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Distractibility in Schizophrenia and Organic Cerebral Disease

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Introduction

Recent investigations of cognitive disorder in schizophrenia (Payne and Hewlett, 1960; Payne, Caird and Laverty, 1964) have indicated that schizophrenic performance in cognitive tests is characterized by a tendency to use very loose, "overinclusive" concepts. This phenomenon which Cameron (1944) termed "overinclusive thinking", has been re-interpreted by Payne (1961) in terms of an impairment of a hypothetical filter mechanism which normally excludes irrelevant stimuli from consciousness and so allows attention to be directed towards the task in hand. McGhie and Chapman (1961) and Chapman (1966) have presented clinical evidence based on the subjective reports of schizophrenic patients supporting the hypothesis that a primary disorder in this disease is an impairment in the selective and inhibitory functions of attention. Chapman and McGhie (1962) and McGhie, Chapman and Lawson (1965a and b) have substantiated and elaborated this clinically derived hypothesis in an experimental setting where the subjects were required to perform various psychomotor and short-term memory tasks with and without distracting stimuli. The results of these investigations, while supporting the hypothesis in a general way, were nevertheless equivocal. The distraction effect in schizophrenia appeared to be confined to those situations where adequate performance involved the processing of a substantial amount of information. This finding was explained in terms of Broadbent's (1958) theory of the human operator as a limited capacity information channel. It appeared that distraction affected the performance of schizophrenic patients only in situations where the limited information channel was fully occupied in handling relevant aspects of the task—for example, in tracking and short term memory tests. Under these conditions the assimilation of irrelevant information produces overloading of the information channel and a consequent breakdown of performance. On the other hand, in those tasks requiring little information processing—for example, in repetitive psychomotor tasks—the channel is operating well below capacity, the assimilation of irrelevant information does not lead to overloading, and consequently does not have any detrimental effect on performance. An analogue of this situation occurs in normal subjects, in whom division of attention between two sources does not necessarily lead to impairment of performance if the informational requirements of each source are small and total information load does not exceed the critical limit (Broadbent and Herron, 1962). For the schizophrenic patient attention tends to be divided between the relevant and the irrelevant, yet impairment in performance need not occur if the informational requirements of the task are kept small.

A further feature of the earlier results of McGhie *et al.* (1965a and b) concerned the heterogeneous nature of the schizophrenic group. While it could be shown that the schizophrenic group as a whole could be statistically differentiated from normal and patient control groups, the variance of schizophrenic distractibility scores was always extremely high, some patients performing substantially at a normal level. A breakdown of the schizophrenic patients by means of a symptom rating scale into two sub-groups according to severity of illness revealed that pathological distractibility was confined largely to the severely ill or "hebephrenic" group.

In view of the present controversy concerning a possible organic aetiology in respect of some forms of schizophrenia (Bleuler, 1963; Chapman 1966) it was considered worth while to extend these two studies to include patients suffering from organic cerebral disease.

A further finding of McGhie *et al.* (1965a) suggested a possible modality difference in short term memory distractibility. It appeared that, while schizophrenic performance was highly differentiated from that of both normal and patient control subjects in an auditory distraction test, no pathological distractibility could be found in the visual modality. There were two reasons why this finding might be attributable to artefact. First, the findings rested on a large number of indpendent statistical tests of data from a wide range of experiments, so that any one result, unless it fitted a pattern, might possibly be ascribable to statistical aberration. Secondly, there were important differences in the construction of the auditory and visual distraction tests, which allowed peripheral factors of attention such as focus and direction of gaze to operate in the visual case. Thus it seemed desirable to construct analogous auditory and visual distraction tests, eliminating the possibility of peripheral visual attentional adjustments, in order that performances in each modality could be directly compared.

Selection of Subjects

The experimental group consisted of 29 patients with a confirmed diagnosis of schizophrenia. The normal control group was drawn from the nursing and secretarial staff at the Royal Dundee Liff Hospital.

Two groups of patients with organic cerebral disease were included for purposes of comparison. These consisted of 12 temporal lobe epileptic patients, all with a demonstrable focal lesion, and 16 patients suffering from arteriosclerotic dementia. Details of number, age and verbal ability, as measured by the Mill Hill Vocabulary Scale for the various groups is shown in Table I.

It is apparent from Table I that there is considerable inter-group variation in mean age. As might be expected, the arteriosclerotic subjects are considerably older than the others, but the purpose of including these subjects was to determine if their performance bore any resemblance to that of the schizophrenic patients.

The second point about the age distribution is that the paranoid group tend to be rather older than the schizophrenic, epileptic and normal control groups. It must be pointed out, however, that in view of the evidence from normal studies of ageing (Broadbent and Herron, 1962) that distractibility tends to increase with age, the fact that the paranoid group was rather older than the schizophrenic patients will tend to lead to a Type II error where the significance of differences between the two groups will be underestimated.

Method

The order of presentation of the auditory and visual distraction tests was randomized, half the subjects in each group performing the auditory test first.

Auditory Distraction Test

This test was a modified form of that previously used by McGhie, Chapman and Lawson (1965a). The subjects

Table I

Distributions of Age and M.H.V. Scores

Group	N	Age		M.H.V. Score	
		Mean	S.D.	Mean	S.D.
Normal	22	31·23	12·04	56·79	9·77
Paranoid	14	47·79	10·05	57·11	15·23
Schizophrenic ..	29	33·00	10·10	53·81	12·29
Epileptic	12	31·83	10·00	38·33	7·07
Arteriosclerotic ..	16	62·38	6·39	49·47	11·95

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were required to retain a series of six pre-recorded digits and to respond by repeating them as soon as the presentation was complete. The digits were recorded on tape by a female voice at an average rate of one per 2 seconds, and the total time per presentation was 12 seconds. The initial and final second of the 12-second trial always contained a digit, but otherwise the positions of the digits in the 12-second period were determined randomly.

In the second (distracting) condition, the six one-second blank periods were occupied by irrelevant digits recorded in a different (male) voice. Ten trials were given without, and ten with distraction; the order of presentation of the two conditions being counterbalanced to minimize practice and fatigue effects. Order was taken into account in scoring responses.

Visual Distraction Test

The design of this test was analogous to that of the auditory distraction test, the only difference being that the relevant and irrelevant digits were presented visually by projecting a coloured film on a screen. Here the relevant digits were in blue, while the irrelevant ones which intervened at irregular intervals in the "distraction" condition were white with a large green circle round them. The instructions, procedure and scoring of the responses were the same as in the auditory test, and administration time was about the same. The subject was seated approximately 10 to 15 feet from the screen and the digits were about 9 inches in height. All subjects were questioned as to the legibility of the digits during the practice trials, and their distance from the screen adjusted accordingly.

Results

The scores of each individual on the auditory and visual distraction tests were converted to error scores to facilitate computation. Each test yielded two scores—a measure of basic retention without distraction which will be designated "O", and a measure of retention under distraction conditions which will be referred to as "D". Throughout this section, a single asterisk denotes the 5 per cent. level and a double asterisk the 1 per cent. level of significance. Mean error scores are shown in Tables II and III and t-tests for correlated distributions have been used to determine in what groups and in which modality condition distractibility occurs.

All groups are significantly distracted in the auditory distraction test, except the paranoid group in whom the mean scores with and without distraction are almost identical. This is in striking contrast to the results of the visual test, where no group shows a significant distraction effect.

Table II

Group Performances on the Auditory Distraction Test

Group	N	"O" condition		"D" condition		t
		Mean	S.D.	Mean	S.D.	
Normal	22	1·73	1·73	4·14	3·92	3·17**
Paranoid	14	5·71	4·84	5·57	5·48	0·42 (n.s.)
Schizophrenic ..	29	5·66	4·37	13·55	12·93	4·09**
Epileptic	12	7·67	7·07	16·17	11·65	4·01**
Arteriosclerotic ..	16	12·81	8·43	21·31	12·63	4·72**

Table III

Group Performances on the Visual Distraction Test

Group	N	"O" condition		"D" condition		t
		Mean	S.D.	Mean	S.D.	
Normal	22	1·18	1·30	1·23	1·04	0·16 (n.s.)
Paranoid	14	5·50	5·50	4·29	5·20	2·11 (n.s.)
Schizophrenic ..	29	11·34	10·98	11·66	11·10	0·03 (n.s.)
Epileptic	12	8·42	7·47	11·08	8·45	1·54 (n.s.)
Arteriosclerotic ..	16	19·56	12·53	21·25	14·80	1·00 (n.s.)

An analysis of variance indicated that the effects of distraction differed significantly between the different diagnostic groups and with the modality in which the test was conducted. Since the main interest lies in the question of distractibility, which is a "within subjects" factor with only two levels, it is possible to derive a distractibility score for each subject in each modality by calculating the algebraic difference between his scores with and without distraction. These scores may then be compared for the different groups by means of t-tests. Hypothesized differences in distractibility were tested for each modality, and results are shown in Table IV. The group mentioned first in the comparisons in Column I of Table IV is in each case the least distracted.

In terms of auditory distractibility, all hypothesized differences prove significant, while in the visual modality only the epileptic group are more distracted than the controls, and this at a marginal level of significance.

Although a very rigid concept of schizophrenia was utilized in the selection of patients, it was decided to identify within the schizophrenic group those patients whose illness had run, or was likely to run, a malignant and chronic course. These patients, who are referred to as hebephrenic, displayed clinical characteristics which included a markedly schizoid pre-morbid personality and an insidious onset in the absence of precipitating factors. The symptoms of this group of patients tended to include marked incongruity of affect, severe thought disorder, bizarre delusions and frequent hallucinations. The selection criteria for this group are more fully discussed by Chapman and McGhie (1962) and McGhie, Chapman and Lawson (1965a). This procedure resulted in the resolution of the schizophrenic group into 15 "hebephrenic" and 14 non-hebephrenic patients. Table V illustrates the distributions of age and Mill Hill vocabulary scores for the two symptom sub-classes.

It will be noticed that the hebephrenic group, were slightly older than the others, but this difference does not achieve statistical significance ($t=1\cdot20$; d.f.$=27$; $p>0\cdot20$). The hebephrenic group also scored slightly lower on the vocabulary test, but this difference also failed to reach significance ($t=1\cdot53$; d.f.$=27$; $p>0\cdot10$). It would seem reasonable to conclude from this that the factors of age and verbal intelligence do not influence the comparisons

TABLE IV

Group Comparisons for Auditory and Visual Distractibility

Groups	d.f.	Auditory t-values	Visual t-values
Normal *v.* Schizophrenic ..	.. 49	2·42*	0·02 (n.s.)
Paranoid *v.* Schizophrenic	.. 41	2·90**	0·76 (n.s.)
Normal *v.* Epileptic ..	.. 32	3·29**	2·07*
Paranoid *v.* Epileptic ..	.. 24	4·41**	2·36*
Normal *v.* Arteriosclerotic	.. 36	3·27**	1·14 (n.s.)
Paranoid *v.* Arteriosclerotic	.. 28	4·97**	1·57 (n.s.)

TABLE V

Distributions of Age and M.H.V. Scores for the Hebephrenic and Non-Hebephrenic Sub-Groups of the Schizophrenic Group

Group	N	Age		M.H.V. Score	
		Mean	S.D.	Mean	S.D.
Hebephrenic ..	15	35·13	11·49	50·40	14·45
Non-Hebephrenic ..	14	30·71	7·81	57·43	9·62

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involving the hebephrenic and non-hebephrenic sub-groups.

In view of the fact that the sub-division of the schizophrenic group into hebephrenics and non-hebephrenics involves ratings which reflect the degree of severity of the patient's illness, it may be argued that the classification so achieved measures nothing more than the chronicity of the illness. In order to go some way towards answering this objection, the schizophrenic group was sub-divided according to whether more or less than five years had elapsed since their last admission. This procedure resulted in a distribution of thirteen chronic and sixteen non-chronic patients. A 2×2 χ^2 test of contingency was then performed on the two variables "chronicity" and "hebephrenia", the result indicating that there was no significant correlation between these two measures ($\chi^2 = 0{\cdot}31$; d.f. $= 1$; $p > {\cdot}80$). We may conclude that the hebephrenic classification does not merely reflect chronic hospitalization.

As in the analysis of the performance of the undifferentiated schizophrenic group, it seemed appropriate to examine the performance of the two sub-groups independently in order to assess where significant distraction effects occur. The results of this analysis mirrored the findings summarized in Tables II and III, both sub-groups being significantly distracted in the auditory test but not in the visual. The important consideration, however, centres on the comparisons between the two sub-groups of schizophrenia and the other clinical control groups with respect to distractibility. Those comparisons are summarized in Table VI, the least distracted group being mentioned first in Column 1.

It is clear that in terms of auditory distractibility the hebephrenic group perform at a significantly lower level than the non-hebephrenic and control groups. The non-hebephrenic patients, on the other hand, are significantly less distracted than the brain-damaged patients. Comparisons of distractibility in the visual task reveal no significant differences, so it may be concluded that the division of the schizophrenic group into clinical sub-groups makes no difference to the negative findings concerning visual short-term memory distractibility in schizophrenia.

In view of the marked modality differences in distractibility. it seemed worth while to examine modality differences in basic retention without distraction. McGhie, Chapman and Lawson (1965c) demonstrated that the normal ageing process involves a decline in the efficiency of visual retention which is much more marked than that in the auditory modality. It seemed possible that this feature of immediate memory is manifest in brain-damaged states and also in schizophrenia. Auditory and visual memory scores were thus compared, and the results are summarized in Table VII.

It is clear that for the two control groups and the epileptic patients the auditory and visual retention scores are comparable. In the schizophrenic and arteriosclerotic groups, however, visual short term memory appears to be markedly inefficient. In order to determine if hypothesized differences between the groups in this respect reached satisfactory levels of statistical significance, measures of the inferiority of visual retention for each subject were derived by subtracting the error score in the auditory modality from the visual error score. The

TABLE VI

Group Comparisons Involving the Hebephrenic and Non-Hebephrenic Groups on Auditory and Visual Distractibility

Groups	d.f.	Auditory t-values	Visual t-values
Non-Hebephrenic *v.* Hebephrenic ..	27	2·36*	0·89 (n.s.)
Non-Hebephrenic *v.* Epileptic ..	24	2·40*	1·82 (n.s.)
Non-Hebephrenic *v.* Arteriosclerotic	28	2·77**	1·21 (n.s.)
Normal *v.* Hebephrenic	35	3·23**	0·73 (n.s.)
Paranoid *v.* Hebephrenic	27	3·34**	1·20 (n.s.)

TABLE VII

Modality Differences in Basic Retention Scores for the Various Groups

Group	N	Auditory Score		Visual Score		t
		Mean	S.D.	Mean	S.D.	
Normal	22	1·73	1·73	1·18	1·30	1·20 (n.s.)
Paranoid	14	5·71	4·84	5·50	5·50	0·17 (n.s.)
Schizophrenic ..	29	5·66	4·37	11·34	10·98	3·45**
Epileptic	12	7·67	7·07	8·42	7·47	0·36 (n.s.)
Arteriosclerotic ..	16	12·81	8·43	19·56	12·53	2·28*

resulting distributions for the various groups are compared in Table VIII, groups with least discrepancy between visual and auditory scores being mentioned first in Column I.

TABLE VIII

Group Comparisons of Modality Differences in Basic Retention

Groups	d.f.	t
Normal *v.* Schizophrenic	49	3·27**
Paranoid *v.* Schizophrenic	41	2·37**
Normal *v.* Epileptic	32	0·83 (n.s.)
Paranoid *v.* Epileptic	24	0·43 (n.s.)
Normal *v.* Arteriosclerotic	36	2·94**
Paranoid *v.* Arteriosclerotic	28	2·14*

Only the schizophrenic and arteriosclerotic groups differ significantly from both control groups in the inferiority of visual short-term memory. In the latter group this might be due to the ageing process itself, so that we cannot conclude that disturbance of this kind is a feature of pathological degeneration of brain tissue. The interesting point is that despite the age difference the schizophrenic group shows a similar disorder of visual short-term memory. The epileptic group, contrary to expectation, showed no evidence of a special vulnerability of visual short-term memory although it must be borne in mind that the number of subjects in this group was rather small for adequate statistical treatment.

A comparison between the hebephrenic and non-hebephrenic patients indicated that it is the former group who show a marked defect in visual short-term memory. Group comparisons involving the hebephrenic and non-hebephrenic sub-groups are shown in Table IX, groups with least vulnerability of visual short-term memory being mentioned first in Column 1.

TABLE IX

Group Comparisons Involving the Hebephrenic and Non-Hebephrenic Groups of Modality Differences in Basic Retention

Groups	d.f.	t
Non-Hebephrenic *v.* Hebephrenic ..	27	3·00**
Non-Hebephrenic *v.* Epileptic ..	24	0·25 (n.s.)
Non-Hebephrenic *v.* Arteriosclerotic	28	1·69 (n.s.)
Normal *v.* Hebephrenic	35	4·84**
Paranoid *v.* Hebephrenic	27	3·49**

It may be concluded from the results that the hebephrenic group show significantly greater inefficiency of visual short-term memory than either the non-hebephrenic group or the control group.

DISCUSSION

The present results appear to confirm our previous findings suggesting a modality difference in distractibility in schizophrenia, the distraction effect being confined to the auditory modality. Furthermore, the effect is specific to that sub-group of schizophrenia designated as "hebephrenic", who demonstrate a degree of distractibility in auditory, short-term memory tasks akin to that found in the brain-damaged groups.

Before discussing the general implications of these divergent findings in respect of the two modalities, we might first consider a possible source of artefact in the present results. Speith

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and Webster (1955) and Speith, Curtis and Webster (1954) have shown that the selection of a relevant auditory message in a situation where irrelevant stimuli are interpolated between relevant stimuli is greatly facilitated if the physical difference between the relevant and irrelevant stimuli is increased. No method is available for easily equating discriminability of stimuli in different sense modalities, so that the point might be made that the present results may merely reflect the fact that the auditory task presented a more difficult discrimination problem, which the schizophrenic and brain damaged patients were relatively less able to deal with efficiently. We are, however, able to answer this point by referring to an earlier experiment specifically concerned with the effect on schizophrenic patients of varying the discriminability of relevant and irrelevant messages. Lawson (1962) applied the Speith technique to groups of schizophrenic and normal subjects in order to determine if stimulus discriminability played any part in the magnitude of the distraction effect in schizophrenic short-term memory performance. The results of this experiment were entirely negative, all subjects being equally affected by the increasing difficulty of discrimination. A breakdown of the schizophrenic group into hebephrenic and non-hebephrenic sub-groups made no difference to the negative nature of the results. It therefore does not seem likely that the different findings in the two distraction tests used in the present study can be explained in terms of discriminability of the stimuli, so that a genuine modality difference appears to exist.

A further source of difficulty in interpreting the present results lies in the apparent contradiction with some previous findings regarding visual distractibility in schizophrenia. Weckowicz's (1960) Hidden Pictures test which differentiated schizophrenic from patient controls involved the visual detection of a pattern with a competing background of irrelevant visual stimuli. McGhie, Chapman and Lawson (1965b) demonstrated that schizophrenics were more distracted than normal subjects by irrelevant visual stimulation in a visual reaction time situation. In addition, Stilson and Kopell (1964) showed that schizophrenic patients performed worse than patient controls in a visual detection test when random visual noise was added to the stimulus display. The various studies by Weckowicz and his colleagues concerning size and distance constancy in schizophrenia have been explained in terms of visual distractibility. In addition to these experimental studies, some account must be taken of the clinical findings of McGhie and Chapman (1961), which suggested very strongly that schizophrenic patients had difficulty in ignoring irrelevant visual stimuli in a situation demanding visual attention. The essential difference between these visual attention situations and those in the present study is that the latter involve *storage* of the relevant stimuli rather than just detection and response. It seemed likely, in view of previous evidence, that the apparent specificity of the distraction effect in schizophrenia and brain-damaged conditions to the auditory modality had something to do with the fact that the tests used in the present study involved the short-term *storage* of information.

Following up this line of enquiry, an analysis was undertaken of the basic auditory and visual retention scores in the absence of distraction. Interest in auditory and visual retention *per se* in schizophrenia and brain-damage stemmed also from a study by McGhie, Chapman and Lawson (1965c) in which it was demonstrated that short-term memory declined much more rapidly with age in the visual modality than in the auditory. It seemed possible that this feature of performance might be manifest in brain-damaged states and perhaps also in schizophrenia, in view of current opinions about the organic nature of some forms of schizophrenia.

The results of this part of the analysis show that the schizophrenic and arteriosclerotic groups have special difficulty in the retention of visually presented stimuli when compared with normal and patient controls. The results in the case of the arteriosclerotic group might have been anticipated in view of the fact that they are considerably older than the other groups, so that one cannot interpret this result as reflecting solely the effects of pathological brain damage. The interesting point is that the schizophrenic group show a similar vulnerability of visual

short-term memory. In contrast, the epileptic group did not show any special defect of visual retention. This suggests the possibility that this disability is more likely to occur with more diffuse cerebral disease.

A good deal is known now about the difference between the processes of auditory and visual short-term memory storage. Sperling (1960, 1963) and Averbach and Coriell (1961) concluded that visual retention involves an initial visual storage system from which material is "read out" into the more permanent auditory short-term memory. The reading out process appears to involve the conversion of the material into an auditory form for rehearsal. Conrad (1964) later demonstrated more directly that visually presented material tends to be stored in an auditory form, since errors of short-term memory closely resemble acoustic confusions even when the stimuli are presented visually. In addition, it was noted by Averbach and Coriell (1961) that the auditory recoding of the visual information took a relatively long time, so that the "read-out" from the visual store into auditory short-term memory was a fairly slow process. It is possible that the relative inefficiency in the storage of visually presented material in the schizophrenic group is due to a disorder in the mechanism which converts the visually presented information into an auditory form for more permanent immediate memory storage.

The phenomenon of specific deficit of visual retention in hebephrenic patients and those with organic cerebral disease requires much closer study, possibly along the lines of investigating the rate of auditory recoding of visually presented material and the decay characteristics of the initial visual storage mechanism. What is clear from this study is that the distraction effect in malignant forms of schizophrenia is confined to the auditory modality, and that a similar vulnerability to distraction, particularly in the auditory modality, characterizes the performance of patients with organic cerebral disease. The absence of the distraction effect in the visual modality may well be a consequence of a deficit at the input stage of visual short-term memory. Such a deficit may effectively reduce the rehearsal load in the visual case to a level where it is invulnerable to distraction.

Summary

Schizophrenic patients, along with temporal lobe epileptic and arteriosclerotic patients, proved to be more distractible in an auditory short-term memory test than normal and paranoid patient controls. This impairment of attention in the schizophrenic group was found to be specific to those patients with a more malignant symptomatology (the "hebephrenic" group). The results of an analogous test of visual distractibility were entirely negative.

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