRODUCTION

Over the past few years Eysenck has been formulating a theory of personality in which the extraversion-introversion dichotomy looms large. Extraverts and introverts are alleged to differ in their tendency to develop and retain cortical inhibition being akin to the "reactive inhibition" of Hull and the "satiation" of Köhler and Wallach. These inhibitory constructs are said to underly a number of behavioral events including conditioning, extinction, reminiscence, figural after-effects, effects of brain injury, and duration of the spiral after-effect. It is assumed by Eysenck that individual differences in the inhibitory potential are related to both behavior in experimental situations and the extraversion-introversion dimension. Therefore, it should be possible to demonstrate behavioral differences between extraverts and introverts for behaviors related to cortical inhibition.

According to Eysenck, certain illusory changes subsequent to inspection of a rotating spiral are governed by cortical inhibition and consequently are related to the extraversion-introversion dimension. The present study constitutes in part a test of this general hypothesis. Before considering the experiments in detail, a more extensive review of the formulation and support of Eysenck's theory is in order.

Extraversion-introversion and Eysenck's Personality Theory

Relation to Psychiatric Classifications. Eysenck believes that the main "facts" or dimensions of personality, which are of importance to the investigation of causal factors, are extraversion-introversion and neuroticism. Referring to a study by Hildebrand (1953) as an example, Eysenck has attempted to show that there is a relationship between these dimensions and nosological psychiatric classifications. Hildebrand hypothesized that an outside criterion of "neuroticism" could be obtained by examining test scores of hospitalized neurotics and people without psychiatric involvement. Likewise, he thought that an outside criterion of extraversion-introversion could be obtained by comparing test scores of hysterics and dysthymics, who, according to Jung, are the prototype groups for the concept of extraversion and introversion respectively. After a battery of several objective tests covering numerous traits such as persistence and suggestibility was administered to groups of hysterics, psychopaths, depressives, obsessionals, anxiety states, mixed neurotics, and normals, intercorrelations were obtained between tests for subjects in all groups, with the exception of the criterion groups of hysterics, dysthymics, and normals. A factor analysis brought out three simple factors, those of intelligence, neuroticism, and extraversion.

"Intelligence tests had high loadings on the intelligence factor; the tests differentiating between the normal and neurotic groups had high loadings on the neuroticism factor; the tests differentiating between the hysterics and anxiety states had high loadings on the extraversion-introversion factor." When factor scores on the two personality factors were computed for the persons in the various groups results were obtained as illustrated in Fig. 1.

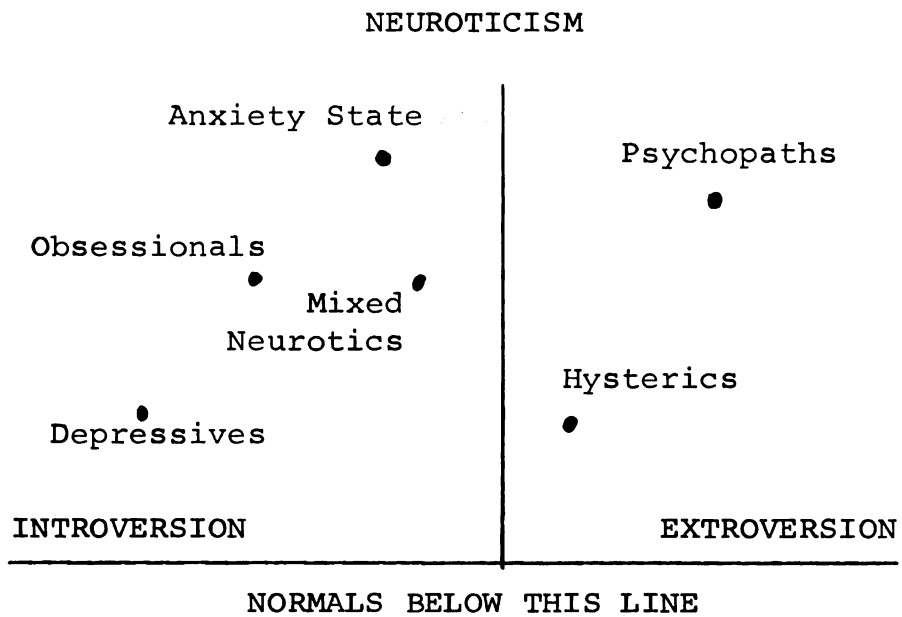

Fig. 1. Position of Various Clinically Diagnosed Neurotic Groups on Two Continua as Determined by Factor Scores

Ten per cent of the normal groups were put on the neurotic side; this corresponds to the percentage shown to have debilitating neurotic tendencies in a normal working-class population (Fraser, 1947). Significant differences were found

to exist between various extraverted groups as well as between neurotic and normal groups. On the basis of these results Eysenck feels justified in using the hysteric group and the dysthymic group as criteria for any hypothesis made in terms of extraversion-introversion.

Several investigators, however, are reluctant to accept these criteria. Among them are Sigal, Star, and Franks (1958) who attempted to validate the E and N scales of the Maudsley Personality Inventory. The MPI, constructed by Eysenck, was item analyzed with the aid of criterion groups consisting of high and low scorers on Guilford's R and C scales. The experimenters supposed that, if the E scale was valid, a hysteric-psychopath group should score high, a dysthymic group should score low and normals should fall in between these two groups. They also felt that if the N scale measures neuroticism the group of normals ought to score significantly below the two neurotic groups.

A chief psychologist at one hospital, and a group of psychologists at another, selected patients which best typified each group. The final sample consisted of 213 normals, 25 dysthymics, 27 hysteric-psychopaths, 15 hysterics, 8 psychopaths, and 52 neurotics. Individual t tests showed that the only significant differences among the various groups on the

E scale were the lower scores of the dysthymics than the normals and the lower scores of the dysthymics than the psychopaths.

Thus on the basis of these findings there is no reason to group hysterics and psychopaths together and dysthymics separately. Doing so here would have resulted in misclassification of 37 per cent of the cases.

Analysis of the scores on the N scale indicated that while there was a significant difference between the means of the normals and the neurotics a great deal of misclassification had occurred.

Cortical Inhibition and Eysenck's Personality Theory

Statement of the Theory. Eysenck cites the work of McCleod (1954) as important in having established an additional fact of significance to any theory of extraversion-introversion. In this study it was discovered by intercorrelating a large number of objective tests given to both monozygotic and dyzogotic twins that a factor of extraversion-introversion could be derived. Furthermore the intercorrelation of factor scores was considerably higher for the monozygotic than the dyzogotic twins.

The implication stemming from these results, namely, that hereditary determinants of extraversion-introversion are more

potent than environmental conditions,has led Eysenck to search for a causal factor of extraversion-introversion in the central nervous system, particularly in the cerebral cortex.

At first Eysenck considered a theory proposed by Pavlov (1941) which maintains that hysterics should have intense inhibition effects as a result of the process of negative induction which in turn is caused by an excessive concentration of excitation in a weak nervous system. Noting that this theory does not lend itself easily to exact and testable predictions and also that Hull's concept of reactive inhibition has been accorded more confirming evidence than that of negative induction, Eysenck has offered a theory based on the former, yet not dissimilar in its essentials to the latter.

The theory is stated in the form of three related postulates.

A. The general law. "Whenever any stimulus-response connection is made in an organism (excitation), there also occurs simultaneously a reaction in the nervous structures mediating this connection which opposes its recurrence (inhibition)."

B. The postulate of individual differences. "Human beings differ with respect to the speed with which reactive inhibition is produced, the strength of reactive inhibition, and the speed with which reactive inhibition is dissipated. These differences

themselves are properties of the physical structures involved in the evocation of responses."

C. The typological postulate. "Individuals in whom reactive inhibition is generated quickly, in whom strong reactive inhibitions are generated, and in whom reactive inhibition is dissipated slowly are thereby predisposed to develop extraverted patterns of behavior and to develop hysterical disorders in cases of neurotic breakdown; conversely, individuals in whom reactive inhibition is generated 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 cases of neurotic breakdown.

Supporting and Nonsupporting Experimental Evidence.

Conditioning: The first prediction which Eysenck has made on the basis of the above theory is concerned with the conditioned response. It follows from the theory that individuals in whom reactive inhibition is easily established should acquire conditioned responses slowly and dissipate them quickly. On the other hand, responses of individuals in whom reactive inhibition is slow to develop should condition readily. Eysenck has pointed out that the results of work done in this

area is subject to more than one theoretical interpretation. For, whereas anxiety is usually related to conditionability, a view in line with the facts presented in Fig. 1 that symptoms of anxiety are located on the dysthymic side of the extraversion-introversion dimension, it must be noted that anxiety also falls over onto the neuroticism dimension. Thus the relation between anxiety and conditionability could conceivably be interpreted in terms of neuroticism rather than in terms of extraversion-introversion.

An example of the latter interpretation has been made by Spence and Taylor (1951) who ran two groups of 50 Ss each in a conditioned eyelid situation. The two groups consisted of Ss who made extreme scores on the MPI. The results indicated a statistically significant difference in amount of conditioning in favor of the anxious group.

The explanation for these results which Taylor and Spence offer is that anxiety is related to drive level. Using Hull's theoretical formulation ${}_{S}E_{R} = {}_{S}H_{R} \times D$ they maintain that higher anxiety should lead to quicker conditioning (${}_{S}E_{R}$) because of increases in drive strength (D). Eysenck has been quick to point out, however, that the experiment involved is not a crucial test in distinguishing between the relative merits of his theory and that of Taylor and Spence since the same

prediction would have been made from either; that is, highly anxious individuals may condition more easily because of their neuroticism or because of their extraversion.

It would appear that a crucial experiment would involve three groups rather than two, namely, a dysthymic group, a hysteric group, and a group of normals. If ease of conditionability is related to neuroticism, then one would expect that both the dysthymics and the hysterics would condition more easily than the normals. On the other hand, if it is to be accounted for on the basis of introversion, one would expect that the group of hysterics should condition least easily, dysthymics most easily, and normals should condition in between the two neurotic groups.

The crucial experiment was carried out by Franks (1954) who compared the acquisition and extinction of an eyeblink CR to a tone CS, a puff of air being used for the US. Eighteen conditioning and ten extinction trials were applied to groups of dysthymics, hysterics, and normals. His results indicate that, in accord with Eysenck's theory "the dysthymics condition more quickly, condition more strongly, and extinguish less quickly than do the normals, while hysterics condition less quickly, condition less strongly, and extinguish more easily than do the normals." Franks (1956) believes that manifest anxiety is related to easy conditionability only in-so-far

as anxious people are introverted. "Taylor's Anxiety Scale differentiates those subjects who condition well from those who condition poorly only to the extent that it fails to measure neuroticism."

Storms and Sigals (1958) find a number of serious flaws in Eysenck's report of Franks' study. One of the most important is the graph presented by Eysenck. These authors insist that, in fact, there is no significant difference in conditioning scores between hysterics and normals. "It may be noted that the graph presented by Eysenck contains certain errors which make the groups appear to differ more than was actually found by Franks."

Another criticism of Eysenck's discussion of this experiment, which Storms and Sigal make, is in regard to the term "conditionability"which Eysenck refers to as a demonstrated trait. It is observed that no such thing has been shown to exist in the literature. Therefore, Eysenck might better have confined his interpretations to eye-blink acquisition per se.

These critics also maintain that Eysenck's conclusion that dysthymics conditioned more rapidly than hysterics was premature. According to them, the learning curves should not be parallel but rather should diverge indicating a difference in slope. An analysis of variance of the first six, the middle six, and the last six trials demonstrated no significant

difference between means. A comparison between sets of trials indicated that any contention that all learning had taken place within the first set of trials is implausible.

Reminiscence: Another prediction which Eysenck claims follows from the typological postulate is that extraverts should exhibit higher scores than introverts on tests of reminiscence. He argues that since massed practice produces inhibition and does so at a faster rate in extraverts than in introverts, members of an extraverted group will have more inhibition generated in them under this condition than will members of an introverted group. Reminiscence is a result of the dissipation of inhibition during a rest period and thus extroverts will show a greater dissipation of inhibition in the form of higher reminiscence scores.

A test of this hypothesis was made by Eysenck (1956) in an experiment involving reminiscence on the pursuit rotor, following massed practice. Three experimental sessions were used, each consisting of thirty successive ten second trials. Each session was separated from the other by ten minute rest intervals. Two reminiscence effects were measured.

The fifty male students who were used as subjects were also tested on the MPI. Results of a product-moment correlation between extraversion and the first reminiscence score is a

value of .29, significant at the .02 level. An insignificant value of .10 was obtained from a correlation with the second reminiscence score. The correlation between neuroticism and the first reminiscence score is .40, significant at the .01 level, between neuroticism and the second reminiscence score is .27. Thus, the prediction made from the typological postulate was supported.

Eysenck offers an explanation for the relationship found between reminiscence and neuroticism. He refers, first, to Kimble's theory (1950) which states that an individual with greater drive will tolerate more reactive inhibition. Then citing Mower (1950), Dollard and Miller (1950), and Taylor and Spence (1951, 1952, 1951) he notes that neuroticism has often been conceptualized as an autonomic drive variable. A combination of these two theories leads him to believe that individuals with strong drives, i.e., high neuroticism, should produce higher reminiscence scores as evidence for the accumulation of greater amounts of reactive inhibition.

Cortical Inhibition and Figural After-Effect

Once Eysenck had demonstrated, to his satisfaction at least, the applicability of his theory to the field of conditioning and learning, he wished to extend its scope to the general area of perception. His rationale for doing so was

based on the observation that Pavlov's conditioned reflex was not intended to be a paradigm for learning, but rather a means whereby he could study the functions of cortical action. Pavlov believed that the discovery of laws of cortical functioning would not only explain the conditioning process but would also provide the foundation for an explanation of more general phenomena such as perception.

Köhler's Terminology and Eysenck's Predictions. The particular phenomenon which Eysenck chose to investigate this possibility was the figural after-effect of Köhler and Wallach (1944). The latter suggest that, when certain parts of sensory surfaces are continuously stimulated, changes occur in the corresponding medium in the cortex. As a result, percepts later occurring in that particular cortical region are in some ways changed or distorted. For instance, if for a measured period of time a circle, the inspection figure, is fixated and then replaced by a square, the test object, whose boundaries lie within the area previously occupied by the circle, the square will appear smaller than another square of exactly the same size which has been presented to a different part of the retina and cortex.

Köhler explains the phenomenon by assuming that every percept is associated with electric currents in the nervous

system, the currents being produced by a difference in brightness intensity of figure and ground. Regarding the visual sector as a volume conductor, figure currents are said to polarize all cell surfaces through which they pass. To this polarizing action the term electrotonus was applied. It is a condition which can prevail for some time after the polarizing current has stopped. The electrotonic effect of figure currents on the cortical area was given the name satiation. When the figure currents of test objects pass through a satiated region the resulting distortions are called figural after-effects.

Polarization of a particular area of cells results in increased resistance to figure currents passing through these cells. The phenomenal correlate of such an occurrence is the displacement of test objects from the affected region. The fact that this displacement shows individual differences and can be used as an operational definition of cortical inhibition in the perceptual field led Eysenck to propose that hysterics should be more prone to satiation effects than dysthymics.

Supporting and Nonsupporting Experimental Evidence.

Kinesthetic After-Effect: Via the kinesthetic modality, Eysenck (1955) tested three specific predictions: (1) satiation effects should appear earlier among hysterics;

(2) they should appear more strongly among hysterics; (3) they should dissipate more slowly among hysterics.

The apparatus used, as well as the procedure, was taken from Klein and Krech (1952). Principally it consisted of a comparison scale, a test object, and a stimulus object. Each of these was made of wood with a metal rider attached so that as the subject moved his thumb and forefinger down along the sides of the object they traversed equal distances on each stroke. The subjects were instructed to adjust the rider on the comparison scale with their left hand until the width of wood between their two fingers felt equal in size to the width of wood of the test object held between the corresponding fingers on their right hand. In this way the point of subjective equality was determined. Next the subjects were told to place the fingers of the right hand on the rider of the stimulus object, which was one inch larger than the test object, and to stroke the sides of the stimulus object for periods of time of either 30, 60, 90, or 120 seconds. Once this was done, the subjects went back to the test object and again found a point of subjective equality. It follows from the theory that hysterics should encounter more of a shrinkage than dysthymics.

Subjects were selected on the basis of two criteria; first, that they fall into the classification of either hysteric or dysthymic by psychiatric diagnosis and second, that they also

fall into these groups by attaining scores of 31 or above for extraverts and 39 or below for introverts. The results were statistically significant in the predicted direction.

Brain Damage: An attempt to further extend his theory has led Eysenck to the field of brain damage. He observed (1955) that hysterics and persons suffering from brain damage often show a marked resemblance in symptomatology. This led him to consider the hypothesis that brain injury produces an increase in inhibition and thus an increase in extraversion. Petrie's work (1952) offers experimental support of such a view. When objective tests used as measures of extraversion-introversion were administered to patients before and after leucotomy, it was shown that on each test a definite shift in the direction of extraversion occurred.

If this finding is a valid indicator of the consequences of brain damage, then, it would be expected that such patients show corresponding changes in after-effect phenomena. Klein and Krech (1952), using the procedure adopted by Eysenck, performed an experiment identical to Eysenck's with one exception. Subjects were not selected on the basis of extraversion or introversion, instead the 12 subjects selected were sufferers of brain injury. Of the sixteen members of a control group none had a history of neurological complication, most had been hospitalized for hemorrhoids and hernias. The obtained results

lead to the conclusion that figural after-effect is much stronger among a group of brain injured persons than among a group of normal controls. Evidence for the striking degree of similarity between the results of Eysenck's hysterics and dysthymics and Klein and Krech's groups is supplied by the following comparison. The average size of the overall after-effect was 12.08 per cent for the brain-injured and 2.25 per cent for the controls. A percentage of 19.50 was the maximum degree of effect for the brain injured, as opposed to 13.00 per cent for the controls. The average over-all effect for hysterics and dysthymics was 11.53 per cent and 4.71 per cent respectively. The corresponding maximum effect was 20.74 per cent and 15.32 per cent.

As striking as these results appear, Jaffe (1954) in a replication of the experiment found no significant differences between 20 brain injured and 20 controls. The discrepancy between the two studies is most likely due to the fact that Jaffe improved the sampling and the control. Also his results were tested at the .05 level whereas those of Klein and Krech were significant at the .10 level.

Klein and Krech account for their results with a theory different from that of Eysenck. They propose an explanation similar to the Köhler-Wallach analysis with one major deviation; they reject the restriction that satiation issues from a difference in intensity between figure and ground. Rather,

they maintain that "any neural activity induces heightened resistance within the area stimulated." Whereas Klein and Krech postulate individual differences with regard to cortical conductivity, Eysenck holds that individual differences lie in the rate at which neural impulses arouse inhibition in the cortical material.

Spiral After-Effects: A subject who has fixated his gaze on the center of a rotating Archimedes spiral will experience, when the spiral has stopped, an after-effect of apparent motion of the spiral, similar but in opposite direction to the original motion. The after-effect lasts for some time, depending almost exclusively on the length of original stimulation.

According to Eysenck's conception of satiation theory, the illusion is an isomorph of "certain unspecified cortico-neural events." These cortico-neural events produce inhibition in the structures mediating the illusion, eventually curtailing the effect. Since the amount of inhibition produced is proportional to the viewer's position on the extraversion-introversion dimension, short duration of after-effect would be expected among hysterics, psychopaths, extraverts, and the brain damaged (Eysenck, 1957, pp. 163-164).

Prince and Deabler (1955) tested the phenomenon of the Archimedes spiral as an indicator of brain damage, hypothesizing

that, whereas nonorganic patients would be able to perceive the negative after-effect, patients with organic brain damage would either be unable to perceive it or would perceive it incompletely. Subjects were seated approximately 8 feet from the apparatus which was turned on for a period of 30 seconds. As the disk was rotating Ss were asked to report what the line was doing. When the motor was shut off each S was immediately asked again to report what the line was doing. The routine was repeated with a presentation of the disk spinning in the opposite direction.

Subjects were made up of a group of forty normal adult males with no known history of organic involvement, a group of forty nonorganic psychiatric cases, and a group of one hundred and twenty organic cases. An analysis of the data by the chi-square technique determined a result significant in the desired direction at the .001 level of confidence.

In a study by Spivack and Levine (1959) one of the goals was to examine the spiral after-effect in terms of a duration of effect parameter rather than merely the report of presence or absence. Their results indicated that the brain damaged group gave significantly greater durations at each of several exposure periods than did the controls; thus they are in complete discord with Eysenck's prediction, as well as Price and Deabler's findings.

Intercorrelation of Visual and Kinesthetic Figural After-Effect: Turning now to another aspect of Eysenck's treatment of neural satiation, it is implied, if not explicitly stated, that there is a positive correlation between figural after-effects in both the visual and kinesthetic modalities. Among the few investigators who have addressed themselves to this consideration are McEwen and Rodger (1960) and Spitz and Lipman (1960). In the former study the apparatus used for the kinesthetic after-effect was somewhat similar to that used by Eysenck and Klein and Krech. The visual apparatus involved consisted of a circle of light as I-figure and two smaller circles of light, one falling inside the I-circle, as T-figures. Subjects were also scored on the extraversion-introversion scale of Heron (1956), a shortened form of the MPI.

When the treatment difference in the kinesthetic modality was removed, as well as the sex difference in the visual modality, a product-moment correlation of .03 was obtained. For N = 32 this value is not significant. In addition insignificant rank correlations were obtained between both extraversion-introversion and kinesthetic after-effects, and extraversion-introversion and visual figural after-effects. Needless to say, these findings would not be expected on the basis of Eysenck's postulates.

Spitz, who also found no significant intercorrelations

between tests of visual and kinesthetic after-effects, argues that if one attributes these results to the specific operations employed, then one must also explain why the theory is given a more valid test under one set of operations than under other sets of operations.

In the opinion of the present writer one additional study need be mentioned in order for a reasonably complete review of Eysenck's theory and its critique to be accomplished. Rechtschaffen (1958) attempted to verify three of Eysenck's hypotheses: (1) extraverts develop greater visual after-effects than introverts; (2) extraverts develop more I_R on a motor-learning task than introverts; (3) there is a positive correlation between individuals' scores on after-effect measures and measures of I_R.

Subjects, 96 volunteers from an introductory psychology class, were administered Guilford's R Scale, a measure of extraversion-introversion. Then each was tested individually on the inverted alphabet printing and visual after-effects tasks. The after-effect task was similar to Wertheimer's (1954), involving the estimation of the distance between two lines before and after the occurrence of satiation, satiation being produced by the inspection of a bar placed between the two lines.

The results support none of the hypotheses tested although they are in the expected direction. Rechtschaffen makes it clear that although his results do not provide evidence for the correlation of I_R with neural satiation, the two concepts may still be similar and even have the same neurological foundation. It may have happened that, when the two phenomena were being measured in his study, different cortical areas were involved.

PROBLEM

An observation, which for some reason has received very little attention among psychologists, is one made by Osgood (1953, p. 243) and Spitz (1958); namely, that an after-effect produced by stimulation with a rotating spiral can be demonstrated as a phenomenal change in test objects other than the spiral itself. For example, when a small square is presented after stimulation by a rotating spiral there is an illusion of expansion after counter-clockwise rotation and an illusion of contraction after clockwise rotation. In order to distinguish this after-effect from the commonly referred to spiral after-effect, where the rotating spiral produces a phenomenal change in the spiral itself, the former will be referred to as the spiral-square after-effect and the latter as the spiral-spiral after-effect. In traditional studies of figural after-effects the observer inspects one stimulus and then is tested on another. In this respect the paradigm used to demonstrate the spiral-square after-effect parallels more closely the design of figural after-effect experiments than does that used to demonstrate the spiral-spiral after-effect.

Since the spiral-square after-effect has not been systematically investigated the present study was originally designed to examine (a) the time course of the spiral-square

after-effect and (b) the relation of this after-effect to extraversion-introversion and neuroticism. In view of Eysenck's typological postulate, interest was centered mainly about the extraversion-introversion variable.

While the research was in progress a study by Lynn (1960) appeared which set out to test six predictions following from Eysenck's theory, four of which are related to the spiral-spiral after-effect: inspection of the rotating spiral should yield (a) a negative correlation between extraversion and duration of the after-effect; (b) a tendency for extraverts to show a greater decrement in after-effect over massed presentations; (c) a greater recovery by extraverts, after a rest period, in seeing the after-effect; (d) a negative correlation between the duration of after-effect and reminiscence as measured on the inverted alphabet printed task.

Moderate yet significant correlations were obtained for the first three predictions. The other correlation while not significant is in the desired direction. As was expected none of the correlations between neuroticism and the primary variables reached significance. A comparison of two extreme groups of 12 extraverts and 11 introverts, chosen on the basis of high and low scores, respectively, on the extraversion dimension of the Maudsley Personality Inventory indicated a greater decrement among the extraverts with repeated presentation;

however, no test of significance is reported.

The fact that Lynn's results were obtained from the spiral-spiral technique led to a second experiment reported herein, in which his procedure was applied in the context of the first experiment.

EXPERIMENT I

Method

Subjects.

The sample consisted of 77 volunteers of both sexes from the introductory psychology course at Michigan State University. There were 41 males and 36 females. Ages of Ss ranged from 17 to 23, with a median age of 18.5.

Apparatus.

The apparatus consisted of five parts: an inspection figure (I-figure), a test figure (T-figure), a reduction screen, a size estimation device, and the Maudsley Personality Inventory (MPI).

I-figure. The stimulus consisted of a rotating Archimedes spiral measuring 7-1/4" in diameter with a single black throw, 3/4" thick, printed on a white background.[1] The fixation point was a standard acorn nut which also fastened the center of the disk to the driveshaft. Current was supplied to the motor by two 1-1/2 volt batteries. Continued performance during testing was insured by a toggle switch which could direct current from either of two power packs.

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[1] "The Spiral Aftereffect Test Apparatus" can be ordered from Psychological Research and Development Corp., 420 W. Lafayette, Boston, Massachusetts.

T-figure. A white 2.5" square was pasted on the center of a medium gray 8.5" x 11" card-board panel. The fixation mark consisted of a black dot in the middle of the square.

Reduction Screen. S viewed each stimulus object through a hole, 3/8" in diameter, punched in a gray panel, similar to that supporting the T-figure. The reduction screen served to prevent extraneous visual stimulation from distracting S's attention.

Size Estimation Device. This apparatus consisted of a 4" white square mounted on a gray 8.5" x 11" cardboard frame, and a gray right angle corner which, as shown in Fig. 2, could border two sides of the square. By sliding the middle of the corner down the diagonal of the white paper S could reduce the square's magnitude to a point of subjective equality with the T-figure.

MPI. The questionnaire (Eysenck, 1959) was designed to give a measure of two personality dimensions: Neuroticism, and Extraversion. Neuroticism is defined by Eysenck as "the general emotional lability of a person, his emotional over-responsiveness, and his liability to neurotic breakdown under stress." Extraversion, as opposed to introversion "refers to the outgoing, uninhibited, proclivities of a person."

Standardization data for the MPI was obtained from an English population consisting of the following: a normal quota

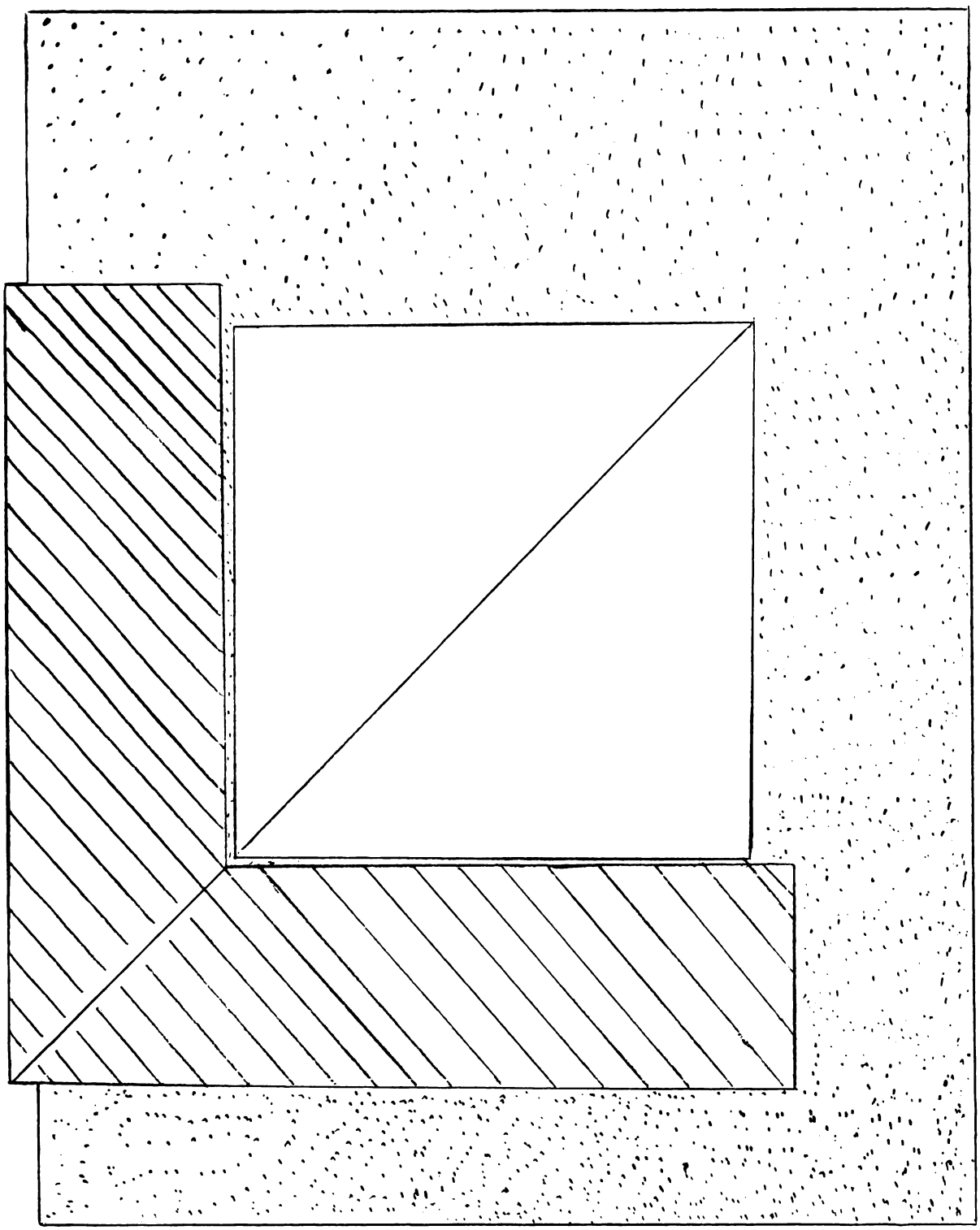

Fig. 2. The Size Estimation Device

sample of 1800; 84 dysthymics (hospital patients); 108 psychosomatics (hospital patients). In addition, large numbers of American students have been tested by Bendig (1959). A sample of 1500 such normals revealed a mean of 20.91 on the N scale, σ = 10.69 of a mean of 28.53 on the E scale, σ = 8.28.

Calculations of Kuder-Richardson reliability coefficients on many samples have produced values between .85 and .90 for the N scale; for the E scale the values lie between .75 and .85. The MPI scales correlate with the corresponding scales of other inventories: N correlates .64 with the Heron scale, .34 and .53 with forms A and B of the Cattell scale, .92 with Guilford's C scales, and .77 with the Taylor Manifest Anxiety Scale; E correlates .80 with the Heron scale, .65 and .67 with The Cattell scale (forms A and B), .79 with the Guilford R scale and -.35 with the Taylor Manifest Anxiety Scale.

Procedure.

Each S was tested individually under daylight conditions. He was seated at a table facing the spiral which was hidden from view by the cardboard to which the T-figure was fastened. Both the spiral and the T-figure were placed on a stand high enough to raise the center of each to approximately eye level, the distance between S and the stand was six feet.

Upon being seated, S was shown how the size estimation

device worked and was then asked to use it to estimate the size of the T-figure. E measured the estimate along the square's diagonal. Measurements were taken to the nearest tenth of an inch. The spiral was next uncovered and the reduction screen given to S. E recited the following instructions:

"Hold the gray card up to one eye in such a way that you are able to view the entire spiral in front of you. I am going to turn on the motor which will rotate the spiral for a period of 20 seconds. At the end of such time I will replace in front of it the gray card containing the white square. I want you to report any change you see taking place which involves the square. Be sure to keep your eye fixed, at all times, on either the silver knob at the center of the spiral or the small black dot at the center of the square."

If S mentioned a change in the apparent size of the T-figure he was allowed to engage in the remainder of the experiment; if no such effect was communicated he was not asked to continue. Each of the 70 Ss who saw the after-effect (seven Ss did not see it) completed the procedure.

Ss were given ten massed trials, each of 20 seconds' duration. The spiral was rotated in a counter-clockwise direction, followed by the presentation of the T-figure. After S indicated the cessation of the expansion after-effect, the

spiral was again immediately presented. At the completion of the last trial, S once more estimated the size of the T-figure. Finally, he completed the MPI, a measure of extraversion-introversion and neuroticism.

Results

Scoring.

The following measures were taken for each S:

1. Duration of spiral-square effect on trial one. This is the time in seconds during which S observed expansion of the square on the first trial.
2. Mean duration of spiral-square effect over all ten trials.
3. Difference score. This is the difference between duration of the spiral-square effect on trial one and on trial ten.
4. Size displacement of T-Figure in tenths of an inch. This is the difference in magnitude of T-Figure before and after ten trials.
5. Extraversion (E) and neuroticism (N) scores as measured by the MPI.

A summary of these measures is found in Table 1.

Table 1. Means and Variances of the Measures Taken

Variable	Mean	Variance
Extraversion	28.49	9.14
Neuroticism	27.16	9.72
Duration (trial 1)	4.02	2.81
Difference score	-0.02	3.12
Mean duration	4.33	2.61
Size displacement	0.86	

Correlation Analysis.

Correlations between the personality variables and each of the three measures based on the spiral-square after-effect are shown in Table 2.

Table 2. Correlations between Personality Variables and Scores based on Spiral-square Effect

Measure	E	N
Duration (trial 1)	.019*	-.054
Difference score	-.008*	-.072
Mean duration	.118*	-.087
Size displacement	.134*	.134

*--Sign is in the opposite direction hypothesized. All values are insignificant at the 5% level.

None of the correlations involving the extraversion dimension are significantly different from zero at the 5% level. The direction of the insignificant correlations is in each case oppostie that predicted by the Eysenck theory. No significant correlations were obtained between neuroticism and measures of the spiral-square after-effect. An insignificant correlation of -0.16 between extraversion and neuroticism lends support to the contention that the two factors are orthogonal, as Eysenck maintains (1959).

Tests of Extreme Group Differences.

Extreme groups of extraverts and introverts were formed by the inclusion of subjects who scored at least ten points above or below the mean on the E scale; for each group N = 10. As can be observed from Table 3 a test of the significance of the difference between the means of the two groups on each measure on the spiral-square after-effect revealed no significant differences, as would be expected from the low correlations. These comparisons, while not statistically significant, actually tend to fall in the reverse of the direction predicted by the typological postulate. A graphic representation of these outcomes is presented in Fig. 2.

Table 3. Results of Analysis of Spiral-square After-effect Measures for Extreme Groups based on Extraversion Scores

Measure	Introverts Mean	Introverts S.D.	Extraverts Mean	Extraverts S.D.	t	$N_I = 10$ $N_E = 10$
Duration (trial 1)	3.10	2.96	3.80	2.69	0.58	
Difference score	-0.90		-0.70			
Mean duration	3.43	1.56	4.79	2.68	1.38	

A similar analysis of extreme groups based on the neuroticism scale confirmed a lack of relationship between this variable and the spiral-square after-effect measures.

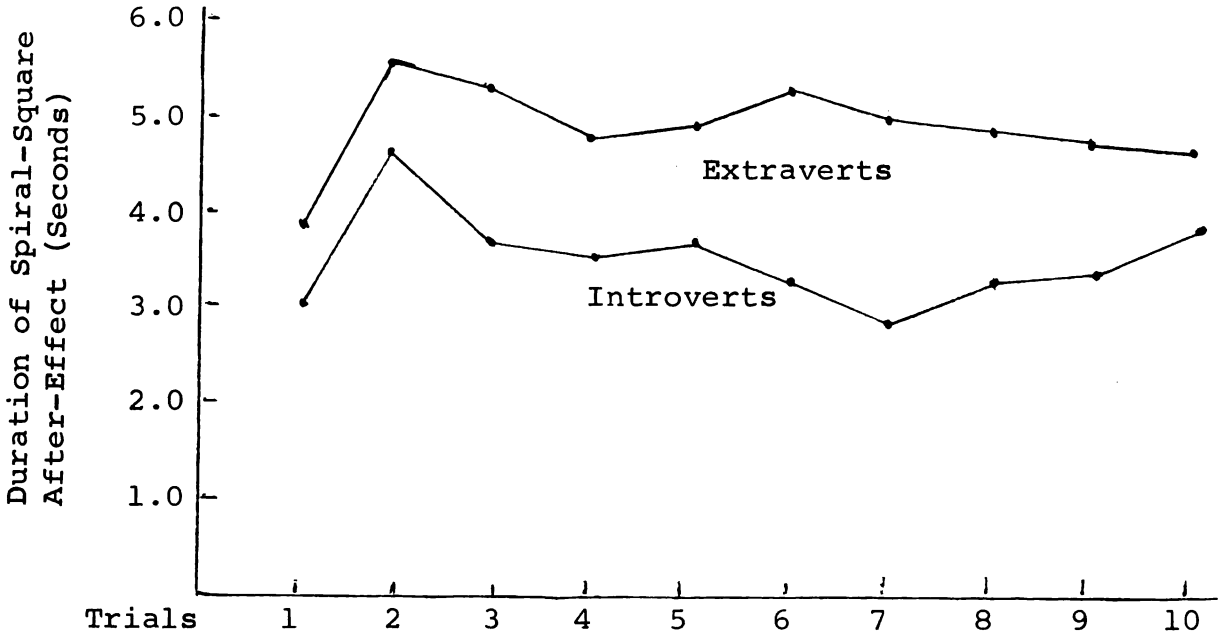

Fig. 3. Spiral Square After-Effect for Extreme Groups (N = 10) on Extraversion-Introversion as a Function of Trials

EXPERIMENT II

While this study was in progress a paper appeared (Lynn, 1960) reporting data very relevant to it. Lynn tested Ss over a number of thirty second trials on the spiral-spiral after-effect, and he related measures of after-effect duration, and difference score (decline) to measures of personality variables taken with the MPI. He found a significant negative correlation between duration (Trial 1) of the spiral-spiral after-effect and extraversion, and a significant positive correlation between the difference score (decline) and extraversion. Both of these relationships are reported as being in the direction predicted by Eysenck's theory.

Since our results with the spiral-square after-effect did not agree with those of Lynn, it was decided to replicate his study in the context of the procedure used in Expt. 1, with a spiral substituted for the square as the test figure.

Method

The procedure in this experiment was the same as that used in the first experiment except that the T-figure was the motionless spiral rather than a square. This was the same spiral which was observed in rotation during the inspection period. Ss reported when the spiral stopped expanding, and the various time measures used in the first experiment were taken.

The sample consisted of 30 Ss selected in a manner identical to the former experiment. Scores on the MPI were also available.

Results

Correlation Analysis.

In Table 4 product-moment correlations between the personality variables and the spiral-spiral after-effect measures are compared with similar correlations from Lynn's data.

Table 4. Correlations between Spiral-spiral After-effect Measures and Personality: A comparison of Lynn's Data with that of Expt. II

	Lynn		Expt. II	
Measure	E	N	E	N
Duration (trial 1)	-.43*	-.13	-.13	-.24
Difference score	.42*	----	-.19	.01
Mean duration	----	----	-.30	.06

The results of the present experiment are essentially negative with respect to a relationship between extraversion and the after-effect measures. This suggests that the failure to find a relationship in the first experiment was probably not due to the use of the spiral-square after-effect instead of the spiral-spiral after-effect.

Tests of Extreme Group Differences.

It is interesting to note that although Lynn breaks his data down into groups of extraverts and introverts, supplying a table of their means and standard deviations, on no measure does he report a test of significance for differences between group means. As can be seen from Table 5 when such tests are made no significant *t*-ratios result. Table 5 also summarizes group data from the present experiment. Again no value of *t* is found to be statistically significant.

In Fig. 3 duration of after-effect is plotted over all ten trials revealing that, contrary to Lynn's results, the total duration of after-effect for extraverts in Expt. II is slightly larger than for introverts; in addition, extraverts tend to experience a less rapid decline in after-effect.

Table 5. Means, S.D.'s and *t*'s of Introvert and Extravert Extreme Groups on Measures of the Spiral-spiral After-Effect: A Comparison of Lynn's Data with that from Expt. II

	Lynn					Spivak				
	Introverts		Extraverts			Introverts		Extraverts		
	N = 12		N = 11		*t*	N = 7		N = 9		*t*
Measure	Mean	S.D.	Mean	S.D.		Mean	S.D.	Mean	S.D.	
Duration (trial 1)	12.09	8.50	7.52	5.31	1.45	10.57	11.02	10.00	6.38	.08
Difference score	1.18	5.33	3.65	4.36	1.15	3.57	10.79	-0.56	11.86	.53
Mean duration	-----	----	----	----		7.33		8.99		

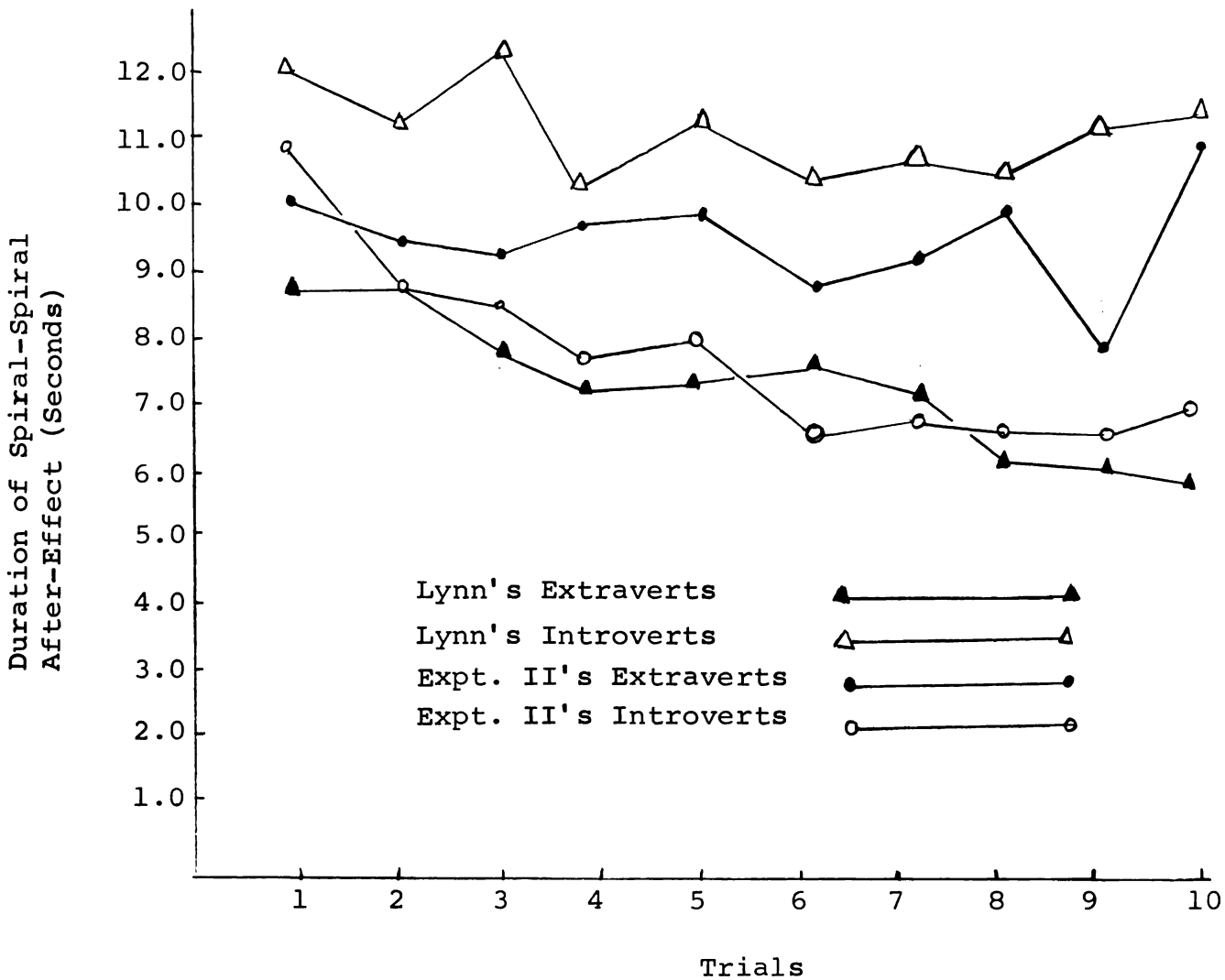

Fig. 4. Spiral-Spiral After-Effects as a Function of Trials: A Comparison of Data from Lynn and Expt. II

DISCUSSION

The study employing the spiral-square after-effect and that employing the spiral-spiral after-effect both found no relationship between extraversion and either duration or the time course of the after-effect. The fact that the Lynn study using the spiral-spiral after-effect did find a relationship between the two variables concerned may have been due to differences in procedure between that study and ours. This is unlikely, however, for two reasons. First, Lynn's published procedure is very similar to ours; second, an investigation by Holland (1958) aimed at isolating the important variables which contribute to the spiral-spiral after-effect discovered that such factors as speed of rotation of the disk, illumination on the surface of the spiral, and the visual angle subtended at the eye have no influence on the illusion. It would appear then that the positive results obtained by Lynn may be due to chance. It must be remembered, too, that his correlations although significant are rather small and none of his *t*'s reach the 5% probability level.

Thus, on the basis of the negative results obtained in this study, and the weak results of the Lynn study it appears that the notion of a relationship between extraversion-introversion and duration or time course of the spiral-spiral

or the spiral-square after-effect is not supported.

The Inadequacy of Temporal Variables in a Test of Personality Differences in Spiral After-effects.

Two possibilities remain with respect to Eysenck's theory: either the theory itself is incorrect or the spiral after-effect studies do not represent an appropriate test of it. The following paragraphs will attempt to show the likelihood of the latter alternative.

In his investigation involving kinesthetic after-effects, Eysenck (1955) proposes that individual differences in accumulation of satiation during an inspection period lead to an after-effect, measured in terms of a change in the apparent magnitude of the test object. Since, according to Eysenck (1957, p. 163), the spiral after-effect parallels this phenomenon in the visual modality (the after-effect occurs during a test period consequent upon stimulation during an inspection period), the measure of the illusion, or after-effect, should be treated as kinesthetic after-effects are treated, namely in terms of a change in magnitude. Thus individual differences in apparent change of size of the test object, after inspection of the rotating spiral, should be expected and these should be related to extraversion-introversion.

Eysenck does not use temporal measures in regard to

the kinesthetic modality; he uses magnitude measures. A parallel magnitude measure appears indicated in the visual case, kinesthetic and spiral after-effects being analogous events. The temporal variables studied in our investigation as well as in that of Lynn may not represent an adequate test of the theory predicting a relationship between personality variables and perception of after-effect.

The prediction of a greater magnitude of figural after-effect for extraverts is supported by the result of Expt. I in which these individuals were observed to overestimate the size of the square after inspection to a greater extent than were introverts.

Several other reviewers (Lykken, 1959 and Storms and Sigal, 1958) have pointed out that Eysenck's explanation of spiral after-effects (1957) is inconsistent with his more general conception of after-effect phenomena. While extraverts are predicted to have longer and stronger after-effects in kinesthetic after-effect experiments as a result, supposedly, of more intensive satiation during the inspection period, the smaller spiral illusion is accounted for by the argument that greater satiation within extraverts during the test period causes the termination of the illusion. Eysenck neglects to mention that satiation produced by the inspection stimulus should presumably evince a stronger after-effect in

this instance also.

In a recent publication Eysenck (1960) presents a distinctly altered version of his theory. Here, inspection is said to build up a process X which is reduced by an opposing satiation process in proportion to S's satiability; what occurs during the period of reversal or after-effect is identical to his original formulation. Eysenck goes on to say that, because the stimulation and the reversal processes are reduced to a greater extent in extraverts, there should be a tendency for them to have shorter after-effects than introverts. However, Eysenck still fails to account for the fact that this prediction is in conflict with those made in kinesthetic after-effect experiments.

Thus, two additional reasons why temporal measures may not constitute a proper test of the theory stems from the nature of Eysenck's neurophysiological accounts of spiral after-effects, which contradict his explanation of kinesthetic after-effects; satiation is said to occur either in the test period or in both the test period and the inspection period, instead of the inspection period alone; after-effects are said to be of shorter rather than longer duration.

A Reformulation of Eysenck's Theory of Spiral After-effects.

In the opinion of the present writer, a suitable

explanation can be made for the negative results found in the current search for significant personality differences, which is still consistent with the results that Eysenck found in kinesthetic after-effect experiments. Once more, the explanation logically derives from a seemingly more accurate application of the Köhler-Wallach theory and the typological postulate than that which Eysenck proposes.

The line of reasoning (diagramed in Fig. 5) proceeds as follows: During the inspection period (T_1), a process X is built up which is reduced in proportion to S's satiability, S_1, which is greater for extraverts than for introverts; S_1 should then result in an after-effect of greater size among members of the former group than among members of the latter. During the after-effect period, (T_2), this process, S_1, underlying the reversal, being physiological in nature is in turn reduced by a satiation process, S_2. As extraverts are said to satiate more quickly, they should perceive the after-effect for approximately the same duration as introverts, whose smaller after-effect takes proportionally longer to dissipate.

The prediction that the size of the after-effect would be larger for extraverts is in perfect agreement with other observations, as well as the one made in the author's own experiment. The significance of the new prediction regarding a lack of individual differences in duration is that the

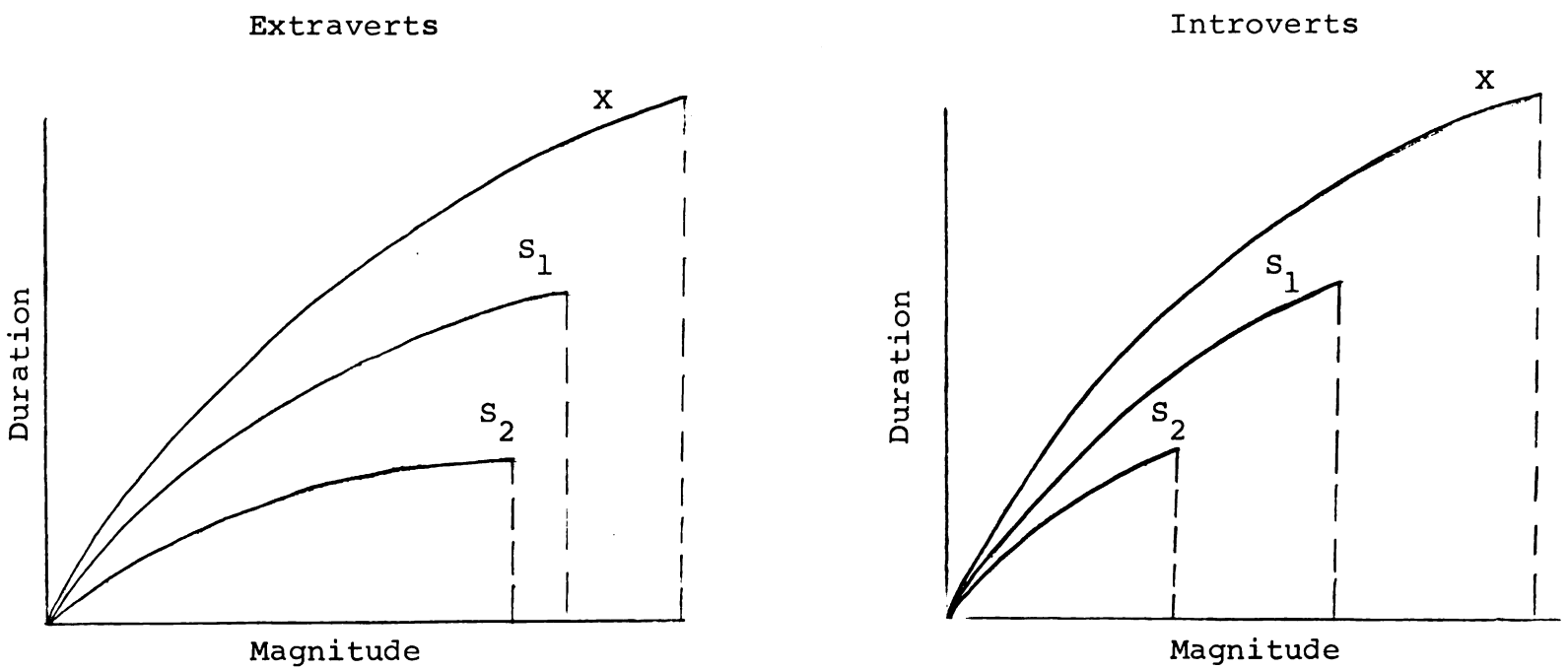

Fig. 5. The Author's Interpretation of Similarity in Duration of After-effect for Extraverts and Introverts Consequent upon Spiral Rotation: (X = a stimulation process built up during inspection; S_1 = a satiation process during inspection; S_2 = a satiation process during the test period)

temporal dimension cannot be used as a measure of these differences in after-effect phenomena.

Explanations for Slight Group Differences.

Still to be accounted for is the fact that in Lynn's study the extravert group had a slight tendency to see the after-effect for a shorter duration than the introvert group, whereas in both the present experiment and the replication of Lynn's study the opposite is true. Costello's (1961) review of the relevant literature pertaining to spiral after-effects among the brain-damaged indicated that investigators who reported shorter after-effects for the brain-damaged than for normals employed the contraction after-effect while those who reported longer after-effects had used the expansion after-effect. Hence it seems plausible that a difference in direction of rotation was partly responsible for the conflicting results. Since Eysenck argues that satiation produced by brain-damage and satiation produced by massed practice are similar, Costello sought a difference in after-effect, contingent upon direction of rotation, among subjects run under the latter conditions.

The results of such a study show that, as expected, the over-all duration of the contraction after-effect tends to be shorter than that of the expansion after-effect. These findings suggest that the slight yet consistent differences in length

of after-effect among extraverts and introverts in the two experiments concerned with here may be due to the fact that Ss viewed the spiral rotating in different directions.

An alternate explanation of individual differences in duration of spiral after-effect is deducible from the theory of cortical inhibition. Simply because the "cooperation" of a subject has been gained does not mean that the effectiveness of the stimuli administered is equal in all cases. Holland (1957) has demonstrated that there is a direct relation between the ability to maintain fixation and the persistence of the after-effect. He asserts that if during a one-minute period of stimulation the fixation point is changed randomly over the surface of the disk no after-effect is observed. It has been stressed in the literature on brain-damage that patients have difficulty maintaining prolonged attention on any test or task, therefore, a difficulty in maintaining fixation may be contributing to the shorter duration of spiral after-effect in organic patients. Since fixation difficulty may itself be a function of the growth of an inhibitory process, this possibility may apply to normal extraverts as well.

On the basis of the above, it is conceivable that the shorter duration of after-effect among extraverts in Lynn's investigation is due to their inability to fixate as well as introverts. In the author's experiments the inspection periods

were rather short (twenty seconds as compared to Lynn's thirty second periods); consequently this difficulty did not have time to manifest itself. The contention is supported by Fig. 6 (Eysenck, 1957) which represents the mean scores of the four most extraverted and four most introverted subjects in an investigation of the relationship of the length of after-effects and extraversion-introversion.

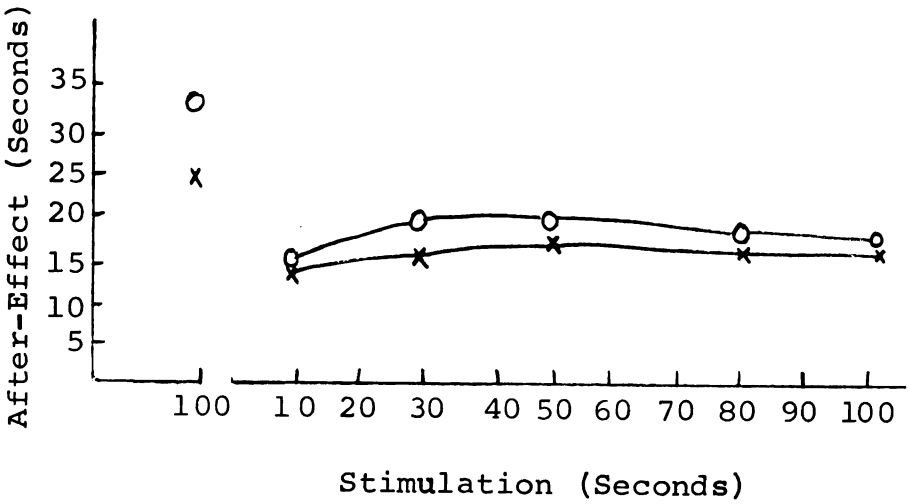

Fig. 6. After-effect in Seconds of Stimulation by Rotating Spiral for Groups of Extraverts (Crosses) and Introverts (Circles). Stimulation for 100 Seconds was Followed by a Lengthy Pause and then by Successive Stimulation for Varying Periods as Indicated on the Abscissa (Eysenck, 1957)

It is apparent that for the period of shortest duration, fifteen seconds, no difference between the two groups exists, while for longer stimulus exposures there is a slight difference; the fact that the difference disappears after one-hundred seconds of inspection is likely attributable to the loss of fixation ability among introverts after long periods of time.

CONCLUSIONS

Although he purports to having a single unified theory, in effect, Eysenck has proposed three separate theories of personality differences in after-effects. Supposedly, greater quantities of satiation (cortical inhibition) within extraverts:

1. produced during inspection result in a kinesthetic after-effect of larger magnitude than for introverts.
2. produced during the test period result in a spiral after-effect of shorter duration than for introverts.
3. produced during inspection and the test period result in an after-effect of shorter duration than for introverts.

The obvious fact that these statements oppose one another indicates that Eysenck has no genuine formulation from which predictions can be logically deduced.

Although the present study substantiates the contention that a larger magnitude of after-effect is experienced by extraverts than by introverts, it doesn't necessarily follow that relative amounts of satiation or cortical inhibition was the responsible factor. The results could be accounted for just as reasonably in terms of such intervening variables as Klein and Krech's "cortical conductivity" (1952) or Wertheimer's "metabolic efficiency" (1954, 1955).

SUMMARY

Eysenck, via a typological approach to the study of personality, has derived by factor analytic techniques two continua of personality on which all individuals normal and abnormal are said to lie, namely, "extraversion-introversion" and "neuroticism." In searching for causal agents to account for these dimensions, Eysenck borrowed the Hullian notion of reactive inhibition. Using this concept as a point of departure, he proposed a postulate of individual differences which states that human beings differ with respect to their capacity to accumulate reactive inhibition. Furthermore, individuals in whom this capacity is strong are, thereby, predisposed to develop extraverted patterns of behavior and individuals in whom this capacity is weak should exhibit introverted characteristics.

Since reactive inhibition is also said to underlie such behavioral events as conditioning and reminiscence, a number of investigations have been carried out attempting to link these phenomena to the extraversion-introversion continuum. In an effort to prove his theory is not limited to the area of learning and conditioning, however, Eysenck has offered predictions concerning behavior in the perceptual field as well, placing particular emphasis on figural after-effects. Maintaining that reactive inhibition and the Köhler-Wallach

concept of satiation are identical constructs, he asserts that extraverts should develop greater after-effects than introverts.

The present study is concerned with an event termed the "spiral-square" after-effect, an illusion which differs from the more commonly observed "spiral-spiral" after-effect in that S reports changes in the size of a square, consequent upon inspection of a rotating spiral, rather than changes in the motionless spiral itself. Since no systematic investigation of the phenomena has been undertaken, it was deemed appropriate to examine both the time course of the after-effect and its relation to Eysenck's typological postulate.

While the research was in progress, a study by Lynn was discovered which reported significant correlations between extraversion and measures of duration and decline of the spiral-spiral after-effect experiment found no such relationship, a second experiment was performed similar to the first, with the exception that the apparatus employed was the spiral-spiral after-effect.

When the correlational analysis of the data from Expt. I was performed, no relationship was found between the temporal measures of after-effect and degree of extraversion-introversion as determined by the Maudsley Personality Inventory. When extreme groups of extraverts and introverts were compared, the only significant t-ratio obtained was from the measure of size

displacement of the square, once more the significance was in the opposite direction predicted. The results of Expt. II likewise indicate no significant correlations or *t*-ratios among the temporal variables concerned, thereby contradicting Lynn's findings.

The fact that a significant difference between introverts and extraverts was obtained on the size displacement measure agrees with a corresponding observation made by Eysenck in the kinesthetic modality.

Not only do the results contradict Eysenck's theory of personality differences in temporal measures of after-effects, but it is also apparent that there are contradictions in the theory itself. In kinesthetic after-effect experiments, for example, Eysenck predicts for extraverts after-effects of *larger size* due to a greater build up of satiation during *inspection*. Conversely, in the visual modality an after-effect of *shorter duration* is predicted, which is allegedly a product of a more rapid accumulation of satiation during either the *test* period (Eysenck, 1957), or during the *test* period and the *inspection* period (Eysenck, 1960). The author's reformulation of the theory is an attempt to account for these inconsistencies.

The conclusion to be drawn from the present study is that differences among people with respect to the magnitude

of spiral after-effect might possibly be related to extraversion. Differences in the duration of spiral after-effect or its change over time do not appear to be related to extraversion.

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APPENDICES

APPENDIX A

MAUDSLEY PERSONALITY INVENTORY

Questionnaire

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 or 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?

APPENDIX B

DATA FROM EXPERIMENT I

S	E	N	1	2	3	4	5	6	7	8	9	10	Est. PRE	Est. POST
1	30	43	1	1	1	1	1	1	2	2	2	2	3.5	3.5
2	10	38	10	8	7	8	4	6	4	4	3	4	3.0	3.0
3	17	24	4	7	3	3	3	4	4	4	4	3	3.3	3.1
4	32	38	6	10	9	8	6	5	5	6	7	4	3.0	3.0
5	33	18	5	4	3	3	3	2	2	4	4	4	3.5	3.4
6	40	22	2	8	8	9	9	10	9	5	7	6	3.4	3.4
7	35	31	3	4	5	6	5	4	6	3	5	5	3.4	4.0
8	21	26	2	4	4	3	3	0	0	0	0	0	3.1	3.2
9	18	33	2	5	5	3	6	4	3	6	6	4	3.1	3.2
10	26	20	4	4	5	5	6	6	6	6	5	7	3.1	3.3
11	36	16	3	2	1	2	2	2	3	2	2	3	3.3	4.5
12	36	20	3	4	5	5	5	5	3	4	3	3	3.2	3.3
13	36	6	3	3	2	3	2	2	2	2	2	2	4.0	4.0
14	5	36	2	3	2	3	3	3	3	2	2	2	3.7	3.7
15	37	40	3	3	2	2	2	1	1	1	2	2	3.5	3.6
16	30	20	3	8	8	10	9	10	8	8	8	11	3.4	4.0
17	28	22	2	2	3	3	2	2	1	2	2	2	3.3	3.4
18	31	22	5	7	8	8	5	4	4	4	3	5	3.6	4.0
19	26	17	3	4	4	4	5	4	4	4	4	4	4.2	4.4
20	15	40	2	3	2	2	2	3	2	2	2	2	3.3	3.4

Appendix B.--Continued.

S	E	N	1	2	3	4	5	6	7	8	9	10	Est. PRE	Est. POST
21	22	12	3	3	3	3	4	3	3	3	3	4	3.1	3.4
22	26	41	2	4	3	3	4	5	5	4	5	3	3.2	3.7
23	13	22	4	2	4	2	3	3	3	2	2	2	4.1	3.7
24	14	21	2	3	3	4	6	5	4	2	2	3	3.6	3.4
25	34	19	4	3	2	2	4	4	4	4	4	4	4.1	3.7
26	21	33	14	12	9	7	30	7	11	11	5	15	4.1	3.7
27	22	40	10	10	11	8	7	8	8	4	5	6	3.7	3.6
28	34	22	4	2	3	3	3	3	3	5	5	3	3.6	3.6
29	15	36	1	2	5	3	3	3	3	3	3	3	3.1	2.6
30	38	16	2	4	6	5	6	5	4	5	3	5	3.2	3.3
31	26	17	3	3	2	3	4	2	2	3	2	2	2.7	3.1
32	21	20	5	5	5	3	2	2	1	2	2	3	3.4	3.1
33	38	26	4	4	4	2	2	3	3	2	2	2	3.6	3.6
34	29	19	2	8	6	4	5	3	2	3	4	3	3.6	3.4
35	40	28	2	3	3	3	3	3	3	3	3	2	3.1	3.4
36	32	30	1	1	2	2	2	3	3	2	3	2	3.2	3.1
37	34	27	7	4	4	5	4	3	3	5	4	4	3.2	3.3
38	17	39	1	2	1	1	1	1	1	1	1	1	3.2	3.1
39	34	42	2	2	3	4	3	2	3	3	4	3	3.6	3.5
40	34	42	5	7	4	5	5	4	3	4	3	3	3.4	3.3
41	16	38	3	2	3	3	3	3	4	5	4	5	3.4	4.1

Appendix B.--Continued.

S	E	N	1	2	3	4	5	6	7	8	9	10	Est. PRE	Est. POST
42	36	26	1	3	3	2	1	3	2	3	2	2	3.3	3.2
43	43	40	3	7	7	9	11	13	9	10	12	11	3.6	3.7
44	24	22	2	2	3	3	2	2	2	2	2	3	3.5	3.5
45	35	18	3	3	4	6	6	6	8	5	6	6	4.0	4.1
46	18	30	1	4	6	5	8	3	3	3	7	14	3.6	3.4
47	37	11	15	31	18	30	32	10	16	9	9	6	3.2	3.3
48	22	32	3	4	2	2	2	1	1	1	1	1	3.6	4.0
49	15	14	4	5	3	3	3	3	3	7	5	3	4.1	4.1
50	24	24	7	7	5	5	4	7	7	7	9	7	3.5	4.0
51	35	16	6	12	9	10	10	8	11	8	8	7	3.3	3.5
52	19	36	4	4	6	4	4	2	1	2	4	5	3.3	3.5
53	37	22	4	5	5	6	8	7	6	5	4	5	3.2	3.6
54	14	34	8	8	5	5	5	5	3	4	7	5	3.4	4.0
55	24	15	6	5	3	4	3	3	4	3	3	4	3.6	3.5
56	38	38	3	6	5	3	4	5	6	6	5	5	4.2	4.1
57	39	35	3	4	3	2	3	3	3	3	3	2	3.7	4.0
58	34	29	3	7	7	8	6	6	7	8	6	6	3.6	3.7
59	23	31	3	4	6	3	7	6	6	6	13	9	3.6	3.7
60	36	14	3	3	3	3	3	2	3	3	3	2	4.0	4.1
61	33	23	2	2	2	2	2	2	2	2	1	2	3.4	3.4
62	42	16	3	4	3	4	4	5	4	5	5	5	3.4	3.6

Appendix B.--Continued.

S	E	N	1	2	3	4	5	6	7	8	9	10	Est. PRE	Est. POST
63	23	30	6	5	4	5	5	7	7	4	5	6	4.0	4.2
64	43	42	5	5	4	3	2	3	3	3	3	3	3.5	4.0
65	23	19	4	2	3	0	2	2	2	2	2	2	3.6	3.4
66	38	28	2	2	3	2	2	2	2	2	2	2	3.1	3.0
67	24	38	8	7	6	7	7	7	6	7	5	8	3.4	3.6
68	36	30	3	3	3	3	2	2	2	2	2	2	3.7	3.6
69	36	46	6	3	5	3	5	4	3	5	3	3	3.1	3.1
70	42	10	11	10	11	6	6	4	4	4	3	4	3.2	3.3

APPENDIX C

DATA FROM EXPERIMENT II

S	E	N	1	2	3	4	5	6	7	8	9	10	PRE	Est. POST
1	30	43	1	1	1	1	1	1	2	2	2	2	3.5	3.5
2	10	38	10	8	7	8	4	6	4	4	3	4	3.0	3.0
3	17	24	4	7	3	3	3	4	4	4	4	3	3.3	3.1
4	32	38	6	10	9	8	6	5	5	6	7	4	3.0	3.0
5	33	18	5	4	3	3	3	2	2	4	4	4	3.5	4.0
6	40	22	2	8	8	9	9	10	9	5	7	6	3.4	3.4
7	35	31	3	4	5	6	5	4	6	3	5	5	3.4	4.0
8	21	20	2	4	4	3	3	0	0	0	0	0	3.1	3.2
9	18	33	2	5	5	3	6	4	3	6	6	4	3.1	3.2
10	26	20	4	4	5	5	6	6	6	6	5	7	3.1	3.3
11	36	16	3	2	1	2	2	2	3	2	2	3	3.3	4.5
12	36	20	3	4	5	5	5	5	3	4	3	3	3.2	3.3
13	36	6	3	3	2	3	2	2	2	2	2	2	4.0	4.0
14	5	36	2	3	2	3	3	3	3	2	2	2	3.7	3.7
15	37	40	3	3	2	2	2	1	1	1	2	2	3.5	3.6
16	30	20	3	8	8	10	9	10	8	8	8	11	3.4	4.0

Appendix C.--Continued

S	E	N	1	2	3	4	5	6	7	8	9	10	Est. PRE	Est. POST
18	31	32	5	7	8	8	5	4	4	4	3	5	3.6	4.0
19	26	17	3	4	4	4	5	4	4	4	4	4	4.2	4.4
20	15	40	2	3	2	2	2	3	2	2	2	2	3.3	3.4
21	22	12	3	3	3	3	4	3	3	3	3	4	3.1	3.4
22	26	41	2	4	3	3	4	5	5	4	5	3	3.2	3.7
23	13	22	4	2	4	2	3	3	3	2	2	2	4.1	3.7
24	14	21	2	3	3	4	6	5	4	2	2	3	3.6	3.4
25	34	19	4	3	2	2	4	4	4	4	4	4	4.1	3.7
26	21	33	14	12	9	7	30	7	11	11	5	15	4.1	3.7
27	22	40	10	10	11	8	7	8	8	4	5	6	3.7	3.6
28	34	22	4	2	3	3	3	3	3	5	5	3	3.6	3.6
29	15	36	1	2	5	3	3	3	3	3	3	3	3.1	2.6

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