DISTANCE CONSTANCY IN SCHIZOPHRENIC PATIENTS*

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RECENT research has shown that constancy of perception breaks down in schizophrenics. Size constancy in these patients has been investigated by Raush (13, 14), Weckowicz (16), and Crookes (2). Raush found that paranoid schizophrenics had increased size constancy compared with normals and other schizophrenics. He predicted that in other types of schizophrenia size constancy might be poorer than in normals. However the difference he found was not statistically significant. Weckowicz found that chronic hospitalized schizophrenics had poorer size constancy than other hospitalized patients and normals. These two investigators determined size constancy by instructing the subjects to adjust the size of an object (a rod or a square) to the size of a standard object at a distance. Crookes used a direct method. His subjects were instructed to reproduce the size of the image of the standard object seen at a distance and not the size of the object itself. He came to the same conclusion as Weckowicz that size constancy in schizophrenic patients was impaired.

The literature on size constancy has been summarized elsewhere (16). It is sufficient here to say that size constancy denotes the ability to perceive the size of an object stable within wide limits in spite of the change of the size of the retinal image with the distance from which the object is seen. The relationship between perceived size and distance in visual space has been studied in normal people by Boring and Holway (9), Brunswik (1), Gibson (5, 6), Ittelson (10), and Gilinsky (7, 8). These authors have found that size constancy is closely related to distance constancy. It depends on an ability to take into account the distance of the perceived object. A retinal image of the same size can be produced either by a small object at a near distance or a large object at a far distance, so there is a reciprocity between the perceived distance and perceived size. They are two aspects of the same phenomenon. Moreover, the ability to perceive the size of an object as constant at different distances depends on the ability to perceive in the terms of the three-dimensional

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Euclidian space, where the units of distance remain constant and where there is no foreshortening of space with increased distance.

A standard physical unit of distance, for instance one yard, subtends progressively smaller visual angles with the increased viewing distance (see Fig. 1).

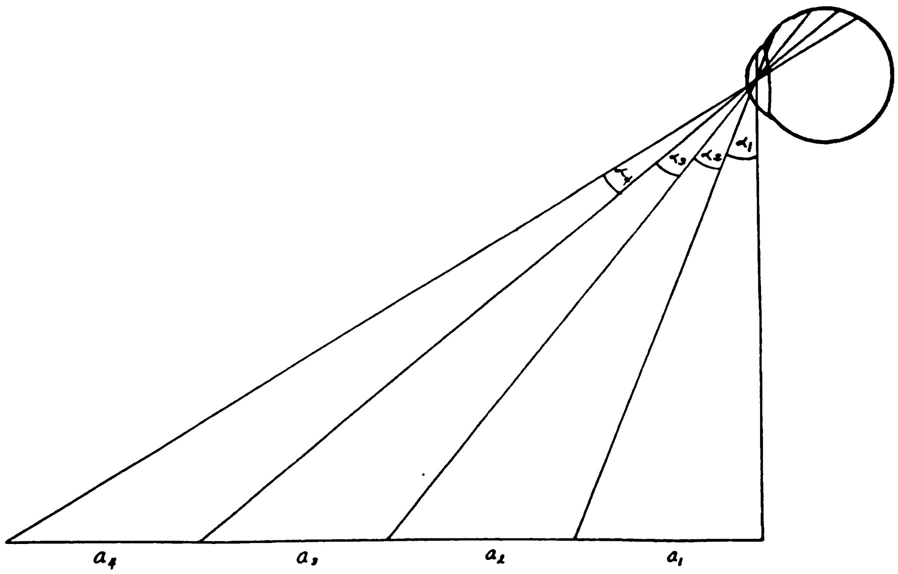

FIG. 1.—Perception in accordance with distance constancy.
Distance intervals: $a_1=a_2=a_3=a_4$.
Visual angles: $\alpha_1>\alpha_2>\alpha_3>\alpha_4$.

In accordance with distance constancy, the progressively shrinking retinal image corresponding to the progressively diminishing visual angles is "interpreted" as being subtended by a constant unit of distance. The distance gradient of the progressively diminishing visual angles subtending a unit of space is interpreted by using the other gradients of the visual field such as the gradient of the diminishing retinal image of a receding object or the various gradients of texture patterns (5).

In perception where distance constancy is absent, a "subjective unit" of distance is that distance interval which subtends the same visual angle irrespective of the distance from which it is viewed. The same visual angle is subtended by progressively longer units of distance with the increase of the viewing distance (see Fig. 2).

From Figure 2, it can be seen that in perception in accordance with the visual angle constancy (retinal image is the same size) there is a gradient of rapidly increasing units of distance which are perceived as being equal.

In normals, perception as determined by experimental procedures is neither completely governed by distance constancy nor by visual angle constancy, but lies between them, although it probably accords more closely with the principles of distance constancy.

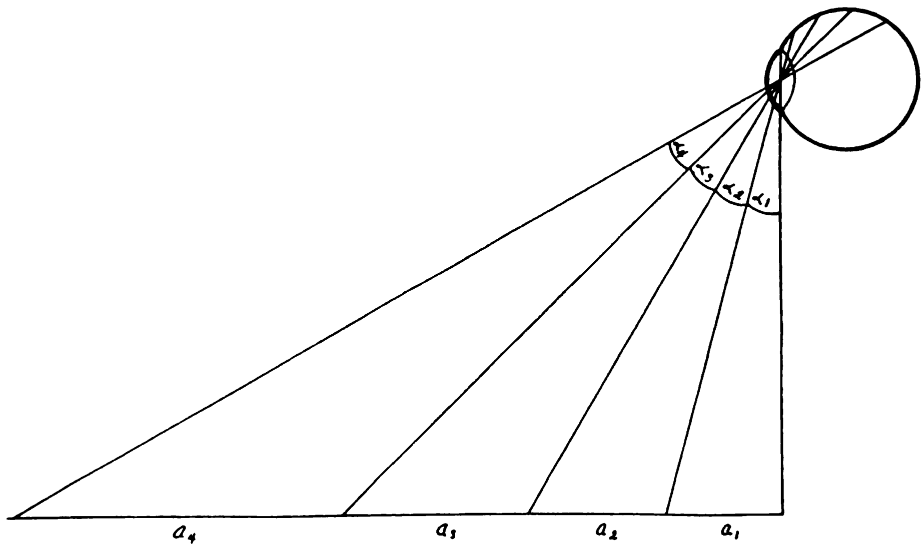

FIG. 2.—Perception in accordance with "visual angle constancy" (distance constancy non-existent).
Visual angles: $\alpha_1=\alpha_2=\alpha_3=\alpha_4$.
Distance intervals: $a_1<a_2<a_3<a_4$.

HYPOTHESIS

As there is a relation between size constancy and distance constancy and as schizophrenics have been found to have poorer size constancy than non-schizophrenics, it can be expected:

1. That they have poorer distance constancy than non-schizophrenics.
2. That those schizophrenic patients who have poor size constancy should also have poor distance constancy.

This paper is a report of an experiment, whose purpose was to test these hypotheses.

SAMPLE

Two groups were used: 20 schizophrenic patients and 17 normal controls. The schizophrenic sample included only patients in whom the diagnosis of schizophrenia had been firmly established by all psychiatrists who had examined them. It consisted of 5 females and 15 males. Seven patients were diagnosed as hebephrenic schizophrenics, three as paranoid schizophrenics, two as catatonic schizophrenics, one as a simple schizophrenic, and six as undifferentiated schizophrenics.

The mean age was 38 years (S.D. $=7\cdot32$). The average length of stay in the hospital was 9 years (S.D. $=5\cdot07$). No patient in whose case there was a possibility of mental deficiency or organic brain disease was included. No patient undergoing insulin or electrical shock treatment was included. Only patients who were co-operative during the experiment were included in the sample. All the patients had their eyes tested and had corrected visual acuity 20/20.

The normal sample included 17 volunteers from the hospital staff, 11 males, and 6 females. The mean age was 28 years (S.D. $=7\cdot72$).

Experimental Procedure

An outdoor experiment was carried out on a flat open prairie with an open horizon. A small cart with a white triangular marker was moved by a series of strings and pulleys away or towards the subject. It was held on a straight path by a white nylon rope stretched from an iron peg at the subjects' feet to another peg 220 yards away. Another marker with a white triangle of the same size and shape as the triangle on the cart was used for marking standard distances. For marking one-yard intervals, a red-painted peg was used. The strings and pulleys were operated by an assistant who stood behind the subject.

The experiment consisted of four parts: In the first part both the movable marker (on the cart) and the other marker were placed at 60 yards distance from the subject. The following instruction was read to the subject: "These two triangles are the same distance from you. The right-hand side triangle can be moved either away from you or towards you. We are going to move the right-hand side triangle away from you. Would you tell us to stop when the right-hand side triangle is the same distance from the left-hand side triangle as the left-hand side triangle is from you. In other words, would you tell us to stop when the left-hand side triangle is half-way between you and the right-hand side triangle." The distances were measured in yards.

In the second part both markers were placed at 120 yards distance from the subject and the following instruction was read: "These two triangles are the same distance from you. We are going to move the right-hand side triangle towards you. Would you tell us to stop when the right-hand side triangle is half-way between the left-hand side triangle and you." The distance estimated by the subject was measured in yards.

In the third part the markers were placed at the 60 yards distance and the instruction was the same as in the second part.

In the fourth part only the movable marker was used. The cart was placed right at the feet of the subject. The following instruction was read: "We are going to move this cart away from you, would you tell us to stop when the near side of the cart is one yard from you." After the subject said "Stop", he was told to turn his back. The distance estimated by the subject as one yard was measured and a red peg was driven into the ground to mark it. The subject was told to face ahead again and the following instruction was read to him: "We are going to move this cart away from you again. Would you tell us to stop when the near side of the cart is one yard from the red peg." The subject was again told to turn his back. The distance from the red peg to the near end of the cart was measured. The red peg was removed from its previous spot and driven into the ground just in front of the near side of the cart. This procedure was repeated 20 times.

Thus in the first part of the experiment the subject was instructed to double the standard distance and in the second and third parts to divide the standard distance into halves. In the fourth experiment he was instructed to estimate successive one-yard intervals, judging the first yard from the point where he was standing and subsequent yards from the point where the preceding interval had been judged.

With perfect distance constancy the subjects should double exactly the first standard distance, divide into halves the next two standard distances and estimate as one yard 20 equal distance intervals.

Over-estimation of the distant halves in the first three parts of the experiment and progressive over-estimation of one-yard interval indicates a breakdown of distance constancy.

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Results

The distribution of the schizophrenic sample was badly skewed, due to extreme over-estimation of the far distances by two subjects, so non-parametric statistical methods* were used in analysing the data. The difference between the estimations of the farther halves of the distances given by the normals and schizophrenics in the first three parts of the experiment is in the expected direction, but not statistically significant. For each task the mean rank was calculated for the normals and the schizophrenics and the significance of these ranks was tested by the Mann-Whitney *U* Test. The results are reproduced in Table I.

TABLE I

Mean Rank of Estimations

	Part 1 Doubling 60 Yards Distance	Part 2 Halving 120 Yards Distance	Part 3 Halving 60 Yards Distance
Schizophrenics ..	17·65	17·64	18·59
Normals	20·59	20·15	19·35
Z	0·82	0·70	0·21
	0·3>p>0·2	0·3>p>0·2	0·5>p>0·4

In both normals and schizophrenics, the objective lengths of the subjective yards increased with the distance away from the subject. These increasing lengths formed a certain gradient. The gradient was much steeper in the schizophrenics, than in the normals. The results of the Median Test are presented in Table II. The Chi-squares for the first eight one-yard estimations are non-significant while the following 12 Chi-squares are significant and become progressively larger.

TABLE II

Estimates of Successive One-Yard Intervals

Successive Yard Judgments	Median Estimate (Inches) Schizophrenics	Normals	x^2	p
1	41·5	38	0·43	N.S.
2	44·5	39	1·74	N.S.
3	45	45	0·00	N.S.
4	50·5	48	1·74	N.S.
5	58·5	51	1·74	N.S.
6	60·5	61	0·43	N.S.
7	67	65	0·43	N.S.
8	83	65	6·97	p<·01
9	84·5	66	1·74	N.S.
10	104	68	3·92	·05>p>·01
11	113	69	6·97	p<·01
12	116	76	10·90	p<·001
13	129	76	6·97	p<·01
14	145	75	6·97	p<·01
15	141	73	6·97	p<·01
16	160·5	77	15·70	p<·001
17	142	82	10·90	p<·001
18	170	86	15·70	p<·001
19	177	89	10·90	p<·001
20	176	89	10·90	p<·001

* Distribution free statistics, which are more conservative and do not allow extreme single scores to bias the results.

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The successive subjective yards were estimated by different subjects at different distances because the subjects who over-estimated the first few yards estimated subsequent yards from a greater distance than subjects who made shorter estimations of the first few yards. To avoid this confounding of individual yard estimations with the distances from which these estimations were made, the yard estimations by the normals and the schizophrenics made at the same distances were compared. (If there was no yard estimations at a particular distance the nearest one above or below was used.) Twenty-eight estimations of one-yard intervals were used. The differences between the estimations of both groups were tested by the Median Test. The results are summarized in Table III.

TABLE III

The Distance at Which the Estimation was Made (yards)	Median Estimate		χ^2	p
	Schizophrenics	Normals		
0	39	38	1·00	N.S.
1	50	39	2·79	N.S.
2	45	44	0·47	N.S.
3	51	46	0·47	N.S.
4	51·5	50	0·11	N.S.
5	54·5	50	0·47	N.S.
6	62·5	61	0·10	N.S.
7	60·5	62	0·47	N.S.
8	70	62	1·80	N.S.
9	73·5	62	2·79	N.S.
10	79	63	2·79	N.S.
11	84·5	64	4·05	·05>p>·01
12	85	67	7·20	p<·01
13	95·5	68	2·79	N.S.
14	104	66	7·20	p<·01
15	104	71	9·03	p<·01
16	108·5	82	9·03	p<·01
17	111	76	4·05	·05>p>·01
18	115	76	5·46	·05>p>·01
19	104·5	76	5·46	·05>p>·01
20	115	78	9·03	p<·01
21	118	77	9·03	p<·01
22	127·5	77	5·46	·05>p>·01
23	129·5	83	9·03	p<·01
24	135·5	80	11·25	p<·001
25	141·5	78·5	7·20	p<·01
26	141·5	82	7·20	p<·01
27	152	82	11·25	p<·001
28	152	84	11·25	p<·001

It can be seen from Table III, that estimations of one-yard lengths at the same distances made by the schizophrenics are greater than those made by the normals. At long distances these differences become very significant.

The schizophrenic subjects had size constancy estimated by the method described elsewhere (16). The two experiments were carried out within 4 weeks of one another. As was reported in the previous paper, size constancy measurements have a relatively high reliability on retest (16).

In order to find the relation between size constancy and distance constancy the estimations of the distances were related to the estimations of sizes. In the size constancy experiment the subjects reproduced by adjusting a rod in front

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of them the size of another rod at 7·5 m. distance and at 15 m. distance. It was assumed that those subjects who under-estimated the distance would under-estimate the size and vice versa. In the distance constancy experiment an under-estimation of a distance would mean a longer distance, corresponding to a certain number of estimated yard intervals and an over-estimation of a shorter distance corresponding to the same number of yard intervals. Therefore the subjects were ranked according to the objective length of the distances that they had estimated as eight yards and also according to that which they estimated as sixteen yards. (The cumulative objective lengths of the first eight and the first sixteen-yard intervals were used as the measures.) The distances of eight and sixteen yards corresponded approximately to the distances of 7·5 m. and 15 m., used in the size constancy experiment.

The ranking was from the shortest distance to the longest distance. The same subjects were next ranked on their size estimation of the standard object at the 7·5 m. distance and the 15 m. distance. The ranking was from the greatest estimation to the smallest estimation.

The Spearman Rank Difference correlation coefficient was found between the lengths of the first eight-yard interval estimations and the estimations of the size of the standard object at 7·5 m. The same procedure was repeated for the lengths of the first sixteen-yard interval estimations and the estimations of the size of the standard object at 15 m.

For the 8-yard distance estimation and size estimation at 7·5 m.:

$$\text{rho} = +0{\cdot}47 \qquad {\cdot}05 > p > {\cdot}01$$

For the 16-yard distance estimation and size estimation at 15 m.:

$$\text{rho} = +0{\cdot}39 \qquad {\cdot}05 > p > {\cdot}01$$

Thus correlations are in the direction predicted by the theory and are significant in spite of the time interval between the two experiments and the very different settings.

Discussion

The results of this experiment indicate that distance constancy is poorer in schizophrenics than in non-schizophrenics and also that it is related to the poorer size constancy found in these patients. There exists the possibility that the difference between the two groups was due to the fact that the schizophrenics had been hospitalized for many years, that they had been "shut in" in a building and that their poor performance was due to their lack of practice in making judgments of distance. However, almost all the schizophrenic patients used as subjects were parole patients, who spent most of the time out-of-doors in the summer, and were probably more familiar than most of the staff with the fields adjacent to the hospital.

The size constancy and distance constancy studies indicate that the visual perception in schizophrenic patients lacks depth compared with the visual perception of non-schizophrenics. The extent of foreshortening is greater. The perceived gradient of equi-distance intervals in depth of the visual field is much steeper and reaches zero value sooner in schizophrenics than in normals. Therefore, these patients live in a "flatter" world than normals do. They do not integrate the third dimension into the visual field to the same extent as the normals do. As the result of this lack of depth of perception, schizophrenics perceive more in the terms of two-dimensional perspective geometry than do normals, who perceive more in the terms of the three-dimensional Euclidian geometry. Gibson (5), has introduced two important concepts, "visual field" and "visual world". The "visual field" type of perception is a perception in accordance with the retinal image and perspective geometry, where two parallels meet and where third dimensions are indicated only by diminishing gradients of the sizes of objects and distance intervals. The seen world is like a photograph completely in two dimensions and in the perpendicular plane to the line of vision. The "visual world" type of perception is perception in accordance with size and distance constancy and Euclidian geometry, where two parallels do not meet and perception is wholly three-dimensional. Neither schizophrenics nor normals perceive completely in the terms of "visual field" or in terms of "visual world", the actually perceived world is a compromise between the two. In both groups perception at near distance is much closer to Gibson's visual world and at far distance is much closer to his "visual field". In both groups a point is reached where perception is completely in terms of "visual field", for instance, the perception of the dome of the sky with the sun, the moon and the stars*. However, both the studies of size constancy and distance constancy indicate that visual perception in schizophrenics is shifted more in the direction of the "visual field" and that of normals in the direction of the "visual world". In schizophrenics the third dimension is less integrated into the perceived world and the limit of the three-dimensional perception is reached sooner than in normals. To put it in other words, the transition from the three-dimensional space to the two-dimensional plane is more rapid.

Gilinsky (7), using diminishing gradients of equal space intervals in the perceived world, has developed the concept of limited, subjective space, ending at a distance where perception becomes wholly two-dimensional and further perception of depth is impossible (the sky with the astronomical bodies). This subjective space is different in different subjects and in different conditions. It appears that on average this subjective limited space is smaller, more constricted in schizophrenics than in normals†.

The lack of depth and "flatness" of the visual world of schizophrenics has theoretical implications for the phenomenology of schizophrenia. Together with impaired form constancy it can change, foreshorten, and distort the appearance of the perceived objects. Perhaps this change in depth perception would account for the complaint of some schizophrenics that things look different, unfamiliar and strange, that they are unreal, grotesque, menacing, as if they were painted or cut out of cardboard.

There are also other intriguing possibilities. Visual perception in the terms of plane geometry is more literal—the size of the retinal image is interpreted literally, while in perception in the terms of Euclidian three-dimensional geometry the perceived size of the object is related to its distance, therefore this type of perception is more relativistic. The lack of three-dimensionality in perception may influence thinking in schizophrenics in the direction of literalness and concreteness and also it may influence their perceived body and their self-concept in the direction of ego-centricity and a poor differentiation of self from non-self. There is some evidence that in these patients perception of time is also changed (11). Thus, there is a possibility that in schizophrenia both the space and time perspectives are changed and distorted, which would account for the strangeness of the world they are living in. This has been studied clinically by phenomenologists (3, 4, 12, 15), but is now being studied experimentally.

* Some people can assume a sophisticated perceptual set, where they perceive in the terms of Gibsonian "visual field"; this is very important for realistic artists as can be seen for instance in early French impressionists.

† In another paper this concept of subjective space as applied to schizophrenic patients will be developed more formally.

Summary

1. Distance constancy was studied in schizophrenics and normals.
2. Distance constancy is poorer in schizophrenics than in normals.
3. This is related to their poorer size constancy.
4. The result of poor distance constancy is that visual perception in schizophrenics is lacking in depth and that these patients live in a "flatter" world.
5. The implications of this finding are discussed.

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