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Kinesthetic perception and schizophrenia

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I. THE PROBLEM

Statement of the problem. It was the purpose of this study to compare normals with schizophrenic psychiatric patients as to their ability to reproduce movements perceived by kinesthetic stimulation. Kinesthetic perception, for the purpose of this study, was restricted to the reproduction of single arm-hand movements in a horizontal plane, away from the body. The magnitude of errors as a function of distance moved was defined as an indicator or kinesthetic perception.

Importance of the study. Certain theories have stressed the central importance of motility and kinesthesis in the development of personality. These theories have emphasized that movement and kinesthetic perception are significant factors which contribute to personality development. Moreover, a number of studies have shown that schizophrenics manifest psychomotor dysfunction in a wide variety of tasks when compared with normals, and these studies suggest that there may exist a widespread defect in psychomotor functioning among schizophrenics in general. In essence, such findings may reflect a generalized defect in kinesthetic perception among schizophrenics which would have resulted in dysfunction on such a variety of psychomotor tasks. A number of studies have suggested that there may be some hereditary factor which is a necessary causative factor in

the pathogenesis of schizophrenia. In addition, other authors have theorized that such a factor may be an inherited neurological defect in the kinesthetic sense which is of significance in the etiology of schizophrenia.

The foregoing theoretical considerations and studies have suggested that there exists a generalized psychomotor dysfunction which is characteristic of schizophrenia and that there may be an inherited neural defect in kinesthetic sensitivity which is a significant causative factor in the etiology of schizophrenia. Therefore, within this framework, an attempt has been made to design an experiment that would measure such a kinesthetic defect.

II. REVIEW OF THE LITERATURE

Kinesthesis. Kinesthesis has been widely investigated over the years, resulting in a variety of labels describing the sense involved. Some examples of the terms which have been used to define the kinesthetic sense are: "position sense", "joint sense", "muscle sense", "deep sense", "body sense", and "bathysthesia". There have been numerous experiments in the literature which have involved kinesthesis, but which curiously enough have failed to mention its existence or influence. However, in a factor analytic study of psychomotor abilities, Fleishman (1953) has reported that one of the very few factors to emerge was that of kinesthetic sensitivity.

The existence of receptors embedded in the muscle which were responsible for originating feelings of posture and body movement was brought to the attention of physiology by Bell (1826) who referred to these receptors as the "muscle sense". Bastian (1880) found that these sensations also arose from the tendons, joints, and skin, and he developed the term "kinesthesis" to refer to this sense. Goldscheider (1898) showed that the perception of movement by the limbs came primarily from the joints rather than the muscles. Through the process of cocainizing the overlying skin and muscles he was able to show that joint sensations were chiefly responsible for providing the sensations for

the discrimination of limb movement. Goldscheider also experimented with discrimination of motion at the joints in terms of threshold determinations and found that of the nine joints tested, the shoulder was the most sensitive and the ankle was the least. More recently, Laidlaw and Hamilton (1937) in a repetition of Goldscheider's experiment found that the hip was the most sensitive and the main joint of the big toe the least sensitive. Their results showed that the movements of the larger and more important joints are perceived more readily by the individual.

Within the framework of this thesis, "kinesthesis" has been defined as "sensations of movement determined by receptor and sensory nerve action, neuro-physiologically determined" (Osgood, 1953 p. 29).

Measurement of kinesthesis. Surveying the apparatus tests of psychomotor ability, Fleishman (1953) isolated seven distinct factors, two of which operationally describe kinesthetic movement: (1) the accuracy with which one is able to make discrete arm-hand positioning movements, and (2) the ability to make postural or bodily adjustments to kinesthetic cues when the body or its members are displaced from equilibrim. In studying the informational value of force, duration, and extent of movement as kinesthetic cues, Fullerton and Cattell (1892) found that the extent of movement was the most informative kinesthetic cue. More recently, Bahrick, Bennett, and Fitts (1955) found that the

addition of force cues, extended practice, and knowledge of results significantly improved the accuracy of positioning movements.

One of the first studies concerned with the perception and reproduction of movements was attempted by Fullerton and Cattell (1892). In their study blindfolded subjects were asked to move a slider by hand to a certain stimulus distance and then they were asked to reproduce that movement as accurately as possible. There findings were that errors increased with increases in the extent of movements but that the magnitude of errors was not proportional. Small stimulus distances produced positive constant errors (CE's) (overestimations) while large stimulus distances produced negative CE's (underestimations). Hollingsworth (1909) introduced the concept of "central tendency" as the point at which the CE is neither positive nor negative. He asserted that this point varies with the range of stimuli presented to the subject. He further stated that if the stimulus distances are presented individually and not in a series there would be no significant CE's. An experiment which supported Hollingsworth's hypothesis was carried out by Raffel (1936) in which reproductions of a one inch stimulus were made quite accurately. However, in another experiment Abel (1936) using a large group of subjects and a stimulus range between 5 and 11 cm. found that negative CE's occurred 62 per cent of

the time except at 5 cm. where reproductions resulted in an equal number of positive and negative CE's. In general, the literature concerning the effect of range on judgment and the effect of single versus series presentation is conflictual and unclear.

The previously cited research was concerned only with the reproduction of movements in one direction away from the body in a horizontal plane. A number of other studies have been carried out in which the direction and plane of movement have been varied. Spragg, Devoe, and Davidson (1950) compared the accuracy of extent of movement with terminal limb position in that movements of distances of 4, 8, 12, and 18 cm. were made either away from or toward the body. Their results indicated that reproduced movement was more accurate at the longer distances than at the shorter distances and that the mean CE was large and positive at the shorter distances and smaller and negative at the longer distances. In addition, this study found that there were no significant differences in movements toward or away from the body at the distances measured. In general, Spragg's results have been confirmed by Smalheiser (1963) who found significant differences between mean CE's and mean average errors (AE's) at all the distances sampled: 4, 12, 20, and 28 cm. His results also confirmed Spragg's results in that subjects tended to overestimate the shorter distances and underestimate the longer distances. Also, this study revealed

that those who tended to overestimate or underestimate in one direction tended to respond in a similar fashion in the opposite direction.

Kinesthesis and personality. Studies dealing with the motor aspects of personality have indicated that muscular modes of activity are fairly accurate in revealing character attitudes that are fairly stable. Brenglemann (1961) had stated that expressive movement such as variability, speed, and extent of movement in psychomotor tasks can be powerful indicators of personality. Allport and Vernon (1933) and Eisenberg (1937) have found a high degree of intra-individual consistency for a variety of psychomotor tasks.

In a study of the level of muscle tension as an aspect of personality Duffy (1946) had subjects perform different tasks at different times and his findings showed that there was a general level of muscle tension which existed regardless of the task involved. He concluded that tension level is a more or less persistent characteristic of an individual, and in this respect, it is an aspect of personality. In other studies with nursery school children Duffy (1930, 1932) has shown significant positive correlations between muscle tension and ratings of excitability, emotional stability, and general nervousness. Muscle tension in this experiment was measured by involuntary hand pressure on a hand bulb during a variety of performance tests. A series of investigations into the kinesthetic responses of psychiatric

patients to stress has been carried out by Malmo, Shagass, and Davis (1951) which showed that psychoneurotic and psychotic patients responded to stress with a greater degree of muscle tension than did controls.

Psychological theory based on the crucial role of kinesthetic stimulation and motility as prepotent factors in personality development has appeared to stem from at least five theoretical sources.

(1) Piaget (1952) has developed a genetic theory of knowledge based on motor action as the source of mental operations. Thus, for Piaget thought grows out of and is intimately related to sensory-motor activity. According to Piaget, the object for the infant does not exist apart from his actions, and his concepts of space and time are closely related to his movements and their duration. The child learns the dimension of space only through his manipulation of objects and his perception of their displacements. In time the child learns to shift the center of space and its objects from his actions to himself which then becomes the midpoint of his world. The concept of causality denotes an intentional use of the relationships between action and the objects affected by that action. Through this intentional use of action-object relationships, sensory-motor activity develops into voluntary intelligent muscular activity.

(2) Piaget's theory of sensory-motor development is analogous to the sensori-tonic theory of Werner and Wapner

(1949) which assumes and attempts to demonstrate empirically that all motor actions and mental operations are modified by kinesthetic stimulation. This theory states that spatial orientation results from the actions of the child and that through action the child learns to locate himself as the center of his idiosyncratic space. In addittion, through actions the child learns object-relationships as well as cause and effect. Thus, for the infant perception is intimately related to the kinesthetic sense involved in different actions, and throughout life one's perceptions are basically sensori-tonic events which in turn are closely related to one's kinesthetic sense.

(3) In common with Piaget's theory and sensori- tonic theory is psychoanalytic ego psychology with its emphasis on the ego as the controller of the motor discharge of tension. Freud (1920) claimed that one's motor apparatuses and their modifications are the basic means with which the organism is able to discharge tension. Only through the discharge of tension is the individual able to achieve a homeostatic condition necessary for adequate functioning. Thus, to Freud the mastery of motility was of prime importance in developing a mature ego. Therefore, kinesthesis in relation to motility and the motor discharge of tension was of primary importance to Freud. More recently, Kulka, Fry and Goldstein (1960) have suggested that a kinesthetic drive exists in infancy which is basic to the development of the important

oral drive.

(4) Body image theory as proposed by Fisher and Cleveland (1958) has stressed that learning to separate one's body from its environment is fundamental in the establishment of one's identity and adjustment. Thus, through motility and kinesthetic stimulation the individual learns to establish his body boundary in relation to his environment. The authors have stated that defects in kinesthetic perception and/or insufficient learning will result in a faulty perception of one's body image and identity, and hence, a faulty or inadequate adjustment.

(5) Finally, Allport (1961) has stressed the importance of bodily sensations in the development of one's self identity and personality. Through his actions the infant develops a vague distinction between himself and what is "out there". Regarding the role of bodily sensations in the development of personality, Allport has made the following statement:

> Probably the first aspect of selfhood to evolve is the sense of a bodily me. The infant receives a constant stream of organic sensations from the internal organs of the body, from muscles, joints, tendons. (...) Throughout life the sense of the bodily me is the basic attest of our existence. Our sensations and our movements feed us with a constant awareness that I am I. The bodily sense remains a lifelong anchor for our self-awareness. (Allport, 1961, p. 113)

Allport has also stated that although the adult personality is highly complex the bodily sense forms an integral part of its functioning. The role of movement and kinesthetic

perception has been given a position of prime importance in Allport's theory of personality development.

It has been made apparent that the importance of kinesthetic perception and movement is basic to each of the above-mentioned theories of personality. The importance of these theories to this study has been to show the plausibility of a theory of personality based on kinesthetic perception and movement.

Psychomotor functioning and schizophrenia. There have been a wide variety of investigations concerned with the psychomotor functioning of schizophrenics. Most of the studies have reported a generalized psychomotor dysfunction manifested by schizophrenics when compared with normals on a wide variety of psychomotor tasks. King (1954) has shown in a variety of tasks involving fine psychomotor movement that schizophrenics manifest a distinct retardation in average performance and are significantly more variable in relation to normals. He also has found that the performance of subacute schizophrenics approximated that of the chronic schizophrenic group in degree of psychomotor retardation and increased variability. However, in comparing neurotics with normals he has found that their psychomotor performance was similar to that of his normal sample. King has presented two possible explanations for his results: that the faulty psychomotor performance of schizophrenics was a symptomatic reflection of mental disorganization; or that the faulty

performance was an indication of a disturbance in the schizophrenics' adaptational, motor adjustment to their environment.

Rodnick and Shakow (1940) in a study of simple reaction time have shown that schizophrenics manifested significantly poorer performance, even when compared to a normal group that was of low intelligence and poor motivation. Huston, Shakow, and Riggs (1937) have shown that schizophrenic patients who were rated as more cooperative in the experimental situation and those more recently hospitalized tended to perform more like normals. Investigating the task of holding a horizontal stylus in a small hole without touching the sides, Huston and Shakow (1946) have found that schizophrenics were slightly less successful than a normal control group. They also have reported in this study that cooperative patients did as well as normals. Wulfeck (1941) has required sequential, integrative patterns of movements, such as star tracing and following rhythmic patterns. On these patterns of movements schizophrenics were less adequate than manic-depressive, psychoneurotic, or normal groups. Fish (1961) in a follow-up study has found the occurrence of varying signs of perceptual-motor maldevelopment among infants and children who subsequently manifested clinical schizophrenia.

Kinesthesis and schizophrenia. A review of the literature has revealed a general dearth of studies concerned with kinesthetic perception, per se, and schizophrenia. However, the studies referred to in the previous section have shown that there was a marked psychomotor dysfunction

manifested by schizophrenics when compared with both psychoneurotics and normals, and obviously kinesthetic sensitivity or perception was involved in each of the tasks used in the various studies. References concerning kinesthesis and schizophrenia come from two major sources, both of which are theoretical in nature:

(1) Rado (1956) has hypothesized that an integrative kinesthetic defect is even more characteristic of "schizotypy" (schizophrenic-like personality) than is the marked, widespread defect in pleasure capacity ("anhedonia"). He has postulated that an integrative kinesthetic defect would result in the individual having a highly variable and inaccurate perception of himself as well as his environment. In addition, such a defect would inevitably lead to increased stress caused by having to deal with such a highly variable and inconstant world. He has further hypothesized that such a kinesthetic defect with its accompanying variability and stress could ultimately develop into the psychosis of clinical schizophrenia.

(2) Finally, Meehl (1962) has postulated a genetic hypothesis as the specific etiology in the development of schizophrenia and has advocated serious reflection on the old European notion of an "integrative neural defect" as the predisposing factor in the development of clinical schizophrenia. He has further hypothesized that such a

neural defect may well be located in the kinesthetic sense. Such neural assembly systems may be poorly consolidated with the result that as a child the individual functions poorly in dealing with reality and later in communication. Such poor functioning would be related to the highly variable and inconsistent feedback from kinesthetic stimulation. However, Meehl has stated that such a neural defect does not always result in schizophrenia; for where the individual's interpersonal regime is favorable and his general resistance to stress is fair, he will remain a well-compensated "normal" who has the predisposing neural defect.

Heredity and schizophrenia. The theoretical considerations proposed earlier by Rado and Meehl have necessitated research into the area of heredity and schizophrenia in order to establish the plausibility of some hereditary factor in schizophrenia.

Perhaps the most extensive study on heredity and schizophrenia was carried out by Kallman (1946, 1953) who has accumulated a large body of evidence favoring the hypothesis that recessive single-factor inheritance is the genetic cause of schizophrenia. One study was composed of 691 pairs of twins and their families. In each twin pair at least one twin was diagnosed as schizophrenic. Kallman has found that 14.3 per cent of the twins had siblings who were diagnosed schizophrenic, 16.4 per cent had one schizophrenic parent, and 68.1 per cent had two schizophrenic

parents. In studying the twin pairs, he has found that 11.5 per cent of the schizophrenic dizygotic twins had co-twins who were diagnosed as schizophrenic, whereas 85.8 per cent of the schizophrenic monozygotic twins had co-twins who were diagnosed as schizophrenic. Of interest in this study was Kallman's category of "separated" and "non-separated" for his monozygotic co-twin sample. This category did not refer to twins separated from birth, but to twins separated 5 years prior to the onset of the one twin's psychosis. Of those "non-separated" twin pairs Kallman found a 91.5 per cent expectancy rate for schizophrenia. Of special interest was the fact that of the "separated" twins 77.6 per cent had twins who subsequently developed schizophrenia.

Rosanoff, Handy, Plesset and Bush (1934) in a similar co-twin study found that 10.0 per cent of the dizygotic twins had co-twins that were diagnosed as schizophrenic and that 67.0 per cent of the monozygotic twins had a schizophrenic twin. More recently, Slater (1953) in a similar study found an expectancy rate of 14.0 per cent for his dizygotic twin sample and 77.6 per cent of his monozygotic twin sample.

Lidz, Cornelison, Terry, and Fleck (1958) have made an intensive study of the parents of fifteen schizophrenic patients, and their findings were that nine of the fifteen patients had at least one parent who could be called schizophrenic, ambulatory schizophrenic, or clearly paranoid in

behavior and/or attitudes. McConaghy (1959) made a study of non-diagnosed parent pairs of ten schizophrenics with the general conclusion that subclinical thought disorders were psychometrically detectable in at least one parent of every pair. Although the above mentioned studies regarding heredity have not eliminated the factor of environmental influence, they have, however, presented data which makes a strong case for the hypothesis that there may exist some type of hereditary factor in schizophrenia.

In the preceeding references a plausible case has been developed for positing the existence of an inherited neural defect manifested by kinesthetic dysfunction as a necessary causative factor in the etiology of schizophrenia.

Hypothesis. It was hypothesized that schizophrenics will show significantly greater mean average error than normals in their accuracy of kinesthetic perception. Measures of constant error were compared but no hypothesis was presented with respect to constant error.

III. METHOD AND PROCEDURE

Subjects. The subjects for this study consisted of 25 "normal" males and 25 schizophrenic males between the ages of 20 and 50. All of the schizophrenic subjects were patients at Stockton State Hospital, Stockton, California and all carried an official diagnosis of schizophrenia. The frequency of specific diagnostic labels of the schizophrenic sample can be found in Table 1.

TABLE I

FREQUENCY OF DIAGNOSTIC LABELS IN THE SCHIZOPHRENIC SAMPLE

Diagnosis	Frequency
Schizo-affective	3
Paranoid	9
Catatonic	3
Hebephrenic	2
Acute-undifferentiated	2
Chronic-undifferentiated	6
Total	25

Patients under electroshock therapy at any time within the prior three months, showing evidence of organic brain damage, or under medication within the prior three weeks were eliminated from the sample. Non-medicated subjects were used since the effect of drugs on kinesthetic performance are unknown, and in general, those who were discontinued from drugs were considered by the hospital staff to no longer

manifest symptoms which would interfere with the test procedure. Hence, in general, the schizophrenic sample may be viewed as showing less manifest symptoms than their presently medicated contemporaries. Schizophrenic subjects were randomly selected from the various wards with the limitations mentioned above.

Normal subjects were procured as volunteers from hospital staff and various union organizations. None had a history of emotional difficulty necessitating hospitalization or outpatient-type treatment and there was no history of mental illness in any family history.

All subjects were tested at Stockton State Hospital. An effort was made to match normal subjects with schizophrenic subjects on age. The rationale for equating the groups only on this one variable was provided by King (1954) who found no significant relationships between a variety of psychomotor performance and the variables of race, intelligence, education, socio-economic status, and body type. He found an age factor clearly manifested which was significant over the age of 49, but between the ages of 20 and 49 psychomotor functioning was approximately the same. There were no significant differences between groups on the control variable of age--see Table 2.

The criteria for the validity of performance was arbitrarily defined as whether or not the individual was able to follow the instructions and operate the apparatus

in an adequate manner. Only two schizophrenics of those tested were unable to meet these criteria and were eliminated from the study.

TABLE 2

MEAN AGE OF SCHIZOPHRENICS AND NORMALS

Group	N	M	SD
Normal	25	33.64	9.50
Schizophrenic	25	33.80	8.36

t= .063; n.s.

Apparatus. The apparatus used was that developed by Smalheiser (1963) for measuring tactual-kinesthetic perception. The major portion of the apparatus was the subject's response track for recording arm-hand positioning movements. It consisted of a wooden panel measuring 13.3 x 84 x 2.5 cm. on top of which were fastened two parallel plexiglass tracks. The slider to be manipulated by the subject was made of plexiglass with bottom steel bearings, so that it fitted securely on top of the two tracks and reduced friction in sliding. The distance the slider was able to move was controlled by the experimentor's inserting a steel rod between the two tracks at distances 4, 12, or 20 cm. from the starting position. Movements of the slider were accurately recorded on paper by a stylus type pen attached

to the slider which recorded the movements exactly on a sliding sheet of paper under the track. The track and steel bearings were constantly oiled to decrease friction.

Operational definition of kinesthetic perception. Kinesthetic perception for the purposes of this study has been defined as the accuracy with which one is able to make blind, arm-hand positioning movements in reproducing a standard stimulus distance. These movements were made in a horizontal plane, directly away from the front of the body.

Procedure. The response panel was placed on a table and covered, directly in front of where the subject was to sit. Each subject was given the following instructions before entering the experimental room:

> We wish to test the accuracy of arm movements at various distances without the benefit of vision. For this reason your arms will be shielded from your vision by a cover. Remember, we are interested in accuracy rather than speed. I shall place your fingers on a slider which you will be able to move. When I say, "Move out to the peg", you will slowly move the slider straight out on the track until you feel it hit a stop. When I say, "Back", return the slider to the starting position. When I say, "Reproduce that movement", try to move the slider out to where you think the stop was on your previous move. When I say, "Back", return the slider to the starting position. Then I will place the stop in a different position, and we will duplicate the procedure again. Keep your one hand in your lap and your back against the chair. Please wait for my signal before moving the slider and keep your hand on the slider at all times. Remember we are interested in accuracy, not speed. You will be given one practice trial. Are there any questions?

After entering the experimental room each subject was seated in front of the cloth-covered response panel according

to whatever hand the subject preferred to use. This position was determined by having the subject sit in the chair so that his arm was in a direct line with the panel. After being seated, the instructions were again repeated. Following this the cover was fastened around the subject's neck in a barber chair fashion with both sides of the cloth supported so that the subject's arm would not contact the cloth when moving the slider. Such contact would only introduce additional cues, other than those produced by kinesthetic stimulation. With the cover-shield fastened around his neck, the subject was unable to see his arm movements or the apparatus, yet he was afforded free arm movement beneath the cover-shield. This point of technique deserves further comment. In order to isolate as much as possible, the single factor of kinesthesis uncontaminated by visual cues, Smalheiser (1963) had blindfolded his normal subjects. As this blindfolding may have been perceived as an anxiety-producing experience to patients, the technique was modified to use visual shielding rather than blindfolding.

Following the second instructions and the fastening of the cover-shield, the subject's preferred hand was placed on the slider, and the positioning movements were begun. One type of movement was measured - movements away from the body along a line perpendicular to the body. Each subject received a practice trial at a standard stimulus distance of

15 cm. as the first trial in the series. The stimulus distances were 4, 12, and 20 cm. Each trial consisted of a movement to a mechanical stop (stimulus distance), a delay of two seconds, and then an attempted reproduction of the initial movement after the stop had been removed. There was a five second interval between each trial. Each stimulus distance was given ten times, with each subject receiving a random order of presentation derived from a table of random numbers.

Analysis of the data. The raw scores recorded for each subject were in terms of a positive or negative estimation error for each reproduction of a stimulus distance. Estimation errors were recorded in terms of millimeter measurements of the distance in error from the stimulus distance. From the raw scores were derived measures of average error (AE) and constant error (CE) for each subject at each of the stimulus distances. Average error was defined as the mean of a subject's estimation errors at a particular stimulus distance regardless of error direction. Constant error was defined as the mean of a subject's estimation errors at a particular distance taking into account the direction of the estimation error. From these mean average error and mean constant error were determined for each group at the three stimulus distances. Two other measures were used in the data analysis. First, was a total average error for each subject which was composed of the sum of each

individual's average errors at the three stimulus distances. Second, was a total constant error for each subject which was composed of the sum of his constant errors at the three stimulus distances.

"t" was used as the statistical test of significance between groups for each of the previously mentioned measures. To support the use of t where homogeneity of variance was questionable, reference was made to Boneau (1960) who found that violating the underlying assumption of homogeneity of variance did not appreciably reduce the accuracy of the t test. The level of significance for this study was chosen as the .05.

IV. RESULTS

Average error. The hypothesis of this study was supported in that schizophrenics showed significantly greater mean average error than normals in three of the four measures of accuracy of kinesthetic perception. At the stimulus distance of 12 cm. no significant differences were found between normal and schizophrenic mean average errors. Of interest was the fact that normals showed a poorer performance at 12 cm. than at 4 or 20 cm., but their mean average error at 12 cm. was still more accurate than that manifested by schizophrenics at the same distance. The mean average error for distance estimation may be seen in Table 3.

TABLE 3

MEAN AVERAGE ERROR FOR DISTANCE ESTIMATION

Group	4 cm.		12 cm.		20 cm.		Total	
	M	SD	M	SD	M	SD	M	SD
Normals	8.40	3.33	10.75	3.13	9.30	3.71	28.45	7.03
Schizophrenics	12.86	5.48	12.52	5.59	14.76	8.24	40.13	15.45
t	3.457*		1.383		3.017*		3.476*	

* $p < .05$

The results found by Spragg, et al., (1950) and Smalheiser (1963) that mean average error of normals increased with distance was not confirmed by this study as the

normal mean average error was greatest at the middle stimulus distance (see Figure 1).

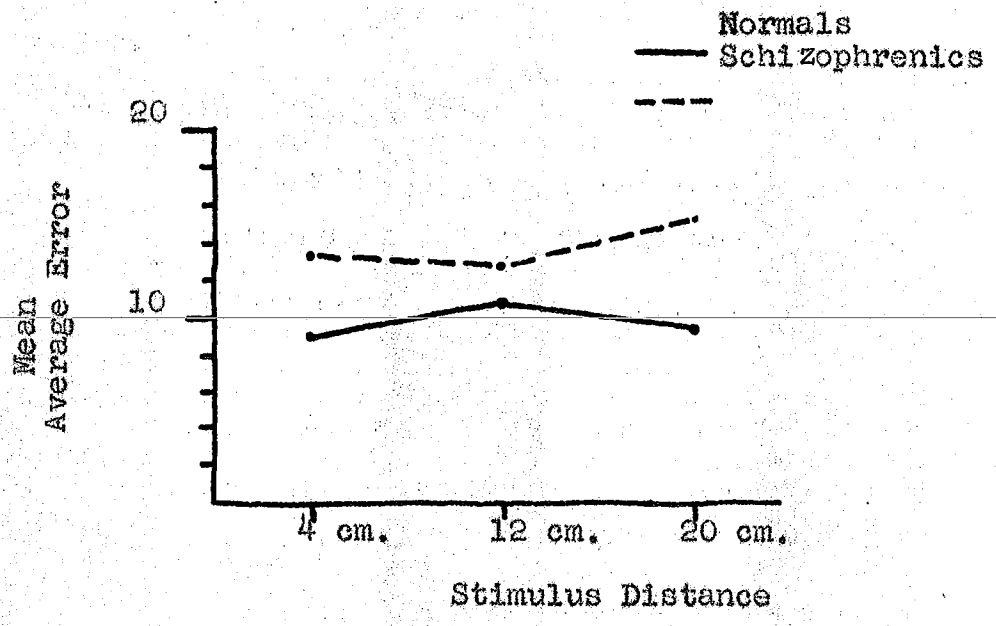

Fig. 1. Mean average error at the three stimulus distances.

The next measure investigated was that of differences in mean average error within groups with respect to stimulus distance. The only significant difference found was in the normal sample between 4 and 12 cm. where they manifested a significantly greater mean average error at 12 cm.

Constant error. In general, the results in terms of constant error for the normal sample were quite similar to those found by Spragg, et al., (1950) and Smalheiser (1963). The present study confirmed their results in that the shorter distances, 4 and 12 cm., resulted in errors of overestimation (positive CE's), whereas the longer distance, 20 cm.,

resulted in errors of underestimation (negative CE's) for the normal sample (see Figure 2). The only significant difference in mean constant error that was found between normals and schizophrenics was at the 4 cm. stimulus distance in the direction of greater mean constant error manifested by the schizophrenic sample (see Table 4).

TABLE 4

MEAN CONSTANT ERROR FOR DISTANCE ESTIMATION

Group	4 cm.		12 cm.		20 cm.		Total	
	M	SD	M	SD	M	SD	M	SD
Normals	+6.2	5.33	+3.0	7.53	-.02	6.75	+9.03	15.88
Schizophrenics	+11.6	7.89	+3.9	9.37	+1.10	12.64	+16.71	23.55
t	2.783*		.367		.383		1.352	

* $p < .05$

Age and performance. One of the variables studied was that of the relationship of age to total average error in the normal sample. It was previously stated that King (1954) had found an age factor involved in the performance of tasks involving fine psychomotor abilities. In his study King found that from ages 20 to 49, age had little influence on psychomotor functioning. In the present study the correlation between age and total mean average error of the normal sample was found to be .01. The correlation for age and total mean average of the schizophrenic sample was .16.

Neither correlation was significantly different from zero. These results supported King's findings for his 20-49 age group.

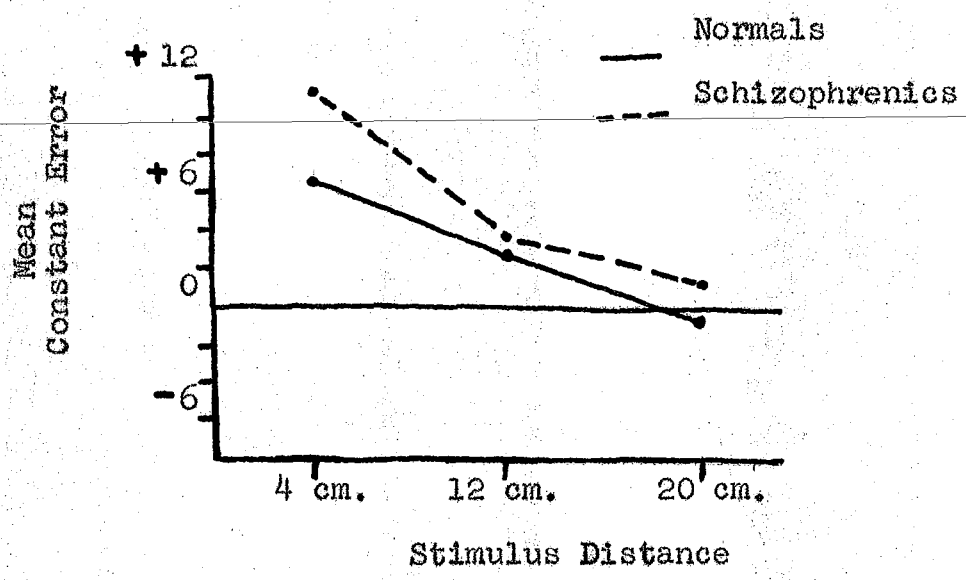

Fig. 2. Mean constant error at the three stimulus distances.

Education and performance. King also found that the variables of intelligence, education, and socio-economic class had no significant relationship to psychomotor performance. To investigate this, it was decided to use education as a rough indicator of intelligence and socio-economic class in evaluating the relationship between these factors and the accuracy of kinesthetic perception. The correlation between education and total mean average error for the normal sample was not significant, and within the

schizophrenic sample the correlation between education and total mean average error was again not significant. Essentially, these findings supported those found by King. The correlations comparing age and education with total mean average error may be found in Table 5.

TABLE 5

CORRELATION COEFFICIENTS COMPARING AGE AND EDUCATION WITH TOTAL MEAN AVERAGE ERROR.

Variable	r	Level of Significance
Normals		
Age	+.01	n.s.
Education	+.08	n.s.
Schizophrenics		
Age	-.01	n.s.
Education	+.01	n.s.

Length of hospitalization and performance. Another factor which was investigated was the relationship between the length of hospitalization of the schizophrenic sample and their accuracy of kinesthetic perception. The correlation coefficient between length of hospitalization and total mean average error was .29 which was not significant. Upon further investigation, it was found that the schizophrenic sample was composed of two rather homogeneous groups with respect to length of hospitalization - those hospitalized a relatively short time (2 years and under) and those hospitalized for a relatively long length of time (4 years

and over). The N in each group was 11 and 14 respectively, which collectively comprised the total N of the original schizophrenic sample. A t was used to test the significance of differences between these two groups. This t was found to be significant in the direction of greater total mean average error manifested by those hospitalized over 4 years (see Table 6).

TABLE 6

TOTAL MEAN AVERAGE ERROR AND LENGTH OF HOSPITALIZATION

Group	N	Total Mean Average Error	SD
2 Years & Under	11	32.95	6.63
4 Years & Over	14	45.77	18.14

$t = 2.369$; $p < .05$

A t was used to test both schizophrenic groups classified according to length of hospitalization and normals with respect to their total mean average error performance. Results showed no significant differences between normals and those hospitalized 2 years and under ($t=1.844$). However, a significant difference was found between normals and those schizophrenics hospitalized 4 years and over ($t=3.318$; $p < .05$). This difference was in the direction of greater total mean average error manifested by those hospitalized 4 years and over.

It was noted that, although there were no significant

differences found between those hospitalized 2 years and under and normals, the t's for these comparisons were in the direction of greater total mean average error manifested by the schizophrenics.

Fatigue and performance. The last factor that was investigated was that of fatigue. Since the stimulus distances were presented in a ramdom fashion with each subject receiving a different order of presentation, it was decided to compare the total average error of the first two reproductions of each stimulus distance with the last two reproductions of each stimulus distance and use this as an indicator of a fatigue factor. These comparisons were made between the schizophrenic subjects' performance and the normal subjects' performance. This method of investigating the fatigue factor was found to be the best measure available due to the fact that each of the first and last two movements occurred rather early or rather late in the order of stimulus distance presentation to each subject. "t" tests for both the schizophrenic sample and the normal sample were not significant (see Table 7). A mean fatigue score was calculated for both groups in terms of a difference score, either plus or minus, between the total average error of the first two movements at each stimulus distance and the last two movements at each distance. The t comparing normal and schizophrenic mean fatigue scores was found to be significant (see Table 7).

TABLE 7

MEASURES OF FATIGUE

Group Movements	Total Average Error	SD	t
Normals			
First 2 at each distance.	63.32	20.05	1.908
Last 2 at each distance.	53.36	16.72	
Schizophrenics			
First 2 at each distance.	76.92	30.72	.968
Last 2 at each distance.	86.76	40.52	

Group	Mean Fatigue Score	SD	t
Normals	-9.52	24.35	2.419*
Schizophrenics	9.88	31.86	

* $p < .05$

V. DISCUSSION

Accuracy of kinesthetic perception. The primary objective of this study was to investigate the question of whether significant differences existed between normals and schizophrenics in kinesthetic perception. Kinesthetic perception was defined as the accuracy with which one is able to make blind, arm-hand positioning movements perpendicular to the body on a horizontal plane. The accuracy of kinesthetic perception was measured by the mean average error of the subject's reproduced movement at each of three stimulus distances (4, 12, and 20 cm.). In addition, an overall measure of the accuracy of kinesthetic perception was used which consisted of totaling each subject's mean average error for each of the three stimulus distances into a total mean average error score.

In general, the performance of the normal sample approximated the findings of Spragg, et al., (1950) and Smalheiser (1963). Specifically, the means, both mean average error and mean constant error, and standard deviations of the normal sample at each of the three stimulus distances were quite close to those found by Spragg and Smalheiser. In addition, this study also confirmed Spragg's and Smalheiser's findings that normal subjects tended to overestimate the shorter distance in terms of positive constant errors and underestimate the longer distance in

terms of negative constant errors. From these findings it was a reasonable conclusion that the normal sample's performance in this study was a fairly representative and valid one.

Schizophrenics were found to differ significantly from normals in their accuracy of kinesthetic perception with respect to three of the four measures involved. These three significant measures were total mean average error, mean average error at 4 cm., and mean average error at 20 cm. In each case the significant differences were in terms of greater mean average error manifested by the schizophrenic sample. These findings were in accord with those found by King (1954), Rodnick and Shakow (1940), and Wulfeck (1941) in that schizophrenics in general manifested significantly poorer performance in relation to normals on a variety of psychomotor tasks. A reasonable conclusion from these findings was that schizophrenics manifest a significant degree of kinesthetic dysfunction in relation to normals.

With respect to 12 cm., schizophrenics and normals did not significantly differ in terms of mean average error. These results are somewhat puzzling in view of the atypical performance of the normal sample at this distance in relation to previous studies in the literature. Former studies have shown that the average errors of normals increased with increases in stimulus distances. However, the normals in this study exhibited the greatest mean average error at the

middle stimulus distance. Such a result could be discussed in terms of chance variation since their overall functioning closely parallels previous research. Another possible explanation was that it was in some manner related to the factor of "central tendency" stressed by Hollingsworth (1909). By "central tendency" Hollingsworth meant that point at which the error is no longer constant in one direction but fairly uniform in both directions. He hypothesized that these errors may be quite large but that they would cancel each other in the calculation of constant error. His only explanation was that this point of "central tendency" resulted from an unclear frame of reference as distance estimations would be affected by the extreme distances equally. This then would result in a highly variable performance lacking in consistent direction. Taking this one step further, it is evident that a "central tendency" effect would possibly result in a large mean average error due to an unclear frame of reference and subsequent variability in performance. This concept was considered to be a reasonable conclusion concerning the normal samples' poorer performance at 12 cm. Such an effect would tend to increase the mean average error of the normal sample to a point where differences between their performance and that of the schizophrenics' typically poorer performance were no longer significant.

Constant error and kinesthetic perception. The measures of constant error were investigated with the result

that out of the four measures investigated only one, 4 cm., was significant in terms of greater mean constant error manifested by the schizophrenic sample. Such a difference may be accounted for on the basis of chance alone. One point of interest regarding constant error deserves comment. At each of the stimulus distances the schizophrenics tended to overestimate the distance. As we have seen, in this study and in previous studies normals tended to underestimate the longer distances. This constant error overestimation at 20 cm. shown by the schizophrenic sample was interpreted as reflecting a type rigidity or inflexibility in the schizophrenic's response pattern.

Variables and kinesthetic perception. The variable of age was investigated, and there was no significant relationship between age and total mean average error for either the normal or schizophrenic group. In addition, education was taken as a rough estimate of each subject's intelligence and socio-economic class. These results showed that there was no significant relationship between education and total mean average error in either the normal or schizophrenic samples. These results have been interpreted to suggest that the variables of age (between 20 and 50), education, intelligence, and socio-economic status have no significant relationship to relatively simple tasks involving kinesthetic functioning.

Another variable investigated was the relationship between length of hospitalization and total mean average

error of the schizophrenic sample. Results showed that there was no significant relationship between these two measures, one of the reasons being that those occupying the middle range of the distribution of months hospitalized contributed a significant amount of error and variance to the correlation. However, when the schizophrenic sample was classified into groups according to the length of hospitalization some interesting results were found. First, those hospitalized 4 years and over significantly differed from those hospitalized 2 years and under in terms of greater total mean average error and variability. Moreover, when each of these schizophrenic groups classified according to hospitalization was compared with normals on the basis of total mean average error, results showed that those hospitalized 2 years and under did not significantly differ from normals. However, those hospitalized 4 years and over differed significantly from normals in terms of greater total mean average error manifested by the schizophrenic group. These findings were concluded to indicate either the presence of two qualitatively different groups comprising the schizophrenic sample or some type of influence exerted by the length of hospitalization on the accuracy of kinesthetic perception.

The effect of fatigue on performance was investigated in relation to the mean average error performance of normals and schizophrenics. There were no significant

differences found between each groups' performance on the beginning trials as compared with the last trials. However, there was a significant difference between the mean fatigue scores of normals and schizophrenics. This difference showed that schizophrenics had a greater total average error at the last two stimulus distances than at the first two distances, whereas the normals had a lesser total error at the last two stimulus distances than at the first two distances. These results seem to indicate that normals were able to benefit from practice, whereas schizophrenic performance was influenced by fatigue.

Interpretation of the data. There were a number of interpretations which were plausible in relation to the results of the study. The rationale of this study was based on a number of theoretical considerations and experimental studies which stressed that there may be a defect in kinesthetic perception which is of significance in the etiology of schizophrenia. The results of this study have shown that schizophrenics in general manifested significantly poorer performance in accuracy of kinesthetic perception. These results seemed to provide evidence in support of these theories. However, further investigation of the findings of this study afford alternative interpretations other than that of inferring the existence of a generalized defect in kinesthetic perception as characteristic of schizophrenics in general.

The results concerning schizophrenics' length of hospitalization and accuracy of kinesthetic perception revealed that the performance of those hospitalized two years and under was not significantly different from that of the normal sample, although it approached significance. However, significant differences were found between the performances of those schizophrenics hospitalized for four years and over as compared to normals. Such differences were not accounted for in terms of age or educational level. If the rationale of a generalized defect in kinesthetic perception was valid, then there should have been no differences found between groups of schizophrenics classified according to length of hospitalization due to the fact that the rationale made no distinction other than that such a defect should be manifested by all schizophrenics. Although this was not the case, the interpretation of a defect in kinesthetic perception cannot be dismissed. The reason being that the N's of the groups classified according to length of hospitalization were small and that the t of those hospitalized two years and under when compared with normals approached significance. The possibility exists that if the N of this group was increased a significant difference might result. Thus, the rationale of a kinesthetic defect may be still valid, but further research with larger N's is needed. In view of the findings concerning length of hospitalization, two alternative interpretations were offered.

First, reference was made earlier to Huston, et al. (1937) who found that schizophrenic patients who were rated as more cooperative and those who were more recently hospitalized tended to perform more like normals than did those rated as more uncooperative or those hospitalized for a longer length of time. More recently, Rosenbaum, Grisell, and Mackavey (1957) presented evidence that defective psychomotor performance was modified by manipulation of social motivation and electric shock motivation. Many schizophrenics performed as adequately under social or shock motivation as did normals which indicated that they had the capacity to perform. More disorganized patients and older patients were least affected and did not approach the normal level even with electric shock. These results were especially relevant, in that they strongly suggested that length of hospitalization, specifically--increased length of hospitalization, was related to poor psychomotor performance. In addition, Rosenbaum's study showed that motivation was a significant factor in the psychomotor performance of schizophrenics. Since those groups hospitalized for shorter periods of time performed similarly to normals and since those groups hospitalized for relatively long lengths of time performed significantly poorer than normals, an hypothesis was offered to explain such findings in terms of a hospitalization effect. It was hypothesized that with increasing length of hospitalization, especially that which extends over four

years, there is a general decrease in level of motivation and external stimulus sensitivity manifested by schizophrenics. Such a condition would result in a poor level of motivation as well as a decreased responsiveness to the environment which would account for the longer-- hospitalized schizophrenic's poorer kinesthetic perception.

Another interpretation concerning the results of this study was based on the factor of a heterogeneous schizophrenic sample. Phillips (1953) in his investigation of case history data and prognosis in schizophrenia developed a scale for prognosis in which the patient was evaluated in terms of three areas: premorbid history, possible precipitating factors, and signs of the disorder. Phillips stated that those whose scores fell at the extremes of this scale quite possibly represented two radically different syndromes. He further intimated that those who fell at this lower extreme may well represent a homogeneous syndrome group which is not truly schizophrenic according to traditional criteria. Becker (1956) in his investigation of this dichotomy has stated that the signs relating to the poor prognosis group ("process syndrome") were: a) a withdrawn, inadequate pre-psychotic personality, b) slow, insidious development of the psychosis, c) relative absence of precipitating factors, and d) presence of a dull, rigid, inappropriate affect. He further stated that the signs relating to the good prognosis group ("reactive

syndrome") are: a) relatively normal pre-psychotic personality, b) acute onset of psychosis, c) presence of precipitating factors, and d) presence of strong emotionality or tension. Garmezy and Rodnick (1959) using the Phillips scale for the "reactive-process" syndromes found that the "reactive" group showed significantly less variability than "process" schizophrenics in tasks of perception, learning and language. They also found that "reactive" performance closely approximated the normal level.

Integrating these findings, the last alternative interpretation stresses that the schizophrenic sample may have been composed of two relatively homogeneous groups, somewhat analogous to the "reactive-process" syndromes. Therefore, the group hospitalized for the shortest time may have been quite similar to this "reactive" group so that their performance would have been expected to be similar to the normals. The other group hospitalized for a relatively long period of time may have been quite similar to the "process" group so that their performance would result in significantly poorer kinesthetic perception than normals. Thus, the original rationale of this study, that of a defect in kinesthetic perception, may apply to only this "process" like group.

No attempt was made to advocate which of the interpretations was the most valid concerning the results of this study. Each was offered as equally plausible

interpretations of the study's results on which further research was needed.

Suggestions for further research. The present findings encouraged speculation regarding future research in the area of kinesthetic perception and schizophrenia.

1. It was suggested that a replication of the present study be carried out with larger samples to investigate the validity of the rationale concerning a generalized defect in kinesthetic perception which is characteristic of schizophrenia regardless of length of hospitalization.

2. It was also suggested that future research investigate further the relationship between length of hospitalization and accuracy of kinesthetic perception by schizophrenics. Inherent in this research would be the attempt to investigate the effect of motivation on performance.

3. It was further suggested that future research in this area concern itself with the "process-reactive" syndrome dichotomy in relation to the accuracy of kinesthetic perception as manifested by schizophrenics. Attention should be drawn to the fact that these groups may well be homogeneous groups - diagnostically and functionally different from one another in that the performance of the "reactive" group closely approximates that of normals in a wide variety of situations. It was also suggested that the rationale concerning the existence of a defect in kinesthetic perception

in schizophrenia may still be applicable to the "process" group but most probably not to the "reactive" group.

4. If the preceeding research is carried out and the "process" schizophrenics manifest a clear defect in kinesthetic perception, a cross-validation study should be investigated by comparing other diagnostic categories with schizophrenics in order to isolate the defect as endogenous to schizophrenia.

5. An attempt should be made to repeat this study on a wide number of newly admitted patients who would be undiagnosed. At a later date, after each has been diagnosed, schizophrenic performance should be compared to normals as well as other diagnostic categories. Such a procedure eliminates the problem of finding a sample of non-medicated patients. Such a procedure could also be investigated in terms of evaluating the task's efficiency in prediction of length of hospitalization for all patients.

6. Ultimately, schizophrenics' parents who have never been hospitalized or under psychiatric care should be studied to see if they manifest the same kinesthetic dysfunction as their offspring, as the rationale of an inherited neural defect in kinesthetic perception of schizophrenics would hypothesize.

7. And, last, the medication effect on such a task as used in this study should be investigated. For if its effect can be negated, then the difficulty of obtaining a large and representative sample would be greatly simplified.

VI. SUMMARY

This study was designed to measure the accuracy of kinesthetic perception in comparable groups of normal and schizophrenic subjects. Patients who were under electro-shock therapy at any time within the prior three months, who showed evidence of organic brain damage, or who were under medication within the prior three weeks were eliminated from the sample. It was hypothesized that schizophrenics would show significantly greater mean average error than normals in their accuracy of kinesthetic perception. Constant error and a number of other variables were investigated but no hypotheses were offered concerning these measures. The results of the experimental procedure were as follows:

1. Significant differences were found between normals and schizophrenics at two of the three stimulus distances in their accuracy of kinesthetic perception as measured by mean average error. This difference was in the predicted direction of greater mean average error manifested by the schizophrenic group.

2. No significant difference was found at 12 cm. between normals and schizophrenics in terms of their accuracy of kinesthetic perception. This finding was discussed in terms of the influence of "central tendency" and a poor frame of reference on the performance of the normal sample.

3. Significant differences were found between normals

and schizophrenics in their accuracy of kinesthetic perception as measured by total mean average error. This difference was in the predicted direction of greater total mean average error manifested by the schizophrenic group.

4. There were no significant differences found between normals and schizophrenics in three of the four measures of constant error. A significant difference was found at 4 cm. in terms of greater mean constant error manifested by the schizophrenic group.

5. No significant differences were found in both groups between the variables of age and education in relation to the accuracy of kinesthetic perception.

6. There was no significant correlation found between length of hospitalization and accuracy of kinesthetic perception. However, when schizophrenics were classified according to length of hospitalization, significant differences were found. Results showed that those hospitalized two years and under did not differ significantly from normals; whereas those hospitalized four years and over did differ significantly from normals.

7. A significant difference was found between normals and schizophrenics in terms of a mean fatigue score. This difference appeared to show that there was a fatigue factor affecting the schizophrenics' performance, whereas normals benefited from practice.

These findings were discussed in terms of their relevance to theories of kinesthetic dysfunction, factors associated with length of hospitalization, and the "reactive-process" dichotomy. Some suggestions for further research were made.

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