SAWYER, TERRY McCRAY. Differential Memory Impairment in Individuals Exhibiting Korsakoff's Syndrome. (1977) Directed by: Dr. David R. Soderquist. Pp. 81.

In the progress of Korsakoff's syndrome two distinctive states are apparent: (a) disordered sense perception and (b) impairment of retentive memory. This study focused on the short term memory dysfunction noted in Korsakoff's syndrome.

The subjects were 96 adult volunteers who ranged in age from 19 to 69 years. All scored within $\pm$ 1 standard deviation from the mean in intellectual functioning on the Maxwell Short Form of the Wechsler Adult Intelligence Scale. Approximately 65% of the subjects were male. The subjects were partitioned into six major groups, 16 subjects per group. Sixteen of the subjects participated as a control group, and the remaining 80 subjects formed the Korsakoff groups. These 80 subjects were subdivided into five groups who had achieved either a one week, two, three, four, or a six to sixteen week period of abstinence from alcohol. All Korsakoff subjects scored within the brain damaged range of functioning as measured by the Reitan Trail Making Test. The normal control subjects scored within the average range.

A free recall task was used to elucidate areas of short term memory impairment in the Korsakoff individuals in contrast with the performances of the control subjects.

The experimental task was presented to each subject following the WAIS and Reitan Test screening procedures. First, two word lists of high frequency nouns were presented auditorially at a rate of one word per second. Following these two practice lists, each subject was sequentially presented with eight additional lists. The first four lists were designated as either suffix or nonsuffix condition with the remaining four lists relegated to the condition not initially assigned. At the end of each list, following the final stimulus item (or after the suffix "zero" in the suffix condition) the subject was requested to write down all the items he could recall in a one minute period.

The suffix and nonsuffix conditions were counterbalanced for order across all subjects. It was also possible to counterbalance the order in which the 16 lists were presented.

The experiment yielded a 6x12x2 mixed ANOVA design with the independent variable being the number of correctly recalled words for each position in the list. Both Serial Position and Suffix-Nonsuffix were repeated measures factors; Groups formed a between factor.

Four specific hypotheses were found to be significant. (a) Performance improved as a function of the abstinence interval, (b) the recency effect became greater as the abstinence interval increased, (c) the primacy effect did

not exhibit such differences as a function of abstinence interval, (d) the redundant suffix affected only recall of the terminal items, and (e) the Korsakoff individuals exhibited more information loss in the suffix condition than the controls. Data were discussed in light of the multistore model and the levels of processing model of human memory.

DIFFERENTIAL MEMORY IMPAIRMENT IN INDIVIDUALS EXHIBITING KORSAKOFF'S SYNDROME

by

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A Thesis Submitted to
The Faculty of the Graduate School at
The University of North Carolina at Greensboro
in Partial Fulfillment
of the Requirements for the Degree
Master of Arts

Greensboro
1977

Approved by

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ACKNOWLEDGEMENTS

Great appreciation is extended to Dr. David R. Soderquist for his invaluable assistance as Committee Chairman. I would also like to thank Dr. Mary Fulcher Geis and Dr. Chong Sook Suh for their suggestions during the preparation of this manuscript.

Special consideration is extended to Dr. Kenneth Rockwell for his critical comments and encouragement.

Above all, I would like to express my gratitude to my father for his unending patience and guidance.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Several models of human memory have been proposed to provide a framework for experimental research. The hypothesized models have often been used to explain, clarify, and expand our knowledge of memory processes. Two influential models in the literature, (a) the multistore model and (b) the levels of processing model, will be reviewed here in terms of human memory functioning. Furthermore, this paper will discuss free recall data obtained from a population of alcoholic brain damaged subjects to elucidate possible impairment in memory processes.

Multistore model. Numerous researchers have postulated a multistore model of memory (Atkinson & Shiffrin, 1968; Craik, 1969; Crowder & Morton, 1969; Murdock, 1967a; Neisser, 1967; Warrington, 1971). This multistore approach uses separate compartments or memory stores with transfer mechanisms linking them in a sequential fashion. These memory stores are (1) precategorical acoustic store (PAS) associated with the individual modality, (2) short term store (STS) or primary memory, and (3) long term store (LTS) or secondary memory.

The precategorical acoustic store is a relatively transient "buffer store" which is specifically auditory and preperceptual (Crowder, 1969). The information in this store is held prior to the process of recognition. The main feature of the PAS relevant to this investigation is that it is capable of storing information for a period of up to two seconds. This information can significantly affect performance on an immediate memory task (Murdock, 1967b). In this procedure, all items are recalled immediately after their presentation. The information in the PAS is added to that available in the short term store (Crowder & Morton, 1969). Consequently, recall from the PAS can be viewed as supplemental output to the output of the STS.

The capacity or function of the PAS is limited by two main factors. Information stored in the PAS can be displaced by succeeding auditory elements. Only the final two to three items of a stimulus list are held in the PAS. The more remote items are overwritten by subsequent ones (Craik, 1969). Another limitation of this store is rapid decay of the information over time. An upper bound of two seconds has been established for availability of items in the precategorical acoustic store (Crowder, 1969). These two factors restrict the recall of information from the PAS to only the last items in the stimulus

list. The earlier items (primacy section) decay prior to recall or they are displaced by the subsequent items.

The addition of a redundant stimulus suffix to the experimental items for immediate recall has been used frequently to investigate the PAS. In tnese experiments subjects receive a block of stimulus items followed by a predictable redundant element. The location and identity of the suffix or last element is known to the subjects and they are advised not to recall this item. The word zero has been used most often in these immediate memory experiments. In the stimulus suffix condition, called such because it has an added suffix item, the redundant element occurs after the presentation of all nonredundant stimulus items but before the reproduction (recall) of these items. This suffix procedure depresses the recall for the most recently presented stimulus items (Crowder & Morton, 1965). The serial position data for the suffix effect, according to the multistore model, have been hypothesized to reflect the displacement of acoustic information from the PAS (Dalezman & Shulman, 1974). When the stimulus suffix is eliminated, the data for the terminal positions show the usual recall advantage. The interpretation of this finding is that information at a precategorical acoustic level is available for two seconds to supplement recall when the suffix is not presented.

The serial position data, then, show no stimulus suffix effect for the items presented early in the list. The detrimental suffix affects only the terminal items because these are the only traces remaining in the PAS. As noted earlier, the initial items decay from acoustic storage prior to the recall condition.

Other properties of the suffix condition support previous research on the unique properties of the precategorical acoustic store. The stimulus suffix effect shows displacement or loss of earlier items whether or not those items carry task information (Crowder, 1969). This finding supports the prelinguistic nature of the store. Morton, Crowder, and Prussin (1971) also supported the precategorical property of PAS by varying the meaning, frequency, and the emotionality of the redundant suffix. These studies revealed no change in the size of the stimulus suffix effect.

The studies of Crowder and Raeburn (1970) support the independence of PAS from linguistic distinctions. These investigators found no difference in the magnitude of the stimulus suffix effect when the "zero" suffix was presented in normal speech or reversed speech. The redundant suffix exhibited the same decrement regardless of its degree of meaningfulness.

The rapid decay of the PAS is shown in studies involved with delayed readout and recall. Crowder (1969)

conducted an experiment varying the delay interval between the last element to be recalled and the redundant suffix. Using intervals of .5, 2.0, 5.0, and 10.0 seconds, he found only selective impairment of performance in the terminal positions at the .5 second interval. Performance was independent of the suffix condition after a two second delay indicating an upper bound of about two seconds for PAS retention.

Another conclusion, based on the rapid decay of information in the acoustic store, concerns the effects of rehearsal and practice. The magnitude of the stimulus suffix effect on the PAS does not vary with repetitions nor does the PAS benefit from practice as to postcategorical traces (Dalezman & Shulman, 1974). Information in the PAS apparently decays prior to each additional repetition if the repetitions are longer than two seconds apart. This lack of improvement with practice is one major difference between the PAS and the short term store.

The rate of item presentation has a great effect on the information stored in the PAS. The PAS has a very limited capacity, and a rapid presentation of stimulus items allows full capacity of the store before the decay begins. This full capacity in the PAS permits increased supplemental output to the short term store. When a rapid rate of presentation is used (four words per second)

and the suffix condition is omitted, recall is significantly superior (Conrad & Hille, 1958).

The magnitude of the stimulus suffix effect is assumed to be a function of the number of items in the precategorical acoustic store. A fast rate of item presentation causes more information to be lost when a suffix is added after the last item in the stimulus list (Dalezman & Shulman, 1974).

Variations in the acoustic properties of the suffix item affect the magnitude of the stimulus suffix effect (Morton, Crowder, & Prussin, 1971). For example, acoustically similar items are more likely to degrade the PAS information. Elmes (1974) found that, in the recall of digits, a zero suffix had a greater effect if it was presented in the same voice than when presented in a different voice from the stimulus items. Speech signals of the same class interfered with recall to a greater extent than those of a different class. He also noted that a zero suffix reduced recall of the terminal digits to a greater extent than a buzzer presented as the suffix. Elmes postulated that acoustic discriminations were made between speech and nonspeech sounds.

The increased recall of items in terminal positions of a recall list has been assumed to be output from short term store or primary memory (Atkinson & Shiffrin, 1968; Waugh & Norman, 1965). This postrecognition store

has the potential for direct linguistic response and may, theoretically, be augmented by relatively unprocessed data in the PAS. This view is supported by Neisser's (1967) work on auditory and visual memory stores. In a verbal memory task supplemental information is only available in the case of auditory input. The visual preperceptual store decays prior to any opportunity for recall. In summary, the short term store provides items for recall in the terminal serial positions, and the PAS supplements the information available in primary memory when the information is presented in the auditory modality.

After a single exposure to the stimulus items, human subjects may forget the items within only a few seconds after the learning trial when they are given no opportunity for rehearsal (Peterson & Peterson, 1959). Memory can depend exclusively on the short term store only for a brief interval after the initial trial unless continued attention and rehearsal are maintained. If the limited holding capacity for stimulus items is surpassed, the information in the short term store will be lost (Dallett, 1965). In summary, the items in the STS are exposed to two types of disruption--decay over time and displacement by subsequent items.

The short term process is presumed to be arranged serially with the long term process and initiates the initial step in the sequence of events leading to long

term storage (Squire, 1975). Performance can thereby be enhanced if the more stable long term storage is permitted to develop (Craik & Levy, 1970).

The long term store differs from the STS on several major variables. It is assumed that information is transferred to LTS through rehearsal and application of an encoding strategy. A slow rate of presentation or a temporal delay after the initial presentation will facilitate transfer of the stimulus information into long term storage. Once information is in LTS, decay and overwriting by subsequent items are no longer major factors resulting in information loss. The STS and LTS are both post-recognition and categorical stores; however, the format for classifying data differs. Long term storage is based on a semantic dimension. The degree of meaningfulness of the incoming material has a significant impact on its storage in long term memory. In typical serial position curves, information from the LTS is assumed to be represented by the initially presented items (primacy); moreover, those items that have been processed on a semantic level will show a high probability of being recalled over an extended time interval than nonsemantic items (Glanzer & Cunitz, 1966).

Levels of processing model. Another approach to explain data concerning human memory is the use of a levels of processing framework (Craik & Lockhart, 1972).

The hypothesized residual memory trace is a central feature of this model, and it is viewed as a byproduct of perceptual processing (Morton, 1970). That is, qualitative changes in the hypothesized memory trace occur as the original stimulus is processed at progressively deeper levels. The flow from one level to another results in a continuum of analysis. Depth of analysis proceeds from a level based on physical features of the stimulus to one that focuses on phonemic features. Finally, the analysis reaches the level of semantic or associative operations.

The depth of processing can be viewed as a function of the degree of semantic involvement (Craik & Tulving, 1975). To obtain a deeper analysis the original stimulus requires semantic encoding. Processing information at this deeper level results in superior retention and a more durable long term memory trace. Consequently, the rate of information loss is a function of the level of processing used for encoding.

Massaro (1970) postulates that the probability of recalling an item is a positive function of the amount of perceptual processing it receives. He concludes that the time involved in the processing is a direct index of the depth of item processing if other variables are held constant. Longer processing intervals should result in deeper analyses of the incoming stimuli. Two major

variables influence the depth of processing. They are: (a) rehearsal time, and (b) rate of item presentation.

Research in two other areas of human memory seem to lend support to Massaro's view. Results from numerous studies have led to the conclusion that rehearsal time is crucial in predicting the probability of recall in a learning task. A long rehearsal time yields a significant improvement in recall. Further studies indicate a second major factor influencing the amount of processing time. The rate of item presentation affects the durability of the memory trace. Data indicate that a slow rate of presentation can enhance recall. In the current framework, these longer intervals between item presentations permit deeper processing to the level required for long term retention.

However, results drawn from several experiments by Craik and Tulving (1975) bring Massaro's hypotheses into question. For example, in two experiments subjects gave a yes or no response to questions concerning typescript, rhyme, and sentences for each stimulus word. These questions theoretically required structural, phonemic, and semantic processing respectively. One of the two experiments was concluded with an unexpected recall task. Craik and Tulving (1975) labeled the initial phase of this experiment an incidental learning task. The second experiment differed only on the recall task. Subjects

in this experiment had prior knowledge that they would be required to recall the stimulus words. The initial phase of this second experiment was labeled as an intentional learning task. In both experiments the exposure and rehearsal time was held constant. Craik and Tulving (1975) reported that recall of the items differed significantly between the two conditions. They concluded that this type of manipulation determined the depth (level) of processing used for encoding the information. The task at the time of input was seen as a powerful determinant of later recall. These results suggest that the amount of processing time and rehearsal time are not the only variables affecting the depth of item processing. Qualitative differences in encoding operations (structural contrasted with semantic) also indicate the depth of processing.

Craik and Tulving (1975) have shown that the level of processing for semantic features can occur at different rates. Stimuli that are very meaningful and highly familiar to the subject reach a deeper level of processing more rapidly than stimuli that have few pre-existing associations. If cognitive structures already exist for the item, then deep analysis proceeds at a faster rate.

In order to account for these differences, Craik and Lockhart (1972) have proposed two types of processing.

They postulate a limited capacity central processor which can perform one of two functions on incoming stimuli. In one process, called Type I, the items are continually "recirculated" at a single level. For example, an item may be processed at the structural or phonemic level but may not reach a deeper level. Moreover, if items are encoded by Type I processing the rehearsal time or the time interval between presentations does not result in a deeper analysis. This postulate is in conflict with Massaro's concepts.

Craik and Tulving (1975) also postulate that recall from memory traces based on Type I processing is evident in the terminal (recency) positions of a serial position learning curve. The incoming stimuli recirculated at the shallow levels of processing are more easily destroyed by interpolated material. If processing is diverted to another task the items may be lost. Furthermore, it should be noted that since these terminal items are processed less deeply they are more susceptible to the suffix condition previously described. The presentation of a suffix interferes with continuous rehearsal necessary to maintain the memory trace.

The second function of the central processor, Type II processing, allows for a deeper analysis and, consequently, a more persistent trace (Craik & Lockhart, 1972). The items receiving this type of processing exhibit qualitative

changes in memory code as they progress through the continuum of analysis. They can be initially screened at the sensory level according to the modality of input and then later can be processed on structural and phonemic attributes. Finally the information may reach a deeper level of processing for semantic analysis where superior retention and enhanced recall are evidenced by the deeper processing.

In Type II processing the increased rehearsal time permits the information to reach the deeper levels of semantic operations. If the stimulus items have a high level of meaningfulness deep processing can be achieved rapidly; a slow rate of presentation will also promote processing to the level necessary for long-term retention.

According to Craik and Tulving (1975), Type II processing is evident in the primacy effect found in serial position curves. The initial items show a high probability of recall, according to the model, because of the deeper level of processing and a more durable memory trace. For example, when the semantic and associative qualities of the stimulus items are processed their registration is strengthened, and the items are less susceptible to decay, displacement, or interference by other materials. If Type II processing is in effect and processing is diverted to another task, the information processed at the semantic level is not destroyed as easily

as the same information processed at a more shallow level. For example, a suffix would have less effect (disruption) on items in early serial positions than on items in the terminal positions. The initial items would reach a deeper level in Type II processing, and the presentation of the suffix would not cause a decrease in recall. In contrast, the terminal items are assumed to be in Type I processing so the suffix terminates their recirculation and alters the quality of the residual trace.

In summary, the levels of processing framework stresses the role of depth of encoding. A more durable trace, manifested by superior recall, is theoretically formed at deeper semantic levels of processing (Craik & Lockhart, 1972). A continuum of analysis that progresses sequentially from structural encoding to semantic operations has been postulated (Sutherland, 1972).

The process of encoding information in human memory has been described in terms of a multistore model and a levels of processing model. Both of these approaches will be further evaluated and contrasted by examining a specific instance of memory impairment. Specifically, it is apparent from clinical diagnoses and research that the processes of encoding, storage, and retrieval are disrupted when prolonged use of alcohol results in brain damage. A form of brain damage, Korsakoff's syndrome, will be reviewed here as an example of how memory processes

are impaired and to set the stage for the research to be reported.

Korsakoff's syndrome and memory deficits. In the progress of Korsakoff's syndrome two distinctive states are apparent: (a) disordered sense perception, and (b) impairment of retentive memory. In the acute phase of this syndrome the sensory disorganization is the more prominent state. The symptoms include illusions, hallucinations, tremulousness, and convulsions with episodes of delirium tremens. Each of these symptoms is linked with the withdrawal from alcohol. The patient is usually amnesic for events just prior to the onset of these symptoms and remains agitated and disoriented for time and place during the acute phase. During this initial period, peripheral neuropathy of the lower limbs and an ataxic gait are prominent symptoms. Within a few days the acute phase is completed, and there is a rapid restoration of reflexes. The polyneuropathy clears quickly and usually completely (Freedman & Kaplan, 1967). After this time the patient becomes less irritable and appears more passive and apathetic.

After the acute phase of sensory dysfunction, a second state becomes more prominent. The impairment in memory becomes salient as the patient exhibits less obvious disorientation (Freedman & Kaplan, 1967). Confabulation or filling in the memory gaps with obviously false

information can sometimes disguise the extent of the memory disruption unless formal diagnostic testing is administered. As the individual progresses into the chronic stages of Korsakoff's syndrome the confabulation is observed less frequently.

Several types of memory impairment noted in the Korsakoff's syndrome have been extensively studied. The two major areas of functioning that are the leading foci of research are: (a) remote memory or LTS functioning, and (b) immediate memory or STS functioning. Standardized intelligence testing has been used to differentiate the two categories of dysfunction.

Victor, Herman, and White (1959) administered the Wechsler-Bellevue Intelligence Scale and the Wechsler Memory Scale to a group of Korsakoff patients at two intervals. The first testing session was conducted at a three to nine week period after initial hospitalization. The interval varied as a function of the condition of the individual patient. The second testing session occurred between the twenty-eighth and the thirty-second week of treatment. They found no tendency for these patients to score higher or lower than average on either the verbal or performance tests on the Wechsler-Bellevue Intelligence Scale. The Korsakoff patients did not appear to have specific profiles on the Scale although they did exhibit multiple fluctuations (scatter) between the

subtests. The patient showed a consistent tendency to score above their own individual means on Picture Completion, Information, and Similarities subtests; they scored below their own means on Digit Symbol, Arithmetic, and Block Design. Victor et al. found that all test performances on the Wechsler-Bellevue Intelligence Scale tended to improve on later testings. On the Wechsler Memory Scale, the Korsakoff patients scored considerably below their own IQ levels. This level of functioning did not improve with multiple retestings.

As the Korsakoff patients continue withdrawal and complete the acute phase, features of their memory impairment gradually change character. Progressive stages can be identified for both STS and LTS functions.

Allen, Faillace, and Reynolds (1971) reported a longitudinal study of eight alcoholics followed for three weeks after their hospitalizations. These investigators noted no improvement on serial learning tasks; however, they found some trend toward progressive recovery in free recall learning tasks during the fourteen day period of withdrawal. The serial and free recall tasks were given at intervals of 3, 6, 10, and 13 days from the time of initial abstinence from alcohol. This study was not confounded by the use of any other medications during the withdrawal period. Although the free recall task showed significant changes over the withdrawal

period, the characteristic recency effect was absent from the recall curve after three days of withdrawal. The researchers postulated that this loss was due to disruption in STS during early withdrawal. Memory functioning showed significant recovery during the 10 to 13 day interval following withdrawal. The recency portion of the serial position curve at that time approximated the curve usually reported for normals. After 14 days of hospitalization no further improvement was noted.

The primacy effect remained unimproved when measured on the third and the thirteenth day of withdrawal; Allen et al. (1971) hypothesized that the memory functions underlying LTS did not recover in a manner similar to the STS functions following withdrawal from prolonged intoxication. Although Allen et al. discussed their data in terms of the multistore model, it could also be evaluated in light of the levels of processing model. The recovery in recency functions indicates Type I processing has increased because items are attended and recirculated at a constant shallow level. The lack of primacy improvement indicates that semantic operations are not being utilized.

Other studies have postulated differences in memory stores to account for the recovery of STS but not LTS in the Korsakoff patient. Cermak and Butters (1973) reported that these individuals are unable to retrieve

information from STM due to increased sensitivity to interference. They concluded that the short term store holds information from 0 to 60 seconds if rehearsal is prevented. Their numerous experiments further indicate that Korsakoff patients do not spontaneously encode information by using a semantic system. Consequently, the limited information retained in STS is further reduced by defective encoding into LTS. Processing may not proceed into the deeper semantic levels.

Butters, Cermak, Lewis, and Goodglass (1973) noted that Korsakoff patients rely heavily on acoustic and associative categorizations but not on deeper level semantic strategies. The reliance on auditory encoding (Cermak & Butters, 1972) produces the rapid recovery noted in the recency portion of the serial position curve. These data support the view that the PAS functions in a manner similar to that noted for normal control groups. Processing at the structural and phonemic levels may improve. Korsakoff patients can retain a normal digit span on a rote basis by using acoustic methods. Supraspan series involving categorizations and retrieval systems show marked impairment (Cermak & Butters, 1972), and there is no indication of Type II processing.

Difficulties in semantic encoding have been studied with cued recall and with stimulus items presented from the same category of meaning. Cermak and Butters (1973)

found that these patients are aided by the use of categories. However, they do not independently employ these cues unless they are provided by the experimenter (Cermak & Butters, 1973). This failure to use semantic categorizations lends further support to the hypothesis of deficits in transfer of information from one level to a deeper one.

Meissner (1968) also concludes that the data on defective functioning is not due mainly to primary memory deficit but to severe impairment in secondary (LTS) memory. These patients have significantly more difficulty in recalling information in the correct order. Often they create order by the process of confabulation. Meissner suggests that the mechanism of sequential organization is severely disrupted. Fragments of stimuli may be recalled but without the proper serial order. This lack of ordering and integration is seen most clearly in the sharp break in performance where material is transferred out of primary into secondary memory. These data could also be interpreted as a lack of Type II processing. The Korsakoff patient is able to effectively handle seven to eight units of information within the limits established for normal functioning of shallow level processing. Rote memory of repeating digits or short sentences is relatively unimpaired, but progressive deterioration occurs with increased amounts of information.

Cermak and Butters (1973) studied material specific memory deficits in patients exhibiting Korsakoff's syndrome. They compared verbal and nonverbal materials across auditory, visual, and tactile modalities. Their findings of normal short term retention of nonverbal materials but severe deficits for verbal materials support the hypothesis that there are failures in verbal encoding. This impairment of verbal retention occurred regardless of the modality of presentation. They concluded that the Korsakoff patient relies heavily on an acoustic strategy. As a result of an encoding deficit, material in STS is highly sensitive to interference (Weingartner, Faillace, & Markley, 1971). The nonverbal information storage is not as disrupted since it does not rely on semantic analysis (Cermak & Butters, 1973). These data can also be viewed as further support for the hypothesis that Type I processing is possible while Type II processing of verbal materials is disrupted.

Statement of the problem. This study investigated the differential effects of alcohol induced brain damage on the processing of high frequency words. The subjects were further classified into subgroups according to the intervals of their abstinence from alcohol. This was done to examine changes in recall as a function of recovery time. The results of previous research indicate that

recall is positively correlated with increasing abstinence intervals.

Victor, Herman, and White (1959) have postulated that Korsakoff patients frequently score within the average range on standardized tests of intellectual functioning while exhibiting significant impairment on short term memory tasks. Since the purpose of this study was to examine memory processes in Korsakoff patients who exhibited no intellectual deficits, the Maxwell Short Form of the Wechsler Adult Intelligence Scale was administered to each subject in order to screen out those individuals with borderline or defective intellectual functioning. The Reitan Trail Making Test was administered to each subject in order to obtain a measure of brain damage. All alcoholic subjects met these two criteria of Average intellectual functioning and significant levels of brain damage.

The salient features of memory impairment in Korsakoff's syndrome have been interpreted by Allen, Faillance, and Reynolds (1971). They have concluded that performance in a serial recall task is significantly poorer than performance in a free recall task due to a lack of spontaneous semantic encoding. In terms of the levels of processing model, the Korsakoff patients are unable to order and sequence the items in a serial task because deeper semantic processing is not employed. This lack of

semantic processing is not as limiting in a free recall task; information can be retrieved from structural and phonemic processing levels and deeper organization is not required. A free recall learning task was used in this study to elucidate the patterns of memory functioning. Based on the work of Allen et al. (1971), it was hypothesized that a free recall task would be a more sensitive measure of recovery than a serial recall task.

Allen et al. (1971) have also drawn conclusions from serial position data obtained from Korsakoff patients in withdrawal from alcohol. Their studies revealed no improvement in serial recall over a two week interval; however, progressive recovery in free recall was noted. Furthermore, the free recall data showed differential recovery effects as a function of serial position. During the two week testing period, the normal recency effect returned but primacy effects remained unimproved. These results further supported their conclusions concerning structural and semantic processing of information. Allen et al. (1971) hypothesized that the recovery of recency effects was due to improvement in short term storage while lack of primacy effects indicated no recovery of the long term storage component. These data can also be conceptualized in the levels of processing framework. The improvement in recency theoretically indicates the strengthening of Type I processing. While

information from this shallow level can be retrieved, processing at deeper levels continues to be impaired and, consequently, no additional output is provided from semantic processing.

Dalezman and Shulman (1974) postulated that the suffix condition significantly impaired acoustic storage; wherefore, a redundant suffix procedure was utilized in the present study to evaluate deterioration at different levels of processing. Butters, Cermak, and Goodglass (1973) hypothesized that Korsakoff patients rely heavily on acoustic storage and conversely, show no significant use of semantic processing. Other investigations (Meissner, 1967) have also shown a sharp decline in recall from serial positions theoretically presumed to indicate Type II processing. The detrimental effects of a suffix on acoustic processing was investigated in this study to determine if Korsakoff patients show greater recency effect impairment than normal subjects when acoustic processing is disrupted by a suffix.

Four specific outcomes were hypothesized from the data on free recall and memory impairment in Korsakoff patients. (a) It was hypothesized that performance on a free recall task improves as a function of the abstinence interval. During the withdrawal phase, recovery in processing functions is exhibited in a greater overall frequency of items recalled; therefore, the main effect

of Groups would be significant. It was further hypothesized that recovery in recall would show differential recency and primacy effects.

(b) A significant interaction between Groups and Serial Position was postulated. It was hypothesized that the recency effect becomes greater as the abstinence interval increases, i.e., processing improves for the terminal items in the list. Moreover, it was hypothesized that significant recovery of the primacy effect would not occur as a function of increased abstinence. These results were expected in accordance with differential recovery in processing levels. As Type I processing increases, the terminal items are recalled more frequently. They are encoded at an acoustic structural level and are available for immediate readout. In contrast, the initial items in the list are not accessible for recall because they are processed at a deeper, semantic level. Since semantic processing is not utilized by Korsakoff patients, they should exhibit a low recall frequency on primacy items. This limitation is evidenced by lack of recovery in the primacy effect.

(c) A significant interaction between Serial Position and Suffix-Nonsuffix was hypothesized. The redundant suffix effects only the recall of terminal items, i.e., recency portion of the serial position curve. The recency effect is greater in the nonsuffix condition when contrasted

with the suffix condition. It was postulated that the presentation of the suffix disrupts attention to and recirculation of the terminal items. Type I processing is diverted and the items are not available for recall. The information on structural and acoustic properties of the terminal items is overwritten by the additional suffix.

(d) A significant interaction between Groups and Suffix was hypothesized. The Korsakoff patients exhibit more information loss in the suffix condition than normal controls. The research of Allen et al. (1971) has shown that these individuals rely almost exclusively on acoustic processing. When this encoding strategy is disrupted by a redundant suffix, the overall frequency of recall is significantly decreased when contrasted with the decline in recall noted for controls who are also in the suffix condition. The controls rely on multiple encoding strategies (structural, phonemic, and semantic); therefore, they are less affected by acoustic disruptions.

CHAPTER II

METHOD

Design. The experiment yielded a 6x12x2 mixed design and was analyzed by an ANOVA and Tukey's HSD post-hoc tests. The dependent variable was the number of correctly recalled words for each position in the list. The data were collapsed over the four lists in each of the two conditions (suffix and nonsuffix). Table 1 shows the experimental design. Both Serial Position (12 levels) and Suffix-Nonsuffix (2 levels) were repeated measures factors; Groups formed a between factor.

Materials. The Reitan Trail Making Test (RTMT) for adults (Parts A and B) were used in the experiment and administered to each subject individually. The RTMT is designed to measure the degree of brain damage and is used to differentiate individuals with and without brain damage (Reitan, 1955). The RTMT is a timed test, and credits are assigned as a function of the number of seconds required by a subject to complete each of the two tasks. The test was administered according to the standardized Reitan procedures. The reliability of the RTMT was found to be .84 in an initial validation study

Table 1

Design Matrix

Group	Serial Position	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12
1	S1 ⋮ S16		
2	S1 ⋮ S16		
3	S1 ⋮ S16		
4	S1 ⋮ S16		
5	S1 ⋮ S16		
6	S1 ⋮ S16		

of 465 subjects (Brown, Casey, Fisch, & Neurringer, 1958; Korman & Blumberg, 1963; Reitan, 1955, 1958, 1959).

The Maxwell Short Form of the Wechsler Adult Intelligence Scale was administered individually to each subject. This form included the Vocabulary subtest of the Verbal Scale and the Block Design subtest of the Performance Scale. The Vocabulary subtest purports to measure concept formation and language development and is influenced by education and cultural opportunities. The Block Design subtest is designed to measure the ability to perceive form and visual-motor integration. Psychomotor speed is the major factor influencing this score. These two subtests have a correlation of .95 with the WAIS Full Scale IQ score (Robb, Bernardoni, & Johnson, 1972).

Two hundred and sixteen of the most frequently occurring nouns from the Howes (1966) word count were selected. These words formed the stimulus item pool and were randomly divided into eighteen lists of 12 words each.

A Panasonic cassette tape recorder model number RS-2648 was used to present full instructions and stimulus lists to the subjects.

Subjects. All subjects were residents of the Guilford County area of North Carolina. A total of 96 adult volunteers formed the subject pool. They ranged in age from 19 years to 69 years with a formal education

level from 4 to 18 years. Approximately 65% of the subjects were male. All subjects scored within a scaled score range of 4 to 16 (below average to above average) on the Maxwell Short Form of the Wechsler Adult Intelligence Scale (WAIS). The Maxwell Short Form included the Information and Block Design subtests. These two scaled score ranges indicated a subject population range from below average (4-7) to above average (11-14) in intellectual functioning.

The subjects were partitioned into 6 major groups, 16 subjects per group. Sixteen of the subjects were volunteers from the Guilford Technical Institute evening school, and participated in the experiment as a control group. The remaining 80 subjects were volunteers in local residential treatment centers or in outpatient programs.

Every subject was individually screened for brain damage via the Reitan Trail Making Test. Each of the control subjects obtained a score in the average range, i.e., a minimum score of nine scaled credits on Part A and three or more scaled credits on Part B for a minimum total of 12 points. The control subjects were also screened by verbal report for a past history of treatment for alcohol or other drug abuse. No history of this type was elicited from any of the control subjects. The 80 alcoholic subjects were also screened for brain damage via the Reitan Trail Making Test. The alcoholic subjects

scored in a range indicating brain damage, i.e., 9 scaled credits or less on Part A and less than 3 scaled credits on Part B for a maximum total of 11 for Parts A and B.

The 80 brain damaged alcoholic subjects were further classified as a function of their abstinence from alcohol, and the five groups of 16 subjects were formed. They were formed on the basis of 1, 2, 3, 4, and 6 to 16 weeks of sobriety.

The means and standard deviations of the demographic variables, Wechsler Adult Intelligence Scale (WAIS) scaled scores for the Information and Block design subtests, the Reitan Trail Making Test (RTMT) scaled scores for Parts A and B, and the abstinence intervals are presented in Table 2 for each of the six groups of subjects.

Procedure. Each subject was briefly interviewed in order to obtain relevant demographic information and a drug history. The individual was asked to write his full name and five high frequency words read by the experimenter to determine that he was literate.

The Maxwell Short Form of the Wechsler Adult Intelligence Scale was then administered individually to each subject, and the two scaled scores were obtained from this measure. If the criterion levels were met (scaled score range from four to sixteen; below average to above average in intellectual functioning), the Reitan Trail Making Test was administered. These procedures constituted the

Table 2

Means and Standard Deviations of Demographic Variables, WAIS Scaled Scores, RTMT Scaled Scores, and Abstinence Intervals of the Six Groups of Subjects

Variable		Group					
		Control	Alcoholics 1 wk.	Alcoholics 2 wk.	Alcoholics 3 wk.	Alcoholics 4 wk.	Alcoholics 6-16 wk.
Age	M	34.80	38.25	40.68	38.00	39.06	37.50
	SD	16.76	11.12	9.78	9.19	7.80	6.94
Education	M	13.28	10.56	12.12	11.43	10.93	7
	SD	2.42	2.52	2.09	2.37	1.60	2.23
WAIS - Info.	M	9.75	8.81	9.18	8.75	9.06	9.25
	SD	2.25	1.59	1.74	1.75	1.39	1.89
WAIS - Bl. Design	M	8.75	8.13	9.43	8.25	9.31	.63
	SD	2.61	1.83	1.87	2.17	1.93	1.36
RTMT - A	M	9.93	4.68	6.37	6.56	6.25	.88
	SD	.24	1.76	2.26	1.46	1.92	2.12
RTMT - B	M	7.68	2.06	2.87	3.06	2.87	.36
	SD	2.10	1.30	2.15	3.75	1.41	1.73
RTMT - A+B	M	.81	3.38	4.63	4.81	4.56	.63
	SD	1.94	2.06	2.86	2.43	2.42	2.34
Abstinence Interval	M	-----	1.00	2.00	3.00	4.00	10.50
	SD	-----	-----	-----	-----	-----	-----

initial screening and provided some of the data required for the subject's assignment to an experimental group.

The experimental task was presented to each subject following the initial screening. First, two word lists were presented for practice and to familiarize the subject with the instructions and apparatus. Following the practice lists, the subject was sequentially presented with eight additional lists. The first four lists were designated as either suffix or nonsuffix condition with the remaining four lists relegated to the condition not initially assigned. The suffix and nonsuffix conditions were counterbalanced for order across all subjects. Since each group consisted of 16 subjects and there were 16 different lists, it was also possible to counterbalance the order in which the lists were presented. Table 3 shows how the lists were assigned within each group.

Each word in the list was presented at a rate of one per second. At the end of each list, following the final stimulus item (or after the suffix zero in the suffix condition), the subject was requested to write down all the items he could recall in a one minute period. A booklet was provided for each subject's responses. The subject was told that the word zero would occur in the suffix condition and he should ignore it.

Table 3

List Presentation Order for Each Group of Subjects

Subject	Practice List	Practice List	List Order
S1	A′	B′	A1N B1N C1N D1N P45 M45 N45 O45
S2	B′	A′	B2N C2N D2N A2N O3S P3S M3S N3S
S3	A′	B′	C3N D3N A3N B3N N2S O2S P2S M2S
S4	B′	A′	D4N A4N B4N C4N M1S M1S O1S P1S
S5	A′	B′	E1N F1N G1N H1N I4S I4S J4S K4S
S6	B′	A′	F2N G2N H2N E2N K3S L3S I3S J3S
S7	A′	B′	G3N H3N E3N F3N J2S K2S L2S I2S
S8	B′	A′	H4N E4N F4N G4N I1S J2S K1S L1S
S9	A′	B′	A1S B1S C1S D1S I1N J1N K1N L1N
S10	B′	A′	B2S C2S D2S A2S J2N K2N L2N I2N
S11	A′	B′	C3S D3S A3S B3S K3N I3N L3N J3N
S12	B′	A′	D4S A4S B4S C4S L4N I4N J4N K4N
S13	A′	B′	E1S F1S G1S H1S M1N N1N O1N P1N
S14	B′	A′	F2S G2S H2S E2S N2N O2N P2N M2N
S15	A′	B′	G3S H3S E3S F3S O3N P3N M3N N3N
S16	B′	A′	H4S E4S F4S G4S P4N M4N N4N O4N

Note. S refers to the suffix condition, N refers to the nonsuffix condition. Each letter represents a different word list and each number a random order of that list.

CHAPTER III

RESULTS

A fixed effects analysis of variance on the data yielded the following results: three main effects Serial Position, Groups, and Suffix-Nonsuffix and three first order interactions: Groups x Suffix-Nonsuffix, Groups x Serial Position, and Serial Position x Suffix-Nonsuffix were significant ($p < .005$). The proportion of the variance accounted for by each of the significant results was .08, .07, and .02 for the effects of serial position, groups, and suffix-nonsuffix, respectively. The proportion of variability accounted for by Groups x Suffix-Nonsuffix, Groups x Serial Position, and Serial Position x Suffix-Nonsuffix was .001, .01, and .04, respectively. Because the main effects must be equalified in terms of these interactions, the data are presented in accordance with the latter's significance. The interactions are shown in Figures 1, 2, and 3.

Groups x Serial Position

A further analysis of the interaction of the interaction by Tukey's HSD post-hoc test was done in two stages. First, multiple comparisons were done in terms of groups at each level of serial position; second, the

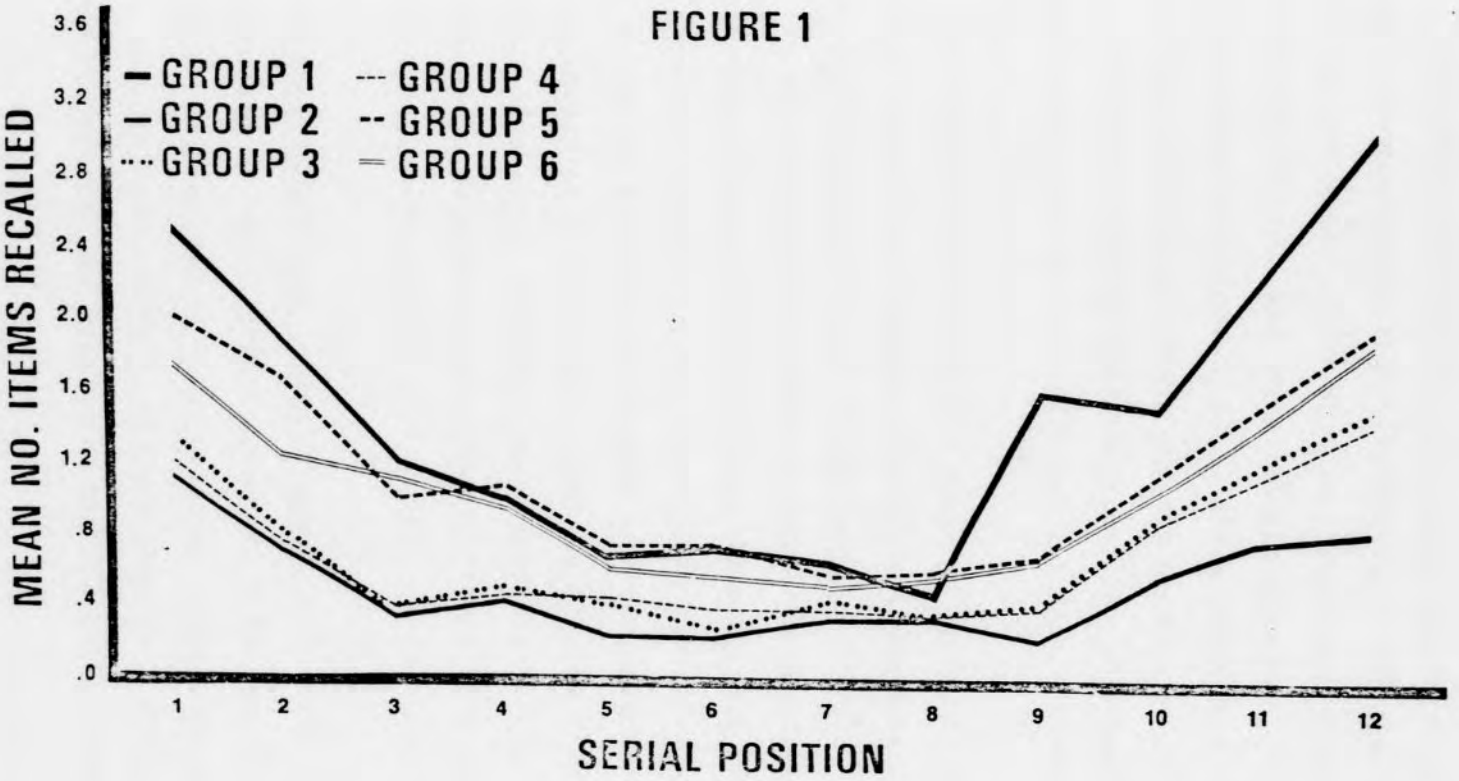
data were analyzed by serial position at each level of groups. These analyses are presented below and may be seen in Figure 1. All reported significances are at $p < .01$ or $p < .05$. Contrasts which were not significant are not discussed.

Groups at levels of Serial Position. At serial position one the control group performed significantly better ($p < .01$) than alcoholics who abstained 1, 2, 3, and 6 to 16 weeks. Alcoholics abstinent for four weeks performed significantly better ($p < .05$) than alcoholics abstinent one week.

At serial position two the controls exhibited significantly better ($p < .01$) recall than alcoholics abstinent one, two, and three weeks. The alcoholics who were abstinent four weeks performed significantly better than alcoholics abstinent one week ($p < .01$) and those abstinent two and three weeks ($p < .05$).

At serial position three the controls recalled significantly ($p < .01$) more items than alcoholics abstinent one, two and three weeks. Alcoholics who were abstinent for four weeks performed significantly better ($p < .05$) than those abstinent one week. Alcoholics abstinent six to sixteen weeks performed significantly better than those abstinent one week ($p < .01$) and those alcoholics abstinent two and three weeks ($p < .05$).

FIGURE 1


GROUP 1
GROUP 2
GROUP 3
GROUP 4
GROUP 5
GROUP 6
MEAN NO. ITEMS RECALLED
3.6
3.2
2.8
2.4
2.0
1.6
1.2
.8
.4
.0
1
2
3
4
5
6
7
8
9
10
11
12
SERIAL POSITION

At serial position four alcoholics abstinent four weeks performed significantly better ($p < .05$) than those abstinent one week. There were no significant differences between the controls and the alcoholic groups.

At serial positions 5, 6, 7, and 8 there were no significant differences among the six groups.

At serial position nine the controls performed significantly better ($p < .01$) than all five alcoholic groups.

At serial position ten the controls performed significantly better than alcoholics abstinent one week ($p < .01$) and those abstinent two and three weeks ($p < .05$).

At serial position eleven the controls performed significantly better ($p < .01$) than all alcoholic groups. The alcoholic groups did not differ from each other.

At serial position twelve the controls recalled significantly more ($p < .01$) items than all the alcoholic groups. Alcoholics abstinent four weeks and six to sixteen weeks performed significantly better ($p < .01$) and $p < .05$, respectively) than alcoholics abstinent one week.

Serial position at levels of groups. For the control group recall at serial position one was significantly superior when contrasted with positions three through eight and position ten ($p < .01$) and nine ($p < .05$). At serial position two recall was significantly better

($p < .01$) than at positions four through eight. Items at serial position nine were recalled significantly more often than items at positions four and seven ($p < .05$) and positions five and eight ($p < .01$). Recall at serial position ten was significantly better than recall at positions five ($p < .05$) and eight ($p < .01$). Items at serial positions eleven and twelve were recalled significantly more frequently ($p < .01$) than items at positions nine and ten.

For alcoholics alcoholics abstinent one week recall was significantly better ($p < .05$) at position one when contrasted with recall at positions five, six, and nine.

For alcoholics abstinent two weeks, items at serial position one exhibited a significantly higher frequency of recall than those at serial positions three and eight ($p < .05$) and six ($p < .01$). Serial position eleven was significantly higher ($p < .05$) than position six. Serial position twelve was recalled significantly more often than positions three, six, and eight ($p < .01$) and positions five and nine ($p < .05$).

For alcoholics abstinent three weeks, items at serial position twelve were recalled significantly more often ($p < .05$) than items at positions three, six, and nine.

For alcoholics abstinent four weeks, serial position one showed significantly greater recall when compared with positions five, seven, eight, and nine ($p < .01$) and

six ($p < .05$). Serial position twelve was recalled significantly more often than positions five and six ($p < .05$) and positions seven, eight, and nine ($p < .01$).

For alcoholics abstinent six to sixteen weeks serial position one was recalled significantly more often than positions five and seven ($p < .05$) and position six ($p < .01$). Serial position eleven was recalled significantly more often ($p < .05$) than position six. Items at serial position twelve showed significantly greater frequency of recall than positions five, six, seven, and eight ($p < .01$) and position nine ($p < .05$).

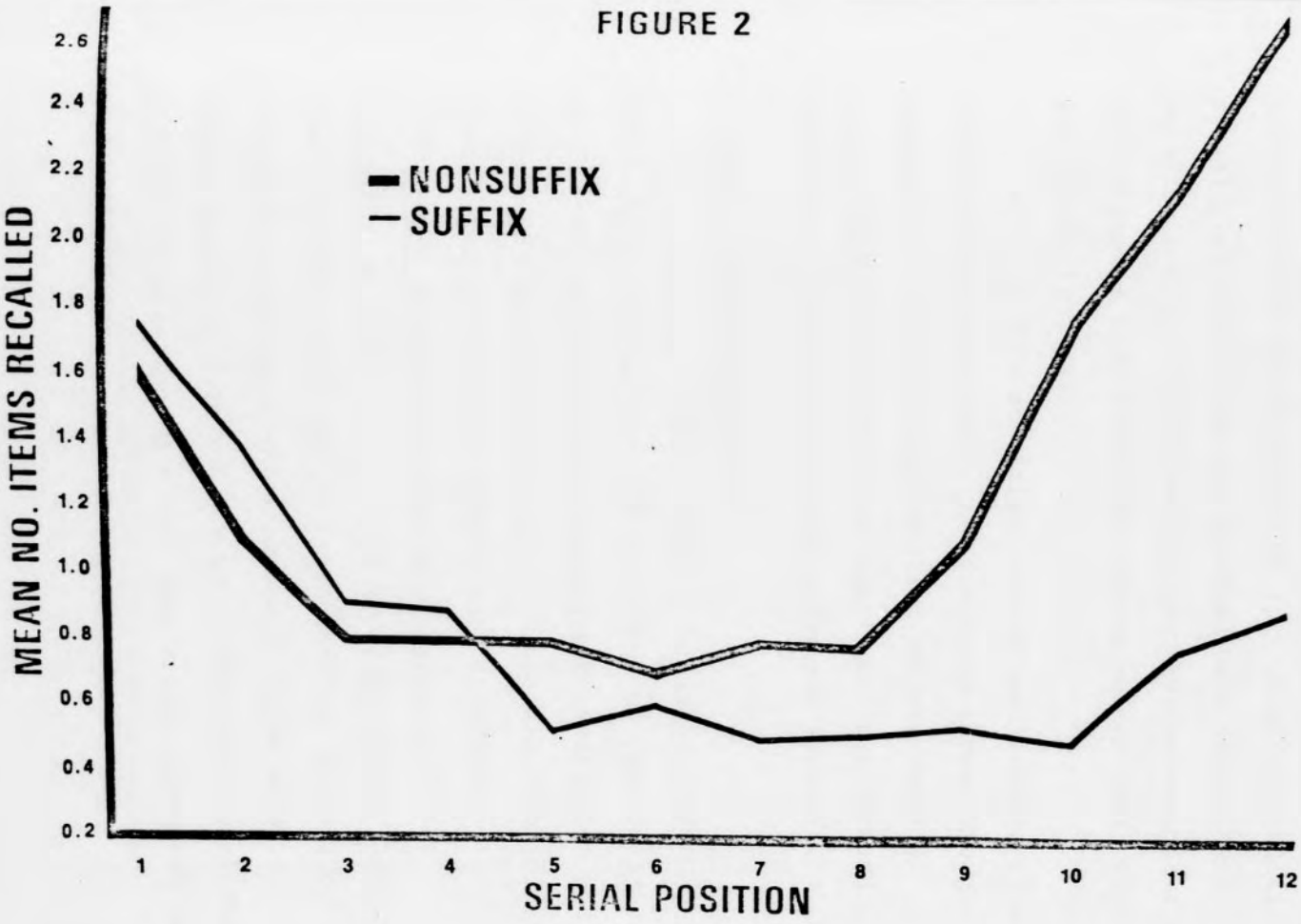
Serial Position x Suffix-Nonsuffix

Tukey's HSD was also applied to the means for the Serial Position x Suffix-Nonsuffix interaction in two ways: (a) serial position at each level of suffix-nonsuffix, and (b) suffix-nonsuffix at each level of serial position. These analyses are discussed below and shown in Figure 2. Significant results are reported at $p < .01$ or $p < .05$, as indicated.

Suffix-nonsuffix at levels of serial position. The nonsuffix conditions exhibited significantly better ($p < .01$) recall than the suffix condition at serial positions nine through twelve.

Serial position at levels of suffix-nonsuffix. In the nonsuffix condition, serial position one showed significantly greater recall than positions three through nine

FIGURE 2


NONSUFFIX
SUFFIX
MEAN NO. ITEMS RECALLED
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
1
2
3
4
5
6
7
8
9
10
11
12
SERIAL POSITION

($p < .01$) and position two ($p < .05$). Serial positions ten through twelve were recalled significantly more often than positions two through nine ($p < .01$). In addition serial position eleven was recalled more often than position one ($p < .05$), and position twelve was recalled significantly more often than positions one ($p < .01$) and eleven ($p < .05$).

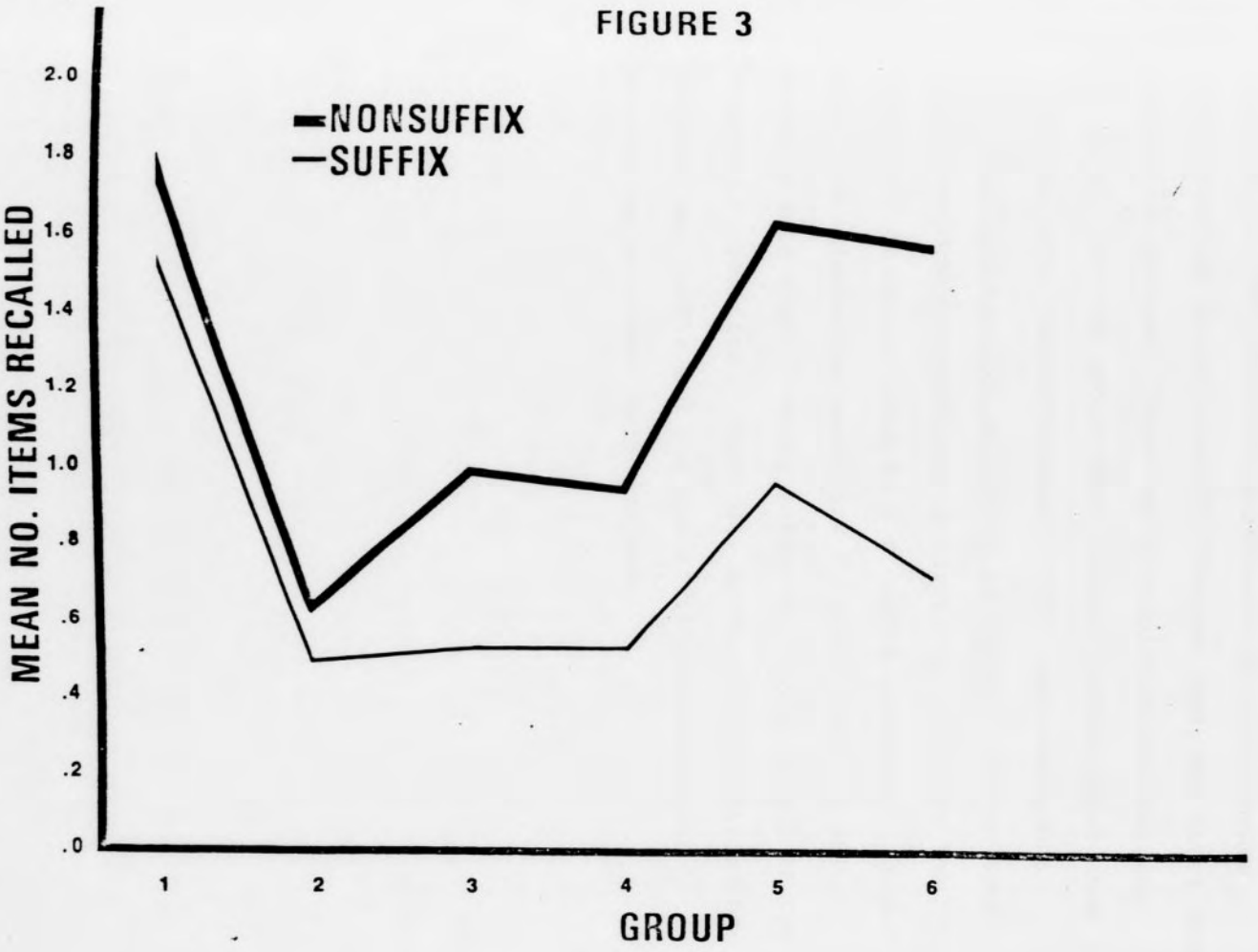
In the suffix condition, serial position was recalled significantly more often than positions three through twelve ($p < .01$). Serial position two was recalled significantly more often than positions four through eleven ($p < .01$) and positions three and twelve ($p < .05$).

Groups x Suffix-Nonsuffix

The analysis of the Groups x Suffix-Nonsuffix interaction follows the same procedure as previously noted. Figure 3 shows the significant interaction and Tukey's HSD post-hoc tests on the means are reported at the $p < .01$ and $p < .05$ levels, as indicated.

Groups at levels of suffix-nonsuffix. In the nonsuffix condition the control group exhibited significantly better recall of the items than the alcoholic groups who were abstinent from one to three weeks. Groups abstinent four and six to sixteen weeks performed significantly better ($p < .01$) than groups abstinent one to three weeks.

FIGURE 3


NONSUFFIX
SUFFIX
MEAN NO. ITEMS RECALLED
2.0
1.8
1.6
1.4
1.2
1.0
.8
.6
.4
.2
.0
1
2
3
4
5
6
GROUP

In the suffix condition the control group recalled significantly more items than any of the alcoholic group ($p < .01$). The four week abstinence group performed significantly better than did the one, two, and three week abstinence groups. There was a nonsignificant decline in recall for the group sober six to sixteen weeks when compared with the performance of the four week group.

Suffix-Nonsuffix at levels of Groups. The control group performed significantly better ($p < .05$) in the nonsuffix condition than in the suffix condition. Moreover, the alcoholics abstinent 2, 3, 4, and 6 to 16 weeks showed significantly better ($p < .01$) recall in the nonsuffix condition. There was no significant difference between the suffix and the nonsuffix conditions for alcoholics abstinent only one week.

CHAPTER IV

DISCUSSION

It was hypothesized that performance on a free recall task improves as a function of the interval of abstinence; therefore, the main effect of Groups would be significant. This difference was found to be significant ($p < .005$). Due to significant first order interactions, this hypothesis will be discussed in view of the following hypotheses: (a) the recency effect on a free recall task increases as a function of the interval of abstinence from alcohol, i.e., a significant interaction between Groups and Serial Position; (b) the recency effect on a serial position curve is greater in a Nonsuffix condition than in a Suffix condition, i.e., a significant interaction between Serial Position and Suffix-Nonsuffix; and (c) Korsakoff patients exhibit more information loss than normal controls in the Suffix condition, i.e., a significant interaction between Groups and Suffix-Nonsuffix. All of these hypotheses were found to be significant at $p < .005$.

Groups x Serial Position

The significant interaction of Groups and Serial Position is shown in Figure 1.

Groups at levels of serial position. The data clearly show that at serial positions one, two, and three the control group had a significantly greater frequency of recall than alcoholics who were abstinent one, two, or three weeks; moreover, it appears that in general there was no difference in recall between controls and alcoholics who were abstinent more than four weeks.

Alcoholics abstinent four weeks performed significantly better at positions one, two, and three than alcoholics abstinent one week; furthermore, the four week group was also significantly better than the two and three week alcoholic groups at serial positions two and three. In addition, alcoholics abstinent six to sixteen weeks exhibited significantly greater frequency of recall at serial position three than did alcoholics abstinent one to three weeks.

The control group performed significantly better than all alcoholic groups at serial positions nine, eleven, and twelve; however, at position ten the controls exhibited significantly greater recall than only those alcoholics abstinent one to three weeks. The four week and the six to sixteen week group performed significantly better than the one week group at serial position twelve.

In general, there is a significant decline in recall from serial position one to serial position five as shown in Figure 1; furthermore, a significant increase in recall

is noted beyond serial position nine. In addition, there are no significant differences in the mid-list positions. With minor exceptions these findings are shown for all groups. Moreover, the groups tend to generally maintain their hierarchy in terms of performance across all the serial positions. This implies that the decrease or increase in performance is due to a common process regardless of the group.

These results can be evaluated in light of the two models of human memory previously discussed. In terms of the multistore model, the controls exhibited significantly greater use of long term storage and categorization of the stimulus items when contrasted with the performance of alcoholics abstaining three weeks or less (primacy effect). In order for this information to be retrieved for recall, these items must have been accurately transferred from the PAS and short term store and then into long term storage. In contrast, the alcoholic groups with shorter abstinence intervals showed significantly less effective utilization of long term storage. Based on the multistore model there are two possible explanations for these results: (1) impaired transfer from STS to LTS, or (2) poor retrieval operations or storage impairment in LTS. Further research is indicated to elucidate the point at which the information is lost.

Based on the multistore model, these results also indicate use of short term store and a supplementary input from PAS (recency effect). The alcoholics with longer periods of abstinence (four or more weeks) showed improvement in these processes on the terminal stimulus item; however, the impairment at the precategorical acoustic level continued to lower performance to a range significantly below that of the controls.

The levels of processing model also provides a framework for interpretation of these findings. Based on this model, the control group easily employs Type II processing at deeper semantic levels and consequently retains the initially presented items (primacy effect). This deeper level processing is not disrupted significantly when the latter items in the list are presented because a long term, durable memory trace has theoretically been formed; therefore, attention to subsequent incoming information does not detrimentally affect the items in early serial positions. In contrast, the performances of the alcoholic groups abstaining one to three weeks indicated a decrement in Type II processing. This finding may be due to their lack of spontaneous semantic encoding and inability to independently form organizational strategies. The items in the initial serial positions are lost due to the presentation of later terminal items. That is, when attention and recirculation of the early items are disrupted

by additional incoming information the early items become unavailable for recall.

An increasing use of Type II processing was indicated after four weeks of abstinence. This possible trend in improvement at the four week level decreased at the six to sixteen week level; consequently, no conclusive statement about recovery of the primacy effect can be made. More investigation is needed with alcoholics abstaining more than sixteen weeks in order to conclude whether or not Korsakoff patients show recovery in Type II processing.

In view of the levels of processing model, alcoholics who had been sober four weeks or more exhibited increased Type I processing and better encoding based on the structural and phonemic features of the input at positions ten and twelve (recency effect). Although this increase was evident within alcoholic groups, the improvement did not bring performance up to the level noted for the controls at positions nine, eleven, and twelve.

In summary, the control group exhibited significantly more long term storage than the alcoholic groups. These alcoholics abstinent one to three weeks showed no significant utilization of semantic, categorical, and organizational strategies. Moreover, if preperceptual rehearsal of the information was disrupted by later input the initial items were unavailable for recall. When the

use of long term storage was evaluated within the five alcoholic groups a slight trend toward improvement in recall of initial items (LTS) was noted only after four weeks of continued sobriety. These findings indicate that this minimum period of recovery is necessary before any improvement in semantic operations is seen.

The control group also exhibited significantly better short term functioning than the alcoholic groups who showed marked decrease in Type I structural processing. The acoustic and phonemic strategies of processing were disrupted regardless of the length of abstinence when contrasted with the performance of normal controls. Items at the terminal list positions were less frequently recalled by all alcoholic subjects than by the controls due to inadequate processing and altered memory traces, according to the levels theory. Within the alcoholic groups significant improvement was noted in shallow, acoustic processing for alcoholics who were abstinent at least four weeks. Furthermore, the increases in alcoholic performances only reached the level attained by the normal controls once even after four months of sobriety.

Serial Position at levels of groups. The control group exhibited significantly greater frequency of recall for items in serial position one when contrasted with items in positions three through nine; furthermore, positions two and nine were recalled more frequently than positions four through eight. Serial positions ten, eleven, and

twelve were recalled more often than positions five through eight. In addition, positions eleven and twelve exhibited significantly greater frequency of recall than positions three and four. Position twelve was recalled more often than positions nine and ten.

These typical primacy and recency effects can be interpreted in light of the multistore model of human memory. They indicate both long and short term storage of input with transfer processes between these two stores for adequate transition of information from one store to another. The recency effect suggests the adequate functioning of the precategorical acoustic store as a supplemental store to the STS. In addition, the transfer of information from STS to LTS or retrieval from LTS is evident in the primacy effect. Items in the LTS are available even after a delay because a durable trace is produced.

These data can also be explained by the levels of processing model by assuming that the recency effect is produced by Type I processing; the items are assumed to be recirculated until they are reproduced at recall. Furthermore, the primacy effect reflects a deeper level of Type II processing. The initial items have, theoretically, received semantic processing and are represented by a durable memory trace; consequently, they are preserved for recall even though attention is diverted to the rehearsal of subsequent terminal items.

In contrast to the control group, alcoholics abstinent one week exhibited no recency effect and only a weak primacy effect. Regardless of encoding strategy (acoustic, structural, semantic) recall was significantly depressed, and all levels of processing showed severe impairment.

Analysis of alcoholics abstinent two weeks revealed both primacy and recency effects. At serial position one frequency of recall was significantly greater than at positions three, six, and eight. Furthermore, serial positions eleven and twelve were recalled significantly more often than positions three, five, eight, and nine.

According to the multistore model, these alcoholics exhibited recency (positions eleven and twelve) and primacy (position one) by increased transfer of items into LTS and also greater use of the PAS.

The levels of processing model also provides a framework for these results. The recency effect was due to improved recirculation and attention to new information. The primacy effect indicated Type II deeper processing at a semantic level. This strategy permitted recall of the early items at serial position one even though subsequent terminal items were attended to also.

The three week alcoholic group exhibited only a recency effect when serial position twelve was recalled significantly more often than positions three, six, and

nine. The four week alcoholic group exhibited primacy and recency effects at serial positions one and twelve, respectively when contrasted with recall at positions five through nine.

The six to sixteen week alcoholic group also showed both primacy and recency effects. Serial positions one and twelve were recalled significantly more often than positions five, six, and seven. In addition, position twelve was recalled more frequently than positions eight and nine; and position eleven, more often than items at position six.

Limited primacy effects (items at position one) and moderate recency effects (items at positions eleven and twelve) were noted. The alcoholics exhibited greater reliance on acoustic encoding as contrasted with minimal use of semantic processing.

In summary, the control group exhibited the typical serial position curve with both primacy and recency effects. These significant increases in the frequency of recall of items at the ends of the curve were due to semantic and acoustic processing, respectively. The alcoholic groups with only brief periods of abstinence (one and two weeks) showed only slight primacy or recency effects due to an overall severe impairment of processing. After four to sixteen weeks of sobriety increased primacy was noted as a result of slightly greater use of semantic

strategies. The recency effect showed a substantial increase with longer intervals of abstinence as a consequence of enhanced acoustic and structural encoding. Due to a heavier reliance on acoustic strategies as contrasted with semantic processing the alcoholics exhibited greater recovery for recency effects than for primacy effects.

Serial Position x Suffix-Nonsuffix

The significant interaction of Serial Position and Suffix-Nonsuffix is shown in Figure 2.

Suffix-Nonsuffix at levels of Serial Position. There are no significant differences between the suffix and nonsuffix conditions for recall of items in serial positions one through eight. These findings result in the conclusion that primacy functions are not affected by the suffix condition. The operations producing the primacy effect have been discussed earlier, and are further supported by these data. In contrast, positions nine through twelve yielded significantly greater recall for the nonsuffix condition. This recency effect is disrupted in the suffix condition due to processing failures. For example, the multistore model suggests that the suffix results in displacement of items in the PAS and lowered capacity for the storage of stimulus items.

The levels of processing model indicates that the suffix interrupts the shallow processing and recirculation of these terminal items when the suffix is presented.

Serial Position at levels of suffix-nonsuffix. In the nonsuffix condition items in serial position one are recalled significantly more often than items in positions two through nine to produce a typical primacy effect.

These results can be evaluated by the two previously described models of human memory. Use of the multistore model yields the conclusion that long term storage of the initial items produced the enhanced recall. The information is transferred from STS to LTS through rehearsal and semantic encoding. The resulting memory trace is not disrupted by any subsequent input. The levels of processing model suggests that the initial items are processed at a deeper semantic level on the continuum of analysis.

In the suffix condition the items at serial position one were recalled significantly more often than items in positions three through twelve. The conclusions drawn from the nonsuffix data in terms of primacy also apply to the results in the suffix condition. In addition, the suffix condition showed a significant increase in the recall of items at position one in respect to the final two terminal items. This finding is not noted in the nonsuffix condition due to a significant elevation in recall at both extremes of the serial position curve.

Data on recall of the terminal items of the serial position curve showed significant differences between the nonsuffix and the suffix conditions. In the nonsuffix condition items in serial positions ten through twelve were recalled more frequently than the items in positions two through nine; furthermore, items in positions ten and eleven were recalled significantly more often than items two through nine. Serial position eleven was recalled more often than position one, and serial position twelve was recalled significantly more often than positions one and eleven. These results yielded a typical recency effect at the terminal positions. In contrast, the data from the suffix condition showed no recency effect whatever.

In summary, the nonsuffix condition yielded the typical serial position curve with primacy and recency effects. In light of the multistore model these results are due to effective storage for long term and short term information. The PAS is providing supplemental output to the STS in the recency effect while the accurate transfer of information from STS to LTS is resulting in the primacy effect.

The levels of processing model supports the data also. In this model both Type I and Type II processing are operational. The primacy effect is provided by deeper level semantic encoding that is undisturbed by additional input.

In addition, the recency effect is a product of shallow structural and phonemic encoding utilized by Type I processing. The continuum of analysis is seen in the two extremes of the serial position curve.

In contrast the suffix condition yielded only significant primacy effects. The increased recall of the early items is due to the same processes as noted for the nonsuffix condition, i.e., semantic encoding for long term storage. The recency effects are absent in the suffix condition due to interference with processing functions that yield terminal item output. According to the multistore model the suffix causes displacement or loss of previous items stored in the PAS. Since this store has a limited capacity the redundant item forces out one or more of the stimulus items. In addition, the extra time required for presentation of the suffix causes additional decay of information in the PAS. Since the output of the PAS is therefore limited, decreases in supplemental information available to STS occur at recall.

The levels of processing model can also account for the data on the suffix condition. The recirculation and acoustic processing of terminal items is diverted when the redundant suffix is presented; therefore, the items at the final serial positions do not have a memory trace adequate for recall.

In summary, the presentation of the suffix condition does not significantly influence the primacy effect. The items producing this effect are already semantically encoded and are consequently protected from subsequent items. The recency effect declines significantly as a function of the suffix condition because the terminal items are subject to loss of attention and rehearsal when processing is diverted to the suffix.

Groups x Suffix-Nonsuffix

The significant interaction between Groups and Suffix-Nonsuffix is shown in Figure 3.

Groups at levels of suffix-nonsuffix. In the nonsuffix condition the controls exhibited significantly better recall of the stimulus items than did alcoholics who had been sober one to three weeks. Furthermore, alcoholics sober four to sixteen weeks showed no significant differences from the controls in terms of recall. The alcoholics sober more than four weeks performed significantly better than alcoholics who had been sober one to three weeks. Therefore, the data for the nonsuffix condition showed recovery in memory functioning as abstinence increased.

In the suffix condition the control group performed significantly better than the alcoholic groups regardless of their intervals of abstinence; however, within the

alcoholic groups there were significant differences. Alcoholics abstinent for four weeks performed significantly better than those sober three weeks or less. These results suggest there is some improvement with longer periods of abstinence; nevertheless, at four months their performance continues to be significantly below that of normal controls.

Suffix-Nonsuffix at levels of groups. The controls showed a significant difference between the suffix and nonsuffix conditions indicating an impairment of memory functions due to the suffix. For the suffix condition the alcoholics who were sober for one week showed no significant differences in recall from the nonsuffix condition; however, these results are interpreted in a different manner for alcoholics sober one week than for other alcoholic groups and normal controls. The nonsuffix overall performance of this group was so low that a floor effect was obtained for the nonsuffix condition. The overall performance, suffix and nonsuffix combined, may be seen in Figure 1. In contrast, the alcoholics abstinent two to sixteen weeks showed significant disruption in recall under the suffix condition, and their improved performance is due to their ability to process the nonsuffix items.

In summary, these results can be evaluated in light of the multistore model of human memory. The alcoholics

rely very heavily on acoustic encoding and supplemental output from the PAS. When a redundant suffix is presented, the items in PAS are displaced or overwritten by the new item; consequently, fewer stimulus words are available for recall. The addition of the suffix word also increases the presentation time from 12 to 13 seconds, and this increases the time for decay from PAS further. As a result, fewer items are available for recall.

The levels of processing model can also be applied to these data. Since the alcoholic subjects utilize Type I processing heavily, they perform at a significantly lower level when this strategy is disrupted. Shallow processing at the structural level requires constant attention and recirculation of the stimulus items in order to ensure later output. The presentation of a redundant suffix diverts this processing activity from the stimulus items, and as a result, they are unavailable for recall. In contrast, the controls utilize both Type I and Type II processing strategies; consequently, they can retrieve information from deeper semantic levels when structural processing is inhibited.

Treatment Implications

The results of this investigation have major implications for the areas of diagnosis and treatment of alcohol abusers. The current evaluation procedures for alcoholic patients should be revised in light of these

findings on differential memory impairment within this population. For example, most alcoholism treatment facilities do not provide different treatment approaches for those patients who exhibit Korsakoff's syndrome and those alcoholics who do not; consequently, this lack of proper screening and placement yields a decrease in therapeutic effectiveness. Furthermore, the present study indicates major differences among the Korsakoff patients themselves. For example, those individuals abstaining from alcohol for three weeks or less showed significantly depressed retentive memory functioning when contrasted with patients having four to sixteen weeks of sobriety. These data yield a definite division within the group of alcohol abusers exhibiting Korsakoff's syndrome.

The significant findings of this study support the conclusions of Victor et al. (1959) that Korsakoff patients may perform in the Average range of intellectual functioning on standardized IQ tests while showing severe impairment in retentive memory. For example, all alcoholics in the present experiment met both the criterion of adequate intellectual functioning and the criterion of significant memory impairment. Therefore, in the diagnosis and evaluation of Korsakoff patients the areas of intellectual functioning and retentive memory both must be investigated to determine the specific deficits of

each patient. If memory impairment is not directly assessed, it may go undetected due to compensation from the general intellectual area.

The broad treatment implications drawn from this study will be discussed in light of current programs in the state. The three major North Carolina Alcoholic Rehabilitation Centers are providing a unique multi-dimensional approach to inpatient treatment; however, the numerous aspects of these programs are presented to all incoming patients with very little regard for the significant variables of chronic organicity with minimal individualized planning based on the individual's abstinence interval.

For example, one of these facilities provides a four week program with eight areas of service: (1) medical intervention; (2) individual and group psychotherapies; (3) intelligence, personality, and aptitude testing; (4) vocational evaluation and placement; (5) unstructured milieu therapy; (6) remedial education; (7) daily educational lectures on the effects of alcohol; and (8) post-hospitalization planning for re-entry into the community. An initial evaluation of this treatment approach suggests a substantial improvement in alcoholism services; nevertheless, when the multiple areas of the rehabilitation are reviewed in light of the data presented

here it is quite evident that the resources allocated for these Centers are being utilized ineffectively.

The major thrust of these programs obviously depends on the patient's heavy reliance on retentive memory throughout the entire four week period of hospitalization. In these rehabilitation programs that utilize group and individual counseling, "relationship," and "insight" therapies, the Korsakoff patients may receive limited benefits from relatively large expenditures of the state Alcoholic Rehabilitation Centers (ARCs). In the North Carolina Centers these therapies are initiated and terminated prior to any substantial recovery of retentive memory functioning (indicated by data from individuals with less than one month's abstinence). Based on these data, this patient population may be unable to utilize semantic encoding spontaneously since long term memory is severely impaired. The outcome of traditional individual and group counseling approaches appears to be very ineffectual under such conditions.

Furthermore, comprehensive psychological testing and vocational placement may be inappropriate during the first four weeks of abstinence due to slow and sporadic recovery in memory. These time-consuming evaluations may have little utility and yield inadequate samples of the patient's full behavioral repertoire. That is, the scores obtained may provide a limited current profile of

functioning but have little predictive value in determining his performance in two to four weeks when retentive memory functioning recovers.

The data supporting severe short term memory impairment during the initial three weeks of abstinence indicate major revisions in ward activities requiring spontaneous recall of rules and instructions. The unstructured milieu approach may have little positive value in a four week treatment program since almost all patients are in an area of significantly impaired functioning. The hierarchical system of patient government and peer direction is not appropriate under these conditions. This view is clearly shown in the present study when only the four to sixteen week groups showed recovery approximating the controls; moreover, little significant difference was noted between the alcoholic groups abstaining from one to three weeks. The Korsakoff patients exhibiting severe limitations of short term memory require a structured daily environment in order to avoid frequent staff intervention.

Another major consideration is the utilization of resources for remedial education and didactic lectures on alcohol while the individual is severely impaired in terms of retentive memory functioning. The amount of information processed, retained, and available for later recall appears extremely limited based on the current data. The findings from this study lead to the conclusion that

instruction prior to the fourth week of abstinence is unlikely to benefit the individual.

Certainly this state has shown outstanding progress in the development of treatment programs for alcoholism as exhibited by this multifaceted approach; nevertheless, this study supports the conclusion that attention is needed in major restructuring of the temporal aspects of the design. Significant changes are necessary in the interval of time required to complete each phase of the rehabilitation program in such a manner that maximal benefits are achieved. In conclusion, it is suggested that additional investigations are needed to assess the differences between Korsakoff patients and other alcohol abusers in order to plan appropriate intervention. Specific treatment programs for early periods of recovery (one to three weeks) are indicated due to this relatively long interval of severe memory impairment. Furthermore, additional data are needed on the recovery of memory functioning in Korsakoff patients who have remained sober more than sixteen weeks to effectively implement therapies and community re-entry. These differential levels of functioning should be accounted for when systems of treatment are developed.

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APPENDIX A

Table of Stimulus Word Lists

Practice List A

1) read
2) meeting
3) amount
4) floor
5) trade
6) pressure
7) paper
8) deal
9) cold
10) property
11) person
12) nation

Practice List B

1) method
2) space
3) industry
4) country
5) color
6) story
7) market
8) statement
9) spirit
10) police
11) hour
12) force

Stimulus List

A1	A2	A3	A4
1) time	1) direction	1) door	1) college
2) eye	2) program	2) program	2) direction
3) problem	3) college	3) money	3) door
4) college	4) man	4) direction	4) program
5) point	5) point	5) eye	5) eye
6) door	6) summer	6) college	6) problem
7) money	7) money	7) problem	7) time
8) program	8) problem	8) summer	8) money
9) man	9) time	9) point	9) point
10) help	10) eye	10) help	10) man
11) direction	11) help	11) time	11) summer
12) summer	12) door	12) man	12) help

Stimulus List

B1	B2	B3	B4
1) government	1) country	1) evening	1) wife
2) field	2) car	2) mind	2) week
3) age	3) age	3) week	3) mind
4) car	4) help	4) field	4) members
5) mind	5) government	5) wife	5) head
6) country	6) head	6) country	6) evening
7) week	7) members	7) members	7) government
8) members	8) evening	8) help	8) car
9) wife	9) mind	9) age	9) country
10) head	10) wife	10) head	10) field
11) help	11) week	11) government	11) help
12) evening	12) field	12) car	12) age

C1	C2	C3	C4
1) service	1) area	1) stage	1) information
2) end	2) others	2) future	2) service
3) voice	3) word	3) information	3) voice
4) information	4) system	4) report	4) stage
5) others	5) service	5) area	5) end
6) night	6) night	6) voice	6) future
7) future	7) information	7) end	7) others
8) word	8) future	8) word	8) report
9) area	9) stage	9) night	9) word
10) system	10) end	10) system	10) system
11) stage	11) report	11) service	11) might
12) report	12) voice	12) others	12) area

D1	D2	D3	D4
1) hand	1) interest	1) water	1) cost
2) water	2) experience	2) force	2) fact
3) fact	3) cost	3) body	3) interest
4) interest	4) hand	4) fact	4) court
5) experience	5) war	5) brown	5) war
6) force	6) family	6) experience	6) hand
7) court	7) brown	7) family	7) force
8) body	8) body	8) interest	8) brown
9) family	9) water	9) war	9) family
10) cost	10) court	10) cost	10) water
11) brown	11) force	11) hand	11) body
12) war	12) fact	12) court	12) experience

Stimulus List

E1	E2	E3	E4
1) course	1) food	1) today	1) saw
2) power	2) school	2) purpose	2) act
3) church	3) society	3) number	3) church
4) number	4) church	4) power	4) food
5) act	5) course	5) saw	5) today
6) west	6) west	6) course	6) power
7) school	7) purpose	7) school	7) society
8) today	8) number	8) act	8) number
9) society	9) power	9) food	9) course
10) saw	10) saw	10) society	10) west
11) purpose	11) act	11) church	11) purpose
12) food	12) today	12) west	12) school

F1	F2	F3	F4
1) light	1) home	1) club	1) case
2) death	2) part	2) children	2) feet
3) feet	3) children	3) case	3) stock
4) community	4) feet	4) community	4) home
5) love	5) stock	5) job	5) death
6) job	6) love	6) stock	6) job
7) part	7) light	7) home	7) community
8) children	8) death	8) death	8) children
9) home	9) club	9) feet	9) club
10) case	10) case	10) love	10) part
11) stock	11) community	11) light	11) light
12) club	12) job	12) part	12) love

G1	G2	G3	G4
1) place	1) effort	1) things	1) day
2) house	2) house	2) south	2) things
3) day	3) life	3) knowledge	3) place
4) life	4) show	4) day	4) south
5) things	5) hands	5) board	5) effort
6) show	6) south	6) place	6) life
7) board	7) knowledge	7) show	7) form
8) south	8) form	8) house	8) board
9) hands	9) things	9) effort	9) house
10) form	10) place	10) form	10) knowledge
11) effort	11) board	11) life	11) hands
12) knowledge	12) day	12) hands	12) show

H1

1) face
2) company
3) change
4) reason
5) action
6) order
7) present
8) example
9) position
10) work
11) material
12) inside

H2

1) present
2) work
3) action
4) material
5) position
6) face
7) reason
8) inside
9) change
10) company
11) order
12) example

H3

1) inside
2) position
3) reason
4) company
5) present
6) action
7) example
8) face
9) material
10) order
11) work
12) change

H4

1) order
2) example
3) material
4) face
5) work
6) reason
7) company
8) present
9) change
10) action
11) inside
12) position

I1

1) year
2) people
3) state
4) business
5) group
6) city
7) sense
8) matter
9) air
10) hope
11) attention
12) question

I2

1) attention
2) state
3) group
4) year
5) city
6) hope
7) business
8) sense
9) people
10) air
11) question
12) matter

I3

1) city
2) attention
3) business
4) air
5) people
6) state
7) matter
8) year
9) group
10) sense
11) hope
12) question

I4

1) group
2) matter
3) state
4) sense
5) air
6) hope
7) people
8) business
9) attention
10) year
11) question
12) city

J1

1) world
2) broom
3) president
4) law
5) line
6) name
7) moment
8) street
9) boy
10) river
11) beginning
12) section

J2

1) street
2) boy
3) moment
4) river
5) name
6) law
7) section
8) beginning
9) world
10) line
11) broom
12) president

J3

1) river
2) moment
3) law
4) section
5) broom
6) boy
7) name
8) street
9) president
10) beginning
11) world
12) line

J4

1) beginning
2) name
3) broom
4) law
5) street
6) line
7) river
8) president
9) section
10) boy
11) world
12) moment

K1

1) figure
2) rate
3) art
4) century
5) class
6) women
7) book
8) nature
9) doctor
10) sort
11) rest
12) secretary

K2

1) figure
2) doctor
3) century
4) rate
5) sort
6) class
7) women
8) nature
9) rest
10) book
11) secretary
12) art

K3

1) sort
2) doctor
3) book
4) nature
5) secretary
6) figure
7) rate
8) century
9) art
10) rest
11) class
12) women

K4

1) rest
2) women
3) art
4) doctor
5) century
6) book
7) sort
8) secretary
9) class
10) figure
11) nature
12) rate

L1

1) department
2) center
3) control
4) policy
5) front
6) north
7) plan
8) evidence
9) million
10) sound
11) street
12) term

L2

1) street
2) control
3) front
4) evidence
5) department
6) plan
7) term
8) sound
9) policy
10) million
11) center
12) north

L3

1) front
2) department
3) north
4) control
5) term
6) policy
7) center
8) sound
9) plan
10) street
11) million
12) evidence

L4

1) plan
2) million
3) street
4) front
5) sound
6) north
7) evidence
8) center
9) policy
10) term
11) department
12) control

M1

1) girl
2) six
3) land
4) mother
5) music
6) top
7) black
8) play
9) surface
10) type
11) care
12) friend

M2

1) six
2) music
3) care
4) girl
5) top
6) black
7) friend
8) surface
9) land
10) type
11) play
12) mother

M3

1) friend
2) land
3) mother
4) surface
5) music
6) black
7) care
8) six
9) play
10) type
11) girl
12) top

M4

1) music
2) play
3) six
4) black
5) girl
6) type
7) friend
8) top
9) care
10) land
11) mother
12) surface

N1	N2	N3	N4
1) university	1) students	1) military	1) child
2) child	2) effect	2) morning	2) level
3) effect	3) child	3) administration	3) university
4) level	4) administration	4) total	4) military
5) students	5) town	5) effect	5) military
6) military	6) university	6) level	6) administration
7) town	7) morning	7) university	7) students
8) morning	8) outside	8) outside	8) total
9) total	9) picture	9) picture	9) morning
10) outside	10) level	10) town	10) outside
11) picture	11) total	11) students	11) outside
12) administration	12) military	12) child	12) effect

O1	O2	O3	O4
1) party	1) subject	1) table	1) building
2) education	2) line	2) red	2) peace
3) value	3) table	3) subject	3) value
4) line	4) minute	4) education	4) tax
5) peace	5) building	5) peace	5) road
6) table	6) party	6) road	6) party
7) red	7) tax	7) building	7) line
8) road	8) education	8) value	8) table
9) tax	9) red	9) line	9) subject
10) subject	10) peace	10) party	10) minute
11) minute	11) value	11) minute	11) education
12) building	12) road	12) tax	12) red

P1	P2	P3	P4
1) process	1) school	1) hair	1) view
2) situation	2) case	2) month	2) heart
3) idea	3) idea	3) ground	3) ground
4) school	4) process	4) everything	4) month
5) month	5) fire	5) situation	5) hair
6) fire	6) situation	6) school	6) idea
7) ground	7) view	7) case	7) everything
8) view	8) hair	8) heart	8) situation
9) everything	9) heart	9) process	9) case
10) heart	10) everything	10) view	10) fire
11) case	11) month	11) idea	11) process
12) hair	12) ground	12) fire	12) school

APPENDIX B

ANOVA Summary Table

Analysis of Variance Summary Table

Source of Variance	Degrees of Freedom	Sum of Squares	Mean Square	F	Utility Index
Groups	5	356.0444	71.20888	39.6989	.0695
Suffix-nonsuffix	1	121.9184	121.9184	188.0887	.025
Serial Position	11	387.2012	35.200010	32.9052	.0779
S (Groups)	90	161.4351	1.793722	----	----
Groups x Suffix-Nonsuffix	5	30.54987	6.109973	9.4261	.0006
Groups x Serial Position	55	97.51392	1.772980	1.6574	.008
Suffix-Nonsuffix x Serial Pos.	11	225.7671	20.52428	20.0664	.0445
S x Suffix-Nonsuffix (Groups)	90	58.33765	.6481960	----	----
S x Serial Position (Groups)	990	1059.046	1.069742	----	----
Groups x Suffix-Nonsuffix x Serial Pos.	55	35.44165	.6443936	.6300	----
S x Suffix-Nonsuffix x Serial Pos. (Groups)	990	1012.591	1.022819	----	----