SEMANTIC PRIMING IN SCHIZOPHRENIA

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by

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ABSTRACT

An investigation of associative and direct priming effects of 17 schizophrenics and 17 non-hospitalized normal controls, was carried out using a reading latency task. Assessment of capacity of short-term memory using activation spread was also investigated. Subjects were presented with word lists in a variety of lag conditions and with two kinds of fillers, (i.e. words and digits). Results showed that schizophrenics evidence normal priming effects and their short-term memory capacity is the same as normals.

CONTENTS

CHAPTER I

NETWORK THEORY AND LITERATURE REVIEW

Contemporary accounts of the mode of representation of information in long-term memory make use of network theory (see Anderson, 1980 for a good overview). Every idea or concept is said to be represented by a node. Wickelgren (1981) states:

> "For every idea (feature, segment, word, image, concept, proposition, etc) that we can represent in our minds, there is assumed to be a particular set of elements that represent (encodes, stands for) the idea ..... Psychologically, a node means nothing more than 'what ever represents an idea'. There must be at least one node representing any idea we have encoded in our minds, or else, by definition, we could not think about that idea." (p. 24)

In much the same way as a cortical neuron is said to have its level of activation raised by a particular set of sensory stimulation, so a node is said to have its level of activation raised by a particular set of sensory events. This is direct activation.

Some events occur together in everyday life. For example bread and butter frequently occur together, as do salt and pepper; brother and sister, etc. In network theory, this kind of associational information is preserved in the links joining the nodes. These links are said to vary in strength as a function of previously experienced frequency of occurrence of the event. The links provide a medium by which activation may spread from node to node. For example, on seeing bread, or on hearing the word bread, activation spreads from this directly activated node to the butter node, so that the node is activated indirectly. The degree to which this activation level is raised and the speed of activation spread is said to be a function of the frequency with which bread and butter have occurred in close contiguity in a person's previous experiences. Thus common everyday occurrences in a person's life have the highest associational value.

Bower (1981) states:

> "A relevant analogy is an electrical network in which terminals correspond to concepts or event nodes (units), connecting wires correspond to associative relations with more or less resistance, and electrical energy corresponds to activation that is injected into one or more nodes (units) in the network. Activation of a node can be accomplished either by presentation of the corresponding stimulus pattern or by prior activation of an associated thought." (p. 134)

Activation spread can be measured experimentally by means of priming tasks. For example, using a naming latency task, the latency in reading the word "butter" is reduced if it is preceded by a strongly associated word, e.g. "bread", but not if preceded by a word having no common association with it, e.g. "doctor". Lexical decision and stroop tasks are commonly used to demonstrate this effect. Typically in a lexical decision task subjects are presented with two letter strings and have to decide if they are words or nonwords. Meyer and Schvaneveldt (1971); Fisher (1977); and Fisher and Goodman (1978) carried out typical experiments. In each task, RT's for pairs of words is measured as a function of the associative relation between two words. Results show that positive responses are faster when the target word is preceded by one associatively related to it. In a stroop task pairs of associated words are used and the word presented as the associative prime causes activation to spread to its common associate, the target. In the case of the stroop task, where the prime word is presented auditorily and the target word is presented as a visual stimulus, the time to name the ink colour of the target word increases in proportion to the forward associative strength of prime to target, (Warren, 1972).

Activation spread is the means by which knowledge is encapsulated in network theory. Seeing the nose, head and whiskers of a tiger appearing out of the jungle, results in the activation spreading to nodes representing hindlegs, tail, etc.

Comprehension, forming a representation in memory of events is said to involve constructing new elements onto an existing network by forming new links between nodes. Only nodes currently in an active state can be linked. (Anderson, 1980).

In network theory, short-term memory is those nodes in an active state. Nodes can only be linked when active. If activation decays too rapidly it would not be possible, for example, to relate an early part of a sentence to a latter part. This is the same for the area of language production, if the activation decays too quickly continuity in thought and speech could be lost. A person would not be able to make associative connections between ideas and events in their environment and cognitive confusion would result.

There have been a large number of studies carried out investigating the capacity of short-term memory but very few from a decay of activation perspective. Utilizing an indirect activation paradigm to investigate decay of activation, Loftus (1974), required subjects to retrieve from memory well learned information about categories such as fruit. Subjects retrieved instances of a category, i.e. "Fruit beginning with p". It took an average of 1.53 seconds to perform this task. Then at varying lags subjects were required to retrieve from the same category another member beginning with a different letter, e.g.

"b". Lag was manipulated by inserting tests on other unrelated categories between the two tests. With 0, 1 and 2 intervening items, retrieval time increased with the number of items interpolated as follows: 1.21 seconds, 1.28 seconds and 1.33 seconds respectively for lags 0 to 3. Thus two items can intervene before the activation has almost completely returned to its resting level.

Warren (1972), designed a stroop task to investigate associative priming. The associated words included category items, e.g. "relatives" and examples of test items belonging to that category, e.g. "aunt". The category items were presented auditorily in lags of 0, 1 and 2. A lag of 0 consists of having a prime word followed by its common associate. In a lag of 1, the prime and common associate will have one word interpolated between them and in a lag of 2, two words interpolated between them. There were four phases to the experiment: a) words presented auditorily, b) presentation of words in coloured ink, c) subject asked to name colours as rapidly as possible and attempt to ignore base word, d) subjects asked to recall the spoken word. In stroop tasks activation is measured by the degree of interference via speed of naming the colour of ink of the target word. Results for this experiment showed that activation lasted for two intervening words. As with the Loftus (1974) experiment there were not quite enough lag conditions to cover the total decay of activation.

Wickelgren, Corbett and Dosher (1980) investigated associative priming, using a speed accuracy trade-off task. Subjects saw 16 consonants with .7 seconds blank in between; a test consonant was then presented which subjects judged to be present or not in the preceding lists. A tapping speed accuracy trade-off method was employed in which subjects pressed both "yes" and "no" keys every .4 seconds, beginning during the blank interval. Both keys were pressed simultaneously at first in this method, but as soon as possible the chosen response had to lead the other, by a time interval that reflected the confidence of the decision. Results showed memory strength in storage declined over the 6 second interval containing the 12 items and only the last item differed from others in its speed-accuracy trade-off function. It was stated that under these conditions only the last item in memory was active. This conflicts with the results of both Loftus (1974) and Warren (1972), who found two items active, and may well reflect the experimental paradigm employed in this latter work.

The persistence of activation in directly activated nodes can be investigated by tasks in which a word is presented as the prime and later the same word is used in a lag condition. Although the direct-indirect activation is drawn by network theorists, (Anderson, 1980), there appear no relevant published studies of the persistence of activation in directly activated nodes.

Others have purported to measure short-term memory capacity, using serial recall and running recognition tasks (e.g. See Murdock, 1974). These are not direct measures of activation decay, as they involve retrieval processes and results can be confounded by serial recall, primacy, recency and other effects.

Problems of rehearsal and strategic effects also pertain to the area of priming effects and activation spread. Posner and Snyder (1975a, 1975b) stated subjects could bring conscious strategies to bear in memory. They postulate two distinct processing modes under which priming can occur. There are two distinct components of attention, 1) Automatic process, which is, a) fast acting, b) occurs without intention or conscious awareness and c) does not effect retrieval from unrelated nodes that have not been activated and, 2) Limited-capacity conscious attention mechanism, which is said to be, a) slow acting, b) cannot operate without intention and conscious awareness and c) inhibits retrieval of information stored in unrelated nodes, which it is not focused on. Posner and Snyder's theory accounts for the semantic facilitation, where the response to "nurse" would be faster following "doctor", than following "bread" because of the automatic priming effect.

Neely (1977), investigated semantic priming by varying the time available to subjects between the priming event and the target array. Results suggest that at 250 msecs, activation has fully occurred. Fisher and Goodman (1978), carried out an associative activation experiment, varying the time available between the priming event and the targets array. Their findings showed that at 40 msecs the prime has just begun to influence the test word processing, when the critical point was passed, after which activation would no longer produce reductions in test processing time. Suggestions were, that if people were conscious of the associations between the prime and its paired associate, they could bring conscious strategies to bear, affecting the reading latency. Fisher (1977), used a lexical task and explicitly instructed subjects to try and take advantage of the presence of associations in letter strings. No effect on the size of facilitation resulted from these instructions. Marcel (1980), investigating consciousness in semantic decisions, using polysemous words, (same spelling, different meaning, e.g. "palm = tree"; "palm = hand"), pattern masked one of his experimental lists of words, which meant subjects were allowed semantic access but were prevented from having conscious awareness of the actual words. His results showed subjects evidenced a priming effect even though they were not conscious of the initial prime. These results are all said to give confirmation for Posner and Snyder's theory of a two component mechanism of attention.

Several other researchers postulated theories to account for facilitation effect, which conflict with those put forward by Posner and Snyder. Smith (1979), demonstrated that whether facilitation occurred depended on the manner in which the prime was processed. Subjects in an associated word task, where it necessitated analysing both the prime and target words for a letter search, produced no facilitation between target and prime reaction times. Becker (1980), suggested subjects create an "expectancy set", in carrying out a word association task and can produce a facilitation effect by using strategies, which do not necessitate reading the whole word before a processing decision is made. Antos (1979), stated that facilitation is due to several factors working together, discriminability, criteria bias and response bias.

In this thesis a reading latency task is employed as it is a simple task for schizophrenics and would produce a useful amount of data in a short experimental session. There has been a cost to the experimental design as a result of this, in the area of loss of control over the cue-target duration, and the build-up of the priming effect. That is, the time interval between words is great enough to allow slower acting strategic effects to occur. However, given the rapid sequences and task demands, it is unlikely that subjects will in fact be able to consciously focus attention on a particular pathway, (Posner and Snyder, 1975a, 1975b).

INVESTIGATIONS INTO SCHIZOPHRENIA

Schizophrenia is undoubtedly a disorder of cognition. Over a period of thirty to forty years a large body of literature has been produced investigating aspects of thought disorder. At Worcester State Hospital in the 1930's, pioneering research demonstrated the cognitive deficits in schizophrenic patients, (Huston, Shakow and Rigg, 1937; Rodick and Shakow, 1940). Other researchers followed, Payne and Hewleth (1960), Yates (1966). McGhie (1970) and Chapman (1956a, 1956b) carried out experiments which assumed that schizophrenics had a defective mechanism for filtering information, or were over-inclusive in their thinking. These theories were based on Broadbent's (1958) model of selective attention, which was found incapable of accommodating later findings.

Kahneman (1953), postulated a "limited capacity" model or a circumscribed quantity or pool of capacity, effort or attention. This effort is allocated to simultaneous activities which compete for supply and when more effort is expended in one direction, there is less available for other activities.

Chapman and Chapman (1965) and Chapman, Chapman and Miller (1964), hypothesized that schizophrenics have a response bias, constraining them to attend only to dominant meanings of words. They stated, schizophrenics tend to rely on the word's strongest denotive meaning, to the relative exclusion of other weaker meanings, which might have been more correct in the context of the sentences they were being presented with. It was equated with "concreteness of thought", associated with schizophrenia, where a rigidity of thought was evidenced. In terms of network theory, if capacity of short-term memory is smaller, that is if activation does not persist as long, subjects will effectively forego the priming effects of context and we would expect the strongest link, (i.e. therefore the most common associate), to be available to the subject. However, consistent with this interpretation are the findings of Naficy and Willerman (1980), who tested schizophrenics with sentences with double meanings, one of which was the normally preferred choice. Results showed that schizophrenics yielded excessively to normal biases in their choices.

There are no theories of thought disorder in schizophrenia rooted in modern network theory. The present study is therefore not directly related to past work. Never-the-less a large body of studies have investigated memory in schizophrenia. The early work in this area constructed a two part paradigm looking at recall and recognition memory. Bauman and Murray (1968), constructed tasks using paired associate recall and paired associate recognition tasks, with word lists. Schizophrenic subjects performed normally on the recognition tasks, in that more complex encoding and search procedures, which involve associative connections, are required for recall.

In network terms, recall involves the spread of activation from directly-activated nodes (i.e. nodes corresponding to retrieval cues), through the network to target nodes, (the to-be-remembered items), (Bower, 1981; Anderson (1980). In word-lists learning tasks, the list context and task instructions usually provide the retrieval cues. For activation to spread from these to the target words, some links must have been established between the potential retrieval cue and the target words at the time of presentation. This linking, or elaboration, corresponds to what has traditionally been termed encoding. We would expect schizophrenics to display a recall deficit if either the processes of activation spread do not function normally, and/or if nodes representing information likely to serve as retrieval cues are not linked to target nodes at the time of presentation. We would not, according to network theory, expect potential cue-target word links to be formed if activation did not persist for long enough, (i.e. short-term memory deficit), for such links to be formed.

A similar argument can be applied to the encoding of semantic relationships. Frequently word lists have been constructed by drawing words from clearly defined categories. Although words are presented in random order, the categorical structure of the lists facilitates recall in normals. However, since it seems likely that such encoding requires "keeping in mind" that certain categories have previously occurred in the list, a deficit in short-term memory (i.e. activation persistence), is likely to result in a failure to link words to category labels in the episodic trace of the word list, and thus category cues and the inherent list organization would not assist schizophrenics.

Bauman (1971); Koh, Kayton and Berry (1973); Russell and Beekhuis (1976); Russell, Bannatyne and Smith (1975), all reported results of recall impairment, which has been explained by assuming that schizophrenics are lacking in ability for mnemonic organization.

Koh and Peterson (1978); Koh, Kayton and Peterson (1976); Larsen and Fromholdt (1976), have shown however that when the experimental paradigm placed the subjects encoding strategy under the experimenter's control, rather than the subjects control, schizophrenics displayed normal recall. In a typical paradigm

Koh, Kayton and Peterson (1976) had subjects view word lists which they rated for pleasantness-unpleasantness and later had them freely recall the lists. Schizophrenics and normals both demonstrated the "Pollyanna tendency" to recall pleasant words more frequently than unpleasant words, evidencing that encoding was normal in schizophrenics.

Koh and Peterson (1978) exercised control via an experimenter-imposed coding task on schizophrenic subjects and they were required to make yes/no judgements as to whether a probe word, a) contained letters, b) rhymed with a word, c) belonged to a conceptual category, or, d) fitted into a sentence. Schizophrenics and normals recalled semantically processed words. Koh noted at the conclusion of this research, "that the mnemonic processing in schizophrenics is perhaps intact in tasks that are more or less automatic and natural but impaired in tasks that require conscious effort on the part of the subjects". These results can be viewed via network theory and in particular Posner and Snyders' (1975a, 1975b), theory of two components of attention, 1) Automatic and occurring without conscious awareness and 2) Limited-capacity and needing conscious attention. Possible deductions could be made equating Koh's automatic processing with Posner and Snyder's, and conclusions be drawn that where no conscious awareness is needed schizophrenics process words as normals; where they become conscious of their own thoughts and decision-making processes, they show a decrement in performance.

Theorists investigating storage and structure in semantic memory, generally agree schizophrenics perform normally in this area. Koh, Kayton and Schwartz (1974), assessed storage structure for common English words, sorting on a basis of similarity and relatedness. Matusarz and Koh (1980), investigated schizophrenics utilization of categorical cues, via a free-recall task; finding retrieval strategies adopted by schizophrenics comparable with those of normals. Taupman, Berzofsky and Kesselman (1976), discovered that release from proactive interference was evidenced by both schizophrenics and normals. Proactive interference occurs in word trials, when items share the same category membership and earlier, items in the list, interfere with the recall of following items and recall probability decreases. Subjects can be released from this interference by changing the category of the following words and the high probability of recall returns. Findings of the above research can be interpreted in network terms as supporting the claim that activation spreads normally in schizophrenics.

As far as I am aware, there have been no studies of the persistence of activation in schizophrenics. Short-term memory capacity has been investigated by other more traditional methods. Bauman and Kolisnyk (1976), investigated the capacity of short-term memory in schizophrenics via a recall task. Lists of digits were presented to subjects and items in the different serial positions were probed randomly, in seven recall trials for each list. Input interference resulted from interpolation of items between presentation and recall of the probed item, and was the same for schizophrenics and normals. Output interference resulted from interpolation of responses between presentation and recall and was greater for schizophrenics than for normals. These results show that input in schizophrenics, i.e. capacity, was normal. The fact that they could recognise the items suggest that they were in store but that output mechanisms were interfered with.

Traditionally one of the fundamental characteristics of schizophrenia, (Bleuler, 1950), has been loosening of associations. Very early studies were felt to support the view that schizophrenics made ideosyncratic associations. (Kent and Rosanoff, 1910). Subjects were given a word and asked to report the first word they thought of. This task does not actually demand the most commonly used associate. Griffith, Mednick, Schulsinger and Diderichsen (1980), used a word and continuous association test on children at high and low risk for schizophrenia. Results showed that although the high risk group did exhibit more deviant associations, it was not seen as predictive of outcome to develop schizophrenia, and premorbid associative disturbance was not a characteristic of those who later became schizophrenic. Again, these results point to normality of mechanisms of association spread in relation to schizophrenia.

The present study by using priming based measures of memory is considered an advance on previous work with schizophrenics because it attempts to measure directly processes of activation spread and persistence which are thought to be basic to memory, perception, language comprehension and production, etc. In particular, a combined priming-and-lag study using reading latency should provide a more direct assessment of short-term memory functioning that has hither-to been available.

This thesis has two aims. First to investigate the performance of schizophrenics in comparison with normals on an associative priming task, demonstrating the effect of spread of indirect or associative activation. On the basis of previous work (Russell, unpublished study), schizophrenics evidence normal priming effects. Reading latencies (i.e. time between the appearance of a word and the beginning of its vocalization), was recorded. When a target word was preceded by a prime, that is a word that was strongly associated with it, e.g. "mother-father", the reading latencies of the target word was less than when preceded by a non-associated word, e.g. "dog-father". The facilitatory effect of associated words was equal for schizophrenics and normals over a range of conditions involving associates, category labels, synonyms and antonyms.

Second, in previous work by Loftus (1974) and Warren (1972), associative activation lasted for two intervening words, between the prime control word and its common associate. It is intended to investigate whether this phenomena can be replicated by schizophrenics and normal subjects in this experiment.

In this thesis the following pattern of results is expected from normal subjects. Firstly, for all lists of lag 0, reading latencies for experimental words should be less than for control words. Words in the control condition are used to give a baseline reading latency for the word as it appears in the list without semantically associated words in close proximity. Words appearing in the experimental condition are the same words that appeared in the control condition, used again, only this time they, (i.e. for associated condition), are preceded by a prime word, which will spread activation to this experimental word, facilitating its processing; thus making its reading latency shorter. Secondly, this facilitation effect should decrease with lag. Lag conditions are where other semantically unrelated words or digits, (i.e. fillers), are interpolated between the prime word, which will start the spread of activation, and the experimental word which will have its processing facilitated by being preceded by this prime. At lag 0, fillers are interpolated between the prime and the experimental word; at lag 1, one filler will be interpolated; at lag 2, two fillers interpolated. It is expected that the rate of decrease of facilitation may be greater for associated than direct lists and differ, with the kind of filler, (i.e. word or digit). The general pattern of normal results, ignoring the differences between lists, is given in Figure 1 denoted by the solid line.

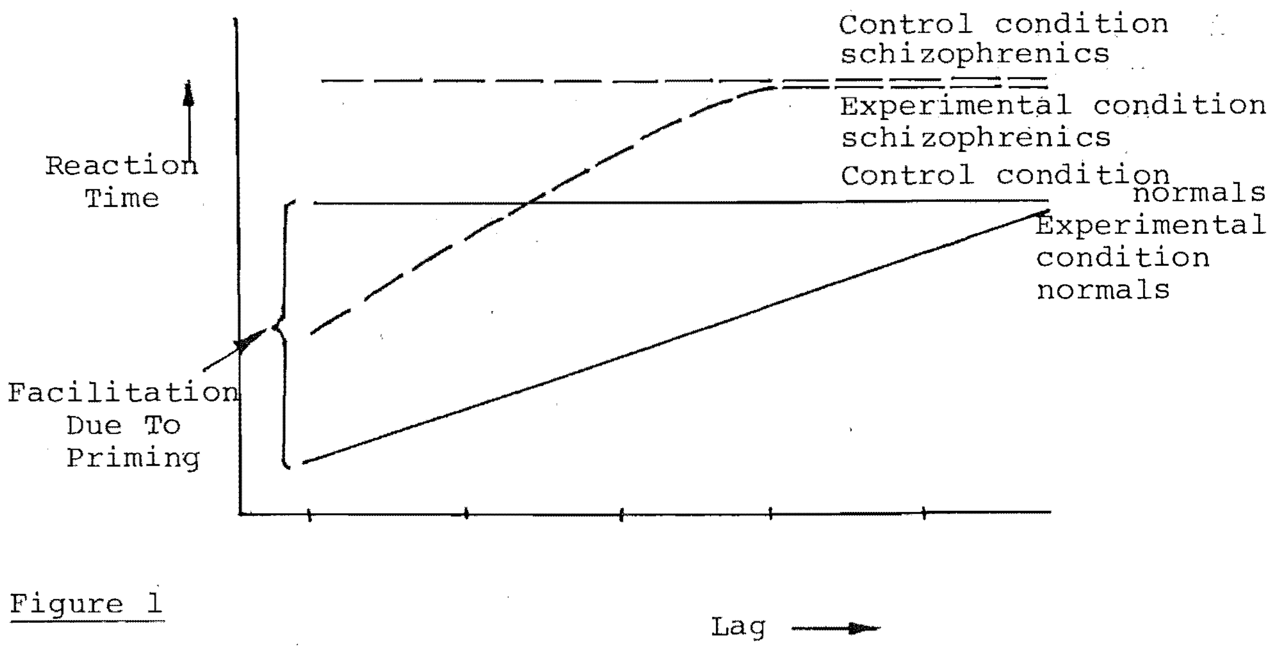

Figure 1

The pattern of results exhibited by schizophrenics may differ in a number of ways. Firstly, their response times may be slower overall. Secondly, they may exhibit a reduced facilitation effect or none at all. If activation spread in schizophrenics does not operate as it does in normals, they may show no facilitation with an associative prime. Thirdly, if there is facilitation, the rate of loss of facilitation with lag may be greater for schizophrenics than for normals.

CHAPTER II

EXPERIMENT 1

METHOD

SUBJECTS

The demographic characteristics of the subject groups are given in Table 1.

(i) <u>Schizophrenic Sample</u>

The sample of seventeen patients tested was drawn from one rehabilitation and one long-stay ward at Sunnyside Hospital, Christchurch, in August 1983. They were selected on the basis of psychiatrist's diagnosis, case histories and clinical psychologist's observations. The diagnosis of schizophrenia was confirmed using the criteria specified by Astrachan, Harrow, Adler, Bauer, Schwartz, Schwartz and Tucker (1972), in the New Haven Schizophrenia Index.

Patients included in this group were a) aged between 21 years and 48 years of age, b) were devoid of symptoms thought to be the result of brain damage, c) had no history of use of halucinogenic drugs, d) no history of heavy chronic alcohol consumption, e) were not receiving electroconvulsive therapy, f) did not suffer epileptic seisures, and, g) were capable of reading the size of letters used on the computer screen.

An attempt was made to express the current level of medication being received by patients in equivalent terms by employing the Phenothiazine Drug Index (PDI), Spohn, Thetford and Woodham (1970), and with the relative drug strengths based on

TABLE 1

Subject Demographic Data

	Schizophrenics	Normals
Age		
Mean	29.38	29.12
S.D.	7.87	8.06
WAIS Vocabulary		
Mean	11.71	12.06
S.D.	2.19	1.90
Education (Years Secondary/Tertiary)		
Mean	3.82	3.82
S.D.	1.73	0.41
Sex (frequency)		
Male	15	15
Female	2	2
NHSI[1]		
Range	4-9	
Mean	6.41	
Previous Admissions		
Range	1-8	
Median	2	
Current Hospitalization in Weeks		
Range	1-328	
Median	60	
P.D.I.[2] (mgm/day/kg)		
Range	0-27.0	
Median	8.87	

1. N.H.S.I. = New Haven Schizophrenia Index

2. P.D.I. = Phenothiazine drug index measuring daily drug intake of patients in terms of a daily equivalent of chlorpromazine per kilogram of body weight (Spohn, Thetford and Woodham, 1970).

Hollister (1970). The PDI gives a measure of daily equivalent milligrams of chlorpromazine per kilogram of body weight.

A shortened form of the Wechsler Adult Intelligence Scale vocabulary subtest (Jastak and Jastak, 1964), was used as a measure of verbal intelligence.

(ii) Control Sample

A sample of seventeen, non-psychiatric non-institutionalized subjects was drawn from the general population and were as far as possible individually matched to the schizophrenic subjects for sex, age, verbal intelligence and educational status.

APPARATUS

An Apple II+ computer was used to present the word lists and store the reading latencies. The words themselves were displayed one at a time, in lower case letters 6mm high, in the centre of a viewing screen. At a viewing distance of about .5m they cast a horizontal (vertical) visual angle of 4.5 (.68) degrees. Words were removed from the screen as soon as the subject spoke into a microphone. The microphone was connected to a cassette tape-recorder which fed a signal to the computer's "cassette in" jack. An assembly language routine converted this signal into the appropriate screen clear command. Reading latencies were measured to the nearest milliseconds using software timing routines modelled after Price (1979), and incorporating a modification of the computer hardware which allowed the timing routines to be synchronized with the vertical TV synch pulse, (Cavanagh and Austin, 1980).

STIMULUS MATERIAL

Four lists of words, of high frequency usuage, were compiled from the Kučera and Francis (1967), list. High frequency words have been shown to have shorter reading latencies. (Forester and Chambers, 1973; Scarborough, Cortese and Scarborough, 1977). Words were three to nine letters long and mainly one or two syllables. Ericksen, Pollard and Montague (1970) and Klapp (1971, 1974), have shown that encoding and preparation for vocalization of three syllable words takes longer than for one and two syllable words.

The main experiment lists consist of two Direct lists and two Associated lists. In the Direct lists the same word appeared in both cue or prime and experimental condition. In list DW (Direct-Word), words were used as fillers separating the first and second presentations of the target word, as follows:

LAG 0	LAG 2	LAG 5	ETC.
tree	apart	plane	
tree	ideal	brown	
	desk	mouth	
	apart	tease	
		alert	
		truth	
		plane	

In list DD (Direct-Digit), two digit numbers (presented in digit form) served as fillers. In both lists lags of 0, 2, 5, 7 and 9 were used.

For each Direct list 8 different words were used at each lag condition to give a total of 5 x 8 = 40 stimulus sets.

The two Associated lists AW and AD consisted of common words and their associates and were compiled from the Keppel and Strand (1970), norms.

They were constructed as follows. The first word in a set of words was the prime or cue. This was followed by 0, 1, 3 or 5 filler items, and then the associate of the prime, as follows:

LAG 0	LAG 1	LAG 3	ETC.
table	bread	light	
chair	low	ample	
	butter	food	
		barn	
		dark	

To see if the prime affected the reading latency of the target word, the target had to appear elsewhere in the list in a control condition. This was achieved by constructing groups consisting of only target words. These were interspersed at random throughout the lists.

List AW used words as fillers while in list AD, digits were used. Seven different target words were used at each lag condition.

Approximately 21 words forming examples of the kinds of word sets encountered in the lists proper were placed at the beginning of each list, but their latencies were not recorded.

The target words and primes for all four experimental lists are presented in an Appendix.

DESIGN

Stimulus material was presented in four stimulus lists; AW, AD and DW, DD. Each list had words in four or five lag conditions. These small sets of lag conditions, were randomly arranged through the list. Different words were used in each list and within each list, in the different lag conditions.

A pilot study carried out with University students showed that it was advantageous to have breaks between sets, when subjects could cough to clear their throats. It was anticipated that the schizophrenic subjects on high doses of medication would have greater difficulty concentrating and sitting still and would require frequent breaks between sets. The final design allowed for breaks of this nature between each set if subjects requested it.

At the beginning of each set the first stimulus word appeared on the screen and disappeared as soon as the subject started to vocalize. Subjects were deemed to have completed articulating a word when a continuous period of silence of 200 msec duration occurred. A 400 msec interword interval began immediately the 200 msec silence criterion was met. The temporal relationships between the screen display; subjects vocal response; and computer activity are displayed in Figure 2.

Four lists were presented in random order to the subject.

PROCEDURE

Subjects were run individually in a single one hour session. Each subject was given a sheet of instructions to read, stating that the task was concerned with reading latencies. Subjects were to expect 4 word lists, each divided into smaller groups for presentation. The experimenter stated "ready" at the beginning of each set and pressed a button on the computer to bring up the first word in each set. Subjects were instructed to start, saying the word that appeared in the centre of the screen, as quickly as they could after it was displayed. Subjects were given a trial on four short lists, which simulated

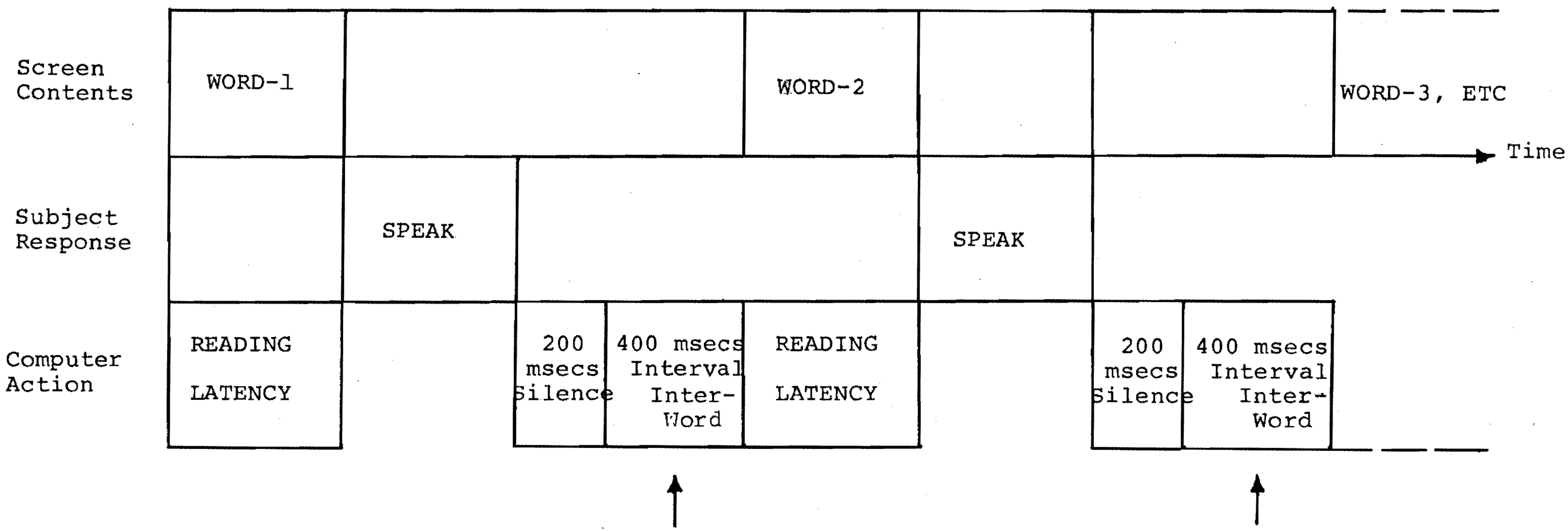

Figure 2. The lists were presented in random order to the subjects

the presentation they could expect in the main lists. Subjects were informed that the main lists were the important ones.

RESULTS

Since the interest in this thesis is in the latencies to words in their control and experimental presentations, RT's to fillers and practice words were not recorded.

Occasionally extraneous noises, or inadvertent vocalizations by the subject occurred at the time a word appeared, or very shortly afterwards. These resulted in very short RT's. In an attempt to remove these from the data, all RT's of less than 100 msecs were rejected. This resulted in 3.5% of responses by schizophrenics and 1% of responses by normals being rejected. Occasionally subjects did not speak loudly enough to trigger voice activated apparatus and hence the word remained in view and very long reaction times were registered. In an attempt to remove these data and those which may have resulted from attentional lapses, all latencies greater than 1000 msecs were rejected. By this criteria 3.4% of the responses of schizophrenics and 0.6% of those of normals were rejected.

The median of the remaining RT's in each condition was found for each subject, to give 8 medians per subject for each of the Associated lists and 10 for each Direct list.

Analyses were performed on these subject median RT's using Lane's (Lane, 1981), general analysis of variance program (modified to run on an Apple II+). This incorporates Huynh's (Huynh, 1978), slightly conservative procedure to protect against Type I errors where the covariance assumptions pertaining to the repeated measures effects are not met. This has the effect of reducing the degrees of freedom used in assessing significance. The reduced degrees of freedom are reported throughout.

Because lag conditions differed in the Direct and Associated conditions, groups x lag x type of filler x target word condition ANOVA's with repeated measures on all but the group factor, were performed on the Direct and Associated data separately.

Associated Lists

Neither the graphs effect, nor any interaction involving groups approached significance. Mean latencies, pooled over groups are presented in Figure 3. Examination of the figure suggests that a facilitation effect occurred at lag 0 but had disappeared by lag 3 for both kinds of fillers. This conclusion is supported by the significant lag X target condition interaction $F(3, 96) = 8.32$, $p < .001$. Other significant effects were; the type of filler, $F(1, 32) = 10.04$, $p < .01$, where latencies with digit fillers were greater; an over-all lag effect, $F(3, 96) = 8.32$, $p < .001$; the type of filler x lag effect , $F(3, 83) = 3.51$, $p < .025$; a target condition effect, $F(1, 29) = 15.62$, $p < .001$; and the interaction of filler x target condition, $F(1, 32) = 7.77$, $p < .01$.

Direct List

Neither the groups effect, nor any interaction involving groups approach significance. Mean reactions pooled over groups are seen in Figure 4. The target word condition effect was significant, $F(1, 32) = 79.47$, $p < .001$. Other significant effects were filler x target condition, $F(1, 32) = 8.16$, $p < .01$,

EXPERIMENT 1

Associated Lists

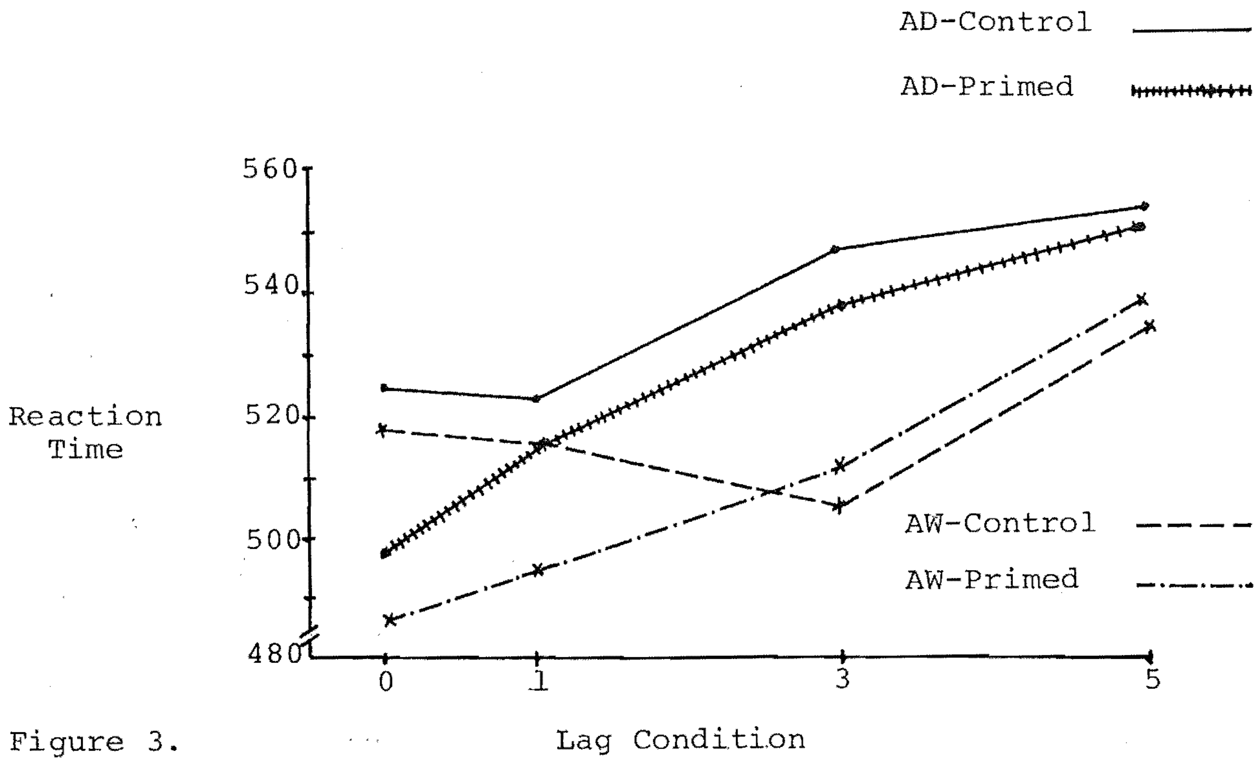

Figure 3.

Direct Lists

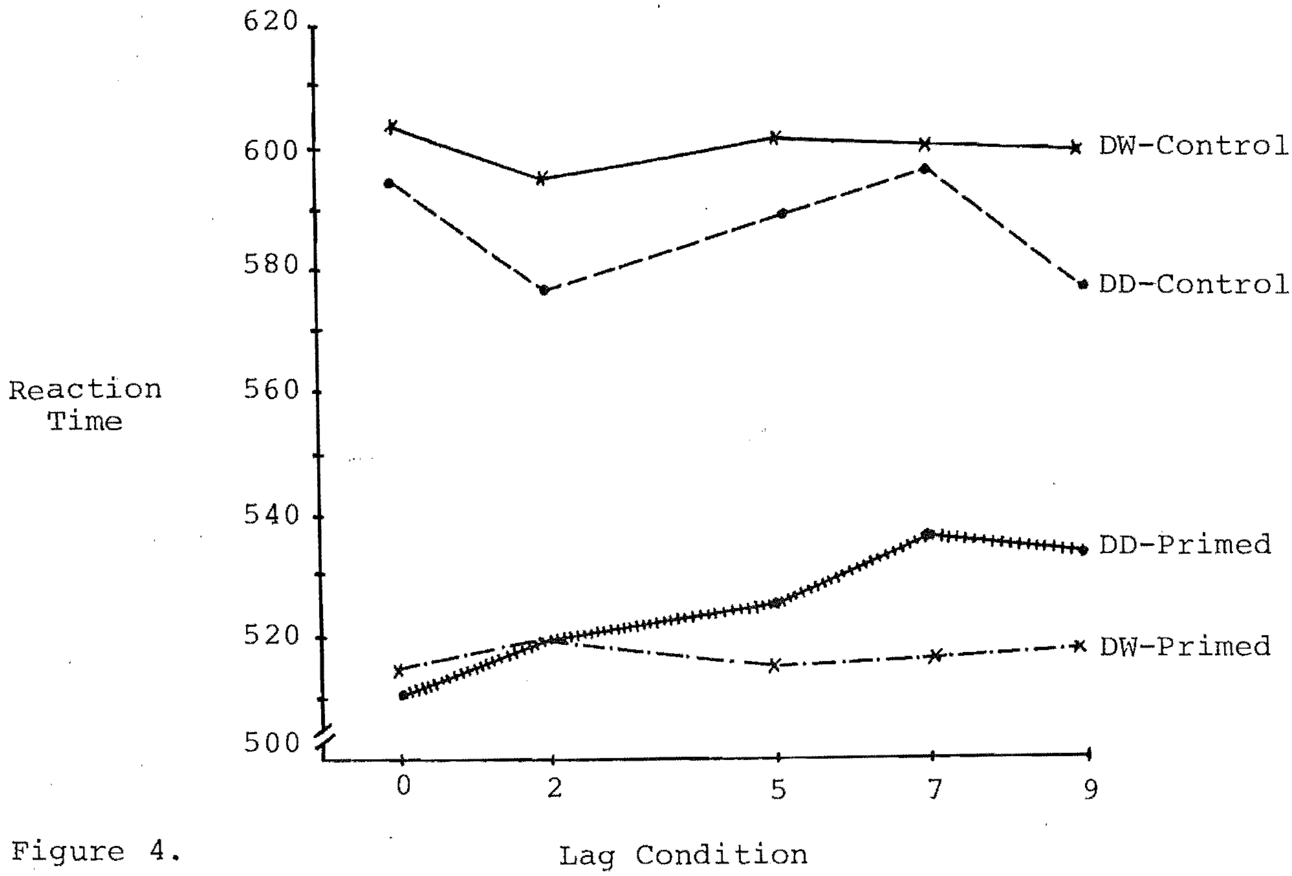

Figure 4.

demonstrating the fact that the facilitation was greater where words were used as fillers; lag x target condition, $F(3, 111) = 3.02$, $p < .025$, which shows a small tendency for facilitation to decrease with lag but unexpectedly the effect was still sizeable at lag 9.

Separate ANOVAS were carried out at lag 9 on the word filler and digit filler data separately. Both were significant. For digits as fillers the control word effect was, $F(1, 32) = 23.71$, $p < .001$ and for digits as fillers, $F(1, 32) = 52.91$, $p < .001$.

DISCUSSION

A weakness in the design of Experiment 1 arises because different prime-target pairs were used at each lag condition and those appearing in the various conditions were the same for all subjects. For example in the associative condition, the finding of a priming effect on latency at lag 0 but not at lag 5 could have arisen because the particular prime-target pairs used at lag 0 produced priming whereas those used in lag 5 did not. Lag effect is confounded with list composition. Similarly, any differences between lists with word or digit fillers and absolute lag effects could be ascribed to confoundings due to list constructions. However the fact that digit and word filled lists behaved in a similar manner with respect to lag lessen this likelihood. Nevertheless, as a check that results were not a function of the specific list, items used, a second experiment using different prime-target pairs was run and is reported in Experiment 2 below.

Also in both AW and AD lists the control words were inserted as a separate set in between truly experimental sets and may have been discriminable from the rest of the remainder of the list. A more satisfactory mode of presenting control words was employed in Experiment 2.

In the Direct list the first word in the list was always used as the control and the same word appeared again at the end of the list as the experimental item. It was felt that a subject could learn this pattern of presentation and selectively retain the first item in active memory by means of rehearsal or some other strategy. Also, the shorter latency to the second presentation (experimental condition) of a word may have arisen, not because of any priming effect, but because latency to the first word was long by virtue of being first in the list. Experiment 2 sought also to clarify this issue.

EXPERIMENT 2

SUBJECTS

Eight University students and two University technical staff in the age range of 19-34 years served as subjects.

Direct Lists

The Direct lists consisted of 363 presentations grouped into 33 sub-lists of 11 presentations each. The first 3 sub-lists were practice lists only.

The lists were constructed so that the last word in each sub-list was the target word. It was preceded in the sub-list by the priming word (in this condition a replicate of the target) and other, filler words. The position of the priming word was determined by the "lag" condition of the list. This lag defined the number of filler words appearing between the priming word and the target as follows:

E.g.	Lag	List
	0	X X X X X X X X X P T
	2	X X X X X X X P X X T
	5	X X X X P X X X X X T
	7	X X P X X X X X X X T
	9	P X X X X X X X X X T

P = Priming word; T = Target word; X = Filler.

There were 5 different lags: 0, 2, 5, 7 and 9 and there were 6 sub-lists for each lag (making a total of 30). Words used as targets (and also as primes) were drawn randomly without replacement from a pool used in Experiment 1 (Direct list, DW). Filler words were drawn randomly without replacement from a disjoint pool of words, some used previously in Experiment 1 as fillers, and others generated by a "stream of conscious" technique.

Associated Lists

The lists with words as fillers: consisted of 252 presentations, comprising 59 sub-lists of varying length, the first of which were practice sub-lists.

Target pairs consisted of a target word and an associated prime. Each target word appeared in two sub-lists (of equal length): one preceded by its associated prime (experimental condition) and once by a neutral filler word (control condition). The prime, or neutral, word always appeared at the start of the list and the target at the end. The intervening list items consisted of a number of filler words depending on the lag condition as follows:

Lag	Experimental List	Control List
0	P T	X T
1	P X T	X X T
3	P X X X T	X X X T
5	P X X X X X T	X X X X X T

P = Prime word; T = Target word; X = Filler

Four different lag conditions were used: 0, 1, 3 and 5. There were seven pairs in each lag condition and two sub-lists (experimental and control) for each pair: thus there were 4 x 7 x 2 = 56 sub-lists.

Target pairs were taken from a pool used in Experiment 1 (Associated list, AD) and were assigned randomly to lag conditions. Filler words were drawn randomly, without replacement, from the same pool as the direct condition.

Associated lists with digits as fillers: were identical to the associated list with words as fillers, except that the target pairs were from Experiment 1 (Associated list, AW) pool and filler items were random two-digit numbers.

RESULTS

Associated Lists

Mean latencies are presented in Figure 5. Median reaction times of all latencies between 200 and 1000 msecs were found for each subject in each condition. A lag x type of filler x target ANOVA was carried out and essentially confirmed the results from Experiment 1. The lag x target condition $F(2, 18) = 4.58$, $p < .025$ was significant, demonstrating that the experimental - control difference is greater at lag 0 and 1 than at lags 3 and 5. Other significant effects are lag, $F(2, 20) = 16.1$, $p < .001$; filler x lag effect, $F(3, 24) = 7.69$, $p < .001$ where latencies tended to increase more with lag in the digit condition.

EXPERIMENT 2

Associated Lists

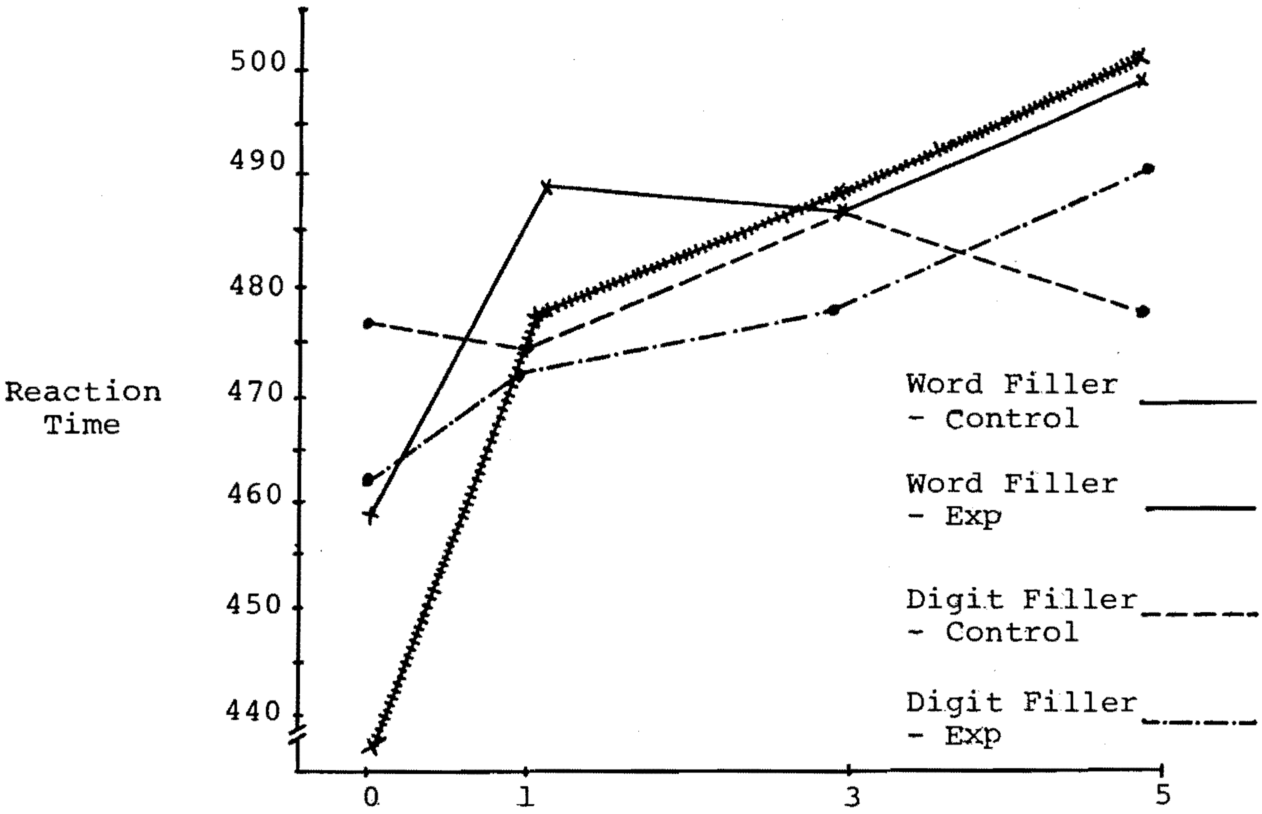

Figure 5

Direct Lists

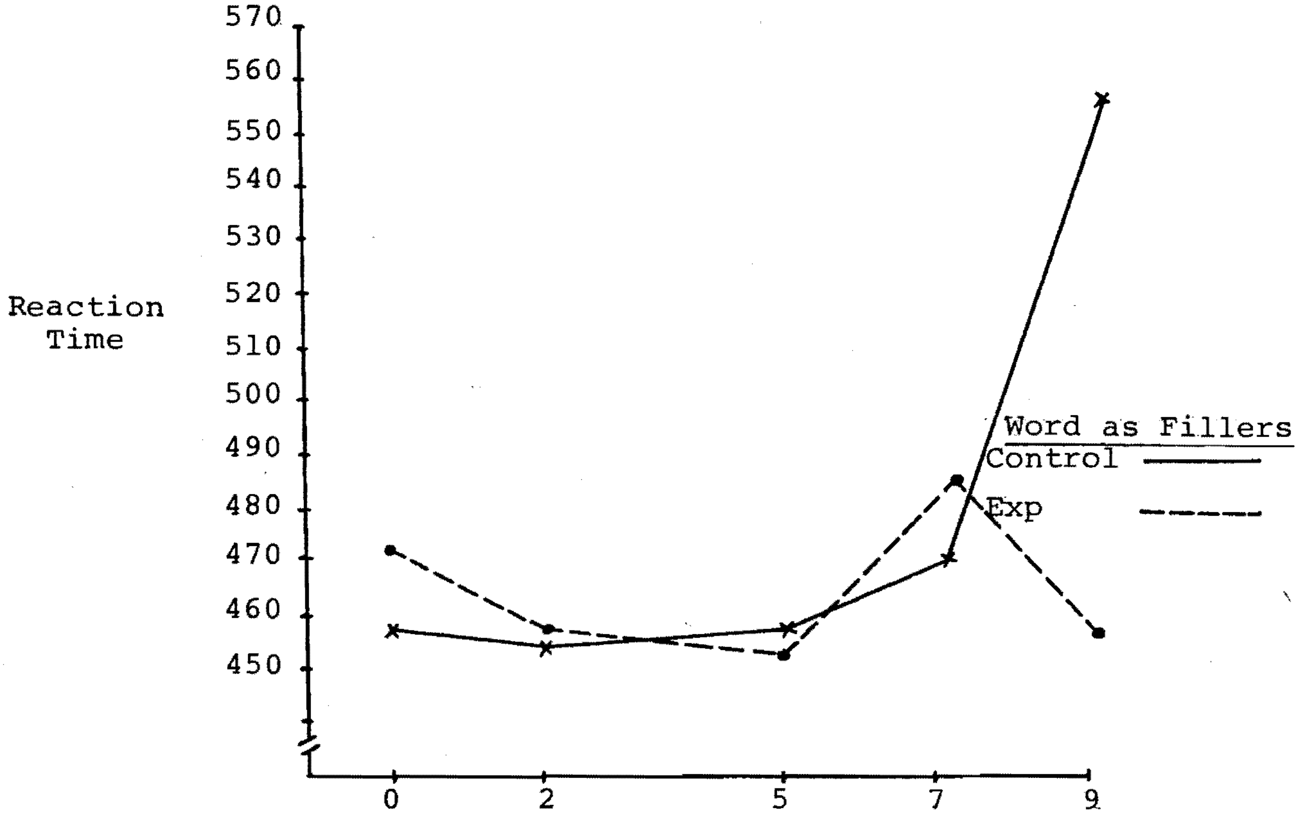

Figure 6

Direct List

Mean latencies are presented in Figure 6. A lag x type of filler x target condition ANOVA showed a significant lag effect, $F(3, 26) = 12.5$, $p < .001$; also significant was whether the word was in the control or experimental condition, $F(1, 9) = 65.32$, $p < .001$, and lag x experimental or control condition $F(3, 24) = 12.88$, $p < .001$ was significant.

DISCUSSION

Results from the Associated lists are similar to those of Experiment 1 (compare Figures 3 and 5). The results from the Associated lists Experiment 1 are therefore not specific to the particular prime - target pairs used. Also, the grouping of control words in bunches does not seem to have biased estimates of the size of facilitation effects.

Results of the magnitude of priming effects from the Direct list demonstrated that results of the Direct list in Experiment 1 were merely an artifact of the control word always being the first word in the list. This was confirmed, when the control lag 9 condition (first word in the list) in Experiment 2 showed approximately the same elevated latency relative to words in associated lists, as all control words in Experiment 1.

The results from the Direct condition in Experiment 2 show very little facilitation at any stage in the list. In priming and activation terms this is difficult to account for and no explanation is offered as to why, on the second presentation of the same word, virtually no facilitation at all is evidenced. Common sense would require some activation but because of the unsatisfactory results from Experiment 1, there will be no further discussion in this thesis on the Direct lists.

CHAPTER III

GENERAL DISCUSSION

Because the same overall pattern of results was obtained for associated lists with word and digit fillers and for both experiments, it is assumed that results in Experiment 1 are not an artifact of the specific prime-target pairs used, nor the grouping of words in the control condition in Experiment 1. With respect to the schizophrenic/normal comparison, this discussion is confined to the Associative lists.

The major finding of this study was that there was no significant difference between the performance of schizophrenic and normal groups. The hypothesized performance decrament, where thought disordered schizophrenics would manifest a smaller facilitation effect from the prime, and that activation would decay more rapidly for this group, did not occur.

The necessary and expected effect of whether a word was in an experimental or control position in the list, was obtained for both schizophrenics and normals. The significant overall lag effect verified the expected decrease in facilitation from lag 0 to lag 3, with the tendency for the latencies of experimental words to increase diverging from lag 0. This was true for lists with both kinds of fillers. Thus digits create no more interference than words when interpolated between control and experimental target words.

Thus, the present experiment, using naming latency have confirmed the results of priming and lag experiments using naming latency (Warren, 1972), and other tasks. (Meyer and Schvaneveldt, 1971); Fisher, 1977; Fisher and Goodman, 1978).

Associative priming effects, i.e. where the reading latency of a word is facilitated when preceded by a high associate, occurred in the same manner and to the same degree in the schizophrenics and normals used. As noted in the introductory chapter, Russell (unpublished), found similar results.

Sperber, Ragain and McCauley (1970), demonstrated a semantic priming effect using a category knowledge task with retarded individuals. The above discoveries suggest that if subjects have a normal priming effect and activation spread, while evidencing cognitive and intellectual deficits, the genesis for the deficits must occur in some other aspect of information processing.

Capacity of short-term memory as investigated by activation spread from associative priming, appears to be normal for schizophrenics. Activation remains for up to three items to intervene between the prime and its common associate. These findings closely follow Loftus's (1974) results, establishing the capacity of short-term memory as approximately two words. Deficits in retrieval from memory for schizophrenics therefore do not appear to be due to a lack of persistence of the activation.

Bauman and Kolisnyk (1976) presented schizophrenics and normals with lists of digits and randomly probed items in serial positions via a recall task. Lists of digits were presented to subjects and items in the different serial positions were probed randomly in seven recall trials for each list. Input interference resulted from interpolation of items between presentation and recall of the probed idea and was the same for schizophrenics and normals. Output interference resulted from interpolation of responses between presentation and recall and was greater for schizophrenics than for normals. These results are indicative of equal memory capacity for both schizophrenics and normals and are consistent with the findings in this study.

Regarding the areas of priming and whether subjects can bring conscious strategies to bear. This study was formulated to replicate the Posner and Snyder (1975a, 1975b), concept of automatic priming, carried out without the conscious awareness of the subject. The experiments were constructed to ensure that subjects were constrained by the experimental demands. Subjects were instructed to start speaking as soon as the word appeared on the screen and rehearsal was made difficult by the rapidity with which filler words appeared between the control and target words. Priming and facilitation evidenced from these tasks were resultant from processes carried out by the subject at automatic levels. This is supported by findings of Koh, Kayton and Peterson (1976), who demonstrated, by experimentally constraining the encoding of schizophrenics and normals by requiring subjects to rate words as pleasant or unpleasant, that on recall schizophrenics and normals would display the same response bias in recalling pleasant words more frequently. On the other hand, Larsen and Fromholdt (1976), looked at word-storage structure (mnemonics), and used a self-paced task with subjects sorting words into self-determined categories, and discovered schizophrenics required more trials to complete the sorting task than the normals. However, Koh and Peterson (1978) have drawn conclusions from this, that mnemonic processes used in recall, function normally if the tasks occur as an automatic process. It could be concluded that if processing occurs at this unconscious automatic level, schizophrenics do not evidence deficits and if tasks become conscious then deficits appear.

Future research in this area of deficits in schizophrenic processing could therefore, centre on this question of what occurs when consciousness enters processing and the actual features of conscious decision making that go wrong and create the deficits evidenced in schizophrenic processing.

Another area of interest arising from this study, are the peculiar results received in Experiment 2, in the Direct Association condition. These results are an anomoly in the terms of network theory. Common-sense dictates that in the visual world, if for example a cat is seen, that this results in an activation of the links and nodes pertaining to the cat in memory. If this cat is followed immediately by another cat, by necessity this must lead to a further activation in this same area of memory, and some facilitation because of the earlier activation. Results from Experiment 2 contradict this idea.

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APPENDIX

ASSOCIATED LIST AW

	CONTROL	EXPERIMENTAL
LAG 0	day	night
	table	chair
	boy	girl
	doctor	nurse
	black	white
	brother	sister
	pepper	salt
LAG 1	uncle	aunt
	bread	butter
	high	low
	man	woman
	mother	father
	early	late
	king	queen
LAG 3	odd	even
	light	dark
	bitter	sweet
	bottom	top
	hot	cold
	good	bad
	stop	go
LAG 5	cow	calf
	cat	kittens
	square	round
	hard	soft
	stomach	food
	large	small
	blossom	flower

ASSOCIATED LIST AD

	CONTROL	EXPERIMENTAL
LAG 0	enemy	friend
	fruit	apple
	cat	dog
	eagle	bird
	lion	tiger
	day	night
	weak	strong
LAG 1	long	short
	soldier	army
	love	hate
	sickness	health
	giant	dwarf
	devil	angel
	heaven	hell
LAG 3	happy	sad
	near	far
	lost	found
	float	sink
	hard	soft
	front	back
	buy	sell
LAG 5	stem	flower
	large	small
	needle	thread
	scissors	cut
	live	die
	quick	slow
	butterfly	moth

DIRECT LIST DW

SAME WORD CONTROL AND EXPERIMENTAL

LAG 0	track pedal tree build bring beach fixed grand
LAG 2	room apart train grain dream state thrill joke
LAG 5	three plane green night brick point drove teach
LAG 7	brush storm eight dance beard wrote grill bloom
LAG 9	design error guest hair hero stage spring value

DIRECT LIST DD

SAME WORD CONTROL AND EXPERIMENTAL

LAG 0	trade crowd play road pipe dark knee adopt
LAG 2	line dirt study unity hope leave work rubber
LAG 5	glass trade well wild daily today bath mate
LAG 7	what bank jail twist join when judge type
LAG 9	battle gain half powder weak write about invent