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The effects of meaningfulness and categorization of nonverbal material on the recognition memory performance of alcoholic Korsakoff patients

Mattis, Vivian Offer, Ph.D.
City University of New York, 1990

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THE EFFECTS OF MEANINGFULNESS AND CATEGORIZATION
OF NONVERBAL MATERIAL ON THE RECOGNITION MEMORY
PERFORMANCE OF ALCOHOLIC KORSAKOFF PATIENTS

by

VIVIAN OFFER MATTIS

A dissertation submitted to the Graduate Faculty in
Psychology in partial fulfillment of the requirements
for the degree of Doctor of Philosophy, The City
University of New York.

1990

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Abstract

THE EFFECTS OF MEANINGFULNESS AND CATEGORIZATION
OF NONVERBAL MATERIAL ON THE RECOGNITION MEMORY
PERFORMANCE OF ALCOHOLIC KORSAKOFF PATIENTS

by

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Advisor: Professor Louis Gerstman

Five nonverbal recognition memory tasks, using faces (meaningful) and computer-generated random shapes (nonmeaningful), were presented to alcoholic Korsakoff patients and normal controls. The results show that when target and distractor items came from different categories, normals showed facilitation in performance while Korsakoffs exhibited increasing disruption in performance over three recognition probes. On tasks utilizing "mixed" stimuli as targets and distractors, Korsakoff performance, although poor, was above chance and resembled normal patterns. This held true for both meaningful and nonmeaningful material. The theory that the activation of a pre-existing network of specific memory representations is sufficient to explain Korsakoff recognition memory is discussed and an alternative "competitive priming" hypothesis is proposed.

For my son, Jonathan,
and for my father, John W. Offer

Table of Contents

	<u>Page</u>
Background and Rationale	1
Methods	
Subjects	13
Design	15
Materials	17
Results	19
Discussion	29
Appendix I: Test Stimuli	37
Appendix II: Recognition Probe Test Orders	58
Bibliography	60

List of Tables

	<u>Page</u>
1. Mann Whitney U Test - Probes 1, 2, 3	25
2. Mann Whitney U Test - Gain	26

List of Figures

	<u>Page</u>
1. Mixed Faces	20
2. Categorized Faces	21
3. Category Contrast Faces	22
4. Random Shapes - Mixed	23
5. Random Shapes - Categorized	24

Background and Rationale

In its early years, neuropsychological research dealt primarily with discovering the effect on behavior of localized brain lesions. Within a clinical setting, the game of "where's the lesion" (the pairing of anatomical brain locus with specific behavior or deficits in behavioral abilities) was, and still is, a prerequisite to diagnosis and a vital and necessary aspect of appropriate treatment planning. In spite of increasing technological advances in radiology, clinical neuropsychological techniques are highly valued and often crucial due to the noninvasive nature of the examination and the increasing accuracy and sensitivity of the procedures.

More recently, however, treatment and rehabilitation have become critical issues (Verfaellie and Cernak, in press). Research in neuropsychology has mirrored this trend, influenced as well by developments in cognitive psychology. Systems, rather than anatomical foci, have become the targets of investigation. Physiological systems, both neuropharmacological and structural, are now seen to be

reflected in systems of behavior, such as memory and arousal. By studying the disruption in performance of patients with neurological disorders, the cognitive psychologist gains a unique glimpse of the underlying demands of different tasks on aspects and levels of information processing. Further, by analyzing the intact abilities of neurologically impaired individuals, the cognitive psychologist can begin to approach an understanding of the way in which the different underlying processing components contribute to the overall behavioral system. Neuropsychologists have also shifted their focus somewhat, from which abilities are impaired to which capacities are intact in specific neurological populations. No longer is it sufficient to ask what behavior is disrupted by a specific brain lesion, the crucial question now is: "What can this patient do?" and "Why is he doing it in such a unique way?"

Amnesia research today reflects this convergence of neuropsychological and cognitive psychological theories. Memory is treated as a system of ongoing processing components that vary depending upon the material, the task and the testing situation. Amnesia, then, is a disruption in information processing along any one or more of a number of different dimensions.

The alcoholic Korsakoff patient has been studied as the classical example of the axial amnesic syndrome (Barbizet,

1970). Produced by bilateral damage to the limbic system, specifically the mammillary bodies and medialis dorsalis of the thalamus (Victor, Adams and Collins, 1971), this syndrome results in a dramatic short-term memory deficit in the presence of otherwise relatively intact cognitive functioning. While alcoholic Korsakoff patients are sometimes disoriented for time and place and severely defective in the acquisition of new information, their abstract ability, digit span (immediate memory), general fund of information (long-term memory), drawing and WAIS Verbal and Performance I.Q.s are generally within normal limits. This has made the alcoholic Korsakoff patient an ideal subject for investigating the nature of the defect or defects causal to organic short-term memory impairment and thereby the structure and mechanisms of human memory and learning.

Warrington and Weiskrantz (1970), using partial information as cues, showed the amnesic syndrome to be a failure of retrieval, rather than consolidation, due to proactive interference. In subsequent studies, Warrington and Weiskrantz (1974; 1978) demonstrated that this interference can inhibit the acquisition of new material as well (List 1 items intruding in the recall of List 2). Further, they found it to be remarkably robust: the proactive interference generated by the learning of a first list did not dissipate over four subsequent learning trials

of a second list. Many studies by Butters, Cermak, and colleagues (Butters and Cermak, 1974; Butters, Lewis, Cermak and Goodglass, 1973; Cermak and Butters, 1972) also highlight the alcoholic Korsakoff patient's susceptibility to proactive interference and go further to implicate an impairment in semantic encoding underlying this sensitivity to interference effects. Cermak, Uhly and Reale (1980) used an encoding-specificity procedure developed by Thomson and Tulving (1970) and demonstrated alcoholic Korsakoff patients' sensitization to strong associates. The representation of an item already in semantic memory can be strengthened without the patients awareness, thereby altering the semantic hierarchy temporarily. This has been called the "out of the blue" phenomenon by Gardner, Boller, Moreines and Butters (1973) and was replicated by Graf, Shimamura and Squire (1985).

Jacoby and Witherspoon (1982) found that amnesics could be biased by prior exposure to a stimulus even when unable to demonstrate recognition of that material on demand. Intact memory without awareness as opposed to impaired memory with awareness (Jacoby, 1984) is one of several contemporary theoretical distinctions in amnesia research. Awareness vs. unawareness can in turn be subsumed under the broader heading of episodic memory. This is part of another theoretical distinction, that of episodic vs. semantic memory (Tulving, 1983). It has been suggested that the

semantic memory of alcoholic Korsakoff patients may be intact (Kinsbourne and Wood, 1975), although their ease of access to its component features may be affected (Cernak, Reale and Baker, 1978). It is episodic memory, that memory of events and items that is personally experienced by the patient, that is impaired in amnesia. More specifically, it is conscious, episodic memory that is impaired in amnesia.

Still another, perhaps even broader, distinction is that of procedural vs. declarative memory (Cohen and Squire, 1980). Amnesic patients seem to be able to learn how to do a variety of tasks (procedural memory) but are usually impaired when required to report what material they have learned (declarative memory). Procedural memory "concerns retention of the process involved in performing a task rather than the specific material learned," whereas declarative memory "involves tasks in which the patient must demonstrate that he knows that a particular stimulus has been presented for learning" (Verfaellie and Cernak, in press). Recall and recognition are tests of declarative memory, while procedural memory may be tapped by such experiments as mirror-reading and mirror-writing. Another well-known example of procedural memory is the Tower of Hanoi task (Cohen, 1984). The episodic vs. semantic memory distinction may be viewed as a subdivision of declarative memory (Cernak, 1985 and Tulving, 1985). To simplify: amnesic patients have deficits in aware, episodic,

declarative memory while unaware, episodic, declarative memory and semantic, declarative memory and procedural memory seem to be relatively spared.

Huppert and Piercy (1976; 1978) using pictures and words with alcoholic Korsakoff patients, suggested a defect in contextual memory for both types of material rather than in memory for items. The increased susceptibility of alcoholic Korsakoff patients to proactive interference can also be viewed as consistent with a theory of deficient encoding of contextual information.

Graf and Schacter (1985) make yet another distinction between forms of memory: they utilize the concept of explicit memory vs. implicit memory. Explicit memory is that which is assessed by conventional tests of short-term memory, such as recall, cued recall, and recognition. Implicit memory, on the other hand, is that which is examined by priming tasks and does not depend on the direct recall of specific material to be learned. Implicit memory is instead measured by enhancement of performance and can be examined without the subjects awareness. One can say that priming tasks reflect episodic memory without awareness. Direct priming, also known as repetition priming, refers to the facilitation in performance seen on subsequent repetition of the same item. Not only have amnesic patients exhibited intact priming effects, but the magnitude of the priming effect has also been found to be comparable to that

of normal controls (Graf, Squire, and Mandler, 1984; Warrington and Weiskrantz, 1974).

The mechanism or mechanisms underlying this preserved priming in amnesic patients is as yet unclear. Some have maintained that it is attributable to the activation of pre-existing memory representations (e.g. Graf, Squire and Mandler, 1984), while others believe it to be an episodic phenomenon (Jacoby, 1983). Schacter and Graf (1986b) propose two types of priming which vary in effect with severity of amnesia: "priming effects attributable to the activation of preexisting structures may decay rapidly within an hour or two, whereas priming that is attributable to a newly created representation may, under some conditions, persist over relatively long temporal intervals" (Schacter and Graf, 1986b). The former type of priming is preserved in most amnesic subjects, while the latter requires elaborative processing and seems to be preserved in only "mildly" amnesic patients.

Mattis, Kovner and Goldmeier (1978) investigated free recall and recognition memory for verbal material, varying meaningfulness and categorization. They found a distinctive pattern in the recognition memory performance of alcoholic Korsakoff patients that clearly distinguishes them, not only from normal controls, but from other amnesic groups of differing etiology. This pattern was of progressively poorer (over three trials) recognition memory for

denotatively categorized word lists and similar to normal recognition memory for novel, meaningless (i.e. nonsense hexagrams and Persian words) verbal lists. These findings were seen to caution against a unitary causal defect model of amnesia. In a subsequent study, Kovner, Mattis, Goldmeier and Davis (1981) found that proactive interference developed only with denotatively categorized word lists, not with connotative lists, and was therefore discarded by the authors as a primarily causal defect in the overall memory disorder. The semantic encoding deficit, however, appeared across semantic list organizations and was retained as a general factor in amnesia. A separate retrieval factor was noted as was an independent causal defect of selective attention, manifested in an inability to appreciate and utilize conceptual dichotomies.

If a deficit in semantic encoding is a general causal defect in amnesia and alcoholic Korsakoff syndrome reflects bilateral pathology, then the question arises as to how performance is affected on tests of nonverbal memory.

L'hermitte (1972) observed differences between alcoholic Korsakoff subjects and post-Herpes encephalitics in patterns of performance on nonverbal memory tasks. Post-Herpes subjects performed better on tasks requiring knowledge of temporal order than on a task which required spatial location of pictures. Korsakoff patients, on the other hand, failed sequential tests but could store spatial

location. Butters, Lewis, Cernak and Goodglass (1973) examined alcoholic Korsakoff patients' performance on verbal and nonverbal memory tasks in the visual, auditory, and tactile modalities. All nonverbal stimuli were nonmeaningful (computer-generated random shapes in the visual modality, sequences of five piano notes in the auditory modality, four-line unfamiliar raised figures in the tactile modality) and all verbal stimuli were consonant trigrams with a 25% or less association value or single raised letters (in the tactile modality). Oral-verbal interference was used in the Brown-Peterson technique with all tasks. The results indicate a material-specific effect such that performance on verbal tasks was significantly poorer than normals across modalities while nonverbal performance was not. This was interpreted to confirm the defective semantic encoding hypothesis. Huppert and Piercy (1976), on the other hand, found that the deficiency of alcoholic Korsakoff patients' recognition performance relative to normals did not differ between pictures, high frequency words, and low frequency words. Strauss and Butler (1978) found impaired recognition performance by alcoholic Korsakoff patients on haptic tasks with both nonverbal and verbal material and point to data from commissurotomy patients to support the hypothesis that different mechanisms are involved in nonverbal and verbal memory processes. They suggest that one of the reasons that

Butters et al. (1973) found no impairment of alcoholic Korsakoff performance relative to normals on nonverbal memory tests was that they did not use material-specific interference tasks. Warrington (1974) has also suggested that memory for nonverbal material, specifically faces, is impaired in alcoholic Korsakoff patients.

The present study was designed to investigate cognitive factors causal to the short-term memory defect for nonverbal material in alcoholic Korsakoff syndrome. Mattis and colleagues (Mattis, Kovner and Goldmeier, 1978; Kovner, Mattis, Goldmeier and Davis, 1981) were successful in employing the variables of meaningfulness and categorization in determining some components of a multifactor explanation of amnesia. These variables may be utilized in the study of nonverbal memory processes as well. Faces have been shown to be meaningful nonverbal stimuli, while computer-generated random shapes of low association value and familiarity are relatively nonmeaningful.

Faces are recognized by normal subjects more accurately than inverted faces (Hochberg and Galper, 1967; Yin, 1969) or photographs of faces presented in photographic negative (Galper, 1970). The extent of disruption of recognition performance caused by inversion of faces is disproportionate to that seen with inversion of other common objects, such as houses (Yin, 1969), and implies that upright human faces are meaningful and therefore processed differently than are

patterns of identical geometrical complexity (Galper and Hochberg, 1971). Using tachistoscopic presentation, Ellis and Shepherd (1975) showed a left visual field superiority for recognition of both upright and inverted faces by normal subjects. Yin (1970) found a material-specific deficit of face recognition in patients with right posterior cerebral damage that could not be accounted for by a general impairment in memory or discrimination of visual objects. Tzavaras, Hecaen, and Le Bras (1970) also found impaired recognition of faces, presented either as photographs or as simple designs, in patients with unilateral right cortical lesions and hypothesized disordered human facial recognition to be an autonomous defect.

Advances in technology have introduced computer-generated random shapes for use in research as nonmeaningful nonverbal stimuli. Vanderplas and Garvin (1959) have determined the association value of computer-generated random shapes of varying complexity (complexity determined by the number of points from which the shape was generated) and have described the interactive effects of complexity, association value, and practice on normal recognition following paired-associates training. In a study of normal human perception and memory using tachistoscopic presentation, Dee and Fontenot (1973) found a left visual field superiority for computer-generated random shapes which seemed attributable to hemispheric differences in memory

rather than perceptual processes. The authors pointed out that the shapes used were high in complexity and low in rated association value but also low in familiarity and meaningfulness.

Both faces and computer-generated random shapes have been reported to exhibit a left visual field superiority and are therefore inferred to be processed more efficiently by right hemisphere functions. In this study, the categorization of both meaningful (male vs. female faces) and nonmeaningful (high vs. low complexity shapes) stimuli is varied in an attempt to further elucidate a multifactor model of anterograde amnesia and specifically address nonverbal memory, and thereby right hemisphere processing, in alcoholic Korsakoff syndrome.

If deficits in nonverbal processing parallel verbal processing deficits (Mattis, Kovner and Goldmeier, 1978), one would expect that alcoholic Korsakoff patients' recognition memory performance as compared with normals would be most disrupted by categorized meaningful material and least impaired with uncategorized nonmeaningful stimuli.

Methods

Subjects

The experimental group consisted of five male alcoholic Korsakoff patients, three resident at the Veterans Administration Hospital in Montrose, New York, and two from the Boston Veterans Administration Hospital. The mean age of the patients was 57.4 years (S.D. = 7.58). As assessed by the Wechsler Adult Intelligence Scale (Wechsler, 1955), the alcoholic Korsakoff patients all had Average general intellectual functioning (mean I.Q. = 102.4; S.D. = 6.77) and did not show any signs of diffuse organicity on screening with the Mattis Organic Mental Status Screening Examination - MOMSSE (Lezak, 1976). Each of the patients exhibited a dense clinical amnesia, manifested in an inability to reliably recall day to day and current events, occasional disorientation to time and place, and variable retrograde amnesia. The alcoholic Korsakoff patients' mean Wechsler Memory Scale (Wechsler & Stone, 1945) M.Q. was 75.8 (S.D. = 7.55).

A normal control group was recruited from the maintenance staff and Volunteer Department of Montefiore Hospital and Medical Center, New York. Seven adult male

subjects were matched as closely as possible with the Korsakoff group for age (mean age = 56 years; S.D. = 2.83), Full Scale I.Q. (mean I.Q. = 109.7; S.D. = 6.41), and socioeconomic background. The Wechsler Memory Scale was administered to each control subject to rule out the possibility of any, as yet undetected, memory problem. All scores were within normal limits.

Design

The procedure used in this study was a further modification of the Buschke list-learning task: twelve free recall trials of a twenty word list with selective reminding (Buschke, 1973). A variant of this task was first devised by Mattis, Kovner and Goldmeier (1978). Recognition memory probes were inserted after recall on the fourth, eighth, and twelfth trials, but before selective reminding. A recognition memory measure was computed for each probe using the statistic d' (Banks, 1970).

This design was modified further in order to accommodate visually presented non-verbal material. Each "list" consisted of twenty pictures arranged in a 4 x 5 matrix (target sheet). The subject was given twenty pictures (target cards) and asked to match them one at a time to the identical picture on the target sheet. This was repeated for a total of twelve matching trials to ensure adequate exposure to each target item. The order of presentation of target cards was random (by shuffling) on each trial. After the fourth, eighth and twelfth trials, recognition memory probes were inserted. These consisted of forty picture cards (twenty target items, twenty distractor items) presented one at a time to the subject with the question:

"Is this a face (shape) you have been matching?" The random order of presentation of target and distractor items was different on each probe but the same across tests. On both matching and recognition, the subjects received immediate feedback as to correctness of response. Each matching trial was timed and errors noted (as corrected spontaneously or by the examiner) and recognition (d') scores were obtained for each probe. The same five tests were given to each subject (in a different random order) with a minimum of one hour free between tests and a maximum of two tests per day.

Materials

Meaningfulness and categorization of material were varied in five tests utilizing the above procedure. In Test 1, male and female faces were used as target items and male and female faces as distractor items (Mixed Meaningful). Test 2 consisted of male faces as target and distractor items (Categorized Meaningful). Test 3 contained male faces as target items and female faces as distractor items (Category Contrast Meaningful). In Test 4, computer-generated random shapes (Vanderplas, J.M. and Garvin E.A., 1959) of equal complexity (6 and 8 points) were used as target and distractor items (Mixed Nonmeaningful). Test 5 was composed of computer-generated random shapes of high complexity (24 points) as target items, shapes of lower complexity (12 points) as distractor items (Categorized Nonmeaningful). All computer-generated random shapes used had known association and content values. The faces were chosen from a Catholic High School yearbook. Within tests, they were all carefully balanced for degree of smile, three-quarter or full face view, length of hair, position of side part, and presence or absence of bangs. Clothing was only visible around the neck area and was identical within Males and Females but different between Males and Females, i.e.

the discrimination of male from female faces could be made on the basis of clothing cues alone.

The test stimuli appear in Appendix I.

The order of stimulus presentation employed for each of the three recognition probes is included in Appendix II.

Results

Figures 1 through 5 present the mean d' scores of alcoholic Korsakoff and Normal subjects on each recognition probe presented during the matching paradigm for each test condition. On each figure, the line crossing at $d' = 0.8$ defines a confidence limit above which any d' represents better than chance discrimination between target and distractor items at the .05 level (Marascuilo, 1970).

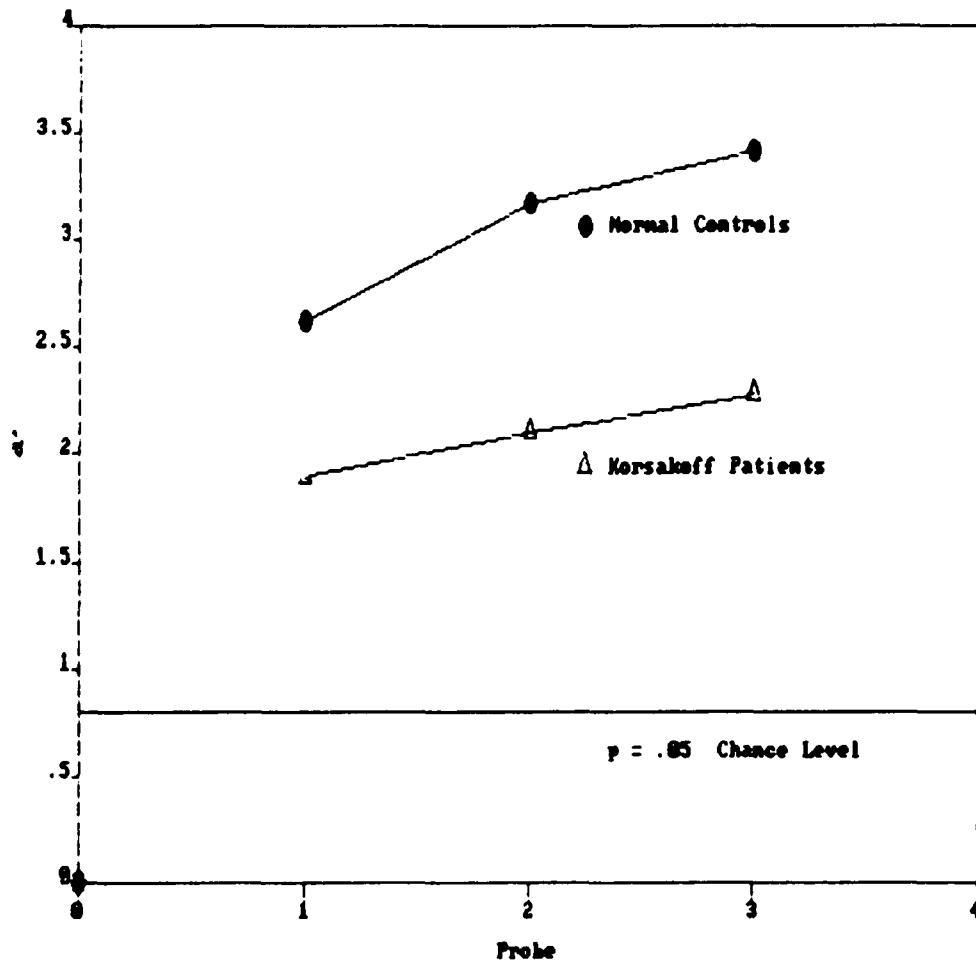
- Figures 1 through 5 -

Korsakoff scores do not uniformly fall below chance expectancy but rather vary as a function of the test condition, as do those of the Normal controls.

The Mann-Whitney U test was used to compare the d' scores of the two groups on each recognition probe for each test and to compare the degree of gain (the d' score on the third recognition probe minus the d' score on the first recognition probe) for each group in each test condition. Since prediction of performance was made possible by application of the findings of Mattis, Kovner and Goldmeier (1978) with verbal material, one-tailed p values were used.

- Tables 1 and 2 -

Figure 1: Faces - Mixed



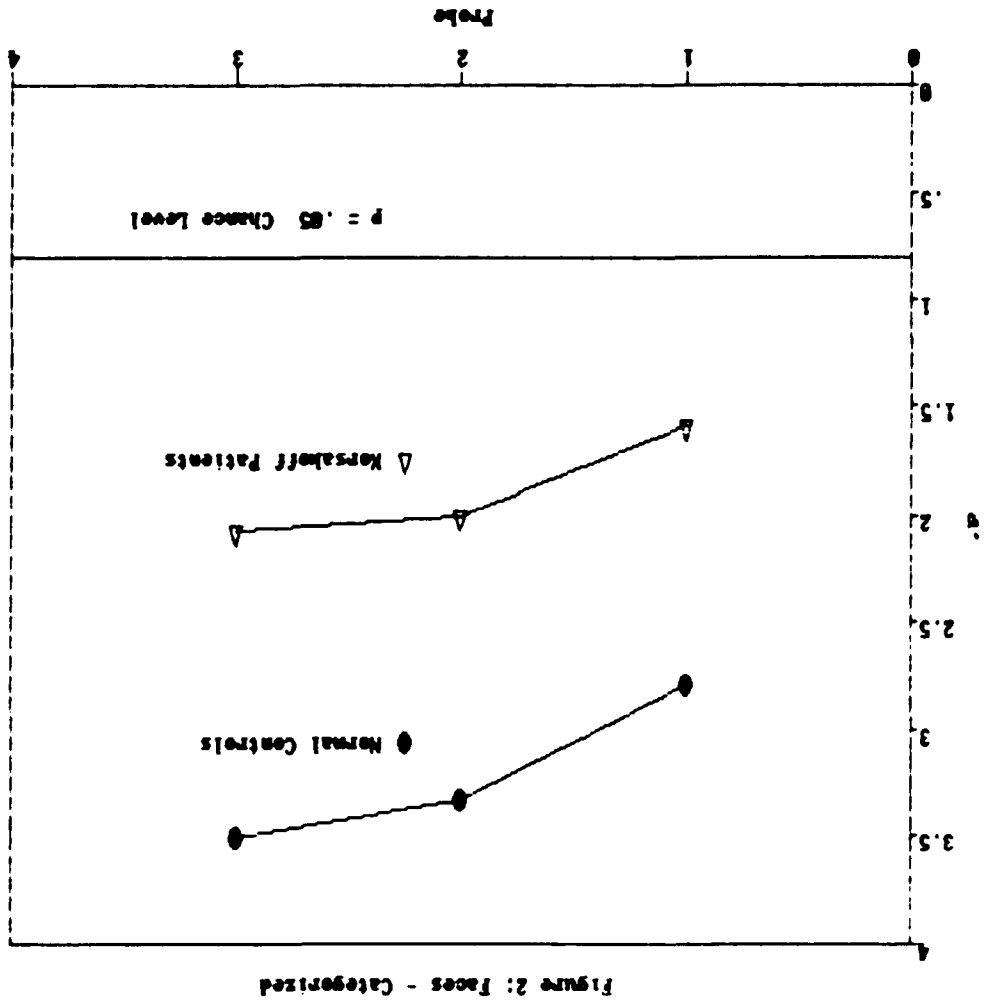


Figure 3: Faces - Category Contrast

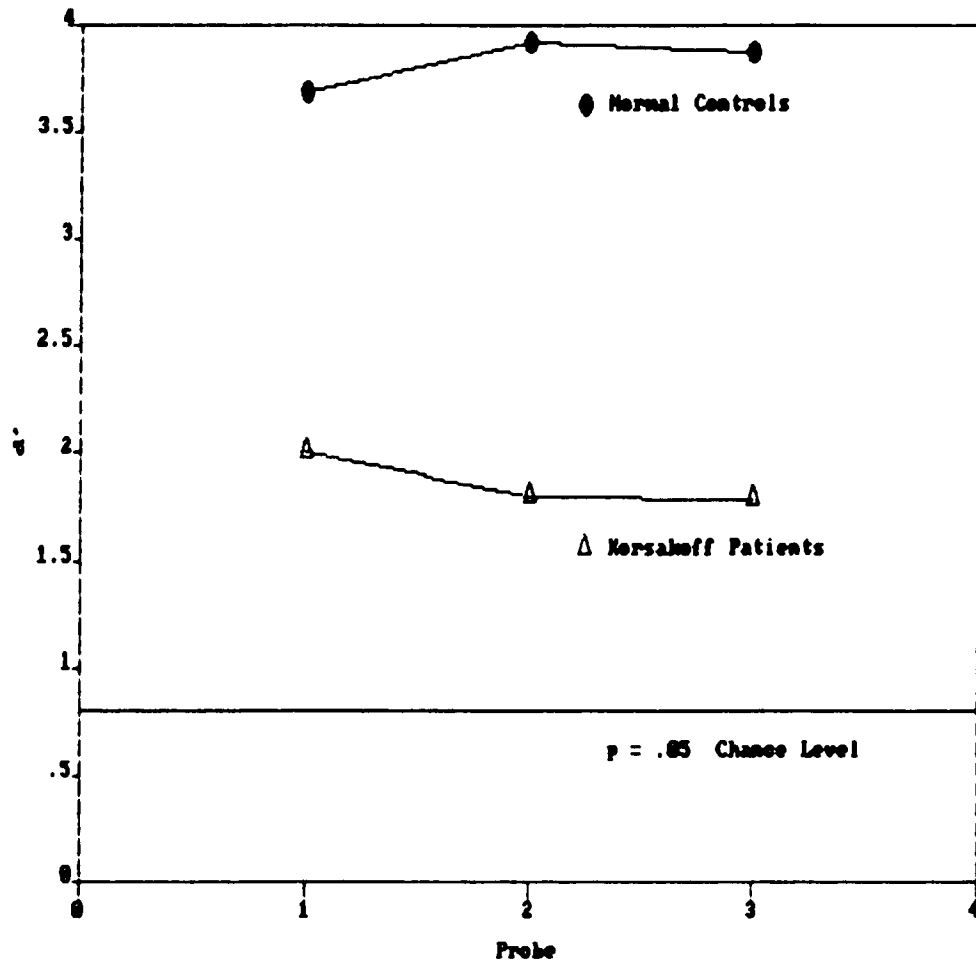


Figure 4: Random Shapes - Mixed

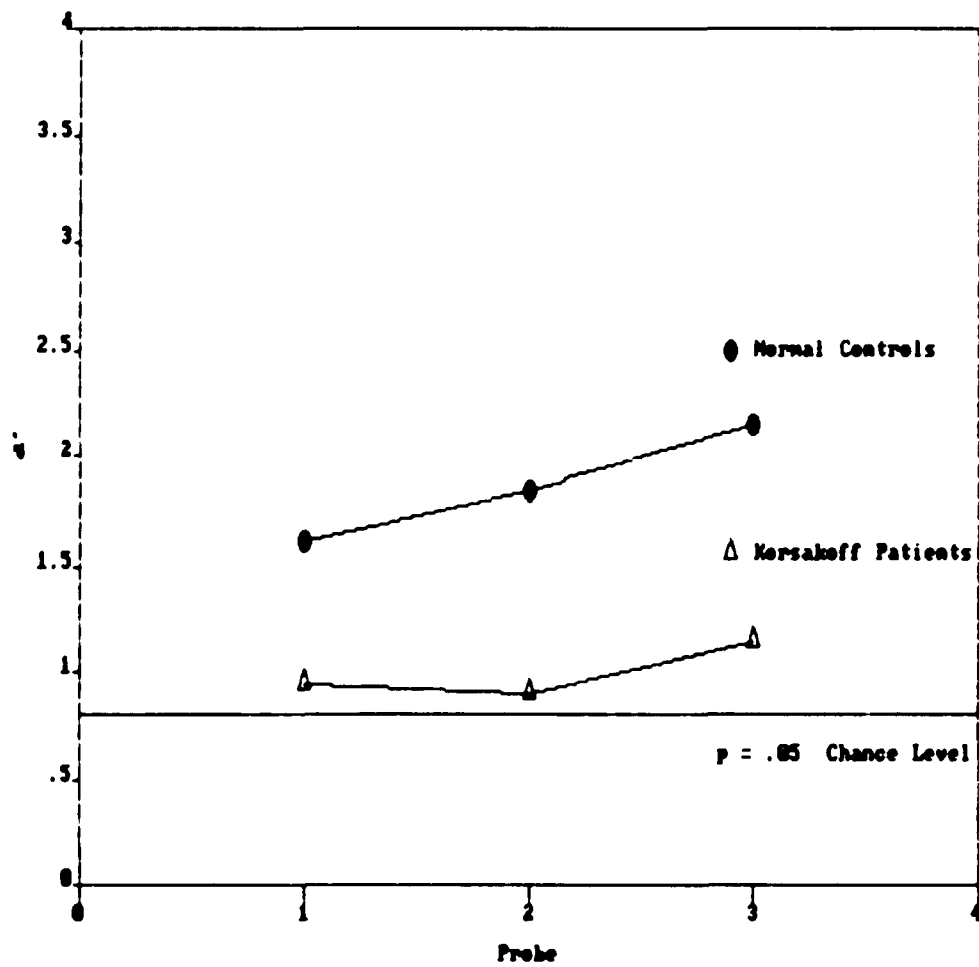


Figure 5: Random Shapes - Categorized

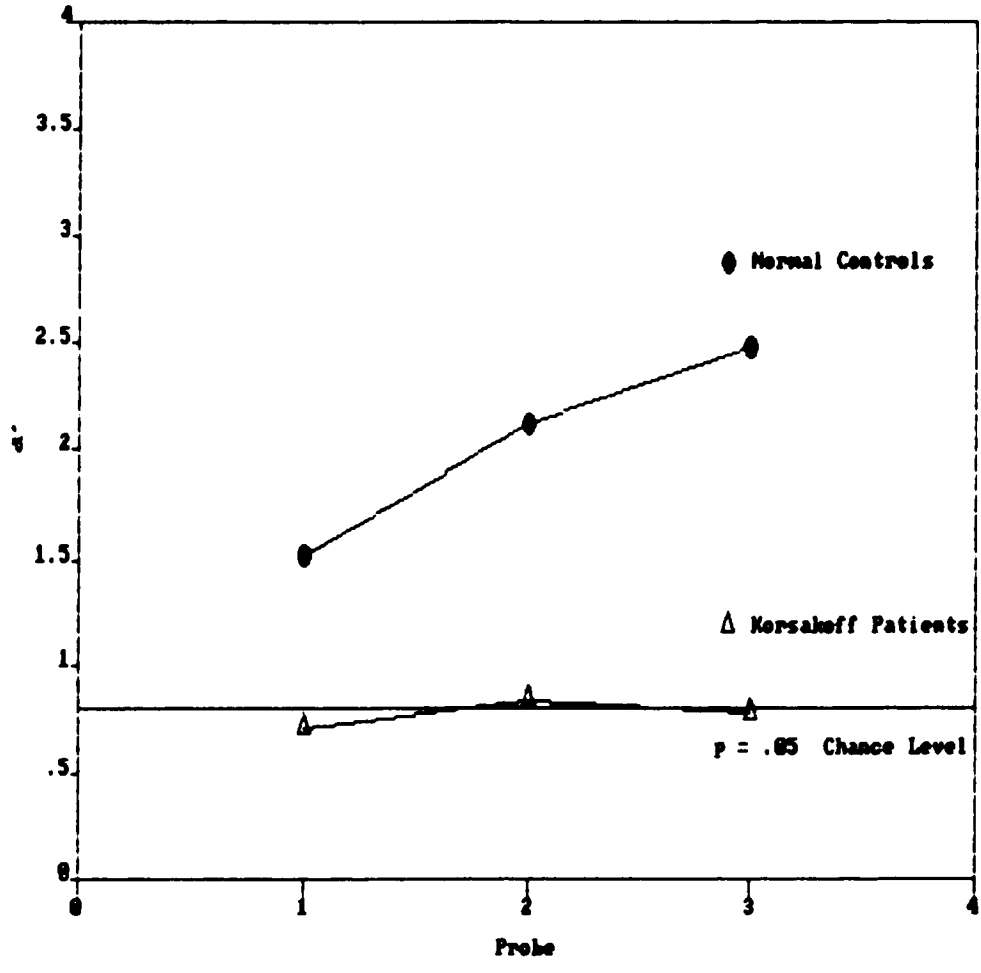


Table 1Mann Whitney U Test

<u>Test</u>	<u>Probe 1</u>		<u>Probe 2</u>		<u>Probe 3</u>	
	<u>U</u>	<u>p</u>	<u>U</u>	<u>p</u>	<u>U</u>	<u>p</u>
Mixed Meaningful	7	0.043*	6.5	0.036*	6.5	0.036*
Categorized Meaningful	8	0.061	5	0.019*	5	0.02*
Category Contrast Meaningful	5	0.018*	0	<0.001*	0.5	0.002*
Mixed Nonmeaningful	9	0.083	4	0.014*	7	0.044*
Categorized Nonmeaningful	10	0.112	8	0.061	4	0.014*

* Significant at $p < .05$

Table 2Mann-Whitney U TestGain (d' Probe 3 - d' Probe 1)

	<u>U</u>	<u>p</u>
Mixed Meaningful	11	0.144
Categorized Meaningful	13.5	0.257
Category Contrast Meaningful	7	0.041*
Mixed Nonmeaningful	16	0.404
Categorized Nonmeaningful	7	0.044*

* Significant at $p < .05$

Alcoholic Korsakoff and control subjects differed significantly in their ability to discriminate target from distractor items on the Mixed Meaningful test (figure 1). While significantly above chance, d' scores of the alcoholic Korsakoff patients were significantly poorer than those of the controls on each of the three recognition probes (Probe 1, $U = 7$, $p = 0.0427$; Probes 2 and 3, $U = 6.5$, $p = 0.0355$).

On the Categorized Meaningful task (figure 2), alcoholic Korsakoff patients also obtained d' scores significantly above chance on all three recognition probes. The Korsakoff group, however, performed significantly more poorly than normals on two of the three recognition probes (Probe 2, $U = 5$, $p = 0.0192$; Probe 3, $U = 5$, $p = 0.01995$).

While the d' scores of alcoholic Korsakoff patients in the Category Contrast Meaningful condition (figure 3) were again significantly above chance, they differed significantly from the control subjects on each of the three recognition probes (Probe 1, $U = 5$, $p = 0.0175$; Probe 2, $U = 0$, $p = 0.00075$; Probe 3, $U = 0.5$, $p = 0.00155$).

The recognition memory of alcoholic Korsakoff patients for the Mixed Nonmeaningful material (figure 4) was likewise significantly above chance. Mean d' scores for alcoholic Korsakoff and normal subjects differed significantly on two of the three recognition probes (Probe 2, $U = 4$, $p = 0.01405$; Probe 3, $U = 7$, $p = 0.0441$).

Only on the Categorized Nonmeaningful test (figure 5) did the Korsakoff d' scores generally fall below chance level. The two groups differed significantly on the last recognition probe (Probe 3, $U = 4$, $p = 0.01405$).

A comparison of the gain scores (the d' score on the third recognition probe minus the d' score on the first recognition probe) for each test revealed a significant difference between alcoholic Korsakoff and normal subjects in the Category Contrast Meaningful and Categorized Nonmeaningful conditions only ($U = 7$, $p = 0.0413$ and $U = 7$, $p = 0.0441$, respectively). While the pattern (see figures 1 through 5) of recognition memory performance of the two groups was similar in each of the other tasks, in these two conditions the Korsakoff recognition memory manifested on the third probe as compared with the first probe was significantly worse than normal.

Discussion

Signal detection theory predicts that the most difficult task will be the one in which there is the most similarity between stimuli (target and distractor items), making for a small signal to noise ratio. In this case, one would predict the Categorized and Mixed faces tasks to be of equal difficulty (male targets vs. male distractors and male + female targets vs. male + female distractors seem to be equally similar). The discrimination required by the Category Contrast faces test should be much easier, since male targets are quite different from female distractors. One would make the same prediction for the Nonmeaningful tasks: computer-generated random shapes of equivalent complexity as targets and distractors are very similar and therefore should be more difficult to discriminate than high complexity targets vs. low complexity distractors.

If one makes a direct comparison of average d' levels between tests, the pattern of test difficulty for each subject group is readily seen. For the Meaningful tests the patterns in increasing order of difficulty are as follows:

Normals - Category Contrast, Categorized, Mixed

Korsakoffs - Mixed, Categorized, Category Contrast.

The following patterns, also in increasing order of difficulty, are apparent when the Nonmeaningful tasks are compared: Normals - Categorized, Mixed

Korsakoffs - Mixed, Categorized.

Clearly, the pattern of test difficulty for Normals is that predicted by signal detection theory whereas for alcoholic Korsakoff patients it is precisely the reverse. Increasing categorization, and therefore decreasing similarity of target and distractor items, made the task easier for Normals but actually made it more difficult for alcoholic Korsakoff patients.

The results of this study confirm the presence of a short-term memory disorder for nonverbal material in alcoholic Korsakoff syndrome and argue against a material-specific effect (Butters, Lewis, Cermak and Goodglass, 1973). Moreover, this study replicates the findings of Mattis, Kovner and Goldmeier (1978) and Kovner, Mattis, Goldmeier and Davis (1981) and extends them to nonverbal stimuli. Mattis, Kovner and colleagues observed a distinctive pattern in the recognition memory performance of

alcoholic Korsakoff patients that clearly distinguishes them from other amnesic groups: "when prior familiarity is equal for both groups, the Korsakoff patients demonstrate a relative decrease in d' as compared to controls as the intrinsic semantic organization of the word list increases" (Mattis et al., 1978). This was seen to support the hypothesis of Butters and colleagues that a semantic encoding deficit was contributory to the alcoholic Korsakoff memory disorder. Mattis et al. (1978) also postulated a "trace strength" theory to explain the negative slope phenomenon with denotatively categorized word lists: stimulation of a target item also stimulates its strong associates (i.e. increased trace strength of both target and associates) such that, with repeated presentations, the just noticeable difference between target and distractor items in a categorized task falls below that level necessary for discrimination. This theory, unfortunately, works well with verbal stimuli but does not appear to explain the phenomenon of recognition memory decline across probes with nonverbal material for which, although faces per se are meaningful, there is no prior familiarity with the particular items used and therefore can be no associates to stimulate.

Kovner, Mattis, Goldmeier and Davis (1981) went on to describe the inability of alcoholic Korsakoff patients to reliably utilize category distinctions as a deficiency of "selective attention." This, however, may be an

oversimplification of the observed findings since the category distinctions did not prove useless to alcoholic Korsakoff patients but rather were increasingly disruptive to their recognition performance.

The disruptive effect (on recognition memory performance) of distractor items taken from a category different from that of the targets may be attributable instead to the intactness of priming effects that has been demonstrated in alcoholic Korsakoff syndrome (Cohen, 1984; Squire, 1986). Conventional memory tests examine explicit memory. Priming tasks, which do not depend upon the retrieval of any specific learning experience, assess implicit memory (Graf and Schacter, 1985; Schacter and Graf, 1986a; Schacter, 1987a). Priming effects are manifested by an enhancement in performance and can be examined without the subject's awareness.

Cermak (1985) and Warrington and Weiskrantz (1982) maintain the viewpoint that priming effects in amnesia reflect an activation of a pre-existing semantic representation rather than new learning. In support of this hypothesis, Cermak, Talbot, Chandler and Wolbarst (1985) found that alcoholic Korsakoff patients did not exhibit priming effects when pseudowords were presented on a perceptual identification task, while normal subjects did. However, just as Mattis and colleagues' trace strength hypothesis was not viable in the context of the present

study, so too is the concept of a pre-existing semantic representation unproductive in an attempt to understand the alcoholic Korsakoff patient's performance on tests of nonverbal memory for which there is no pre-existing network of specific memory representations waiting to be activated.

It has been suggested by Schacter and Graf (1986b) that there are two types of priming which vary in effect with severity of amnesia. Using word-completion tests with amnesic subjects, they were able to demonstrate implicit memory for new associations (i.e. associations that had no pre-existing representation in memory). They subsequently found the priming effect for new associations only following a study task that required elaborative processing (the generation of a sentence that linked each member of an unrelated word pair in a meaningful way); there was no implicit memory demonstrated following the non-elaborative task (the comparison of the number of vowels in each member of the unrelated word pair). Schacter and Graf conclude that the priming effect which is preserved in most amnesic subjects is that priming which can be attributed to the activation of pre-existing memory representations. There is another priming which requires elaborative processing and which seems to be preserved in only "mildly" amnesic patients. (The authors acknowledge the difficulty in clearly defining the severity of amnesia; they grouped amnesics, with each group of mixed etiologies, according to

differences in magnitude of I.Q.-M.Q. splits). Schacter and Graf found further that priming effects for new associations were not affected by the experimental manipulation of degree of elaborative processing required (as was explicit memory), nor by experimentally induced interference (again, as was explicit memory). This dissociation between implicit and explicit memory led them to propose that "at least some amnesic patients are able to establish the components of a memory representation that are produced by relatively low degrees of elaboration, and that support implicit memory for new associations, even though they are unable to store those components of a representation that are produced by more extensive elaborative processing, and that support explicit remembering."

Jacoby and Dallas (1981), extending the conclusions of Huppert and Piercy (1976; 1978), have hypothesized that it is the ability to retrieve contextual information that is impaired in amnesia, while the generation of relative perceptual fluency (that which produces a feeling of familiarity) remains intact. This perceptual fluency is what enables the amnesic patient to exhibit facilitation in priming tasks and display a relatively intact recognition memory.

In order to explain the results of the present study, it may be necessary to postulate the presence of two priming effects in competition. Within this "competitive priming"

hypothesis, there would exist two priming effects, one for target items and one for distractor items, with the second priming (eg. of different category distractor items) forming a competition with the first (target items). While one exposure to the second, categorically different stimuli is not enough to be disruptive, repeated exposures increase the priming effect of the second (distractor) set of stimuli. Thus, the degree of competition between the two sets of stimuli (between target items and contrasting category distractor items) is increased with each repetition of the second set (distractor items) and recognition memory, as measured by d' , is increasingly impaired. When male and female faces are presented as target stimuli (Mixed condition), the two potentially different categories are primed equally with no decrease in d' seen across probes.

This theory is similar in reasoning to the "trace strength" hypothesis (Mattis et al., 1978) but utilizes a broader cognitive framework and thereby explains equally well the performance of alcoholic Korsakoff patients with meaningful and nonmeaningful as well as verbal and nonverbal material.

It may be of potential therapeutic benefit to explore the possibility of manipulating priming effects, and limiting the competition of these effects, in alcoholic Korsakoff patients' environment in an attempt to maximize

their useful skills and recognition of day to day events. Glisky, Schacter and Tulving (1986a; 1986b) used an approach that focussed on the "acquisition of domain-specific knowledge" and had some success in using a priming technique to teach alcoholic Korsakoff patients a small computer vocabulary and rudimentary computer skills.

The nonverbal recognition memory tests presented in this paper have a direct clinical use in the diagnosis of alcoholic Korsakoff Syndrome. Further research would be helpful, however, to determine if these tests could be shortened and still preserve the distinctive negative slope phenomenon of alcoholic Korsakoffs' d' recognition performance on categorized tasks. Also, comparative research needs to be done, administering these tests to patients with different forms of amnesic disorders, in order to confirm that this decline of d' across probes on only categorized tests is indeed unique to, and therefore diagnostic of, the alcoholic Korsakoff amnesic syndrome.

Appendix I: Test Stimuli

Test 1: Mixed Meaningful

Target Items: Male and Female Faces



Test 1: Mixed Meaningful

Distractor Items: Male and Female Faces

Test 2: Categorized Meaningful

Target Items: Male Faces

Test 2: Categorized Meaningful

Distractor Items: Male Faces



Test 3: Category Contrast Meaningful

Target Items: Male Faces

Test 3: Category Contrast Meaningful

Distractor Items: Female Faces

Test 4: Mixed Nonmeaningful

Target Items: 6 Point and 8 Point Random Shapes

Test 4: Mixed Nonmeaningful

Distractor Items: 6 Point and 8 Point Random Shapes

N.B. The dot denotes the top of each recognition card, and appears on both target and distractor cards.



Test 5: Categorized Nonmeaningful

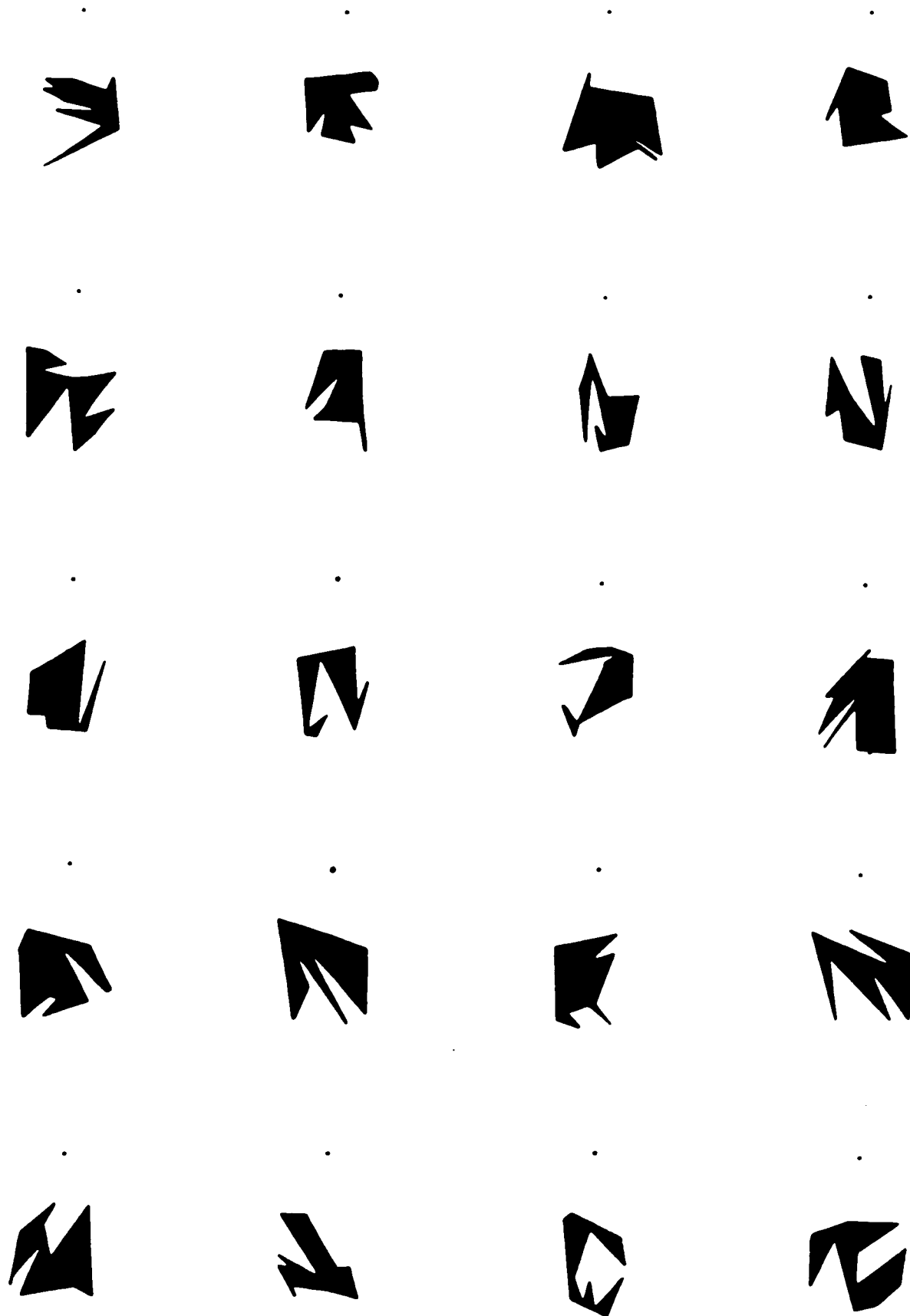
Target Items: 24 Point Random Shapes



Test 5: Categorized Nonmeaningful

Distractor Items: 12 Point Random Shapes

N.B. The dot denotes the top of each recognition card, and appears on both target and distractor cards.



Appendix II: Recognition Probe Test Orders

Bibliography

- Anderson, J.R. (1976). Language, memory, and thought. Hillsdale, New Jersey: Erlbaum.
- Baddeley, A.D. and Warrington, E.K. (1973). Memory coding and amnesia. Neuropsychologia, 11, 159-165.
- Banks, W.P. 1970. Signal detection theory and human memory. Psychological Bulletin, 74, 81-99.
- Barbizet, J. (1970). Human memory and its pathology. San Francisco: Freeman.
- Bobrow, D. and Collins, A. (Eds.) (1975). Representation and understanding: Studies in cognitive science. New York: Academic Press.
- Buschke, H. (1973). Selective reminding for analysis of memory and learning. Journal of Verbal Learning and Verbal Behavior, 12, 543-550.
- Butters, N. and Cermak, L.S. (1974). The role of cognitive factors in the memory disorders of alcoholic patients with the Korsakoff Syndrome. Annals of the New York Academy of Sciences, 233, 61-75.
- Butters, N., Lewis, R., Cermak, L.S., Goodglass, H. (1973). Material-specific memory deficits in alcoholic Korsakoff patients. Neuropsychologia, 11, 291-299.
- Cermak, L.S. (1975). Imagery as an aid to retrieval for Korsakoff patients. Cortex, 11, 163-169.
- Cermak, L.S. (1985). The extent of semantic priming in amnesics. The Psychonomic Society Meetings. Boston.
- Cermak, L.S. (1987). Models of memory loss in Korsakoff and alcoholic patients. In O. Parsons, N. Butters, and P. Nathan (Eds.), The Clinical Implications of Neuropsychological Deficits in Amnesia. New York: Guilford Press.

- Cermak, L.S. and Butters, N. (1972). The role of interference and encoding in the short-term memory deficits of Korsakoff patients. Neuropsychologia, 10, 89-95.
- Cermak, L.S., Reale, L. and Baker, E. (1978). Alcoholic Korsakoff patients' retrieval from semantic memory. Brain and Language, 5, 215-226.
- Cermak, L.S., Talbot, N., Chandler, K. and Wolbarst, L.R. (1985). The perceptual priming phenomenon in amnesia. Neuropsychologia, 23, 615-622.
- Cermak, L.S., Uhly, B. and Reale, L. (1980). Encoding specificity in the alcoholic Korsakoff patient. Brain and Language, 11, 119-127.
- Cohen, N.J. (1984). Preserved learning capacity in amnesia: Evidence for multiple memory systems. In N. Butters and L.R. Squire (Eds.), The Neuropsychology of Memory. New York: Guilford Press.
- Cohen, N.J. and Squire, L.R. (1980). Preserved learning and retention of pattern-analyzing skills in amnesia: Dissociation of knowing how and knowing that. Science, 210, 207-210.
- Dee, H.L. and Fontenot, D.J. (1973). Cerebral dominance and lateral differences in perception and memory. Neuropsychologia, 11, 167-173.
- Ellis, H.D. and Shepherd, J.W. (1975). Recognition of upright and inverted faces presented in the left and right visual fields. Cortex, 11, 3-7.
- Galper, R.E. (1970). Recognition of faces in photographic negative. Psychonomic Science, 19, 207-208.
- Galper, R.E. and Hochberg, J. (1971). Recognition memory for photographs of faces. American Journal of Psychology, 84, (3), 351-354.
- Gardner, H., Boller, F., Moreines, J. and Butters, N. (1973). Retrieving information from Korsakoff patients: Effects of categorical cues and reference to the task. Cortex, 9, 165-175.
- Glisky, E.L., Schacter, D.L. and Tulving, E. (1986a). Learning and retention of computer-related vocabulary in amnesic patients: Method of vanishing cues. Journal of Clinical and Experimental Neuropsychology, 8, 292-312.

- Glisky, E.L., Schacter, D.L., and Tulving, E. (1986b). Computer learning by memory-impaired patients: Acquisition and retention of complex knowledge. Neuropsychologia, 24, 313-328.
- Graf, P. and Schacter, D.L. (1985). Implicit and explicit memory for new associations in normal and amnesic subjects. Journal of Experimental Psychology: Learning, Memory and Cognition, 11, 501-518.
- Graf, P., Shimamura, A.P. and Squire, L.R. (1985). Priming across modalities and priming across category levels: Extending the domain of preserved function in amnesia. Journal of Experimental Psychology: Learning, Memory and Cognition, 11, 386-396.
- Graf, P., Squire L.R. and Mandler, G. (1984). The information that amnesic patients do not forget. Journal of Experimental Psychology: Learning, Memory and Cognition, 10, 164-178.
- Grossberg, S. (1978). A theory of human memory: self-organization and performance of sensory-motor codes, maps, and plans. Progress in Theoretical Biology, 5, 233-374.
- Grossberg, S. (1982). Processing of expected and unexpected events during conditioning and attention: A psychophysiological theory. Psychological Review, 89, 529-572.
- Hasher, L. and Zacks, R.T. (1979). Automatic and effortful processes in memory. Journal of Experimental Psychology: General, 108, 356-388.
- Hochberg, J. and Galper, R.E. (1967). Recognition of faces: I. An exploratory study. Psychonomic Science, 9, 619-620.
- Huppert, F.A. and Piercy, M. (1976). Recognition memory in amnesic patients: effect of temporal context and familiarity of material. Cortex, 4, 3-20.
- Huppert, F.A. and Piercy, M. (1978). The role of trace strength in recency and frequency judgments by amnesic and control subjects. Quarterly Journal of Experimental Psychology, 30, 346-354.
- Jacoby, L.L. (1984). Incidental vs. intentional retrieval: Remembering and awareness as separate issues. In L.R. Squire and N. Butters (Eds.), The Neuropsychology of Memory. New York: Guilford Press.

- Jacoby, L.L. and Dallas, M. (1981). On the relationship between autobiographical memory and perceptual learning. Journal of Experimental Psychology: General, 110, 306-340.
- Jacoby, L.L. and Witherspoon, D. (1982). Remembering without awareness. Canadian Journal of Psychology, 36, 300-324.
- Kinsbourne, M. and Wood, F. (1975). Short-term memory processes and the amnesic syndrome. In D. Deutsch and J.A. Deutsch (Eds.), Short-term Memory. New York: Academic Press.
- Kovner, R., Mattis, S., Gartner, J., Goldmeier, E. (1981). A verbal semantic deficit in the alcoholic Korsakoff syndrome. Cortex, 17, 419-426.
- Kovner, R., Mattis, S., Goldmeier, E. (1983). A technique for promoting robust free recall in chronic organic amnesia. Journal of Clinical Neuropsychology, 5, (1), 65-71.
- Kovner, R., Mattis, S., Goldmeier, E., Davis, L. (1981). Korsakoff Amnesic Syndrome: The result of simultaneous deficits in several independent processes? Brain and Language, 12, 23-32.
- Kovner, R., Mattis, S., Pass, R. (1985) Some amnesic patients can freely recall large amounts of information in new contexts. Journal of Clinical and Experimental Neuropsychology, 7, 395-411.
- Lezak, M. (1976). Neuropsychological assessment. New York: Oxford University Press.
- L'hermitte, R. and Signoret, J.L. (1972) Analyse neuropsychologique et differentiation des syndromes amnesiques. Revue Neurologique, 126, 161-178.
- Lynch, G., McGaugh, J.L., Weinberger, N.M. (Eds.) (1984). Neurobiology of learning and memory, New York: Guilford Press.
- Marascuilo, L.A. (1970). Extension of the significance test for one-parameter signal detection hypotheses. Psychometrika, 35, 237-243.
- Mattis, S. and Kovner, R. (1984). Amnesia is as amnesia does: towards another definition of the anterograde amnesias. In L.R. Squire and N. Butters (Eds.), Neuropsychology of memory. New York: Guilford Press.

- Mattis, S., Kovner, R., Gartner, J., Goldmeier, E. (1981). Deficits in retrieval of category exemplars in alcoholic Korsakoff patients. Neuropsychologia, 19, (3), 357-363.
- Mattis, S., Kovner, R., Goldmeier, E. (1978). Different patterns of mnemonic deficits in two organic amnesic syndromes. Brain and Language, 6, 179-191.
- Schacter, D.L. (1987a). Implicit memory: History and current status. Journal of Experimental Psychology: Learning, Memory and Cognition, 13, 501-518.
- Schacter, D.L. and Graf, P. (1986a). Effects of elaborative processing on implicit and explicit memory for new associations. Journal of Experimental Psychology: Learning, Memory and Cognition, 12, 432-444.
- Schacter, D.L. and Graf, P. (1986b). Preserved learning in amnesic patients: perspectives from research on direct priming. Journal of Clinical and Experimental Neuropsychology, 8, (6), 727-743.
- Squire, L.R. (1980). The anatomy of amnesia. Trends in NeuroSciences, 3, (3), 52-55.
- Squire, L.R. (1986). Mechanisms of memory. Science, 232, 1612-1619.
- Strauss, E.H. and Butler, R.B. (1978). The effect of varying types of interference on haptic memory in the Korsakoff patient. Neuropsychologia, 16, 81-90.
- Thomson, D.M. and Tulving, E. (1970). Associative encoding and retrieval: weak and strong cues. Journal of Experimental Psychology, 86, 255-262.
- Tulving, E. (1983). Elements of Episodic Memory. Oxford: The Clarendon Press.
- Tulving, E. (1985). How many memory systems are there? American Psychologist, 40, 385-398.
- Tzavaras, A., Hecaen, H., Le Bras, H. (1970). Le probleme de la specificite du deficit de la reconnaissance du visage humain lors des lesions hemispheriques unilaterales. Neuropsychologia, 8, 403-416.
- Vanderplas, J.M. and Garvin, E.A. (1959). The association value of random shapes. Journal of Experimental Psychology, 57, (3), 147-154.

- Vanderplas, J.M. and Garvin, E.A. (1959). Complexity, association value, and practice as factors in shape recognition following paired-associates training. Journal of Experimental Psychology, 57, (3), 155-163.
- Verfaellie, M. and Cermak, L.S. (in press). Neuropsychological issues in amnesia. In Martinez and Keener (Eds.), Learning and Memory: A Biological View (Second Edition).
- Victor, M., Adams, R.D., Collins, G. (1971). The Wernicke-Korsakoff syndrome: A clinical and pathological study of 245 patients, 82 with post-mortem examinations. Oxford: Blackwell.
- Warrington, E.K. (1974). Deficient recognition memory in organic amnesia. Cortex, 10, 289-291.
- Warrington, E.K. and Weiskrantz, L. (1970). Amnesic syndrome: consolidation or retrieval? Nature, London, 228, 628-630.
- Warrington, E.K. and Weiskrantz, L. (1974). The effect of prior learning on subsequent retention in amnesic patients. Neuropsychologia, 12, 419-428.
- Warrington, E.K. and Weiskrantz, L. (1978). Further analysis of the prior learning effect in amnesic patients. Neuropsychologia, 16, 169-177.
- Warrington, E.K. and Weiskrantz, L. (1982). Amnesia: A disconnection syndrome? Neuropsychologia, 20, 233-248.
- Wechsler, D. (1955). Manual: Wechsler Adult Intelligence Scale. New York: The Psychological Corporation.
- Wechsler, D. and Stone, C. (1945). Manual: Wechsler Memory Scale. New York: The Psychological Corporation.
- Weinberger, N.M., McGaugh, J.L., Lynch, G. (Eds.) (1985). Memory systems of the brain: Animal and human cognitive processes. New York: Guilford Press.
- Weingartner, H., Grafman, J., Boutelle, W., Kaye, W., and Martin, P.R. (1983). Forms of memory failure. Science, 221, (4608), 380-382.
- Yin, R.K. (1969). Looking at upside-down faces. Journal of Experimental Psychology, 81, 141-145.

Yin, R.K. (1970). Face recognition by brain-injured patients: a dissociable ability? Neuropsychologia, 8, 395-402.