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RECALL DEFICIT IN ACUTE SCHIZOPHRENIA

by

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Abstract

The present research is designed to investigate a recall deficit in schizophrenia which has been reported by some workers. Twenty-four acute schizophrenics and 24 normal subjects of average verbal intelligence were selected. Patients were selected on the basis of psychiatric diagnosis and MMPI profiles. Random series of 5 and 7-digit lists were presented on a memory drum for recall. A successive probe technique randomly probed for each serial position on every presentation.

Schizophrenic recall was definitely poorer than that of the control group. The recall curves of the 7-digit data especially, were remarkably similar, while those of the 5-digit list suggested the possibility of a ceiling effect for normals. Patients had more omissions and insertions while frequency of reversals was unchanged; they also made progressively fewer responses after the first few attempts at recall. A high and low recall patient group could be delineated, the former scoring as well as the controls. The following hypotheses were discussed, defective rehearsal, defective search mechanism, trace decay, interference factors, and motivational effects. Some suggestions were made for further research.

ACKNOWLEDGMENTS

I extend sincere thanks and appreciation to my thesis supervisor, Dr. E. Bauman for his patient and constructive criticisms throughout all phases of this research.

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Introduction and Review of the Literature

Reviews of the literature concerning psychological deficit in schizophrenia by Payne (1961), Yates (1966) and Zimet and Fishman (1970) reveal the scarcity of relevant research on memory. Topics such as intelligence, perception, attention, abstractness, and communication appear to provide the mainstream of investigation of the schizophrenic process.

One of the earliest investigations of memory in psychiatric patients was done by Clark L. Hull (1917) who was interested in retention of associations among the "insane". Pairing 12 Chinese characters with 12 nonsense syllables, he required nine patients and 10 normals to achieve two consecutive error-free trials during initial learning. He found that his patients took much longer to form associations but subsequent recall after one week revealed no significant differences in recall. He therefore postulated that the patients' memory disturbance was primarily one of registration rather than retention.

Eysenck (1952) tested a group of psychotics, neurotics, and normals on a task calling for recall of letters on cards. He found that the memory of psychotics on this task was significantly poorer than for the other two groups. Cohen (1950) tested a group of neurotics, organics, and schizophrenics on the Wechsler Memory Scale and found no significant differences across all of the subtests for the three samples. Greenberg (1953) reported that his sample of chronic schizophrenics performed rather poorly as compared to normals on this

same test.

Brengelmann (1958) was interested in the effects of exposure time on the immediate recall of 48 neurotics and 48 schizophrenics. He administered the Figure Reconstruction Test which consists of five simple shapes arranged around a central reference point. He found that at the two second exposure duration, there were no significant differences between groups. At 30 seconds, however, the schizophrenics obtained higher rotation errors which he attributed to their lack of ability to maintain a level of mental preparedness.

Blatt (1959), investigating recall and recognition vocabulary, found that on the Ammons Full Range Picture Vocabulary Scale his group of 69 schizophrenics were equivalent in recognition scores to the normal subjects. On the Wechsler-Bellevue Vocabulary Scale, which called for a process of recall, he found that his patients did not score quite as well as the normals.

Donahoe, Curtin, and Lipton (1961) explored the susceptibility of schizophrenics to interference effects in both the acquisition and retention of a set of rote verbal units. They constructed three sets of six nonsense syllables each, a nonsense list (NI), a meaningful list (M), and a second nonsense list to be interpolated between the learning and relearning of NI. Schizophrenics required significantly more trials to reach criterion of one perfect trial on original learning. The effects of interpolation showed no difference between groups. Recall on the first relearning trial after interpolation showed patient recall scores to be statistically similar to those of normals. Lang and Luoto (1962), however, found that chronic schizophrenics were more susceptible

to interference effects by interpolation of a nonsense list than were neurotics and nonpsychiatric patients.

Belmont, Birch, Klein, and Pollack (1964) divided a sample of schizophrenics into a group which had a history of marked behavior disorders in childhood, and one who did not. They required these subjects, as well as 19 normals, to give their verbal impressions of the series of Rorschach cards, and to recall these reports later. They found that the early disturbed schizophrenics had poorer recall of their responses than the other two groups, and postulated a relationship with CNS dysfunction.

McGhie, Chapman, and Lawson (1965) were interested in the effects of distraction on the perception and immediate recall of information. They presented sequences of six letters or numbers alternately in the visual or auditory channels to a group of 36 schizophrenics, 40 normals, and 20 nonschizophrenic psychotics. They found that auditory distraction on a visual task led to greater performance decrements in schizophrenics while both types of distraction had similar effects on an auditory task. When the two modalities were integrated for retention and recall, most errors were found in vision. These workers concluded that schizophrenics are particularly suseptible to distraction effects in perception and recall of visual elements.

In a recent review of the literature, Yates (1966) concluded that schizophrenics do have memory difficulties and explained these as follows. Drawing upon Broadbent's (1958) filter theory, he suggested that the rate at which information is processed in schizophrenics is abnormally slow. Since short-term memory will hold items in store for only a

limited time, the amount of information which is lost is greater for these patients. When short-term memory (STM) difficulties arise, these are primarily due to the schizophrenics's inability to handle rapid input.

Gladis (1967) performed an experiment where he gave 45 schizophrenics and 36 normals a list of eight paired associates, and after original learning tested for retention after periods of 7, 14, or 28 days. He found no differences between groups for learning trials to criterion. Mean recall scores were however significantly poorer across conditions ($p < .001$). Number of items recalled also decreased as retention interval lengthened.

Phelan, Levy, and Thorpe (1967) postulated that concept learning in schizophrenia is affected by their memory deficit. Chronic schizophrenics do poorer on concept tasks since they cannot recall the hypotheses which they sampled and rejected during search for a solution. The patients were found to use cue selection in concept formation but did poorly since they failed to benefit from past experience, but also since their selection procedure was much slower with more errors than for normals.

Cohen (1968) tested two groups of schizophrenics divided according to their field articulation levels. He presented negative and positive affect-arousing words in a paired-associate learning situation and concluded that the learning and recall of schizophrenics was not disrupted by negative material. He found however that high field articulators reached criterion of two errorless repetitions in fewer trials, recalled more positive stimuli, and showed less deterioration in recall of negative

material through time. A normal control group was not employed.

The interference theory of Lang and Buss (1965) suggested to Bogard (1968) that white noise used for distracting purposes would have a significant effect on recall performance of chronic schizophrenics. He divided the 81 patients into nine groups at three noise levels and found a nonsignificant effect on recall with noise presented during learning and during recall.

In a recent study, Spohn, Thetford, and Woodham (1970) investigated visual information processing in schizophrenic and normal subjects. They presented 40 cards containing six consonants each in varied exposure times of 50, 250, 750, and 1100 msec's, as well as 40 cards at a constant 50 msec exposure duration. The span of apprehension (SA) under both conditions was significantly poorer for the patient group. All subjects did better as exposure time increased, but schizophrenics did not improve at the same rate as the normals. In agreement with McGhie, Chapman, and Lawson (1965), the authors suggested that schizophrenics seem to process visual information less efficiently than normals. They postulated that perhaps an SA experiment reflects short-term memory processing which is poorer in schizophrenics due to their relatively slower rate of reading off visual information from a display. Though current level of memory was statistically controlled, patients originally scored poorer on the Wechsler Memory Scale (M.Q. 82 versus 105).

Nachmani and Cohen (1969) were interested in recall as well as recognition performance of schizophrenic patients. They administered 15 items comprised of states of the United States or names of edible plants to 30 schizophrenics and 30 neurotics under both conditions.

As they had expected, schizophrenics had poorer recall scores than neurotics, while recognition differences were insignificant. They related their work to research by Rosenberg and Cohen (1966) which suggested that in verbal communication, the speaker's role is a two-stage process, while that of the listener is comprised of only a single stage. Similarly in recall, the observer must sample items from an underlying subset and then decide whether or not this sample is a member of the recall list; in recognition, the sampling stage is not involved. Schizophrenic defecit in recall is due to their faulty comparison stage judgements when the task requires them to integrate this process with one of sampling in recall.

Prior to Nachmani and Cohen's (1969) research, Bauman (1965) suggested from the findings of Blatt (1959) that recall memory would be impaired in schizophrenics while recognition would be normal. Eight patients and eight normals were selected on the basis of the Goldstein-Scheerer Object Sorting Test and the Payne Object Classification Test as being overinclusive. Of the 24 subjects, 16 were thus considered as non-overinclusive in each group.

In the recall task the subjects were required to reproduce as many of the 20 four-letter stimulus words as they could recall from a single presentation. For recognition, a choice was provided between synonyms of the stimulus words, words which rhymed with the stimulus words, and words which rhymed with the synonyms.

Schizophrenics were poorer than normals in recall, while recognition scores did not differ. Overinclusive schizophrenics produced similar scores to overinclusive normals in recall while the overinclusive

patients tended to do better in the recognition task. Pattern of errors did not differ between groups. Bauman (1965) concluded that overinclusive thinking had no significant effect on memory performance in general.

He provided three possible theoretical explanations of his results. Schizophrenic deficit could be due to an abnormally rapid trace decay (Inglis and Caird, 1963) so that trace strength falls below the level of recall, but still is above the threshold of recognition. Within the framework of interference theory, schizophrenics possibly may have a great deal of difficulty in retrieval from storage phase. Previous research (McGhie, 1966) has shown these patients to be abnormally susceptible to environmental distractions which presumably interfere with the memory process. This does not however explain why recognition scores do not differ between the groups. On the other hand, schizophrenics may have difficulty in organizing the material at input. The strength of associative linking between items must be greater for recall than recognition since the latter requires less organization and therefore has not been affected.

In a further investigation, Bauman, (1968), suggested the possibility that the recall difficulties of schizophrenics may be due to an associative defect at input. That is, schizophrenics are unable to organize incoming information in an efficient manner and consequently perceive input as unstructured and disorganized. It could then be predicted that these patients would not benefit from the organization which may be inherent in a serial list.

Twenty-four schizophrenic patients and 24 normal subjects were given 32 seven-letter lists, half of which were random (R) while the other half

were organized (O) CVCVCVC sequences. Each subject repeated the lists out loud (voiced) or silently (mouthed) as it was felt that the recall deficit might be overcome as additional auditory cues were made available. The findings of this study indicated that schizophrenics recalled fewer correct responses and made more errors than normals. Organization at input tended to increase correct responses in both groups. Bauman (1968) concluded that schizophrenics are able to profit from organization at input. The effect of voicing did provide additional auditory cues and facilitated recall in schizophrenics and normals alike. Analysis of the results indicated that the patients made more omissions than normals, and these increased steadily from the first to the last serial positions. The omissions of normals however showed a serial position curve. It was suggested that the difference was due to excessive proactive inhibition in patient recall with interference at output being the important feature of the schizophrenic's memory difficulty.

In a second experiment, Bauman (1968) was interested in the schizophrenic's own ability to organize stored material. He gave one half of his subjects instructions which might facilitate organization of trigrams by alphabetical means, while the other half were told to do their best. In the recall task, patients did not score as well as normals. Instructions for organization facilitated recall in normals while this effect was not produced in the schizophrenic sample. Recognition scores were similar for both groups, seemingly unaffected by subjective organization. Bauman again suggested that there was an interference effect during the process of retrieval in schizophrenia which made subjective organization difficult. He likened this to excessive "noise" at output which made retrieval of

weak memory traces difficult. Besides speculation on the "rapid decay" hypothesis previously mentioned, he proposed that the process of responding may have greater interference effects for schizophrenics during retrieval of weaker memory traces.

To summarize the work thus far, it appears obvious that the field of immediate memory in schizophrenics is not altogether unequivocal. Most of the workers reviewed, appear to have found some recall deficit though there is no agreement whatsoever regarding the underlying processes responsible. Yates (1966) and Spohn et al. (1970) attribute it to slower information processing at input. Nachmani and Cohen (1969) are convinced that it is due to faulty comparison stage judgements during integration with sampling of response. Lang and Luoto (1962) and McGhie et al. (1965) are interested in interference effects caused by interpolation of elements or extraneous distraction. Bauman (1968) is certain that schizophrenic recall deficit is not due to a lack of organization at input, but to difficulty of organization just prior to output. He has also speculated (Bauman 1965, 1968) that an abnormally rapid trace decay may be involved, and is fairly certain that schizophrenics suffer from interference effects at the retrieval stage of information processing.

It may be useful to provide a rigidly controlled experiment on schizophrenic recall where through the analyses of correct responses as well as errors, the immediate memory situation could be analyzed. Bauman's (1965, 1968) subjects were classed generally as acute patients with inclusion of chronics to provide median hospital stays of 5.5 and six months respectively (means, 2.5 and 2.2 years). There have been workers (Mednick, 1958; Payne, 1961; Venables, 1966) who have suggested that

the cognitive effects of chronicity may differ, though Bauman (1968) has not found this to be the case in memory.

The present investigation is intended to provide information about:

1. Recall difficulties of acute schizophrenic patients;
2. The pattern of responses and error of these patients compared to a normal control group;
3. The underlying processes responsible for difficulties with recall.

Method

General Design

Random series of 5 and 7-digit lists were presented on a memory drum to 24 schizophrenic patients and 24 normal subjects. A successive probe technique for recall was employed which randomly probed for each serial position on all series. Subjects were required to recall as many digits in their respective positions as they could without time limit.

Materials

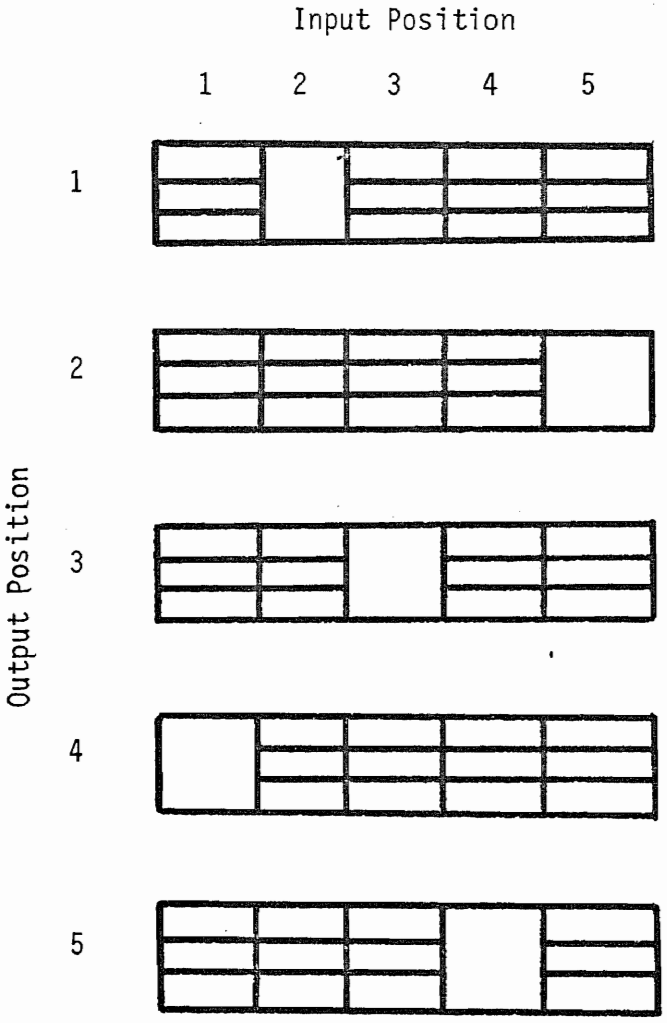
The digits were selected from a table of random numbers (Edwards, 1965) in series of five and seven digits. The order of presentation of the two was random. A second series from the table was applied to randomize digit position for recall. This procedure was controlled to the extent that each digit position was probed exactly five times across trials. This therefore accounted for twenty-five 5-digit lists and thirty-five 7-digit lists for recall.

The digits were presented on an Electrocraft memory drum. Rate of presentation was 2.3 digits per second for the 7-digit series and 1.7 per second for the 5-digit series. After each display, the machine was stopped with no time limit imposed on recall. Prior to digit presentation in the experimental condition, five series of 3, 4 and 5 digits were employed to explain the method of recall.

This method called for successively probing each digit position on every series. Figure 1 shows a 5-digit response sheet employed for recall. Subjects were required to fill in the digit for a particular position always beginning at output position #1 and progressing

Figure 1

A 5-Digit Recall Sheet



consecutively to the last.

Procedure for Selecting Subjects

The problem of the reliability of diagnosis has been reviewed by Kreitman (1961) and Beck (1962) who agree that differences exist partly due to factors of psychiatric experience, examination, nomeclature, and lack of provision for independent judgements at the time of original diagnosis.

In order to overcome the final point, the Minnesota Multiphasic Personality Inventory (MMPI) was administered to all participants. Subjects' responses were profiled for diagnosis and actuarial description (see Hathaway and Meehl, 1951; Dahlstrom and Welsh, 1960; Marks and Seeman, 1963; and Gilberstadt and Duker, 1965).

Digit recall shows a correlation to intelligence which, for purposes of this study, had to be carefully controlled. Payne (1961) has indicated that when normal and psychotic groups were compared, the type of test which yielded the smallest mean difference between groups was a vocabulary test. He concluded that the vocabulary level of psychotic patients provided a good measure of pre-illness and present level of intellectual functioning. This was in agreement with Moran, Gorham, and Holtzman's (1960) findings in which they retested 30 schizophrenics over a six year period on selected vocabulary tests and found no significant changes. Bannister (1962), Payne, Caird and Laverty (1964), Bauman (1965, 1968), and Spohn, et al. (1970) have employed vocabulary measures as estimates of verbal intelligence. In the present study, the Vocabulary subtest of the Wechsler Adult Intelligence Scale was used for the reasons stated, but also because it correlated highest with Full Scale intelligence.

Subjects

Twenty-four acute schizophrenic patients and 24 normal subjects were used in this investigation (see Table 1). Eleven patients were chosen from McKellar Psychiatric Clinic, McKellar General Hospital, Thunder Bay, 11 from Lakehead Psychiatric Hospital, Thunder Bay, and two by referral from a psychiatrist in private practice. Ages of patients ranged 16 to 39 with a mean of 23.96; normals ranged 16 to 39 with a mean of 23.79 ($t=0.094$, N.S.). Length of hospitalization for patients ranged one to 155 days with a mean of 19.86 days and a median of 12.50.

The verbal I.Q. of patients averaged 100.83 and normals 101.04 ($t=0.1073$, N.S.). Educational achievement by grades was 10.54 for schizophrenics and 10.63 for the control group ($t=0.176$, N.S.).

Patients were initially selected by psychiatric diagnosis but if the MMPI did not confirm it, they were rejected. In this manner, 23 patients were not employed in this study due to this diagnostic conflict. Profiles were compared to those outlined by Marks and Seeman (1963) and Gilberstadt and Duker (1965). The averaged profiles are illustrated in Figure 2. Appendix A provides Hathaway MMPI profiles for both groups. The patient sample, without exception, includes the Schizophrenia scale (8) as highest or nearly so, with only three normals showing minor elevations of several other scales. Bauman (1968) has extensively discussed the use of MMPI data as a diagnostic complement and concluded that a patient sample so selected had a common core of schizophrenic symptomatology.

All patients were still on medication. Daston (1959) tested 26 chronic schizophrenics in a blind drug study with two phenothiazine drugs and found that immediate memory remained relatively intact.

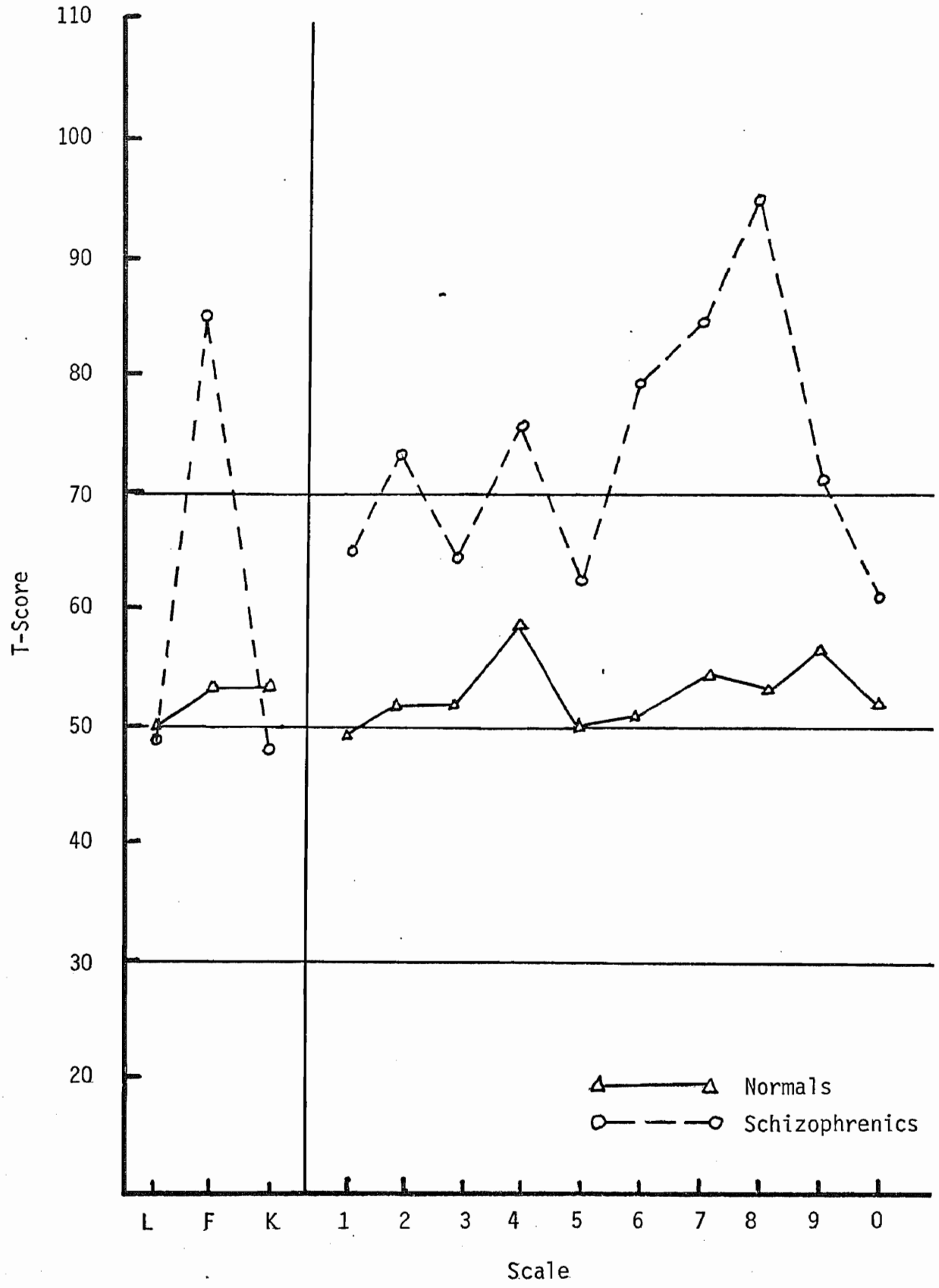
Table 1

Subjects Selected

		Mean	S.D.	Median	Range
Schizophrenics	Age (yrs)	23.96	6.15	22.00	16-41
	Verbal I.Q.	100.83	10.27	100.00	85-120
	Education (grade)	10.54	1.83	10.00	8-14
	Length of Hospitalization (days)	19.86	31.55	12.50	1-155
Normals	Age (yrs)	23.79	6.22	21.50	16-39
	Verbal I.Q.	101.04	9.13	102.50	80-125
	Education (grade)	10.63	1.67	10.00	8-15

Figure 2

Averaged MMPI Profiles



Kelly, Marquis, Gerard, and Uhr (1958a, 1958b) found that chlorpromazine showed no dependable drug effects on 51 behavioral measures. Bauman (1965, 1968) reviewed a number of studies and concluded that the effect of drugs on memory in schizophrenic patients was not a crucial variable to consider. Patients were not deprived of their medication also because psychiatrists and the attending physicians are often reluctant to interfere with an ongoing treatment program. Drug withdrawal at times leads to a deterioration in a patient's behavior to the point where he may be untestable.

The subjects included 13 males and 11 females in each group. Normals were selected from workers in both hospitals, employees of Lakehead University, students of the Adult Education Centre, Thunder Bay, persons employed elsewhere, and by personal aquaintance. They were paid for their services.

Experimental Procedure

The procedure was divided into two separate sessions, the first involving interview and administration of the MMPI. On the second occasion, the vocabulary subtest was given in conjunction with memory testing. Following the five practice exercises and explanation of the procedure, the random series of five and seven digits were presented for recall. At completion, each digit position had been probed five times accounting for 25 lists of five digits and 35 of seven digits. Vocabulary and memory testing averaged about 65 minutes.

Instructions to all subjects were as follows:

> I would like you to look at this machine. Through this little window you will see some numbers go by. Try to remember them, o.k? Now you have just seen the numbers 6-1-3 go by. Here on this sheet I will ask you to write the numbers down, one in each of these squares.

In this first square where there are two lines the first number to be entered is 6. But I don't want you to write this number in. I want you to write in the second number in this blank square. You see, this is for the first number, this for the second and this for the third. The second number from the numbers 6-1-3 is 1, isn't that right? Good! See I don't want you to write in the third number either.

Now look here, the first square is blank so I want you to write in the first number from the numbers 6-1-3 which of course is 6. Good! Here the last one is blank and the number 3 should go in. Do you understand? Good!

Now watch the window again. You have just seen 2-5-4 go by. Look here. I don't want the first number which should go in the first square, I don't want the second but I want you to write in the third number from the numbers 2-5-4. This number of course is 4. Good! Here I want the second number, 5 and here the first, 2. Good! Do you understand?

Now you will see four numbers. Try to remember them...7-3-5-2. Here I don't want the first number but the second, which is 3; here I want the last which is 2; here the first which is 7 and the 5 should go here. Do you understand?

O.K. let's try two on your own...1-2-6-3. The first number here is 1. Good! The third number is 6. Good! Now do this one on your own... 4-7-5-3-2. Here the third is 5, here the last is 2, here the second is 7, here the fourth is 3 and the first which is 4.

Now do you understand what I want you to do? Write in only the numbers which are wanted in the blank square. Write in the second or the fourth or any one which is left blank. Keep all of the numbers in your mind and give only the one asked for. Start at the top and work towards the bottom. If you can't remember one then skip it and go onto the next. O.K. Any questions?

Results

A preliminary inspection of the 5-digit data showed the means and standard deviations to be correlated ($r=-0.954$, see Table 2). Subsequently, all raw data for 5 and 7-digits was converted by square root transformation (Edwards, 1965, p. 128).

Figure 3 outlines the proportions correct across positions for the 7-digit data. Recall scores are well separated for each position and show the familiar primacy and recency effects of the serial position curve. Summing across all of the positions, normals showed correct recall of 70.24% of the digits, while patients only 39.23%.

A trend analysis of variance (Edwards, 1965) was performed on the data (see Table 3). The recall scores of the schizophrenic sample were poorer than those of the normal group ($p < .001$). The performance of the groups differed across positions ($p < .001$) but the pattern of recall was the same suggesting a basic similarity in the recall process.

The serial position curves for seven digits showed a significant linear and quadratic component (see Appendix B) while analysis of the Groups x Positions interaction of these components indicated that the linear effect was the same for the two groups while the quadratic effect differed (Appendix B). This means that the combined curves have a relatively straight descending portion as well as a pronounced curvature. The linear effect does not differ between groups but the curvature does, likely to the difference at position number five.

Figure 4 outlines the proportions correct across positions for

Table 2

Bartlett's Test of Homogeneity of Variance
Chi-Square Values[a]

	7-Digit Data	5-Digit Data
Original	18.69	111.65
	N.S.	p<.001
Transformed	--	5.98
	N.S.	N.S.

[a]Edwards (1965) p.125

Figure 3

Proportion Correct for Each Serial Position for the 7-Digit Data

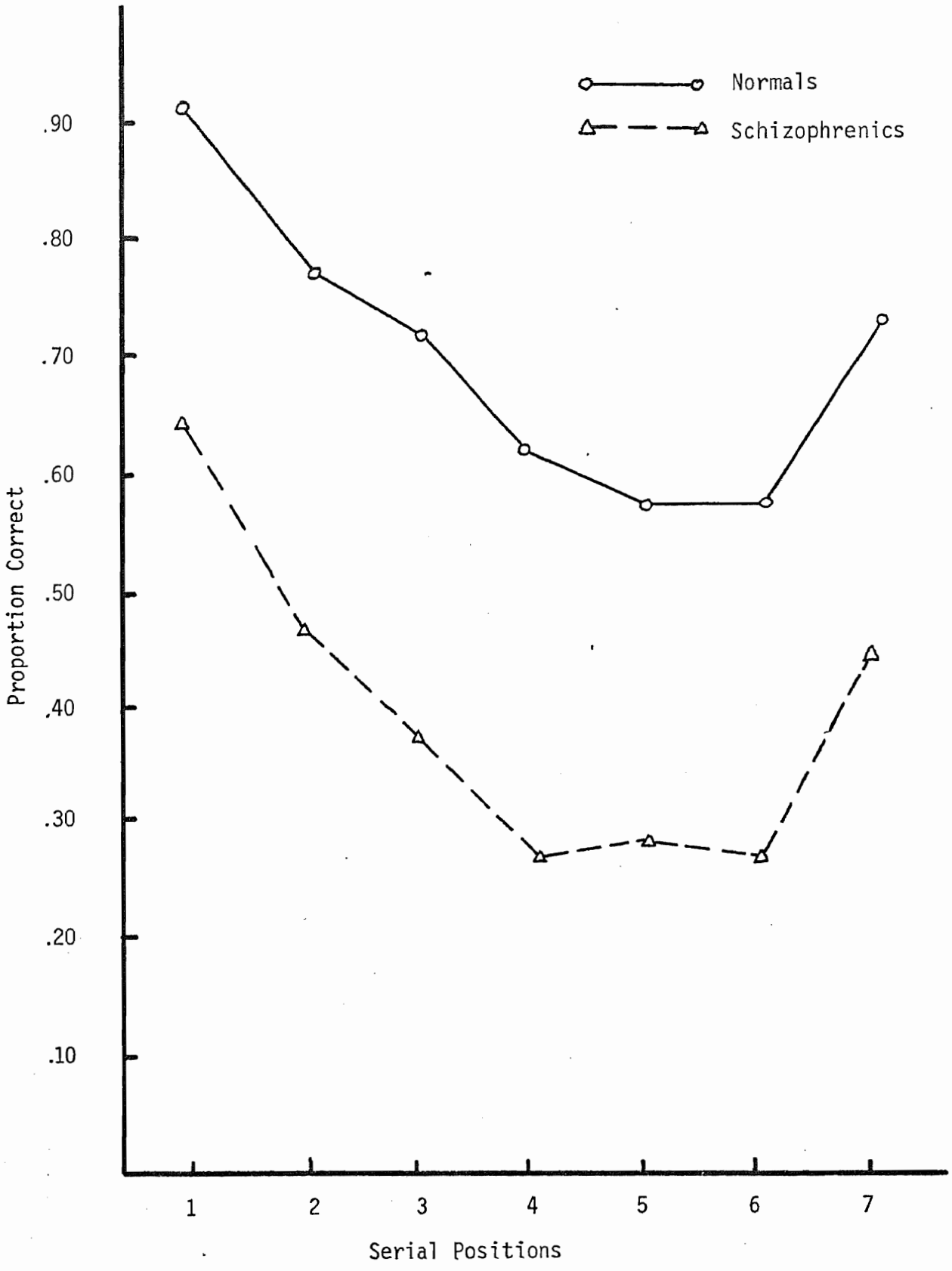


Table 3

Analysis of Variance of Serial Position

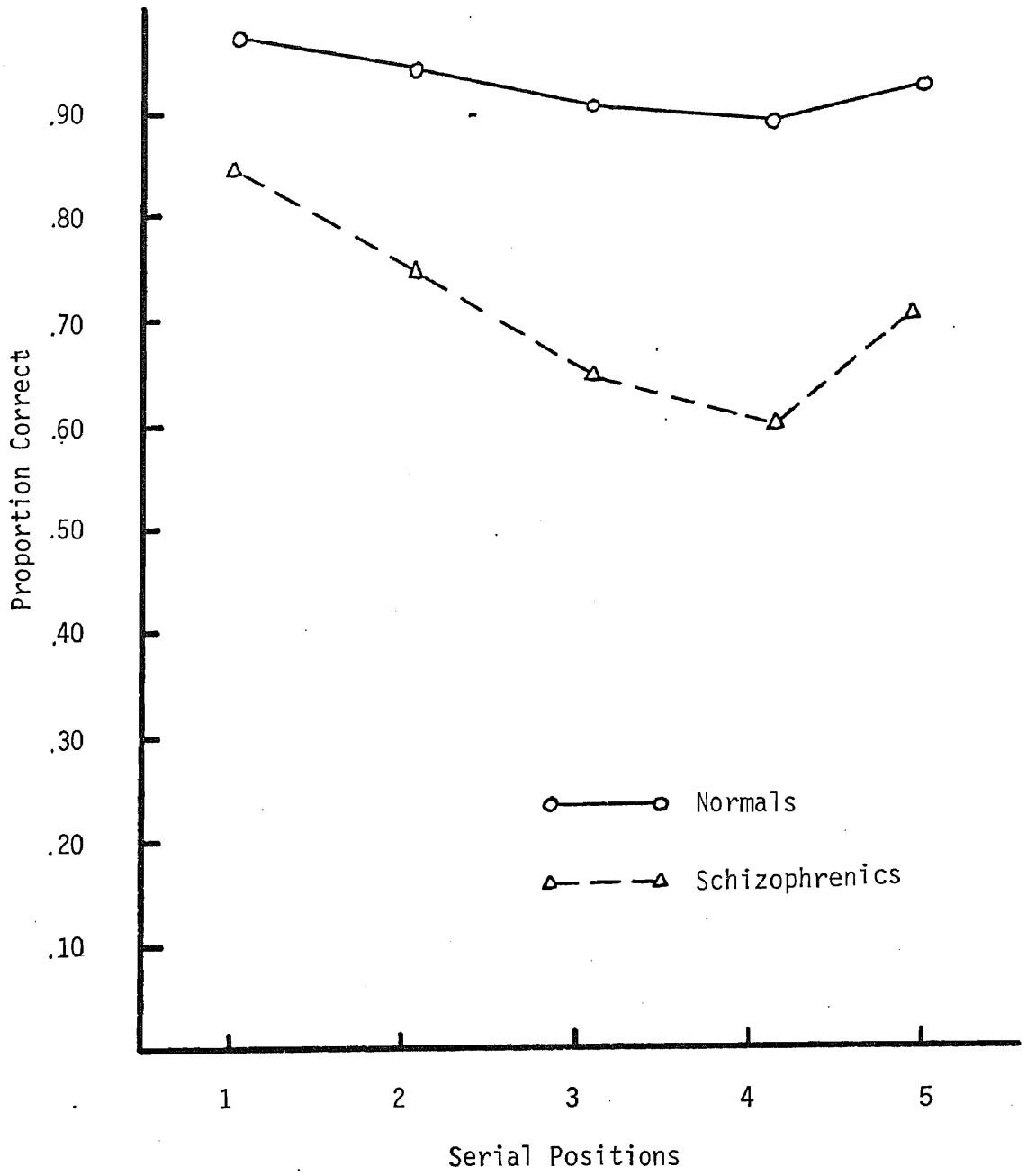
For the 7-Digit Data

Source	SOS	df	MS	F
Groups (A)	166.170	1	166.170	34.865***
Error (a)	219.722	46	4.766	
Position (B)	94.596	6	15.766	42.495***
A X B	4.398	6	0.733	1.976
Error (b)	102.559	276	0.371	
Total	587.445	335		

***p<.001

Figure 4

Proportion Correct for Each Serial Position for the 5-Digit Data



the 5-digit data. Totalling across the five positions, normals correctly responded to 93.30% of the items while schizophrenics only 70.43%.

A trend analysis of variance (Edwards, 1965) was performed (see Table 4). Again the recall scores of the patients were poorer than those of the control group ($p < .001$). As with the 7-digit analysis, there is also a difference across Positions ($p < .001$). The interaction indicates that the recall scores differ between the groups across positions. There is a linear and quadratic component in the data and the interactions of these components suggest that the recall curves differ both linearly and quadratically (see Appendix C). This might be attributed to a ceiling effect in the control group.

Inspection of the patients' raw scores showed a wide variation in correct recall across subjects. The possibility of a relationship of recall to age, I.Q., education, hospitalization, and MMPI profiles was investigated. Table 5 outlines the analysis across positions of the eight highest and eight lowest scores for patients, selected from the 7-digit data.

Within the sample of schizophrenics, two groups could be differentiated; a high and a low recall group ($p < .001$). The former scored 56% total correct across the seven positions while the latter only 22%. The effect across positions was significant as expected ($p < .001$). The interaction does not approach significance suggesting again that the recall process remains unchanged though correct recall varies considerably.

High and low patient scores were not related to age nor to I.Q.

Table 4

Analysis of Variance of Serial Position

For the 5-Digit Data

Source	SOS	df	MS	F
Groups (A)	28.375	1	28.375	24.890***
Error (a)	52.440	46	1.140	
Position (B)	7.373	4	1.843	16.908***
A X B	1.869	4	0.467	4.284**
Error (b)	20.233	184	0.109	
Total	110.290	239		

** $p<.01$
*** $p<.001$

Table 5

Analysis of Variance of Patients' Data Selected for High (H) and Low (L) Recall for the 7-Digit Data

Source	SOS	df	MS	F
H & L Recall Groups (Y)	101.590	1	101.590	39.575***
Error (a)	35.939	14	2.567	
Positions (B)	38.424	6	6.404	16.380***
Y X B	2.669	6	0.444	1.136
Error (b)	32.849	84	0.391	
Total	211.471	111		

***p<.001

However there were differences within the schizophrenic group in terms of educational attainment and length of hospitalization (see Table 6). Patients with high recall results were better educated and had been in hospital a shorter time prior to testing.

The possibility of variation of MMPI profiles between these two groups was not borne out. Table 7 shows that the high and low recall groups do not differ but also that the shapes of the profiles are similar (i.e. the Recall Groups x Scales interaction was not significant). (also see Figure 5)

Figure 6 shows correct recall of the 7-digit data across positions for normals and schizophrenics (as in Figure 3), with high and low performance patients included. An analysis of variance for treatment means with unequal samples was performed on the data from the 24 normals and eight high recall schizophrenics (Edwards, 1965). When position means were considered, the scores of the high recall patients did not differ from those of the normal group (see Table 8). In summary, a group of patients who can perform as well as the average of the normals has been delineated while still retaining similarity of age, I.Q., and MMPI profiles to those of their poor recall counterparts.

In the 5-digit analysis, employing a similar procedure of selection of the 8 highest and 8 lowest scores of patients, again it was possible to differentiate a high and low recall group ($p < .001$)(see Table 9). The former scored 91.3% total correct across the five positions while the latter only 51.5%. Unlike the 7-digit data, the recall curves for the high and low schizophrenic groups differed ($p < .05$) (also see Figure 7). This suggests the possibility of a

Table 6

Analysis of High and Low Patient Recall Groups

For the 7-Digit Data

		Age	I.Q.	Educ'n	Hosp'n
High Recall	Mean	22.375	106.875	12.375	6.375
	Standard Deviation	2.594	11.973	1.798	7.744
Low Recall	Mean	22.875	97.500	9.000	16.378
	Standard Deviation	4.594	7.500	0.707	8.395
	t score	0.250	1.755	4.623***	2.317*

*p<.05

***p<.001

Table 7

Analysis of Variance of MMPI Scores Selected for High (H) and Low (L) Recall for the 7-Digit Data

Source	SOS	df	MS	F
H & L Recall Groups (Y)	68.906	1	68.906	0.136
Error (a)	7079.138	14	505.652	
MMPI Scales (Z)	12876.381	9	1430.709	13.924***
Y X Z	935.282	9	103.920	1.011
Error (b)	12946.237	126	102.747	
Total	33905.944	159		

***p<.001

Figure 5

Averaged MMPI Profiles for Normals, High Recall Schizophrenics, Low Recall Schizophrenics, and All Patients

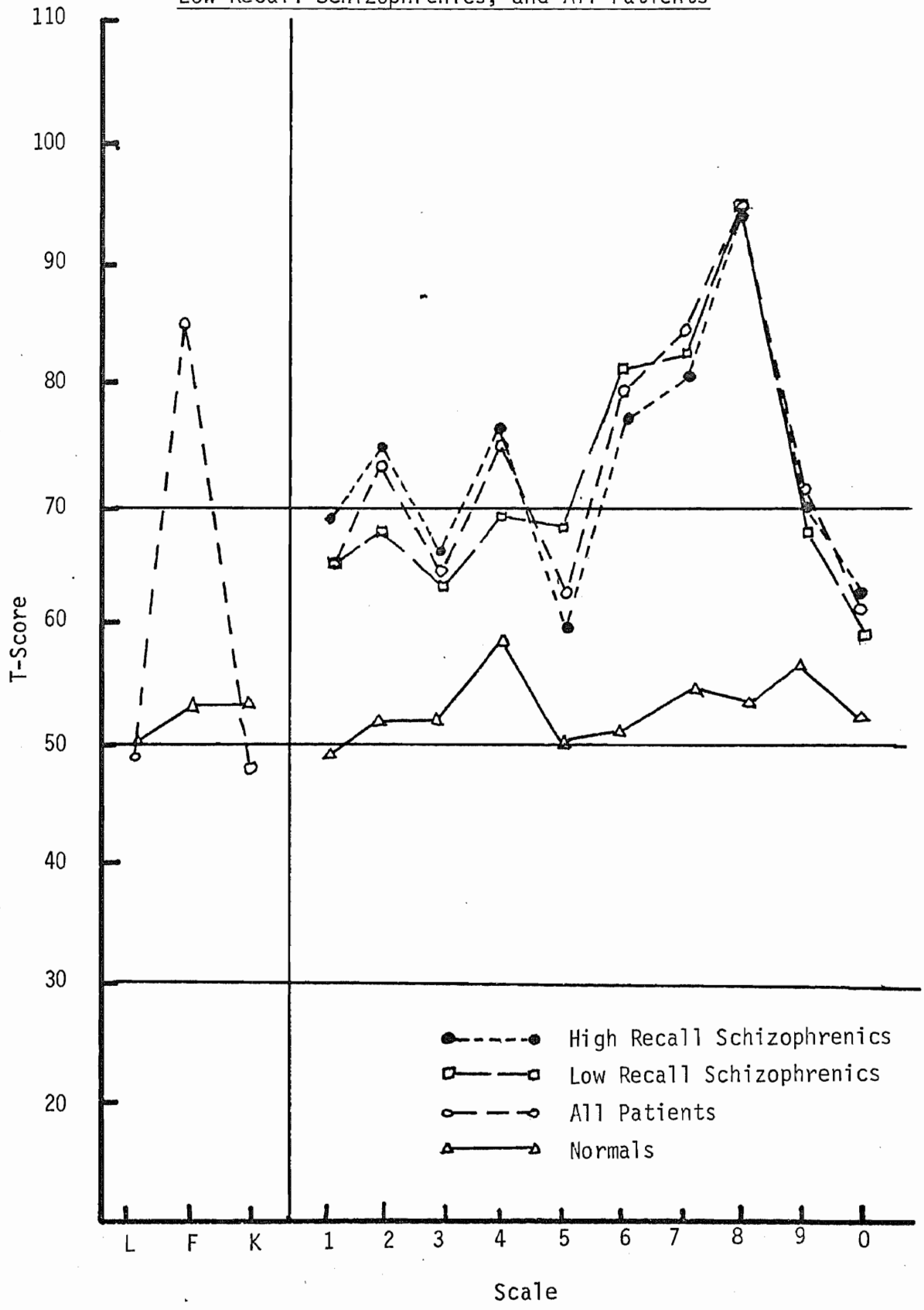


Figure 6

Proportion Correct for Normals, High Recall Schizophrenics, Low Recall Schizophrenics, and All Patients for the 7-Digit Data

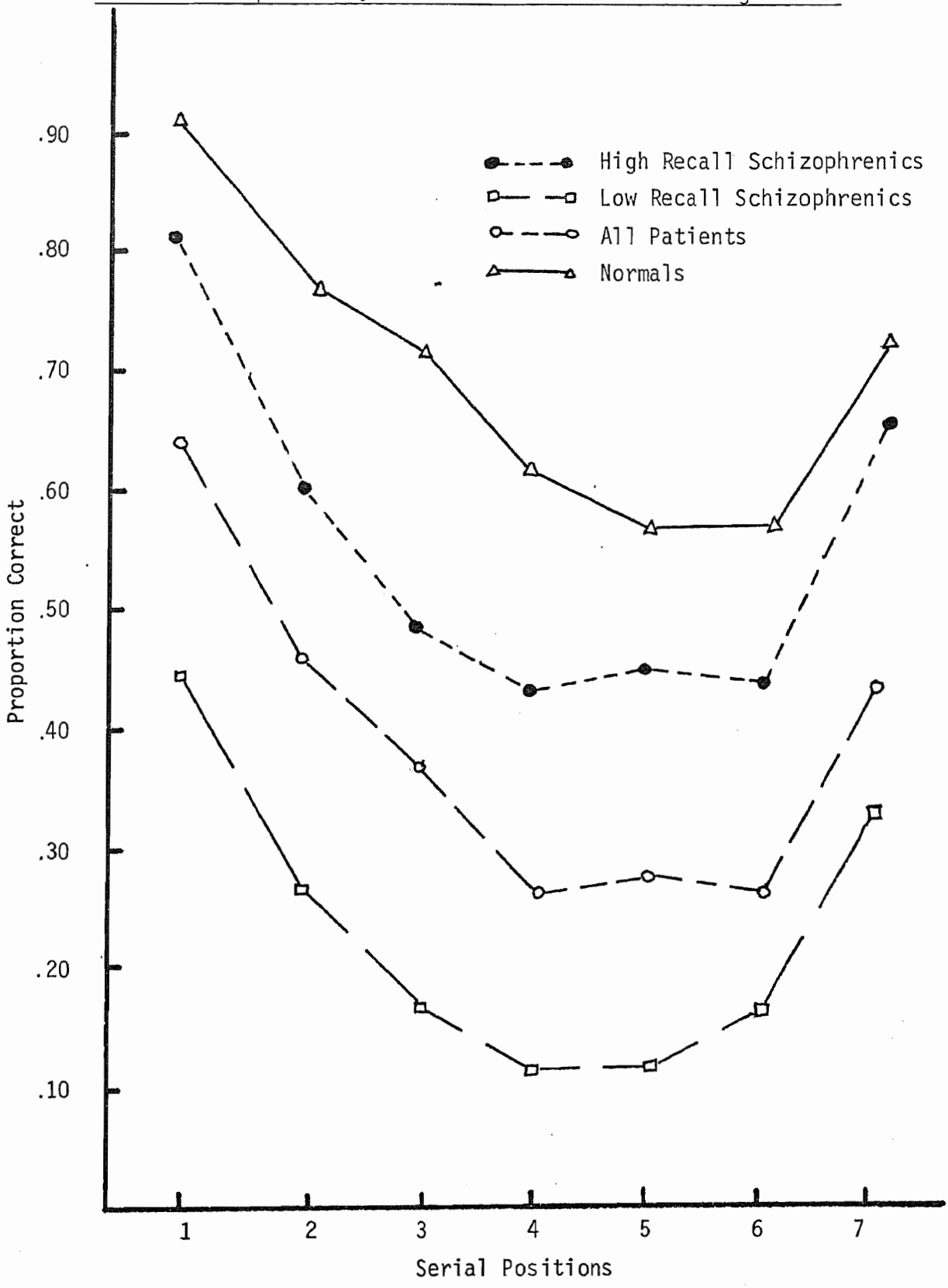


Table 8

Analysis of Variance of Position Means of Normals and High Recall Schizophrenics for the 7-Digit Data

Source	S.O.S.	df	MS	F
Groups (A)	0.500	1	0.500	1.355
Positions (B)	2.538	6	0.423	1.146
A X B	0.146	6	0.024	0.650
Error		210	0.369	

Table 9

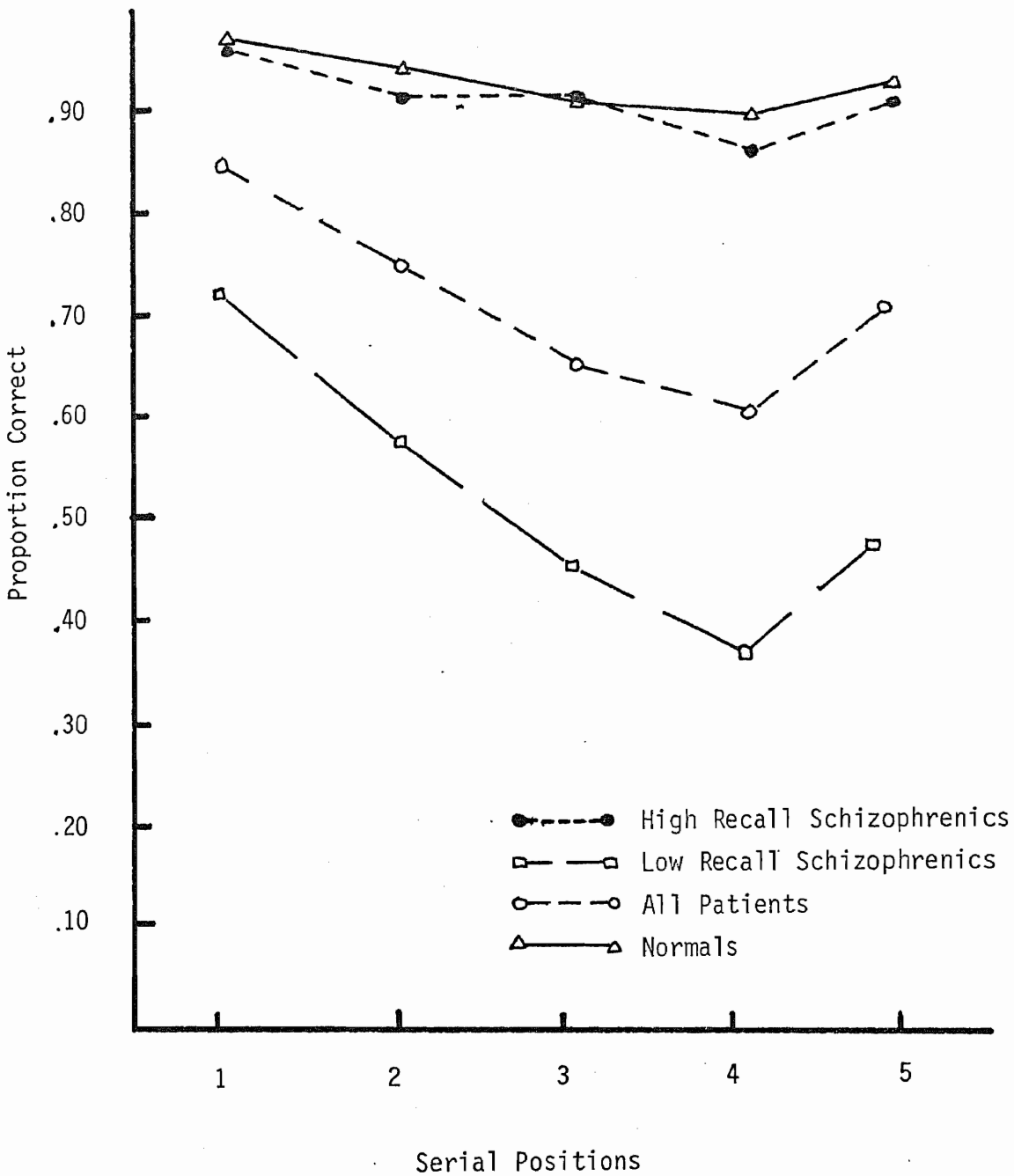
Analysis of Variance of Patients' Data Selected for High (H) and Low (L) Recall for the 5-Digit Data

Source	SOS	df	MS	F
H & L Recall Groups (Y)	32.873	1	32.873	33.612***
Error (a)	13.700	14	0.978	
Positions (B)	5.637	4	1.409	6.839***
Y X B	2.432	4	0.608	2.951*
Error (b)	11.525	56	0.206	
Total	66.167	79		

*p<.05
***p<.001

Figure 7

Proportion Correct for Normals, High Recall Schizophrenics, Low Recall Schizophrenics, and All Patients for the 5-Digit Data



difference in the recall process between the two selected patient samples.

Again, ability to recall was not related to age nor I.Q., while patients with better performance were better educated (see Table 10). Length of hospitalization was not included in the analysis due to the inclusion of one patient whose stay was longer than all others combined. Finally, as in the 7-digit analysis, high scoring patients showed no appreciable difference in recall when compared with normal controls (see Table 11)

Table 12 illustrates the analysis of the 7-digit recall scores when errors rather than correct responses were considered. The 5-digit data has not been included since there were too few observations for adequate discussion. The term "ommissions" refers to the subject's failure to respond. Patient's omissions by far outnumbered those of the controls ($p < .001$). "Reversals" are alternate changes in adjoining positions as when the numbers "78" are entered rather than "87". The groups did not differ on this variable. All other errors were considered as "insertions" and again the patient scores had a preponderance ($p < .01$).

Figure 8 illustrates the error analysis in terms of the proportion of each type to the total error. The curves of the omissions are widely separated, with the data for schizophrenics seeming to show progressively greater omissions from serial position #1 to #7. This is unlike the curve for the normals which is more U-shaped. The curves for reversals appear relatively even across the positions. There seems to be generally a declining function in the proportion of insertions from the first to the last position.

Table 10

Analysis of High and Low Patient Recall Groups

For the 5-Digit Data

		Age	I.Q.	Educ'n
High Recall	Mean	22.500	105.625	12.250
	Standard Deviation	2.449	13.095	1.984
Low Recall	Mean	22.375	103.125	9.625
	Standard Deviation	5.170	7.473	1.218
	t score	0.057	0.438	2.986**

**p<.01

Table 11

Analysis of Variance of Position Means of Normals and High Recall Schizophrenics for the 5-Digit Data

Source	SOS	df	MS	F
Groups (A)	0.0058	1	0.0058	0.0515
Positions (B)	0.0703	4	0.0176	0.6125
A X B	0.0069	4	0.0017	0.0151
Error		120	0.1127	

Table 12

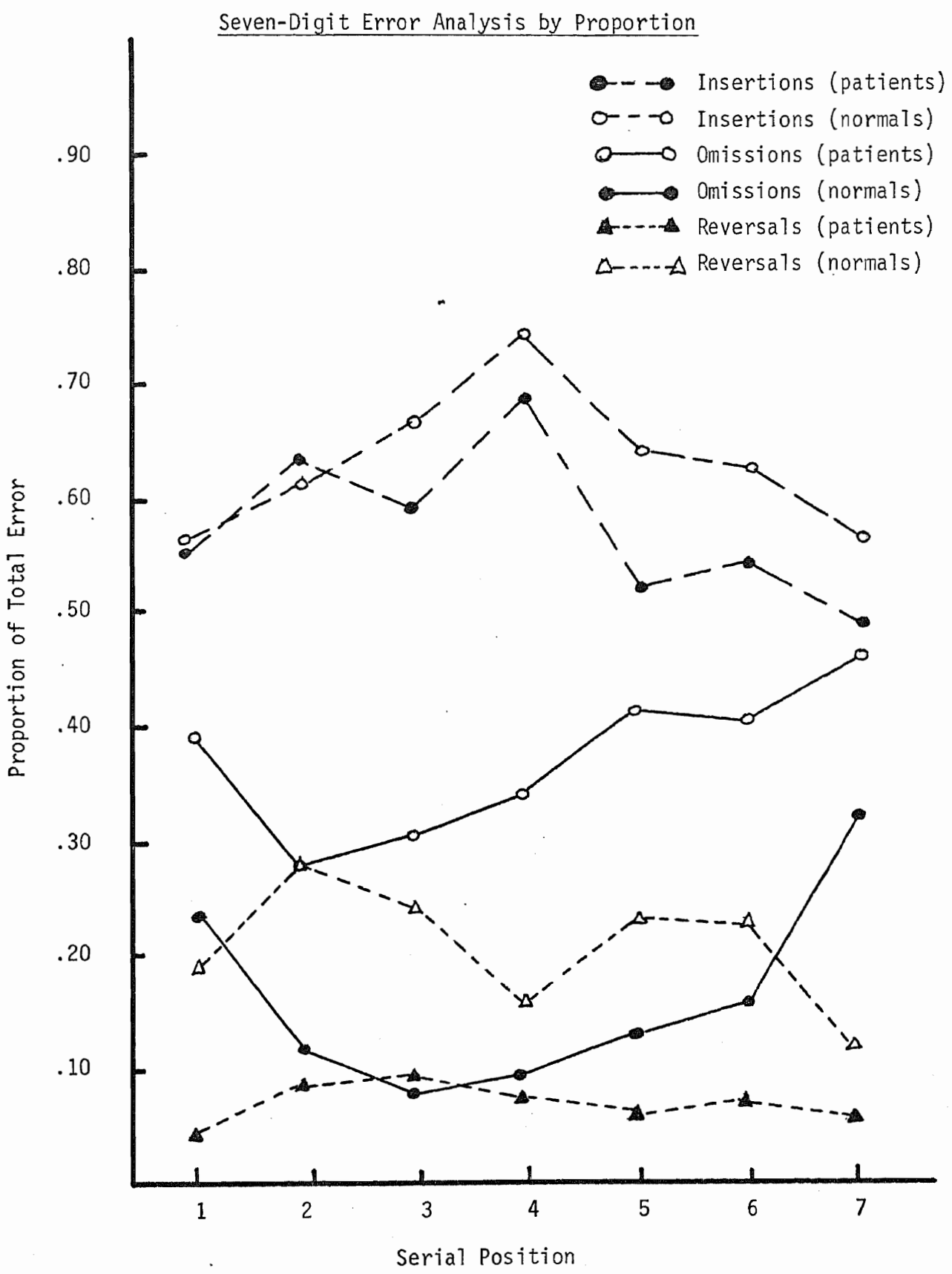
Analysis of Errors for the 7-Digit Data

	Omissions		Reversals		Insertions	
	Schiz.	Norm.	Schiz.	Norm.	Schiz.	Norm.
Mean	55.13	10.54	10.38	15.04	82.96	46.92
Standard Deviation	39.72	16.30	6.97	9.16	39.35	33.74
t score	5.03***		1.96		3.37**	

** p<.01

*** p<.001

Figure 8


Seven-Digit Error Analysis by Proportion
Insertions (patients)
Insertions (normals)
Omissions (patients)
Omissions (normals)
Reversals (patients)
Reversals (normals)
.90
.80
.70
.60
.50
.40
.30
.20
.10
Proportion of Total Error
1
2
3
4
5
6
7
Serial Position

Figures 9 and 10 illustrate the subject's attempted recall from the first digit responded to the last. This is unlike the serial position analysis of previous graphs for the former referred to the input series of the digits. In the present case, reference is being made to output, that is the first response, second response etc., disregarding errors (see Tulving and Arbuckle, 1963). Normals responded to 95.6% of the 7-digit material while patients only 77.5%. For the 5-digit lists, normals attempted 99.5% while patients 94.8%. The curves show that the responses of normal subjects are relatively evenly distributed across output positions. Schizophrenics however, appear to show a progressive decline in attempted recall after they have made several responses, although a statistical analysis has not been conducted.

Figure 9

Spaces Filled in Across Output Positions for the 7-Digit Data

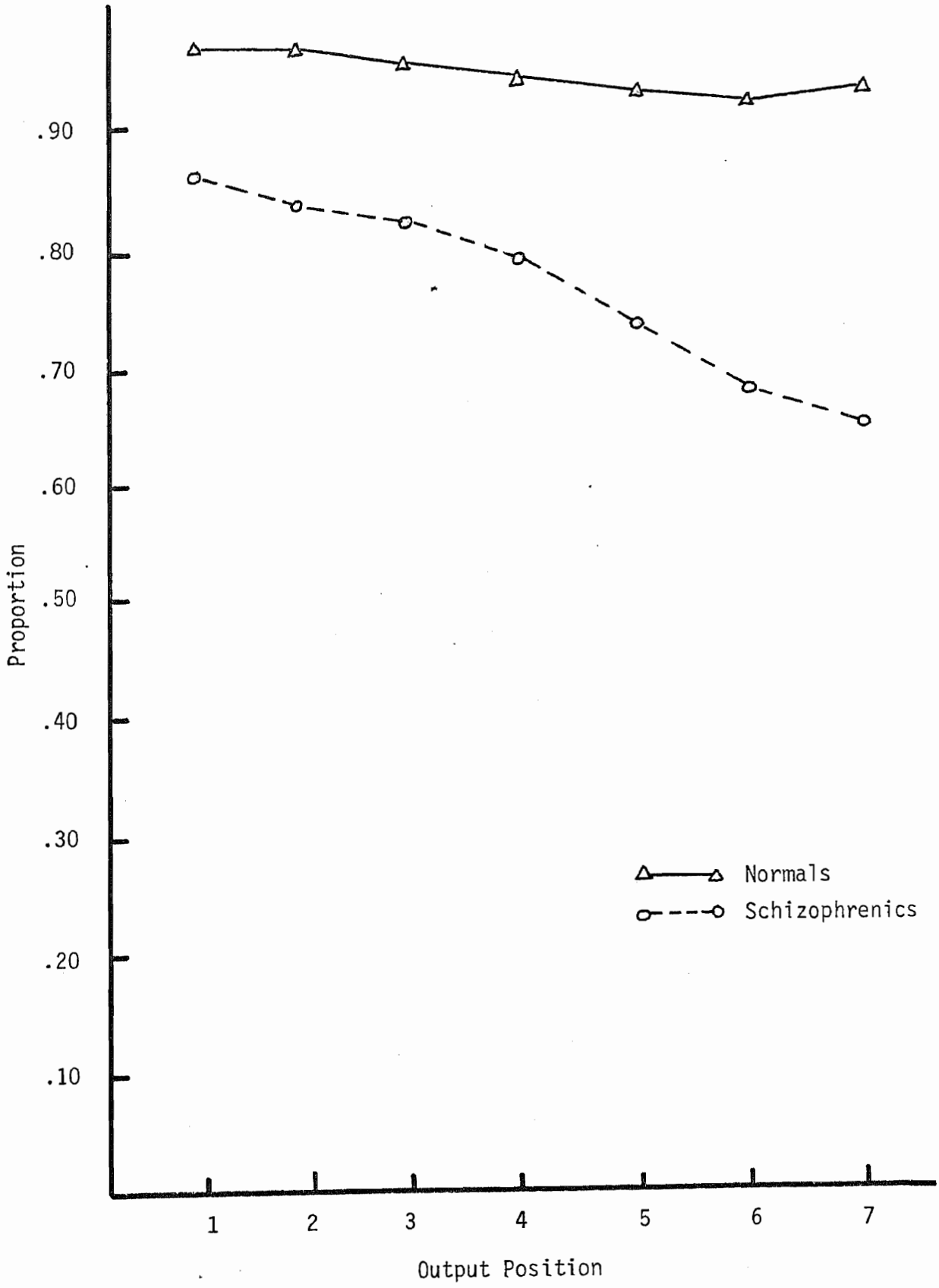
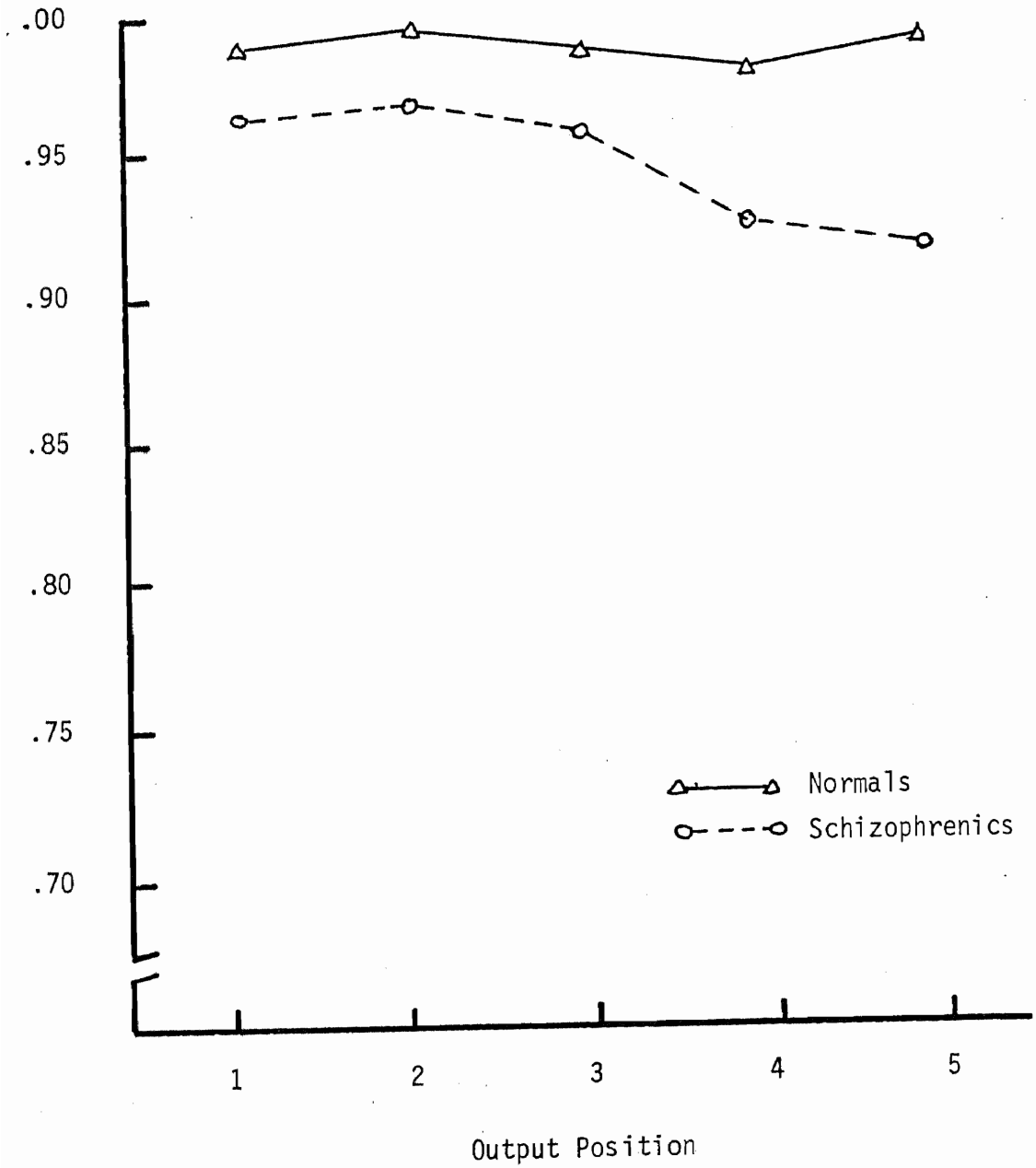


Figure 10

Spaces Filled in Across Output Positions for the 5-Digit Data



Discussion

The present study has produced several points for discussion. In consideration of the sample selected, it has been shown that a recall deficit exists in acute schizophrenic patients, as expected from previous research. When a review of the patient group is made, this finding is of further interest.

To begin, there appears to be little doubt that the sample was one of patients suffering from schizophrenia. The initial diagnosis of the psychiatrist was confirmed in every case by the MMPI employed as a selection device. With a mean age of 24, the sample was a relatively young one with a verbal intelligence quotient that was well within the average range (I.Q. 100.8). Bauman (1965, 1968) had found a recall deficit in a slightly older group which at age 31 were not quite as intelligent (I.Q. 91). They were hospitalized a longer time with an average stay between 26 and 30 months. This can be compared to the present sample whose stay averaged only 20 days. There were no "chronic" patients in the present study.

When the recall task itself is considered, there are several hypotheses which may be brought forward to provide some explanation of the recall deficit in the acute schizophrenic sample. In brief, these are as follows; defective rehearsal, defective search, trace decay, interference factors, and motivational effects. These explanations are discussed in turn with their supportive evidence.

Bjork (1970) was impressed by the role of rote rehearsal in contributing to the memory process. He found that the repetition of

items for memory was a distinct and well defined feature which experimental subjects found reasonable and commonly did. Sperling and Speelman (1970), Howe (1967), and others, have indicated that subvocal rehearsal, when possible, prior to report, was actually the rule and not the exception. The role of rehearsal, according to Bernbach (1970) was to produce multiple copies of a single memory store, call replicas. Bjork (1970) suggested that besides providing additional copies to short term memory, this activity aided in converting the information to long term storage. It also might have increased the strength of a single memory trace.

It is possible, then, that schizophrenics performed poorly on the present recall task due to difficulties with the process of rehearsal. Search through memory, as indicated by Shiffrin (1970) as well as Norman (1966) may be considered as a sequential, or serial activity, rather than a random one. Subjects usually began at some point in the task and sequentially scanned through memory until the point of retrieval. The digit recall task in this study was one which included covert rehearsal prior to each response. For example, the first digit to be recalled (output digit #1) involved repetition of each digit up to and including the position which was probed. The second scan involved another successive serial search until the next position was indicated, and so on (see Shiffrin, 1970). Thus, for the single presentation of a list, there were five or seven memory searches, depending on list length.

Since the search was serial in manner, then it follows that the first part of each list was rehearsed much more than the last (see

Bernbach, 1970). For example, the last position of a 7-digit list was repeated only once while the first position, at least seven times. A declining linear function of correct recalls could be expected, and in fact has been obtained (see Figures 3 and 4). The recency effect which contributed to the quadratic component may be due to the last position providing an "anchor cue" as suggested by Fiegenbaum and Simon (1962). The expected steeper progressive rise in proportion of omissions (see Figure 8) for the patient group, may be due to their difficulties with the rehearsal of stored material.

The application of the rehearsal principle should be considered as a tentative explanation which may not cover the facts of all exeriments on recall in schizophrenia. In many studies, the process of rehearsal was not involved, or even controlled, yet a deficit in recall was noted. This hypothesis must therefore be considered as only a possible contributing factor in the schizophrenic deficit.

Shiffrin (1970) was convinced that though rehearsal was an important aspect in recall, the search process itself merited inclusion in theories of memory. He formulated a general theory of the memory process where retrieval was considered as a recursive search. During each search, general decisions were made regarding what memory store to consider. Once this had been selected, then specific decisions were made whether to emit a response, what response to emit, and whether to terminate or continue with the search. The search continued until the subjects responded, time ran out, or the task was terminated by the subject's own initiative due to a lack of reasonable success. Final emission of a response was the product of a decision process, as outlined by the theory

of signal detection (see Green and Swets, 1966), or as a criterion decision (Wickelgren, 1970).

The main distinction between recall and recognition appears to be that recall involves a search process while recognition does not (Kintsch, 1970; Melton, 1967; Peterson, 1967; Shiffrin, 1970). Difficulty with recall is due to the absence of the items to be judged and these must then be drawn from memory. Recognition requires only the decision and not the sampling or retrieval stage. Bauman (1965), in his study of immediate recall and recognition in schizophrenics, found a definite recall deficit while recognition remained relatively intact. This was confirmed by further work (Bauman, 1968) and also by Nachmani and Cohen (1969). The latter concluded that recognition memory does not involve a sampling stage (i.e. retrieval) and consequently the schizophrenic deficit was due to their difficulty in integrating a decision phase with one of retrieval.

In that recognition memory has been shown to be relatively unaffected by the schizophrenic process, then it is reasonable to hypothesize that the recall deficit may be due to difficulties with the search, or retrieval aspect of memory. As mentioned, a search will be terminated by the subject's own initiative due to a lack of reasonable success (Shiffrin, 1970). It appears that in this study, the patients had little success in their search through memory, and consequently they were hesitant to respond. This was indicated by their greater number of voluntary omissions on the response sheets. Furthermore, after several responses had been made, the recursive search appeared to fail in somewhat of a linear fashion. Figures 9 and 10 illustrate this point quite well.

Normals continued to respond evenly since their searching mechanism was not affected.

The hypothesis of a defective search mechanism is not without important confounding variables. Shiffrin (1970) himself has stated that the decay of the information in the memory stores must be considered as contributing to the termination of the search. This brings forth the familiar trace decay hypothesis, as reviewed by Brown (1958), Conrad (1967), Conrad and Hille (1958), and Peterson (1963). Stimulation sets up a memory trace which decays with the passage of time. Performance tends to decrease as a function of the retention interval. The latter appears to be the case in the present investigation but does involve quite an oversimplification.

Conrad and Hille (1958) have outlined the variables that must be controlled in order to propose that trace decay was unequivocally involved. They contended that in order to properly investigate this phenomenon, rehearsal, during the time period in question, must be kept to a minimum. This was not the case in the present study where rehearsal was an integral part of the procedure. Factors of interference must also be controlled. These were not meant to be controlled, and are discussed in the following section. Finally, the experiment was designed to keep presentation time of the 5 and 7-digit material constant. Despite this, poorer recall was noted with the slightly longer list of digits. This was found despite the fact that the small difference in list length should not have been a vital consideration (Waugh and Norman, 1965).

Bauman (1965, 1968) has further suggested that the recall deficit in schizophrenia may be due to an abnormally rapid trace decay.

Patients did poorly on recall tasks since the memory traces were lost more rapidly. This hypothesis does not provide a satisfactory explanation of the recall process of the patients in the present study due to the nature of the task itself. Unlike Bauman's (1968) work which called for serial recall of a list immediately after presentation, the present task involved a successive probe technique. Output order varied for each presentation. The recall curves were similar for both groups and could provide no evidence relative to this hypothesis.

The role of factors of interference in memory has been discussed by many (Peterson, 1966; Postman, 1963; Tulving and Arbuckle, 1963, 1966; Underwood, 1957) as providing explanation where forgetting is concerned. Some investigators stress proactive and retroactive interference effects. Decrements in performance due to prior presentation of other items is termed proactive interference; decrements caused by subsequent presentation of other items is termed retroactive interference. Most memory experiments that investigate these factors arrange the task with different interpolated activities inserted, and then measure subsequent retention of the original material.

The present investigation does not fit this type of experimental paradigm and consequently specific extralist proactive and retroactive effects are not immediately obvious. In that Underwood (1957) for example, has found previous recall lists to cause a decrement in performance of subsequent ones, it is possible that such factors as chance similarities between lists, as well as length of the experiment may have contributed some interference factors. It is obvious however that extralist experimental factors are difficult to identify and describe and

must be left unspecified.

There are however intratrial experimental factors which can be considered. Tulving and Arbuckle (1963, 1966) reported that there were two sources of intratrial interference in immediate recall, those associated with the presentation of the material, and attempted recall, or input and output. These workers presented common nouns in a paired-associate learning experiment systematically varying number of intervening inputs and outputs prior to recall. They found that items early in the input sequence were little affected by output interference. Those in the middle input positions showed a slight tendency toward poorer recall with increasing position in the output sequence. Finally, for late input items, it was shown that the more attempted recalls which followed the latter items in a recall list, the smaller was their availability at the time of recall. The function describing this relation was negatively accelerated.

The recall task of the present investigation with acute schizophrenics might involve both sources of interference. The output function of patient recall of Tables 9 and 10 showed a progressive decline of attempted responses. After several recalls had been made, schizophrenics progressively made fewer attempts. Normals, however, kept up a steady rate of responding from first response to last. The patient scores could involve the influence of output interference factors to a greater degree than for the control group for the process of successive responding itself formed an interfering element (Underwood and Postman, 1960).

Shiffrin (1970) proposed that recovered information may be used by

the subject to redefine further responding. That is, each attempt at recall serves to change the task as the subject monitors his own behavior. It is possible that patients made more errors and omissions, and had greater intrusions since their attempts at recall were poorer. When errors were made, it might be more difficult for them to provide correct responses following incorrect ones since positional and other cues were incorrect and hence interfering. With more responses each recall attempt provided further response interference in almost a retroactive paradigm.

The effect of input interference might predict a successively declining curve with poorer recall shown following a number of interpolated inputs. If schizophrenics had suffered from excessive input interference, then one would expect their preformance curve to fall increasingly further below that of normals with each successive input position. Since the two curves were parallel, however, one might conclude that schizophrenics and normals do not differ in input interference. The fact that the schizophrenic curve was uniformly lower than that of normals can be explained in terms of greater output interference since number of interpolated outputs was held constant for all input positions. These findings tend to confirm earlier suggestions (Bauman, In Press) that the schizophrenic recall deficit may be due to excessive output interference.

Other factors of interference have also been investigated. Lang and Buss (1965) reported that the general psychological deficit in schizophrenia was due to factors of associative interference. They concluded that schizophrenics have more unique, nonshared associations, and these associations, like external distractors, served to deteriorate performance

because of their intrusive nature. Shakow (1962) felt that these patients entertained more irrelevant associations and were also more susceptable to chance distractors. Lawson, McGhie, and Chapman (1967) reviewing much of their own research, concluded that schizophrenics suffered from an impairment in the selective and inhibitory functions of attention. These patients were highly susceptable to distraction effects where the processing of substantial amounts of information was involved. These findings were explained in terms of Broadbent's (1958) theory of the human operator as a limited capacity information channel. According to them, in short term memory tasks, the assimilation of irrelevant information produced an overloading of the information channel and therefore a breakdown in performance.

The present experimental task was not readily amenable to the accurate investigation of factors of associative interference, chance distractors, or the impairment of mechanisms of attention, although these appear to be experimentally valid and worthy of at least cursory mention. It is possible that besides the effects that have already been mentionned, these also are directly involved in contributing to lower recall in schizophrenic subjects.

The final hypothesis to be discussed is one which suggests that the schizophrenics were poorly motivated and that it is this lack of motivation which accounted for their poorer recall. Schizophrenics had fewer responses and made progressively fewer attempts at recall after the first few items. However these first attempts were also poorer though their motivation should have been relatively intact. If this explanation is to be considered useful, then it would hypothesize a

lower general level of motivation, but also one that is more specific, calling for cessation of response following several attempts at recall. There appears to be no direct manner in which this explanation can be refuted and consequently it must be considered as a possible contributing variable in the schizophrenic recall deficit.

The final section which is open for discussion involves the data for patients divided into a high and low scoring groups. Inspection had revealed a wide variability in patient scores which was confirmed when these two groups could be statistically delineated. Of particular interest was the low scoring 7-digit sample (see Figure 6) which did maintain a very similar recall curve to the other groups. Though the overall correct recall was only 22%, compared to 70% for normals, the curve suggests again a similar underlying process (i.e. more output interference for poor recall schizophrenics, less for good recall schizophrenics). The 5-digit data showed a difference between the low and high scoring group suggesting, by the shape of the curve, (see Figure 7) that a ceiling effect was involved.

High scorers performed as well as the control group. However, they did not differ on the MMPI profiles from other patients, nor by age or I.Q. The suggestion is that in fact there may be some patients diagnosed as schizophrenic, both by a psychiatrist and the MMPI, who do not show a recall deficit. In this particular sample, they differed from low scorers according to education and length of hospitalization prior to testing. This is puzzling and one wonders if it is actually a stable phenomenon, or one induced by the wide variability of scores within two relatively small patient samples.

Suggestions for Further Research

It seems that more questions have been brought up than really have been answered. Further research is needed to investigate some of the points which have arisen.

1. Work should be done simultaneously looking at both extra-experimental factors of interference as well as those directly built in as intralist elements.
2. The hypothesis of a rehearsal defect is a unique one which should be investigated carefully in an experimental situation involving both its presence and absence.
3. Further work requires the integration of some of the studies on deficit of attention in schizophrenia with the type just done.
4. Correct recall differed with length of hospitalization. It would be useful to include another hospitalized group such as a neurotic one to study the importance of this factor.
5. Wickelgren (1970) suggested that there was evidence to postulate four separate memory traces, very short term memory (VSTM), short term memory (STM), intermediate term memory (ITM) and long term memory (LTM). Since this represents a division of the gross memory process, a study investigating these four facets would be quite relevant.

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Appendix A

Schizophrenic MMPI Profiles		Control Group MMPI Profiles	
8967'41352	1:23:10	'567-1	3:4:8
02786'43-9	2:10:8	'4368-2	3:1:22
86743'1295	3:19:8	'850 476	1:10:10
869714'2360	1:41:4	'492-56	4:0:19
68742'10539	1:14:12	427'13890	1:12:9
869745'01-2	1:25:7	43'276018-9	4:2:15
687'295-1	2:12:10	'74238-5	1:2:20
8721435 69'0	4:21:5	'369-251	4:6:9
867 24901'35	9:30:21	'4293-60	3:3:17
9685'7412	3:17:8	'620 47-1	2:2:16
67 8924'0513	4:7:5	'9765-21	2:3:11
89413'2675-0	2:14:13	'647-58	3:4:9
8132764'509	4:14:16	'2470 3816-9	3:8:13
8746'59012	5:24:20	'65-0	6:2:20
7389'42615	5:7:16	'-6875	1:4:7
8740629'31-5	3:25:7	'9-1	4:3:18
27814653'90	8:20:19	9'8072-1	2:11:6
89341'5762-0	4:11:15	'904-67 13	4:5:7
86724351'09	5:18:10	'94-6	4:3:12
879'0516-4	7:16:5	'5483-0	4:4:22
864079 21'3	4:15:7	'43178-650	9:0:22
28745396'01	2:8:7	'24-5809	3:2:13
8725431'906	2:21:6	'954-361	1:2:12
87642159'03	4:20:9	'0-8	4:4:9
Mean Profile			
876429'1350	4:18:10	'49	4:4:14

Appendix B

Orthogonal Comparisons of 7-Digit Data

	F
Linear Component	-101.70***
Quadratic Component	140.22***
Linear Component of the Groups x Position Interaction	2.82
Quadratic Component of the Groups x Position Interaction	8.46**

** $p<.01$

*** $p<.001$

Appendix C

Orthogonal Comparisons of 5-Digit Data

	F
Linear Component	36.99***
Quadratic Component	24.81***
Linear Component of the Groups x Position Interaction	7.65**
Quadratic Component of the Groups x Position Interaction	7.43**

** $p<.01$

*** $p<.001$