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Visual Perception as a Function of Chronicity in Schizophrenia

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Although much effort has gone into the description and classification of schizophrenic behaviour patterns, little attempt has been made to detail the course of the disorder. The present paper is an effort to trace the effects of chronicity on perception by use of a cross-sectional method. The specific tasks were selected to maximize autochthonous factors in perception. At the same time a demonstrable sensitivity to emotional states was desired, since changes in the schizophrenic condition are often considered reflections of reaction to stress. A wide enough area of behaviour was encompassed so that a general pattern, if one emerged, could be considered typical of perception as a whole. Four areas were examined:

Closure has been previously investigated (Cohen, Senf and Huston, 1956; Snyder, 1961; Snyder, Rosenthal and Taylor, 1961; Street, 1934), and is sensitive to differences between normals and schizophrenics. In addition, Snyder (1961) has suggested a relationship to emotional stress and to chronicity.

Threshold for the visual identification of forms also appears quite pertinent. Attneave (1954) has conceptualized form perception as an information handling process in which the perceiver uses only a portion of available, redundant configural cues. Presumably there are wide differences in the ability to code visual data. The relevance of this area to schizophrenia is suggested by Blaufarb's (1962) assertion that information processing is critically involved in the oft-noted difficulty of schizophrenics to perform well on extremely complex tasks, such as the interpretation of proverbs. The sensitivity of this function to stress was demonstrated by Jones (1957).

The third function to be studied was *depth perception*. The perception of size and distance by schizophrenics has been a source of intensive study, usually by means of the constancy phenomenon. Weckowicz and his co-workers (Weckowicz and Hall, 1960; Weckowicz, Sommer and Hall, 1958) have found distance constancy to be defective in schizophrenics. Several other workers noted deficiencies in size constancy (Crookes, 1957; Sanders and Pacht, 1952; Weckowicz, 1957) although there are contradictory data (Leibowitz and Pishkin, 1961).

In the present study, depth perception was selected for investigation because it was viewed as a process common to both size and distance constancy and because there is evidence that depth perception is sensitive to changes in emotional state (Hennis and Ulrich, 1958).

Finally, the *CFF* was chosen as a perceptually primitive task which is extremely sensitive to a multitude of non-retinal factors. Goldstone (1955) noted sharp differences between high and low anxious groups; Irvine (1954) between schizophrenics and paretics; and McDonough (1960) between process and reactive schizophrenics. Landis, Dillon, Leopold and Rutschmann (1958) offer suggestive evidence that CFF is related to response to shock therapy in schizophrenics.

Method

Subjects

A total of 120 schizophrenics and 20 hospitalized, non-psychiatric controls were used in this study. All schizophrenic Ss were drawn from the wards of the Milwaukee County Mental Health Center. The entire schizophrenic population was surveyed with regard to suitability for inclusion. Patients who showed the following characteristics were eliminated: age below 20

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or over 55; psychosurgery; extensive shock therapy in past history or shock therapy within the previous month; presence of complicating organic diagnoses; mutism; visual impairment.

The remaining pool was then classified into six groups with respect to the date of admission at which the earliest diagnosis of schizophrenia was made. The interval between that date and the date of testing, the duration of disorder, was taken as our measure of chronicity and labelled as follows: *Group 1* (acute): less than 6 months; *Group 2*: 6 months to 5 years; *Group 3*: 6–10 years; *Group 4*: 11–15 years; *Group 5*: 16–20 years; *Group 6*: over 20 years. Groups 2–6 will be referred to as the "chronic groups".

From each of the six duration-of-disorder groups, a random sample of 20 Ss was drawn. When any of these Ss proved to be untestable or unavailable, substitutions were made on the basis of similar actuarial characteristics. Eleven schizophrenics refused to take part and six were judged untestable; they were distributed randomly throughout the six groups. Controls were drawn from a tuberculosis sanatorium in the same hospital complex. The patient population is equivalent to the schizophrenic groups in socio-economic status.

The pertinent actuarial characteristics of the sample are summarized in Table I. In those areas where comparison is possible (Pa-nonPa status, sex ratio, age, education, total hospitalization, closed-open ward status) the chronic groups closely match the characteristics of the population from which they were chosen. The high release rate of the acute population makes a similar comparison for that group impossible.

The chronic groups appear to be samples from a population that differs principally in the duration of disorder. Each group has spent approximately the same proportion of time in the hospital, irrespective of how much earlier the initial diagnosis had been made.

Procedure

All Ss were tested individually during two successive periods, lasting a total of about 1½ hours, separated by a short rest period. The tests, described below, were administered in the same order to all Ss: *Session 1*: Street Visual Gestalt Test, Jones Probability Grid Figures, Depth Perception; *Session 2*: CFF. The Shipley-Hartford vocabulary test was then administered as an estimate of intelligence. This particular order of administration seemed the most likely to limit fatigue and maintain interest. Two Es were used, each conducting a session. During the course of the study, examiner bias effects were evaluated by exchanging Es. Analysis of twenty successive cases indicated that there were no significant differences related to Es. No further attempts were made to counterbalance task and E.

TABLE I

Actuarial Characteristics of the Sample

Variable	Group						
	1	2*	3	4	5	6	Controls
Age	29·05	30·55	35·60	38·85	45·05	50·50	43·30
Education (years)	11·25	10·75	10·90	10·70	11·50	10·35	10·05
Vocabulary score	25·46	26·56	25·74	23·93	23·50	22·54	28·53
Hospital (years)		1·94	4·23	8·65	12·40	18·40	
Hospital/duration (ratio)		·61	·57	·68	·68	·73	
Sex: female/male (frequency)	12/8	10/9	14/6	17/3	14/6	14/6	8/12
Pa/nonPa (frequency)	13/7	6/13	10/10	9/10	6/14	4/16	
Ward status: closed/open (frequency)†	18/2	5/12 (2)	5/13 (2)	4/12 (4)	3/16 (1)	2/16 (2)	

* 1 S missing.

† Numbers in parentheses refer to Ss on whom data is unavailable.

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The Shakow (1946) co-operation scale was scored for each S at each session.

The following tasks were employed:

Street Visual Gestalt Test (Street, 1931): This test consists of 15 5×7 plates on which appear silhouettes of common scenes or objects (e.g. bust of man, sailboat, locomotive). The S's task was to identify the object. The test was administered without time limit, in order of ascending difficulty and with inquiry where response was unclear. The score obtained was the number of correct identifications.

Jones Probability Grid Figures (Jones, 1957): This test consisted of eight series of stimulus plates, each series comprised of 17 variations of a black-and-white alphanumerical or geometric figure (e.g. letter H, diagonal stripes, number 88). The stimulus plates were made up of matrices with differing proportions of filled cells. Each series represented 17 levels of increasing visual information in 2½ per cent. increments.

In administration a series was presented serially, one plate at a time, until correct identification was made. The order of presentation was the same for all Ss, with the first series (letter H) used as a trial and not scored. Instructions were a simplified version of the original set (Jones, 1957), but Ss were urged to make some response to each card. Score was the number of the card on which identification was made. If the stimulus was not identified, the Ss was arbitrarily given a score of 18.

Depth Perception: A modification of the Howard-Dolman apparatus was used. It consisted of an enclosed box, the interior of which was illuminated by a 75 w. bulb located behind an opaque glass plate at the rear. A viewing aperture was cut into the front of the box. Inside the apparatus two vertical black rods, approximately ⅜ inch in diameter were mounted on parallel tracks. The experimental task required S to bring one rod, which was movable, in line with the stationary standard by means of attached cords. The standard rod was adjusted by E prior to the experiment and kept in a constant position throughout. All determinations were binocular and performed in a fully lighted room. The distance between S and the viewing aperture was kept constant at five feet.

The standard rod was left at a point equidistant between the front and rear of the apparatus. At the beginning of each trial, E set the movable rod a predetermined distance from the standard; settings were obtained at 15 starting positions. Absolute error scores (mm.) were obtained.

CFF: A beam of light from a 6-w. bulb was directed by means of a system of lenses to an eyepiece with an aperture 5 mm. in diameter. The light subtended a visual angle of 3° 50′ on the retina. Flicker was provided by a black and clear plastic disc with a light-dark ratio of 1 : 1 which interrupted the light beam. The disk was rotated by a variable-speed motor, controlled by rheostats, with control knobs placed in positions convenient both to E and S. Either could independently alter motor speed. Rotation frequency was read directly from a Metron direct-reading tachometer coupled to the motor.

Central fixation of the light stimulus was assured by a rubber bombsight eyeguard attached to the eyepiece. A motor control knob was mounted below and to the right of the eyepiece. Testing was performed in a dark room, a shielded 7·5 w. red bulb serving to illuminate the tachometer sufficiently to allow recording of responses.

A five-minute dark-adaptation period preceded the administration. Determinations were begun at the lowest illumination level; S was instructed to turn the control knob until the flickering of the stimulus light ceased and to report verbally as well. After appropriate resetting of the motor speed by E, a descending series was run, S adjusting the knob until the onset of flicker occurred. Five different illumination levels were used, at intervals of 1 log unit, the highest intensity being in the range of 1,100 ml. Illumination was manipulated by means of Wratten neutral density filters. All readings were monocular, taken with S's right eye. Three ascending and three descending readings were obtained at each illumination level.

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Results

Control of Extraneous Variables

Before analysing the test data, the extraneous variables judged likely to influence performance were examined. The schizophrenic groups were adequately equated on education, vocabulary score, sex distribution, Pa-nonPa frequency, relative potency of tranquillizing medication, and Shakow motivation ratings.

Significant group differences did occur on the age and length of hospitalization variable. It was felt that the latter variable was logically similar to the chronicity variable used in this study and has indeed often been used as a measure of chronicity. From this viewpoint, length of hospitalization could not be considered a contaminating extraneous variable and no attempt was made to evaluate its effect. However, the age variable presented a distinct problem, since group differences were significant and since it correlated significantly (−·19) with CFF and the Jones Test (·22). Consequently, the analysis of covariance was used to partial out its effect in the analysis of these test results.

The sensitivity of the CFF to a host of organismic variables (Landis, 1954) made it necessary to evaluate the effects of several other possible sources of bias. Statistical analysis indicated that the schizophrenic groups did not differ significantly on females' position in the oestrus cycle on day of testing or time of day when tested (a.m.–p.m.). Significant differences occurred with regard to amount of smoking and alcoholic intake during extramural life, but neither of these variables correlated with CFF measures obtained.

We therefore conclude that groups are relatively free from bias attributable to extraneous factors, the exceptions being differential effects of age on the Jones and CFF tasks.

Analysis of Test Performance

Street Test: An extensive body of evidence indicates that the Pa-nonPa breakdown is behaviourally meaningful. Therefore, these subgroups were tested separately. Group means are presented in Table II.

Examination reveals a gradually decreasing pattern of performance with increasing chronicity. To relate the performance of the schizophrenic groups to controls, an overall between-within analysis of variance was performed across all seven groups. A significant F ratio was obtained ($F=2\cdot47$, 6/132 df, $p<\cdot05$).* A supplementary Duncan Range test was per-

* One Pa S in Group 2 was inadvertently misclassified and his data are omitted from analysis. Snedecor's (1956, p. 310) method of compensating for missing data was used here and later with adjusted degrees of freedom.

Table II

Mean Number Correct Identifications for Schizophrenic and Control Groups: Street Test

Group	Mean	Group	Mean
6	7·60	6 Pa	6·00
5	7·75	5 NonPa	7·21
4	8·30	4 NonPa	7·82
3	8·75	6 NonPa	8·00
1	8·80	3 NonPa	8·30
Control	9·10	1 Pa	8·38
2	9·30	4 Pa	8·89
		5 Pa	9·00
		2 NonPa	9·00
		3 Pa	9·20
		1 NonPa	9·57
		2 Pa	10·00

Note: Group means are listed in order of magnitude to facilitate statistical comparison. Means joined by a vertical line are not significantly different; means not so joined are differentiated beyond the ·05 level.

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formed on these scores, and the results are indicated by the vertical lines to the right of the means in the second column of Table II. It appears that the significant differences obtained lie between the two most chronic groups on the one hand, and the acutes and controls on the other.

A supplementary analysis of variance with unequal cell frequencies (Snedecor, 1956, p. 382) was then performed in order to analyse the Pa and nonPa subgroups as well as chronicity without reference to controls. Here neither the chronicity nor Pa-nonPa effect achieved significance, but the interaction was significant at the ·05 level (F=2·74, 5/107 df). Duncan's (1957) extension of the Range Test to experimental designs with unequal cell frequencies was used to examine this interaction further. The results of this analysis are represented by the vertical lines to the right of the tabulated cell means in Table II. The process of increasing impairment is noteworthy primarily in nonPa groups with an inversion in extreme chronicity. This inversion might be artifactual, since the number of paranoids serving in this cell is very small. Pa subgroups show little change throughout the major part of the range studied, although a gradually diminishing process is described. Acute and early chronic groups do not differ significantly.

Jones Test: A preliminary analysis of variance was performed comparing all seven groups on the number of sets in which a correct identification was made. There was a trend in the direction of fewer identifications with increasing chronicity, but it fell short of significance. It was concluded that the failure to respond was not a significant biasing factor in the final results.

Group means, in terms of card number on which identification was made, are presented in Table III.

One notes a gradual trend in the direction of higher information threshold with increasing chronicity, though with several inversions. An analysis of variance was performed on chronic groups broken down into Pa and nonPa subgroups. No term achieved significance. When Pa and nonPa groups were combined, a between-within analysis across all seven groups revealed differences significant at the ·05 level (F=2·40, 6/132 df). The F-ratio fell far short of significance (F=1·40, 6/131 df) when analysis of covariance was used to partial out the effect of age. The significant group differences noted above thus seem to be a function of variables involved in the ageing process. If the Jones Test does indeed measure the meaningful function of threshold for visual identification, it appears that this ability is little impaired among schizophrenics.

TABLE III

Mean Threshold for Visual Identification: Jones Test

Group	Mean Score
Controls	10·86
6	14·00
5	13·60
4	12·05
3	13·78
2	10·12
1	11·40

Depth Perception: Mean absolute error scores were obtained for each S and served as data for our analysis (Table IV).

TABLE IV

Mean Error Scores: Depth Perception

Group	Mean
5	23·64
4	15·00
6	11·76
3	9·60
1	6·77
2	5·16
Controls	5·01

Note: Group means are listed in order of magnitude to facilitate statistical comparison. Means joined by a vertical line are not significantly different; means not so joined are differentiated beyond the ·05 level.

There is an almost perfect linear pattern of decrement from Group 2 to 5, with a sharp inversion in the most chronic group. A two-way analysis of variance comparing Pa-nonPa and chronicity groups was performed. The chronicity variable was the only one to achieve significance (F=2·46, df 5/107, $p < ·05$); Pa-

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nonPa groups were not statistically differentiated. When the Pa and nonPa groups were combined, and analysis of variance performed across all seven groups, the resulting F ratio achieved significance beyond the ·01 level ($F=2\cdot97$, 6/132 df).

A Duncan Range Test was performed to compare differences between pairs of group means, and the results are represented by the vertical lines to the right of the means column in Table IV. It is clear that the only significant differences are provided by comparisons of Group 5 with controls, acutes, and early chronics. Re-examination of our data failed to reveal any evidence of a selective sampling bias in either Group 5 or 6 which would account for this deviant performance.

CFF: Several schizophrenic Ss gave scores which deviated little if at all from the initial settings. Hence, it was decided that any score in which CFF differed less than 2 c.p.s. from the initial setting would be discounted. For purposes of analysis CFF was taken as the median judgment of valid scores within each illumination level.

The first analysis was performed on group mean CFF scores across all illumination levels. The curves generated by these data are plotted in Figure 1. Grant's (1956) adaptation of the Trend Test was used.*

Results revealed a highly significant difference among group means ($F=4\cdot75$, 6/126 df, $p<\cdot001$). The overall curve is composed of a significant positive slope ($F=745\cdot36$, 1/126 df, $p<\cdot001$) and a significant superimposed quadratic component ($F=208\cdot23$, 1/126 df, $p<\cdot001$). The groups differ in the degree of slope ($F=3\cdot81$, 1/126 df, $p<\cdot001$), but not in degree of curvature. It is clear that over the illumination levels studied, CFF increases monotonically for all groups as illumination increases. The rate of increase, however, is less for the extreme chronic groups than for the controls, acutes, and early chronics.

To determine where in the process of chronicity significant changes occur, further comparisons were made using the CFF score from illumination level 3, the score deemed most stable and reliable. Group mean CFF and adjusted CFF obtained after partialling out the effects of age are presented in Table V.

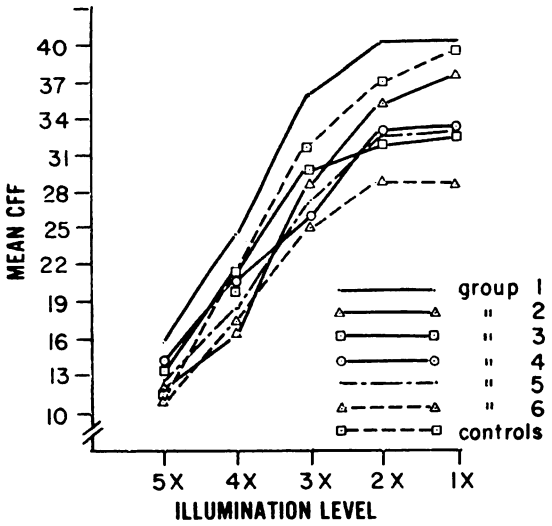


FIG. 1.—CFF as a function of ascending illumination level (logarithmic steps). Abcissa values are filter factors. Parameter is subject group.

TABLE V

Mean CFF Scores for Groups, Illumination: Level 3

Group	Mean	Adjusted Mean
1	35·78	35·47
Controls ..	31·74	31·86
3	29·68	29·68
2	28·26	27·98
5	27·79	27·96
4	26·95	26·93
6	25·70	26·03

Note: Means and adjusted means are listed in order of magnitude to facilitate statistical comparison. Means joined by a vertical line are not significantly different; means not so joined are differentiated beyond the ·05 level.

A two-way analysis of variance, comparing chronicity groups and Pa-nonPa subgroups, was performed. Only differences attributable to chronicity were significant ($F=16\cdot27$, 5/104 df, $p<\cdot001$); consequently the Pa and nonPa

* Several Ss gave invalid data in one or more illumination conditions. In the trend test, Ss were randomly dropped from the full cells in order to provide equal cell frequencies. In all other analyses of CFF data, appropriate methods for unequal cell frequencies were used.

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subgroups were combined for further statistical treatment. Analysis of covariance was performed comparing all seven groups, with the effect of age partialled out. Significant differences among groups were obtained ($F=3\cdot14$, 6/128 df, $p<\cdot01$). By using the method outlined in Lindquist (1956, p. 327) differences between individual cell means were compared, and the results are indicated by the vertical lines to the right of the means in Table V. It is evident that decrement is limited to the extreme groups, a pattern noted previously on the Street Test. However, the performance of the acute group is strikingly differentiated from all chronic groups and elevated, though not significantly, above the level of the controls.

Discussion

The present study suggests that somewhat different patterns of decrement exist for each of the four perceptual functions studied. On the closure task, nonPa groups exhibited a gradual pattern of decrement which significantly differed from the normal standard only in the final stages of chronicity. In contrast, Pa groups were almost equivalent in performance to the normal group throughout most of the range studied. No differences between controls and schizophrenics occurred on a task measuring the ability to identify forms from incomplete visual information. On depth perception, a linear pattern of decrement appeared across most groups, although a very sharp reversal took place during the final stage. Only on CFF were acute schizophrenics sharply differentiated from chronics. There the dichotomy was quite striking, the acutes achieving a CFF far in excess of that shown by chronic groups. The CFF curve, generated by comparing five different levels of illumination, was mathematically similar in form for all groups, being composed of linear and curvilinear elements and differing only in mean and slope.

The complexity of the results precludes any attempt at integration until their replicability has been established. Despite this fact, certain common features are evident and deserve comment. In this population, acute schizophrenics are never significantly inferior to the control group and occasionally, as in the CFF task, reach a superior level of performance. The typical decremental pattern is linear, through much of the range of chronicity studied. Where decrement does occur, it is generally so gradual that often only the extreme groups are statistically differentiated from controls. Interestingly, Pa and nonPa groups perform equivalently on all tasks but the Street. It may be significant that divergent performance occurred only on the task in which meaningful material was employed.

Several problems are raised by the results of individual tasks.

Street Test: The most nearly relevant study, that of Cohen, Senf and Huston (1956), used the Street Test to compare normals with chronic and acute schizophrenic groups and found differences only between the chronics and controls. The mean duration of illness for their chronics suggests that they are equivalent to our Group 4; their results are reasonably comparable to ours. Snyder (1961) argues that the closure deficit, which he noted in chronic schizophrenics, is related to progressive decrement of the tendency toward central reorganization of what is perceived. In acute cases, however, this tendency, because of emotional turmoil, should lead to closure that exceeds normal efforts. His task called for active participation by the S and is for that reason difficult to compare with the present task. None the less, we do not find the alleged superiority of acutes in our study. If such a tendency exists in the similarity of performance of acutes and normal controls, it is obscured by other factors and is not likely to represent a psychologically meaningful characteristic. The progressive deficit in schizophrenia of long duration is a meaningful feature, however, and may reflect something akin to what Snyder postulates.

Jones Test: No difference existed between the schizophrenic groups' ability to process visual information. This finding would be of considerable importance if replicated on other samples, since it suggests that the primitive perceptual function involved in this activity remains relatively unimpaired throughout the

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course of a disorder in which other functions become less and less efficient. Unfortunately, the construct validity of the Jones Test is not yet established; we know only that it is sensitive to stress and that it is affected by age. The inability of the test to differentiate schizophrenic groups might well be a function of non-informational factors inherent in the task or the mode of administration. The fact that the Street Test, a superficially similar task, was administered immediately prior may also be a factor. The varied stimulus material found on that test could have introduced expectations of more varied material on the Jones than the E indicated and led to confusion on the part of the Ss.

Depth Perception: The clearly linear pattern of decrement found in Groups 2–5 suggests that the results obtained reflect a genuine, lawful process. The curve seems to represent gradual degeneration of performance with restitutional efforts taking place during the last stage of chronicity. It is difficult to suggest a reason for this phenomenon.

No information is available regarding the relationships among depth perception, size constancy and distance constancy; but a functional connection appears logical since the same visual cues are operative in all three areas. It is tempting to relate the present results to the constancy research. Seven studies of constancy in schizophrenia are known to the authors in which maximal cue situations are used and which also contain sufficient specification of sample variables to allow comparison with our own schizophrenic groups.

The single classifiable study done with an acute group (Rausch, 1952) and that done with early chronics (Lovinger, 1956) find no perceptual deficit; they are consistent with our results. Five studies were done on groups similar to our Group 4 where differences between normal and schizophrenic performance are of marginal statistical significance. Of these studies, four find significant differences (Crookes, 1957; Weckowicz, 1957; Weckowicz and Hall, 1960; Weckowicz, Sommer and Hall, 1958) and one found no differences (Leibowitz and Pishkin, 1961). No studies have been performed on extreme chronic groups. Within the narrow limits reported, the earlier studies are consistent with our work.

CFF: Several perplexing features occur in the CFF results. Acute schizophrenics are frequently characterized as highly anxious, and chronics as successfully defended against anxiety (Mednick, 1958). Moreover, the literature (Goldstone, 1955; *cf.* also Buhler, 1961, especially his review of unpublished studies) is conclusive in relating CFF to anxiety. Consequently, one should expect significant differences between the two groups. However, the same studies indicate that CFF is *lowered* with increasing anxiety. This is in sharp contrast to our results in which the supposedly highly anxious acutes achieve a much *higher* threshold than the supposedly non-anxious chronics. The relevant literature on CFF and schizophrenia is of little help in resolving the difficulty. One possibility lies in the methodological differences between the present study and the bulk of earlier work. The principal difference is the use in this study of a method by which S rather than E manipulated the speed of rotation. It is conceivable that anxious Ss (or acute schizophrenics) assume a set for speedy response when E has control of the frequency of flicker, and a set for precision when S is allowed to manipulate the controls himself.

Summary

This study was designed to investigate the relationship between perceptual deficit and chronicity in schizophrenic patients. Tests used included the Street Visual Gestalt Test, Jones Probability Grid Plates, depth perception, and critical fusion frequency (CFF). A total of 120 schizophrenics was assigned to six groups differing in duration of illness and compared to a control group of 20 TB patients. Extraneous variables deemed likely to affect performance were adequately controlled.

Analysis showed a pattern of steadily decreasing performance with increasing chronicity on the Street Test; non-paranoid schizophrenics declined more rapidly than paranoid schizophrenics. No significant differences appeared on the Jones Test, a fact which suggests that the

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threshold for information needed to make a visual identification is not impaired with increasing chronicity. On depth perception, significantly defective performance occurred only with an extremely chronic group, although the pattern of decrement was clearly linear up to that point. On the CFF task all groups showed similar threshold curves over five levels of illumination. When a single reliable measure of CFF was used, acute schizophrenics showed an extremely high threshold value while chronic groups were significantly lower. Normals performed in an intermediate position.

Evidence supported the existence of widespread perceptual deficit in schizophrenia, but one which might become apparent only after long duration. The pattern of deficit differs from task to task.

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