A COMPARATIVE STUDY OF DISORDERED ATTENTION IN SCHIZOPHRENIA

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INTRODUCTION

IN recent years there has been increasing experimental evidence that specific disturbances of perception occur in schizophrenia. Reduced size constancy in schizophrenic patients has been reported in studies by Raush (13), Crookes (6), and Weckowicz (16). Further investigations by Weckowicz and his colleagues (17), have also demonstrated reduced distance constancy in schizophrenia. (The retinal image of an object alters proportionately with the distance at which it is perceived. Size and distance constancy refer to our normal ability to compensate for changes in the stimulus and thereby to retain a stable perception of the object.) Brengelmann (3) and Angyal (1) have shown that schizophrenic patients have difficulty in reproducing briefly exposed visual stimuli. Penrose (12) has shown that schizophrenics perform poorly in a variety of tests involving visual discrimination.

More recent work along these lines suggests that perceptual disorders in schizophrenia are correlated with other cognitive abnormalities such as disturbed thinking. Weckowicz and Blewett (18), investigating the relationship between size constancy and concept formation in schizophrenia, found the two to be connected. They considered that the disorder of abstract thinking displayed by schizophrenics was due to "over-inclusiveness" and that this same factor was responsible for the perceptual anomalies observed in their patients. Their conclusion was that "the abnormalities of thinking and perception in schizophrenic patients can be described as an inability to attend selectively or to select relevant information". The perceptual and other cognitive difficulties found in schizophrenia are thus, in the opinion of these authors, secondary to a breakdown in the scanning or focusing mechanism of attention.

Payne (10) and his fellow workers carried out a careful study to differentiate between concrete and over-inclusive thinking in schizophrenia and their findings tend to confirm that schizophrenic thinking is abnormally over-inclusive. Discussing the theoretical implications of their work, these authors conclude that the abnormalities of thinking and perception found in their patients were secondary and related to a primary inability to attend selectively to sensory data. These views are in accordance with those expressed by earlier investigators (Schilder (15), Cameron (4), Arieti (2), McKellar (8)), who suggested that schizophrenic thought disorder is a product of a more primitive disturbance in selective attention.

The present authors (7) reached similar conclusions in a clinical study of undeteriorated schizophrenic patients which led them to postulate the general hypothesis that "The earliest reported symptoms of a schizophrenic illness indicate that a primary disorder is that of a decrease in the selective and inhibitory functions of attention". A number of secondary hypotheses can be

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derived from the personal reports of these schizophrenic patients: (1) that the difficulty in selective attention experienced by schizophrenic patients is most pronounced when they have to inhibit stimuli in one sensory channel, in order to deal effectively with information in an alternative channel; (2) That schizophrenic patients tend to be particularly distracted by irrelevant auditory stimuli in their environment, which interfere with both their visual perception and thinking; (3) that they have great difficulty in coping with situations demanding the integration of sensory data from more than one modality; (4) that sensory stimuli produce a disruption in the normally smooth sequence of motor responses, this being particularly marked in the case of auditory stimuli.

On the basis of earlier clinical observations (7), the authors developed a battery of experimental tests in an attempt to assess, in a more objective manner, symptoms of cognitive dysfunction reported by the patients. The work reported in the present paper consists of an application of these experimental techniques to schizophrenic and non-schizophrenic groups in an attempt to assess the validity of the hypotheses outlined above.

Selection of Subjects

The investigation was confined to patients between the ages of 17 and 30 years. Selection was restricted in this manner to avoid the inclusion of more chronic patients, in whom it was felt that factors, such as long duration of illness and hospitalization, might tend to obscure the primary disorders. Accordingly, a list was compiled of all patients in Dundee Royal Mental Hospital in this age group, where the diagnosis of schizophrenia was not in doubt. A total of 16 patients was so obtained. A further four similarly selected schizophrenic patients were obtained from Murthly Hospital, Perthshire. In this manner, 20 mental hospital schizophrenic patients (18 males and 2 females) were selected.

A normal control group was constructed, comprising 20 members of the nursing staff, matched with the schizophrenic patients in age, sex and educational level. A second matched control group of 20 non-schizophrenic mental hospital in-patients was formed, to allow some check on the specificity of the findings to schizophrenic patients. It was originally intended that this patient control group should be composed of 20 patients suffering from endogenous depression. It proved, however, difficult to find such patients within the set age limit who presented with a clear-cut depressive illness. Consequently, the patient control group was finally made up of 10 patients with depressive psychoses and 10 patients with a behaviour disorder, with a psychopathic or epileptic basis.

Method

Each subject was investigated over two 1-hour testing sessions. Three of these tests were standard procedures, used previously by other workers, while the remainder were devised by the present authors to examine the phenomena reported in their previous clinical study.

1. *Von Kuenburgh's Figure-Matching Test*

This test figured prominently in the test battery used by Rylander (14) in his study of patients after frontal lobectomy. It has been used more recently by Costello (5) in his study of visual imagery in leucotomized schizophrenic patients. In this test the subject is shown for five seconds a data card bearing a number of meaningless figures. On each data card one figure is duplicated in two different positions on the card. The subject is next presented with a multiple

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choice card bearing a number of alternative figures and is asked to identify the figure duplicated in the previously presented data card. He is also presented with a location card on which the figures are omitted and asked to indicate the positions of the originally duplicated figure. In the version of the test used in the present investigation, there are two sets of twelve problems of this type. In the first set of twelve the data card contained four figures, two of which are identical. In each series the subject is first shown a trial card to ensure that he understands the nature of the task and his performance on this occasion is not scored. The subject may then be asked to respond by both identifying the duplicated figure and locating its position, or he may be required to respond to one only of these alternatives. The test is so arranged that presentations of the dual and single tasks are equally distributed. The test was scored so as to provide a total single choice score (either identification *or* localization) and a total multiple choice score (identification *and* localization). A ratio of these two scores provided a total discrepancy index indicating the comparative difficulty experienced by the subject in coping with the dual task.

2. *Stroop Test*

This test, which has been used fairly extensively to study the effects of distraction and perseveration, was included in the battery of tests applied by Weckowicz and Blewett (18). The subject is first presented with a card on which is printed, in black, a list of names of colours and he is timed in reading the list aloud. He is likewise tested in his speed of naming a list of variously coloured spots. Finally he is presented with a third list bearing names of colours which are printed in inks of conflicting colour. Here he is asked to ignore the word and to name the colour in which it is printed. A comparison of the subject's score on the second and third parts of this test provides an index of distractibility, which indicates the degree to which his thinking is interfered with by conflicting perceptual cues.

3. *Closure Test*

This is a version of the test first published by Mooney (9) where the subject is shown a series of pictures, exposed for 10 seconds, which require for their identification varying degrees of perceptual "closure": i.e.the task demands that the subject selects, organizes and responds to the relevant stimuli making up the hidden figure, while at the same time inhibiting the irrelevant background stimuli. The score consists of the total number of correctly identified figures.

4. *Serial Integration Test*

The apparatus consists of a box containing eight windows, each of which can be illuminated separately. Through these windows a series of ten words can be exposed so that the subject can only see one letter, or part of one letter, at a time. To respond correctly the subject must integrate the individual items of information when the presentation of each word has been completed. The score here is simply the number of words correctly identified.

5. *Spot Tracer Test*

The subject is asked to indicate, by means of a hand-operated lever, the movements of a spot projected by film on a screen. On the film the spot moves

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randomly either to the left or right of centre, returning to its resting position for a short, but irregular, period before the next movement. The subject's task is to move the hand lever in a lateral direction corresponding to that of the spot movement. The subject's responses are automatically traced on a two-pen electrical recorder. In the second part of the test the subject is again asked to track the spot, but is sporadically subjected to auditory stimulation in the right or left ear (high-pitched buzz). The auditory input is arranged so that it is synchronized with the movements of the target spot. Precautions were taken to allow for any fatigue effects by reversing the order of presentation of the two parts of the test in half of the subjects of each group. The object here is to determine the effects of an extraneous auditory stimulus upon visual-motor performance. Five separate scores are taken on this test consisting of: (1) T1= number of correct responses on the first task; (2) T2=number of correct responses on the second task (with auditory stimulation); (3) D/I=a distraction index (ratio between score 1 and score 2); (4) RO=ratio of omissions (spot movement without response from subject) in Task 2 as compared with Task 1; and (5) RM=ratio of misdirections (subject's response contrary to spot movement) in Task 2 compared with Task 1.

6. *Auditory-Visual (Distraction) Test*

The subject is shown briefly on film a set of six random letters or numbers and then asked to indicate the symbols in their correct order. In all he is shown a series of eight sets of this type at twenty second intervals (Task 1). This is followed by a similar series presented orally on magnetic tape (Task 2). The duration of presentation of each set is arranged to be identical with the period of visual presentation in the first task. The subject is next required to attend to and report another visual series, comparable with the series presented in Task 1, while being exposed simultaneously to an auditory series. Here the subject is instructed to report only the visually presented series and to ignore the auditory series (Task 3). Finally, the demands of the third task are reversed so that the subject is required to inhibit the visual series and report only the auditory series (Task 4). To report successfully on the relevant information presented to him on any one sensory channel, the subject is required to inhibit the irrelevant information reaching him on an alternative channel. Five scores in all are obtained in this test: (1) T1=score on Tasks 1 and 2; (2) T2=score on Tasks 3 and 4; (3) T=total score of correct responses; (4) VS=visual selection score (indicating the effect of auditory distraction); and (5) AS=auditory selection score (indicating the effect of visual distraction).

7. *Auditory-Visual (Integration) Test*

In this test a similar set of six letters or numbers is used, each individual item of which is presented alternately in the auditory and visual channels. Thus, the first letter or number of the set might be presented visually, the second auditorily (on tape), the third visually and this order maintained until the set of six items is completed. The order of presentation of each set is arranged so that the distribution of the initial item is divided equally between auditory and visual channels (i.e. V-A-V-A-V-A- *or* A-V-A-V-A-V). The subject is required to report each complete set in the order of items presented. A series of 20 sets is presented in this manner. The task thus demands the integration of information derived from two sensory channels and presents a wholly different problem

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from that introduced by the two previous tests. Three scores are obtained in this test: (1) T=the subject's total score (the number of correctly reported sets); (2) V=the visual score (the number of correctly reported visual items); and (3) A=the auditory score (the number of correctly reported auditory items).

8. *Auditory-Rotor Test*

The apparatus consists of a small hand-operated friction-free wheel which is connected with a moving-coil galvanometer so that the speed of turning is indicated at any given moment on a dial unseen by the subject. The subject is first allowed practice in turning the handle of the wheel and instructed to find a comfortable turning speed. Once he has established his personal tempo he is asked to turn the wheel at a constant speed for a period of 40 seconds, readings being taken at the 10th second and at 10-second intervals thereafter. After a rest pause of 60 seconds, the subject repeats the same task and this procedure is repeated four times to obtain a total of 16 readings. On the second run of the test, the procedure is repeated while the subject is subjected to a variable auditory rhythm introduced through earphones (recorded metronomic rhythms). The aim here is to examine the effect of variable auditory input on motor output. The score is a comparison of the variability in turning rate on the first run (T1) with that of the second run (T2) to give the final distraction index (D/I).

Apart from the 8 tests described above, each subject completed the Mill Hill Vocabulary Scale to give some indication of his current educational level. Finally a standard check list of information pertaining to the history of the illness and symptomatology was completed for each subject.

RESULTS

The various test scores were analysed to find out which of them differentiated the schizophrenic group from both the patient and normal control groups. Differences were accepted as significant at and beyond the 0·05 level. The results of the analysis of the data on each test are indicated in the following tables showing the mean scores, standard deviations and significance levels reached in contrasting the performance of each group. (N.C.=Normal control group; P.C.=Patient control group; S.G.=Schizophrenic group.)

TABLE I

Figure-Matching Test

Group:	M.	S.D.
N.C.	5·75	9·35
P.C.	17·40	13·98
S.G.	37·50	29·40
Group Comparison:		
N.C. *v.* P.C.	t=3·02 (p<0·01)	
N.C. *v.* S.G.	t=2·83 (p<0·01)	
P.C. *v.* S.G.	t=2·06 (p<0·05)	

It can be seen that this test successfully differentiates (·01 level) both patient groups from the normal control and also, at a lower level of significance

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(·05), the schizophrenic from the non-schizophrenic group. The results suggest that schizophrenics have particular difficulty in directing their attention simultaneously to two different components of the visual field.

TABLE II

Stroop Test

	M.	S.D.
Group:		
N.C.	82·70	50·45
P.C.	81·55	43·01
S.G.	109·45	115·58
Group Comparison:		
N.C. *v.* P.C.	Not significant	
N.C. *v.* S.G.	Not significant	
P.C. *v.* S.G.	Not significant	

Although the schizophrenic patients show relatively more distraction on this test, the differences are not significant and the test does not differentiate any of the groups in this study at a satisfactory level of significance.

TABLE III

Closure Test

	M.	S.D.
Group:		
N.C.	9·60	2·67
P.C.	9·25	3·57
S.G.	3·70	3·44
Group Comparison:		
N.C. *v.* P.C.	Not significant	
N.C. *v.* S.G.	Not significant	
P.C. *v.* S.G.	Not significant	

Although the trend is again towards a poorer performance by the schizophrenic group, the differences are not significant.

TABLE IV

Serial Integration Test

	M.	S.D.
Group:		
N.C.	18·60	1·36
P.C.	15·90	3·56
S.G.	14·20	6·90
Group Comparison:		
N.C. *v.* P.C.	$t=3·07$ ($p<0·01$)	
N.C. *v.* S.G.	$t=2·73$ ($p<0·01$)	
P.C. *v.* S.G.	Not significant	

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The performance of both patient groups on this test was significantly poorer than that of the normal controls. The test, however, fails to distinguish between the schizophrenic and non-schizophrenic patient group.

TABLE V

Spot Tracer Test

	T1		T2		D/I		RO		RM	
Group:	**M**	**S.D.**	**M**	**S.D.**	**M**	**S.D.**	**M**	**S.D.**	**M**	**S.D.**
N.C.	44·45	4·42	45·00	2·17	−2·23	9·81	0·05	0·67	0·00	0·45
P.C.	43·90	2·90	44·20	1·83	−1·02	5·75	0·20	1·40	−0·45	1·66
S.G.	39·60	8·31	32·45	12·82	19·75	18·49	0·15	7·89	5·65	5·25
Group Comparison:										
N.C. *v.* P.C. ..	Not significant		Not significant		Not significant		Not significant		Not significant	
N.C. *v.* S.G. ..	$t=2·21(p<0·05)$		$t=4·24(p<0·01)$		$t=4·58(p<0·01)$		Not significant		$t=4·71(p<0·01)$	
P.C. *v.* S.G. ..	Not significant		$t=3·96(p<0·01)$		$t=4·68(p<0·01)$		Not significant		$t=4·84(p<0·01)$	

The fact that the scores of the two patient groups on the first part of the test (T1) are not significantly different, indicates that the schizophrenic patients perform the tracking task with relative adequacy in the absence of the distracting stimulus. The deterioration in the schizophrenic performance occurs in the second task during which the auditory signal is introduced. The score (T2) on this task successfully differentiates the schizophrenics from both control groups. This deterioration in performance is due to an increased number of misdirections, the errors of omission remaining virtually constant between the two tasks. There are, in fact, two possible forms which errors of misdirection may take on the test, dependent upon the relation between the direction of auditory input (L. or R. ear) and the lateral movement of the target spot. Inspection of the data showed no definite connection between direction of auditory input and direction of response.

These results support the earlier clinical observation that schizophrenic patients are rendered particularly susceptible to a disturbance of visual-motor activity through their inability to inhibit extraneous auditory stimuli.

TABLE VI

Auditory-Visual (Distraction) Test

	T1		T2		T		VS		AS	
Group:	**M**	**S.D.**	**M**	**S.D.**	**M**	**S.D.**	**M**	**S.D.**	**M**	**S.D.**
N.C.	13·54	1·40	13·75	5·99	27·25	2·59	1·75	17·81	−10·60	25·32
P.C.	11·20	2·98	11·25	4·07	23·15	7·01	10·45	30·29	−6·05	42·18
S.G.	10·60	4·60	8·75	4·57	19·35	7·72	16·45	37·29	19·80	34·60
Group Comparison:										
N.C. *v.* P.C. ..	Not significant		Not significant		$t=2·38(p<0·05)$		Not significant		Not significant	
N.C. *v.* S.G. ..	Not significant		$t=2·89(p<0·01)$		$t=4·22(p<0·01)$		Not significant		$t=2·92(p<0·01)$	
P.C. *v.* S.G. ..	Not significant		Not significant		Not significant		Not significant		$t=2·07(p<0·05)$	

Inspection of Table VI reveals that the total score on this test significantly distinguishes both patient groups from the normal controls, but not from each other. The visual selection index yields no significant difference between the three groups, although the schizophrenic group shows the highest level of impairment. The auditory selection index differentiates the performance of the schizophrenics from that of both patient and normal controls, although the difference between the schizophrenic and non-schizophrenic patients is only of borderline significance. The results here indicate that the schizophrenic subjects

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have difficulty in screening out extraneous visual stimuli which disrupt their ability to focus attention on the relevant incoming auditory information.

TABLE VII

Auditory-Visual (Integration) Test

	T		V		A	
Group:	M	S.D.	M	S.D.	M	S.D.
N.C.	15·50	3·47	18·20	1·72	18·85	1·68
P.C.	11·45	5·84	16·70	3·04	15·65	4·58
S.G.	6·15	4·69	12·70	4·76	14·90	3·08

Group Comparison:			
N.C. *v.* P.C. ..	$t=2·60 (p<0·02)$	Not significant	$t=2·41 (p<0·05)$
N.C. *v.* S.G. ..	$t=6·98 (p<0·01)$	$t=4·48 (p<0·01)$	$t=4·26 (p<0·01)$
P.C. *v.* S.G. ..	$t=3·08 (p<0·01)$	$t=3·10 (p<0·01)$	Not significant

While the total score on this test indicates that the schizophrenic group perform at a significantly low level in comparison with both control groups, it is also evident that the non-schizophrenic patients are themselves distinguished from the normal subjects. When we break up the total performance into its visual and auditory components, however, it is only the visual score which isolates the schizophrenic group from both control groups. It would appear that the schizophrenic patients experience particular difficulty in integrating information distributed over two sensory channels. Where this failure of integration occurs, it is likely to show itself mainly in relation to information carried in the visual sensory channel.

TABLE VIII

Auditory-Rotor Test

	T1		T2		D/I	
Group:	M	S.D.	M	S.D.	M	S.D.
N.C.	1·29	9·19	0·95	0·81	−0·25	1·62
P.C.	1·17	6·92	0·86	0·52	−0·64	1·36
S.G.	0·96	7·36	2·19	0·40	1·28	1·17

Group Comparison:			
N.C. *v.* P.C. ..	Not significant	Not significant	Not significant
N.C. *v.* S.G. ..	Not significant	$t=3·06 (p<0·01)$	$t=3·32 (p<0·01)$
P.C. *v.* S.G. ..	Not significant	$t=4·59 (p<0·01)$	$t=4·68 (p<0·01)$

This test proved to be highly successful in differentiating the schizophrenic group from both control groups. It will be remembered that this score indicates to what extent the pattern of motor output is disrupted by variable auditory stimulation.

In order to establish any possible correlation between test performance and the clinical picture, the clinical check list was next consulted. Inspection of the clinical data showed that the 20 schizophrenic patients could be divided

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into two equal sub-groups to which we shall refer hereafter as Schizophrenics A and B. The ratings of the clinical features by which the two groups are distinguished are indicated in Table IX below.

TABLE IX

	A	B
Mean duration of illness ..	4·7 years	3·5 years
Premorbid personality ..	Inadequate	Adequate
Social adjustment	Severely impaired	Impaired
Onset of illness	Insidious	Acute
Thought disorder	Gross	Moderate
Hallucinations	Frequent (auditory)	Infrequent
Affect	Marked flattening and incongruity	Partial or good preservation

It is obvious from the above table that the categories involved are not mutually exclusive and are dependent upon subjective evaluation, but nevertheless the differences between the two sub-groups were clearly observable and allowed an approximate dichotomy. This rough clinical grouping distinguished those patients (Schizophrenics A) whose psychosis has taken a much more severe and malignant form, from the remaining patients (Schizophrenics B). Indeed the former group, in the course of their illness and present clinical state, closely conform to Kraepelin's criteria of dementia praecox and what others have referred to as "nuclear" or "process" schizophrenia. These patients would be classified as belonging to the hebephrenic sub-type of the illness. The patients in sub-group B are in contrast more preserved in their personality, show less marked thought disorder and display a higher incidence of paranoid symptoms. Because of the composition of the patient control group, the subjects fell into two distinct and numerically equal groups of depressed and non-depressed patients, the latter presenting with behaviour disorders.

The various test scores were now re-analysed in respect of these four clinical groups and the mean scores of each are detailed in Table X overleaf.

Although this further breakdown of the two patient groups produces four sub-groups with only ten patients in each, the analysis of the results yields some interesting observations. First these sub-group scores indicate that, in spite of its composition, the patient control group as a whole would appear to be homogeneous in respect of its test performance. In no case do any of the test scores show a significant difference between the depressives and non-depressives constituting the patient control group. The trend on most tests is for the depressives to perform somewhat better than the non-depressive patient controls. When we consider the schizophrenic group it is apparent that the two sub-groups differ markedly in test performance. The rule here is for the subjects in Schizophrenics A group to perform at a considerably poorer level than those in group B. The earlier analysis of the total group scores demonstrated that eight of the test scores (distributed through six of the tests in the battery) successfully separated the schizophrenic group from both control groups. An analysis of the scores broken down into sub-groups as in Table X, reveals that in the case of six of these eight scores, the poorer performance of the schizophrenic group is largely due to the subjects in Schizophrenics A. It would thus seem that much of the difference between the performance of our schizophrenic and control subjects is due to the 10 schizophrenics in sub-group A.

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TABLE X

Mean Scores (Patient Sub-Groups)

	Figure-Matching	Stroop	Closure		Serial Integration	Spot Tracer			Auditory-Visual (Distraction)			Auditory-Visual (Integration)			Auditory-Rotor
	D/I	D/I	T	M	T	D/I	RO	RM	T	VS	AS	T	V	A	D/I
Depressives ..	12·4	65·3	8·8	2·4	16·7	−·79	0·0	−0·1	24·1	4·4	−26·2	11·8	17·3	16·2	−28·7
Non-depressives ..	22·6	86·0	9·7	2·4	15·1	−1·24	0·5	−0·8	22·2	16·5	10·1	11·1	16·1	15·1	5·5
Difference between Means	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Schizophrenics (B)	21·3	97·5	8·0	4·1	18·8	7·76	0·5	2·0	25·7	4·2	27·1	8·50	15·3	15·4	0·91
Schizophrenics (A)	53·7	111·4	7·4	7·1	9·4	31·74	0·0	9·3	13·0	28·7	12·5	3·80	10·6	14·4	1·66
Difference between Means	t=2·80 p<0·02	NS	NS	t=2·19 p<0·05	t=5·43 p<0·01	t=2·69 p<0·02	NS	t=4·15 p<0·01	t=4·67 p<0·01	NS	NS	t=2·46 p<0·05	t=3·05 p<0·01	NS	NS

Discussion

An earlier clinical study of schizophrenic patients led us to formulate the general hypothesis that one of the primary disorders occurring in schizophrenia is a breakdown in the selective-inhibitory functions of attention. This breakdown was considered to be responsible for a number of specific cognitive changes. A clinical analysis of the manner in which this breakdown manifested itself in the behaviour of the schizophrenic patients allowed us to postulate four secondary hypotheses. (1) That the impairment in selective attention was most marked in situations involving stimuli in more than one sensory channel; (2) that schizophrenic patients were most susceptible to the distracting influence of auditory stimuli which tended to disrupt both their visual perception and thinking; (3) that these patients have pronounced difficulty in integrating sensory data from more than one modality; (4) that sensory stimuli (particularly in the auditory field) interfere with the motor output of schizophrenic patients. The aim of the present investigation was to transfer these clinical observations to an experimental setting in order to estimate their validity. This transition from a clinical to an experimental examination of the same phenomena would appear to have been made with a reasonable degree of success, and the findings support the hypotheses derived from our previous work. Although the present test battery does not cover the complete range of the attentive anomalies indicated by the reports of the undeteriorated schizophrenic patients in our former study (7), it has nevertheless yielded results which allow certain limited conclusions.

Investigations involving schizophrenic patients are often criticized on the grounds that the patient's capacity to co-operate and maintain a constant response in any form of testing is so low that any findings are of doubtful validity. Before considering the significance of our data we might observe that we have found surprisingly little evidence to support this view. Although many of our schizophrenic patients were either markedly withdrawn or disturbed in their behaviour, their co-operation was sustained throughout the two testing sessions. The standard instructions to each test appeared to be readily comprehended by the patients who showed by the appropriateness of their response that they understood the nature of the tasks presented to them. The question of co-operation would of course present a greater problem with more acute or more deteriorated schizophrenic patients, some of whom might prove to be inaccessible to such detailed testing.

The consistency of the schizophrenic patients' performance was most noticeable in the first standard run of each test, which we used to provide an assessment of the patient's ability to cope with the task in the absence of a distracting stimulus. Indeed where the task was confined to one sensory channel and was not subject to external distraction, the schizophrenic patients performed at a relatively adequate level. On the Auditory-Visual (Distraction) test they performed both the initial auditory and visual series at a comparable level with the non-schizophrenic patients. This was again true of their performance on the Spot Tracer test when the task was confined to the tracking of the visual target. Their ability to maintain a constant motor output on the Auditory-Rotor test was slightly better than both the non-schizophrenic patients and normal subjects so long as the distracting auditory stimulus was absent. Under these conditions the schizophrenic patient showed reasonably good control over his attention. It was only when his attention was required to be selective, particularly when the selectivity involved information in competing sensory channels, that

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he showed the characteristic deterioration in performance. The suggestion that auditory input appeared predominant in disrupting attention is possibly an artefact based on the one-sided nature of the present test battery. In the only test (Auditory-Visual Distraction) which directly examines the disrupting effect of visual input upon auditory perception, the schizophrenic patients showed a significant impairment in performance.

The schizophrenic patients demonstrated a failure in the control of attention which was most evident in their inability to eliminate from the mass of external stimuli that which was irrelevant to the current task. Much of schizophrenic symptomatology becomes understandable when viewed in the light of such a basic deficiency in selective attention.

If, as it would appear, the selective process of attention is impaired in schizophrenia, we might suppose that the patient would find himself progressively unable to direct and control his reactions to the environment. Recently, Payne (10) has reviewed the reports of cognitive abnormalities in schizophrenia and reaches the conclusion that the diverse findings of most previous investigations could be interpreted as follows: "The mechanism of attention itself seems to become defective. Whatever filtering mechanism ensures that only the stimuli (internal or external) that are relevant to the task enter consciousness and are processed, seems no longer able to exclude the irrelevant. This has numerous repercussions. Thinking becomes distracted by external events. It also becomes distracted by irrelevant personal thoughts and emotions which may even become mixed up with the problem. Selective perception becomes impossible, so that instead of dealing with the essence of the problem, irrelevant aspects are perceived and thought about. . . ." Our findings support this general conclusion and illustrate some of the components of defective attention.

Although there have been a number of recent studies of cognitive performance in schizophrenia most workers, for the purpose of their investigation, have considered the schizophrenic group as a clinical entity. Few attempts have been made to relate the measurements of cognitive dysfunction either to clinical symptomatology or to the conventional sub-types of schizophrenia. Weckowicz and Blewett (18) found evidence that paranoid schizophrenics showed relatively little disturbance of selective attention. In their study it was the non-paranoid, largely hebephrenic, schizophrenic patients who demonstrated a distinct disorder of attention. Our own findings, although based on small groups, would support the conclusions of Weckowicz and Blewett (18) that it is the more disordered hebephrenic type of patient who is subject to a pronounced impairment of selective attention. We find it of some interest that the schizophrenic patients are much more homogeneous in their performance on tasks involving psychomotor performance where the impairment of selectivity appears to be general to the whole schizophrenic group. Although this finding requires further investigation it would suggest the possibility that selective attention is disturbed in schizophrenia but that this disturbance may be distributed differently according to the form of the illness. In the one test (Auditory-Visual Distraction) which directly examines the effect of visual distraction upon auditory perception, it is the schizophrenics in "B" sub-group who showed the greatest decrement in performance.

The limitations of the test battery and the small numbers of subjects involved in the present study preclude any firm answer to many of the questions regarding the conditions underlying the disturbance of attentive behaviour in schizophrenia. Our findings do, however, provide a useful basis for further

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studies. The sensitivity of the more productive tests in the present battery might be increased and their range widened. A remodelled test battery should also bring under inspection a number of variables neglected in the present study. The influence of visual distraction on attention in both the auditory and visual fields requires more careful examination. It would seem important to ascertain the specific aspects of psychomotor output (e.g. speed, accuracy, co-ordination, etc.) which are affected by both visual and auditory input. Finally, before we can form any opinions regarding the specificity of our findings to schizophrenic patients, it would be necessary to apply these tests to other diagnostic groups, in particular to patients with organic brain disease. Further work along these lines might provide a useful aid in diagnosis and widen our understanding of the mechanisms operating behind the schizophrenic symptomatology.

Summary

A previous clinical study (7) suggested that a breakdown in the normal selective and inhibitory functions of attention is a primary disorder in schizophrenia. The present investigation attempts to examine experimentally the validity of this general proposition and of other specific hypotheses derived from it. A battery of tests designed to assess the effect of distracting stimuli upon attentive behaviour was applied to matched groups of 20 schizophrenic patients, 20 non-schizophrenic and 20 normal subjects. It proved possible to differentiate the schizophrenic group from the normal and patient control groups by their poor performance on a number of these tests (Figure-Matching, Spot Tracer, Auditory-Visual Distraction, Auditory-Visual Integration, Auditory-Rotor). Although the scores produced on these tests significantly differentiate the schizophrenic group as a whole, there was a wide scatter in the individual performance of the schizophrenic patients. Some of the schizophrenic patients returned scores on the tests which were at least as high as that of the lowest scoring subjects in the non-schizophrenic patient group. Further analysis revealed that this overlapping of individual test scores was mainly due to the marked deficiency of the hebephrenic patients, all of whom performed at a significantly low level. The implications of these findings are discussed and future lines of investigation are considered.

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