ALCOHOL STATE DEPENDENT LEARNING: EFFECTS OF REPETITION AND RECOGNITION ON RETRIEVAL OF FACES, NAMES, AND WORDS

by

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ABSTRACT

This investigation was designed to examine several types of memory tests in order to determine if there were differences in their sensitivity to state dependent learning (SDL) and the acute effects of alcohol. Four memory tests were compared in a two session experiment using 1.1 ml/kg of alcohol (A) or placebo (P). Four groups of human subjects (P-P, A-A, P-A, A-P) were used in a factorial design in which subjects learned in the first session, and were tested 2.75-12 minutes and approximately 48 hours later. In this design, SDL resulted if the groups which changed state (P-A, A-P) forgot more between sessions than the same state groups (P-P, A-A). Alcohol-induced short term memory changes were assessed by examining the number correct in both sessions; alcohol effects on retrieval processes could be assessed by examining the effects of alcohol given during the second session.

Three test variables were manipulated by contrasting four of the tests. These variables were:

1. Face vs. name recognition.
2. Name recognition vs. name recall.
3. Degree of learning of names (number of stimulus repetitions during learning).

Recognition was tested by a four alternative forced choice test; free recall was employed here.

SDL was significant for name recall, but not for name recognition. The SDL difference between name recall and recognition proved significant. This was interpreted as evidence of an interaction between SDL and context dependent learning. In contrast to previous animal studies, no appreciable effect of degree of learning on SDL was found, indicating that SDL may be of practical importance in many situations in which material is well learned. Several alternate explanations for previous findings are advanced. The contrast between SDL of face and name recognition produced a trend that was difficult to interpret.

The effects of alcohol on short term memory and retrieval processes were consistent with the interpretation that alcohol acts by blocking memory consolidation. Session 2 alcohol had no effect on retrieval processes in any of the tests. Session 1 alcohol impaired all recall tests more than recognition tests. This finding may indicate that alcohol impairs storage of the higher order memory units needed to mediate successful search in recall more strongly than it hinders storage of the elementary units needed for recognition, in which search processes are less important. This fragmentation of higher order units is in accord with the previously suggested hypothesis that alcohol blocks

memory consolidation within several minutes after learning. The relationship of these findings to "blackouts" induced by higher doses of alcohol is discussed.

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CHAPTER 1: INTRODUCTION

State Dependent Learning

For many years, pharmacologists and psychologists have hypothesized that administration of psychoactive drugs such as alcohol elicits rather specific patterns of behavior. That is, these drugs were thought to produce effects on behavior which were rather consistent across different individuals--effects determined largely by the drug's highly reproducible modification of certain neural systems.

However, the discovery of state dependent learning (Girden & Culler, 1937) raises the possibility that some of these "specific" effects may in part be conceived of as learned response patterns. State dependent learning (SDL) refers to the experimental observation that material learned in one state of consciousness is remembered better in that state than in any other state, including the baseline (or presumably "normal") state. Most of the SDL studies have used psychoactive drugs (and placebos) to manipulate the state of the subject. The study of SDL may therefore be useful in understanding the effects of drugs on behavior.

This report attempts to answer three general and fundamental questions about the phenomenon of SDL:

1. Can this phenomenon be reliably demonstrated with alcohol in man?

2. Do some types of learning tasks show more evidence of SDL than others?

3. Can SDL be demonstrated with tasks that may be relevant to skills used in social interaction?

Experimental evidence. Evidence for SDL has been developed in animal (for reviews see Barry, 1974, and Overton, 1972) and human studies. (The relevant human studies will be reviewed in the section starting on page 8.) The finding that retrieval of material is state dependent may be generalizable to a fairly large number of states induced by psychoactive drugs (Overton, 1972) and other altered states such as sleep (Evans, Note 1) and the mood swings in manic depressive disorders (Weingartner and Murphy, Note 2).

However, problems in design and analysis mar the conclusions of many of the human and animal studies (Cowan, Note 3). The most frequently used analyses confound SDL with differences in initial degree of learning between experimental groups. In addition, human SDL is not found with every type of memory task, and only a limited variety of tasks have been tested. Findings with some types of tasks have been unreproducible across studies. Additional efforts to demonstrate SDL, in which improved design and

analysis must be used are necessary in order to yeild less ambiguous and more reproducible findings.

Task differences. Despite these problems, there are several studies which indicate that some kinds of tasks generally show more evidence of SDL than others. This experiment sought to confirm an implication that could be drawn from other human studies: Recall tasks show more SDL than do recognition tasks. Also, animal experiments had indicated that a greater initial degree of learning (of the material to be tested) decreases the amount of SDL. Here, two tasks which differed in the number of repetitions of items given during learning were used to test this hypothesis in humans.

Skills relevant to social situations. Psychoactive drugs such as alcohol are most often used in social situations. It is therefore important to understand drug effects on social interaction. Examining the usefulness of SDL in explaining drug effects on social interaction would optimally require a test of SDL in a social situation. Unfortunately, SDL is currently difficult to demonstrate, even in the laboratory. Trying to measure this phenomenon in a real or simulated social situation without the benefit of maximal experimental control seems premature at this point.

However, there is another approach to relevance to social interaction that one can pursue. One can devise laboratory tests which test memory skills that may be relevant to social situations. It must be understood, of course, that in abstracting any such skill from its normal social context, much of the "social" nature of the skill may be lost, and the skill itself may be altered considerably. Subsequent generalization of results to the social situation may be difficult. However, at this stage of development of SDL research, this is a compromise that should be made if relevance to social situations is considered desirable.

Accordingly, two steps towards testing memory for skills that may be relevant to social interaction were taken by developing several novel laboratory tasks. First, lists of male first names were used in place of lists of nonsense syllables or words in the recall/recognition tasks. These name lists may be more socially meaningful than the lists that were previously used. Second, a test of recognition for male faces was devised. This task used precisely the same format as the name recognition test included here.

Design and Analysis

The 2x2x2 Factorial Design

The majority of animal studies of SDL have involved a drug discrimination design, in which the animal is taught to perform two competing state dependent responses. For example, rats may be taught to take the right-hand fork in a T-maze while under the influence of the drug, and the left-hand fork if given a placebo (Barry, 1974; Overton, 1972).

In man, almost all studies of SDL have used an experimental design called dissociation. In this design, verbal material is learned in either the drug or nondrug state. Subsequently, in another session, retrieval is tested in either the drug or nondrug condition, with some subjects changing states and others remaining in the same condition. If the changed state subjects retrieve significantly less of that which they originally learned than the same state ones, SDL is said to occur.

Table 1

The Factorial Design for Measuring SDL

Type of Group	Session 1	Session 2
Same Condition	Placebo	Placebo
Same Condition	Drug	Drug
Changed Condition	Placebo	Drug
Changed Condition	Drug	Placebo
Activity	Learning and Testing	Testing

The most common designs for measuring state dependence are variants of the "2x2 factorial". Four groups of subjects are used (see Table 1), and the experiment takes place in two sessions, separated by enough time for the drug effects to wear off. In most designs, material is learned and initial degree of learning tested during the first session, although some experiments have omitted the initial test. Session 2 consists primarily of another retrieval test. This is really a 2x2x2 factorial design, rather than a 2x2 factorial, as there are two drug states in Session 1, two drug states in Session 2, and two sessions.

Problems of Analysis

This error in nomenclature presages a more serious statistical error in the analysis of the experiments that use this type of design (for a review of analysis of variance, see Keppel, 1973). If it is restated in its most precise form (Cowan, Note 3), the SDL hypothesis predicts that the amount of retrieval of the changed state groups will change (decrease) more from Session 1 test to Session 2 test than will the retrieval of the same state groups. However, most statistical analyses of the experiments using this 2x2x2 design have concerned themselves with assessing the significance of the difference in performance between the same and changed state groups in Session 2 only. They failed to use the proper measurement--the differential change in performance between these groups from Session 1 to Session 2. Statistically, this amounts to ignoring the third "x2" (sessions) in the 2x2x2 factorial.

Most of the previous literature has used the two-way interaction term, Session 1 drug state x Session 2 drug state, in an analysis of variance of the Session 2 data only. The correct analysis involves forming a specific contrast between the two changed state groups and the two same state groups, and examining how this changes across sessions--evaluating the contrast x sessions interaction. This term is mathematically identical to the three way

interaction, Session 1 drug state x Session 2 drug state x sessions. The statistical analysis in prior experiments appears to be incorrect because it confounds pre-experimental differences between groups treated similarly in Session 1 with SDL; both false positives and false negatives can result (Cowan, Note 3). The three way interaction term will be used to evaluate SDL throughout the analysis of this experiment.

Drawing conclusions from the SDL literature reviewed here is made difficult by the improper statistical analyses. One is forced to rely on the general form of the summarized data in each paper and the weight of the evidence in order to establish hypotheses for this experiment.

Systematic Task Differences and State Dependence

The overall purpose of this experiment was to obtain confirmatory evidence of SDL, employing the more accurate statistical analysis. In accomplishing this, there were three substantive issues that were studied, each of which is discussed in the following paragraphs:

1. Is there a difference in SDL between free recall and recognition?

2. Is there a difference in SDL as a function of the degree of learning?

3. Would it be possible to demonstrate SDL on two novel tasks which deal with memory for people's names and faces?

Free Recall, Cued Recall and Recognition

In a free recall experiment, the subject is initially exposed to a list of stimuli; after an interval, he is asked to write down all the stimuli he can remember. Cued recall is a variation of free recall, in which clues or hints (cues), most often of a linguistic nature, are given to the subject during both learning and testing. In a typical cued recall experiment, the subject is given a category label (ie. a type of vehicle) which serves as a cue for the category exemplars (ie. bus, train, helicopter, streetcar) during learning and testing. An even stronger cue, a literal copy of the stimulus itself, is supplied to the subject during recognition testing. His task is to select the stimulus which he learned from several other decoys. The decoys are present only during testing.

Free recall. Free recall for verbal stimuli has been studied extensively with alcohol (Goodwin, Powell, Hill, Lieberman, & Viamontes, 1974; Jones, 1973; Petersen, 1974; Weingartner, Eich, & Allen, 1973; Weingartner & Faillace, 1971; Weingartner, Stillman, & Eich, Note 4), amphetamines and barbiturates (Bustamante, Rosello, Jordan, Pradera, & Insua, 1968), and marijuana (Darley, Tinklenberg, Roth, &

Atkinson, 1974; Eich, Weingartner, Stillman, & Gillin, 1975).

Despite the statistical problems and the small magnitude of the effect, the similarity of findings across studies, and in particular the results of the Eich et al. (1975) study (which had an adequate sample size (15) and used the same subjects in all four conditions to reduce variability), leads to the conclusion that SDL can be shown with verbal free recall for both alcohol and marijuana states. Across these studies, 7 different tasks or measurements produced evidence of SDL that was either significant or questionably so, while 3 produced negative results.

Cued recall. There are three studies in which SDL of free recall and cued recall were compared, two using alcohol (Goodwin et al., 1974; Petersen, 1974) and one employing marijuana (Eich et al., 1975). The Goodwin et al. (1974) study failed to find evidence of SDL with the recall task that they used, making comparison with their cued recall task not worthwhile. The other two studies seemed to demonstrate that supplying retrieval cues diminishes SDL, although there were some problems (relatively minor in comparison to those of other studies) in design and analysis in both of these experiments (Cowan, Note 3).

Recognition. A marijuana study by Darley et al. (1974), which contrasted free recall and recognition of the same word list, provided some evidence that SDL is less pronounced in recognition tests, but the lack of a Session 1 recognition test must be considered a serious drawback. It was therefore decided to examine the recognition--recall difference, using alcohol instead of marijuana, and employing the statistical treatment specified above.

Hypothesis. There will be more evidence of SDL with free recall tests than recognition tests.

Degree of Learning and State Dependence

The effect of the original degree of learning (number correct) on subsequent SDL in humans is a much less well studied area than cueing effects.

Degree of learning and retention. Most studies which have investigated the effect of initial degree of learning on subsequent retention have used learning to a criterion (a certain percentage correct) to control the amount of original learning of the word list. Any original learning beyond the arbitrary criterion is known as "overlearning"; for example, giving the subject twice as many trials as he needs to reach the criterion produces 100% overlearning. Retention is measured as the percentage of the amount of original learning which remains; forgetting is the percentage lost. The general observation here is that a

higher initial degree of learning produces better retention over a subsequent interval (Postman, 1962; Underwood & Keppel, 1963; Underwood, 1964).

Overlearning studies. The common observation that people who are intoxicated do not easily forget their name or address lends credence to the idea that SDL does not occur with very thoroughly learned items. Several studies (Aman & Sprague, 1974; Cohen & Rickles, 1974; Goodwin et al., 1974; Hill, Schwin, Powell, & Goodwin, 1973; Overton, 1972; Rickles, Cohen, Whitaker, & McIntyre, 1973) have mentioned this idea, most often as an ex post facto explanation for negative results.

The only human SDL studies which have employed overlearning are those by Cohen and Rickles (1974) and Rickles et al. (1973). They used an overlearned paired associate list to study SDL with marijuana. This group did not contrast overlearning with any other learning condition. Therefore, one cannot draw any conclusions about SDL and overlearning from these data. They concluded that SDL was present with the light marijuana smokers used in the earlier study, but statistical problems cast doubt on the trustworthiness of this finding. The later study, which tested heavier smokers, did not find SDL.

Two animal studies (Bliss, 1973; Iwehara & Noguchi, 1972) tested the hypothesis that overlearning attenuates SDL, and both obtained results consistent with it.

No previous human experiments had directly studied the effect of degree of learning on SDL. Both of the animal overlearning studies had used distributed, rather than massed, practice. To check whether a larger degree of initial learning attenuates SDL, the present study employed a repetition difference (six repetitions vs. one) between two lists, massed practice, and more proper statistical analysis.

Hypothesis. There will be more evidence of SDL with the one repetition recall test than the six repetition recall test.

Name and Face Recognition

Name recognition. It is possible to preserve the format and technology of verbal learning tests, and yet to change the content so that one can test an (artificially isolated) social skill--remembering people's names.

Names and faces are socially relevant stimuli with many similar kinds of associations. In life, they are often encountered together. Presenting them separately here represents a compromise necessary to achieve simplicity of design and interpretation, and to allow the examination of the other task differences. This compromise allowed an

orderly second step from the existing SDL literature towards relevance to social interaction--the development of a face recognition task in a format equivalent to that of the name recognition task. Both name and face recognition skills involve adeptness at remembering identity. Yet, despite the fact that no previous direct comparisons had been performed, it is likely that the two skills are cognitively quite different. There is some evidence to suggest that the two tasks are processed primarily in opposite cerebral hemispheres (Benton & Van Allen, 1968; De Renzi, Faglioni, & Spinler, 1968; Galin, 1974; Geffen, Bradshaw, & Wallace, 1971; Hilliard, 1973; Milner, 1968; Warrington & James, 1967; Yin, 1970).

Face recognition. Face recognition may possibly be an activity which is different in important ways from recognition of less socially relevant patterns. Some authors of studies of recognition for faces have suggested that still photographs of faces are recognized by using a skill specific to faces (Galper, 1970; Hochberg & Galper, 1967; Yin, 1969; Yin, 1970).

Evidence cited to support this "specific skill" hypothesis included the finding that positive (white on black) photographs of faces were recognized better than negatives (Galper, 1970; Galper & Hochberg, 1971). Also, inverted positives were more difficult to recognize than

upright positives (Goldstein, 1965; Hochberg & Galper, 1967). This inverted--upright difference was stronger among adults than children (Goldstein, 1965), indicating the possible importance of learning this skill. The difference was more salient with faces than with other objects usually seen in one orientation (mono-oriented), such as houses, airplanes, and men-in-motion (Yin, 1969). Yin (1970) found that patients with right posterior cerebral injuries did more poorly than patients with other unilateral injuries on a test of recognition of upright faces, but better than the comparison group if the faces were inverted. This pattern was not found with recognition for upright and inverted houses in the two patient groups.

These results can be explained in two ways--the "specific skill" and the "quantitative difference" hypotheses. Both assume that there are two methods by which faces can be recognized. The first is a holistic skill, primarily processed in the posterior part of the right cerebral hemisphere, which operates by examining the spatial relationships of the face considered as a gestalt. The second process is primarily a left hemisphere, verbally mediated procedure in which certain parts of the face (distinctive features) are selected, labelled, and used to mediate storage and retrieval. The large inverted--upright difference may result from operation of the first process,

which may be assumed to be learned primarily with (positive images of) faces in an upright orientation. Patients with right posterior injuries and people who lack proficiency in using the first method may employ the second one, which is not as strongly tied to the orientation of the stimulus. These people may have developed proficiency in selecting distinctive features which those that use the first process lack. They may therefore perform relatively better with inverted faces, but less well with upright exposures. Evidence consistent with this was reported by Yin (1969), who found that those (normal) subjects who did well with inverted faces had relatively greater difficulty with the upright ones, and vice versa.

The hypothesis that facial recognition is a specific skill, based only partly on pattern recognition abilities, rests largely upon the finding that this inverted--upright difference is larger with faces than with pictures of other mono-oriented objects. These pictures may also be assumed to be processed by the holistic processor located in the right hemisphere. However, it is difficult to conclusively reject the quantitative difference interpretation, which states that face recognition is 1) processed more holistically, and 2) more thoroughly learned than recognition for the other objects that were tested.

The first assertion--that faces are processed more holistically (and less via verbal labelling)--is supported by the finding that right hemisphere patients showed greater impairment on recognition of faces and of highly abstract patterns than of chairs (de Renzi & Spinnler, 1966). These authors (and Milner, 1968) concluded that all highly complex visual patterns requiring very subtle distinctions must be processed almost exclusively by the right hemisphere mode. Simpler stimuli such as chairs and Yin's houses, airplanes, and men-in-motion may be more capable of being (simultaneously) processed by abstraction and labelling of specific features. Another rationale for this assertion which can be advanced here is that recognition of facial expressions must usually proceed simultaneously with other left hemisphere processing during social interaction. Recognition of other objects may more frequently occupy one's full attention (both hemispheres) while it is being learned.

The recognition difference between positive and negative photographs that was cited as evidence for the specific skill model may simply be explained by the second assertion: Recognition of positives may be assumed to be a more thoroughly learned skill due to greater previous exposure.

Previous studies. In the only study of a similar social skill, Goodwin, Powell, Bremer, Hoine, and Stern

(1969) used 10 neutral pictures (photographs of models from mail order catalogues) and 10 presumably emotional photographs (nudist magazine photos) which were shown to the subjects during Session 1. No initial learning test was conducted. The Session 2 recognition test involved picking these photos from a group of 40, 20 of which had not been shown before. The report was rather unclear as to the precise details, but as described, the testing method did not seem to adequately deal with the problem of response bias (the tendency of the subject to pick more or less photos than he had originally been shown). The Session 2 results show a basement effect (a restriction of the variability of scores because they are too low) for the neutral photos, which were apparently too similar to each other. The apparent tendency toward SDL for the emotional photos is difficult to evaluate because of the lack of Session 1 data. The authors concluded that SDL did not take place with either type of photograph.

Results of studies using pattern recognition skills with visual stimuli other than faces (Aman & Sprague, 1974; Bustamante, Jordan, Villa, Gonzales, & Insua, 1970; Crow & Ball, 1975; Osborne, Bunker, Cooper, Frank, & Hilgard, 1967; Stillman, Weingartner, Wyatt, Gillin, & Eich, 1974) have shown SDL in 3 cases, 2 of which used incorrect analyses (Cowan, Note 3). Despite the problems that these studies

had encountered, there was still a strong possibility that SDL could be demonstrated with the faces in this study. It was hypothesized that a holistic processor, pushed to its limit by the subtle differences between faces, might encode faces very differently in different drug states. In contrast, verbal encoding might be less sensitive to drug-induced changes, particularly with names, which were thought to be less complex stimuli than faces. In addition, faces often evoke subjective reactions, which become part of the memory unit which is stored. These subjective reactions could differ in different drug states. If so, each of these encoding differences should result in additional difficulty in retrieving this memory unit in a disparate state. For these reasons, it was (rather intuitively) hypothesized that face recognition would show more evidence of SDL than name recognition.

Test format. In order to develop a test of facial memory, and a directly parallel test of memory for names, the four alternative forced choice recognition design was chosen for several of the name and face tests. This design was chosen because it is difficult to test memory for any stimulus that is both pictorial and complex without using a recognition test. Testing recall of this type of stimulus requires the subject to sketch his response. Experimental problems result because there is difficulty in achieving

consensus about what quality of response to call correct, and because people differ considerably in drawing skills. However, the recognition paradigm is probably much less sensitive to SDL than is recall, thus creating a dilemma for the experimenter.

This experiment does not employ relevance to social interaction as an independent variable, since these tasks are not directly contrasted with any tasks which are less relevant, and parallel in design. In addition, it would be impossible to attribute any SDL difference found in this experiment to differences between the properties of all names and all faces, rather than just the specific name and face stimuli used here. This is because it is practically impossible to equate these sets of stimuli with respect to such important properties as information content, familiarity, and nature and frequency of associations. Differences in these properties may possibly also influence SDL differences between sets of stimuli. Even if one could generalize beyond these sets of stimuli, it would still not be possible to attribute any differences found to the name vs. face dichotomy. Other tasks would have to be included in order to exclude the influence of dichotomies such as pictorial vs. verbal stimuli and right vs. left hemisphere processing.

Hypothesis. There will be more evidence of SDL with face recognition tests than with name recognition tests.

Alcohol Effects on Learning and Memory

Within the confines of a SDL experiment, it is possible, by use of analysis of variance, to examine independently the effects of the drug employed on learning and memory (Cowan, Note 3). For this experiment, several factors mitigated in favor of using alcohol. These included the relatively large literature on alcohol and SDL, and a considerable number of studies of the effects of alcohol on memory. The use of alcohol also afforded the opportunity to rather easily monitor blood levels.

Implications of Previous Studies

Retrieval mechanisms. Jones (1973) found that alcohol depressed short term (10 minute) recall more than immediate (seconds) recall. His results indicated that all of the agent's effects on long term memory could be due solely to the short term memory decrement. No alcohol effect on the retrieval process itself was found. These findings supported the conclusions of a previous review of alcohol's effects by Ryback (1971).

In this experiment, the minimum interval between Session 1 learning and testing (2.5 minutes) was longer than the span of immediate memory. Rehearsal during the interval was discouraged. From Jones' work and Ryback's review, one

may hypothesize that alcohol given during Session 1 will probably affect retention in both sessions. Since the evidence indicates that retrieval mechanisms are not impaired by alcohol, intoxication during Session 2 was not expected to affect retrieval.

Hypothesis. Alcohol given during the second session will not affect retrieval during Session 2.

Recall vs. recognition. Petersen (1974) contrasted free and category cued recall for the same word list in a 2x2x2(x2) design; the category names were present during learning and served as the cues for cued recall. He tested free recall immediately after Session 1 learning, and cued recall after that. If the Session 1 alcohol and placebo groups are compared, free recall in the alcohol groups shows a sizeable decrease from Session 1 to Session 2, but cued recall in the intoxicated groups does not decrease more than in the nondrug groups. Unfortunately, no analysis of variance was done to confirm this particular effect.

Providing retrieval cues may therefore be expected to ameliorate the Session 1 alcohol induced memory deficit here, because of the longer learning-testing interval. In both sessions, recognition was expected to be impaired less than recall.

Hypothesis. Alcohol will impair recall more than recognition in both sessions.

Degree of learning. The interaction of alcohol effects with degree of learning was also of interest, particularly since no previous studies have been done on this problem. From the previous evidence that alcohol given during learning (Session 1) impairs retrieval (in both sessions), but alcohol given at retrieval (Session 2) does not, one may surmise that alcohol must act in some way to 1) prevent formation (consolidation) of the memory trace or 2) to degrade it. This is consistent with the finding that a rapid rise in blood alcohol level may induce a blackout, or total loss of memory for events which occurred more than several minutes before (Ryback, 1971). If a minimum strength of trace is needed for retrieval, then retrieval of the more weakly learned items may be selectively depressed by alcohol given during learning. Here, the one repetition tests, particularly recall, might be predicted to be more strongly affected by intoxication during learning.

Hypothesis. Alcohol given during learning will impair recall of the one repetition name list more strongly than recall for the six repetition name list.

Summary of Design and Hypotheses

Design

The three independent variables which were manipulated in this investigation were:

1. Recognition vs. recall.

2. Degree of learning--one vs. six repetitions.

3. Face vs. name recognition.

Alcohol or placebo was used in the 2x2x2 factorial design shown in Table 1.

So that the results of this entire experiment might be compared with a task that had been previously employed, a one repetition word recall task, modified from Weingartner and Faillace (1971) was also included. A direct comparison between name and word recall tasks with precisely similar format was not used, because comparability with the literature was thought to be more important.

Hypotheses

In summary, the six hypotheses to be tested were:

1. There will be more evidence of SDL with free recall tests than recognition tests.

2. There will be more evidence of SDL with the one repetition recall test than the six repetition recall test.

3. There will be more evidence of SDL with face recognition tests than with name recognition tests.

4. Alcohol given during the second session will not affect retrieval during Session 2.

5. Alcohol will impair recall more than recognition in both sessions.

6. Alcohol given during learning will impair recall of the one repetition name list more strongly than recall for the six repetition name list.

CHAPTER 2: METHODS

Overview

A 2x2x2 (4 groups, 2 sessions) factorial design was employed to test state dependence. Eight different subjects were used for each of the groups; alcohol or placebo was used in each of the two sessions. Three novel tasks permitted the simultaneous manipulation of three independent variables: face vs. name recognition, name recognition vs. name (free) recall, and the number of repetitions of the name items during learning.

Subjects

Thirty-two subjects were selected from approximately 105 respondents to advertisements at local colleges. Preliminary questionnaires limited the population to males between 21 and 30 who were in good health. The subjects were not heavy users of alcohol (some experience but less than 7 fl. oz. per week at present) or other drugs with the possible exception of cigarettes. Only Caucasians were allowed to participate because of the known cultural influences on facial recognition (Cross, Cross, & Daly, 1971), and the possible differences in alcohol metabolism among races (Wolff, 1972). Oldfield's (1971) handedness

inventory was used to further limit the population to right-handed subjects, in an attempt to minimize the number of subjects with modes of information processing mixed between cerebral hemispheres. Of the 50 subjects selected to participate in the experiment, an additional 18 were discontinued for various reasons (non-comprehension of instructions, illness, intolerance of the taste of the alcohol, admitted inconsistent attention). These subjects were usually terminated before the end of Session 1.

At the time that the subjects were scheduled to participate in the experiment, they were given instructions that were designed to minimize the differences in their pharmacological state upon arrival in the laboratory. They were asked not to eat or use tobacco, coffee, tea, or cola for 3 hours before the experiment; they were requested not to use other drugs for 48 hours before the first session and between sessions.

Procedure

A 2x2x2 (4 groups, 2 sessions) factorial design was used. Each of the 32 subjects was randomly assigned to one of the four groups (placebo--placebo, placebo--alcohol, alcohol--placebo, alcohol--alcohol). The subjects were tested two at a time (or individually, if there were dropouts). Tomato juice with alcohol (1.1 ml/kg or 0.87 gm/kg, which is equivalent to 2.60 fl. oz. of absolute

ethanol for a 70 kg person) or a tomato juice placebo was prepared for each subject. The subject was requested to consume this during a 20 minute period. This resulted in peak blood alcohol measurements ranging between .053 and .109 g/dl.

Despite the fact that the subjects were not informed about which drug group they were assigned to, they could not be presumed to be blind to their drug condition, because the alcohol-intoxicated subjects had been given a reasonably high dose of an agent familiar to them. Camouflaging the taste of the alcohol was also very difficult.

The experimenter knew about the subject's condition in two ways--through observation of overt signs of intoxication and because it was necessary that he prepare the drinks. Therefore, additional measures were taken to minimize contamination of results due to interaction between the experimenter and the subjects, and interaction between the two subjects. Instructions were presented to each subject via tape recorder and headphones, and could also be read from a script given to him. Data were recorded on the answer sheets by the subjects themselves. The subjects were requested not to interact with each other, and not to let each other know whether or not they were given alcohol.

The instructions to the subjects are included as Appendix A.

Memory Tasks

Three new slide presentation tasks were developed specifically for this investigation. They permitted the simultaneous manipulation of three independent variables: face vs. name recognition, name recall vs. name recognition, and number of name repetitions during learning. These tasks were:

1. A one repetition men's face recognition task (1-Face).
2. A one repetition men's name recall and recognition task (1-Name).
3. A six repetition men's name recall and recognition task (6-Name).

For each of the two name tasks (1-Name and 6-Name), two different tests were administered--a recall test followed by a recognition test. The same learning presentation and list of names was used for the two tests within each name task. Separate learning presentations and name lists were used for the 1-Name task and the 6-Name task.

In addition, a word recall task (1-Word), modified from Weingartner and Faillace (1971) was used for comparison with previous studies. This word list was presented through headphones, and the words were spoken once. All of these tasks employed 20 items each.

In order to familiarize the subjects with the test formats, two practice tasks--a 20 item two repetition men's face recognition task (2-Face) and a 5 item one repetition women's name recall task--were administered just before drug ingestion. The face recognition task served as practice for the slide presentation tasks; the women's name recall task gave the subjects experience with the auditory presentation format.

Task design rationale. Several design limitations were important in the decision to use this particular task structure. First, there is only a limited period after consumption of an acute dose of alcohol during which the blood alcohol level is at an approximate plateau. In most subjects at the dose level used here, this plateau begins approximately 50 minutes post-ingestion and lasts for about 80 minutes (Freund & O'Hollaren, 1965; Wallgren & Barry, 1970). With ascending blood levels, the increases in behavioral effects may precede blood level changes by several minutes. Since achieving the maximum drug effect and making the tasks comparable were both considered to be desireable here, this strongly limited the duration of possible testing, and also made balancing the order of the four tasks (1-Face, 1-Name, 6-Name, 1-Word) necessary. Second, interference between items will act to strongly reduce subject's scores if too many different items are used

(Hall, 1971). Compensating for this by repeating items during learning in this experiment would have been extremely time consuming, and the extra time necessary would have resulted in testing at lower and less effective blood alcohol levels.

Therefore, it was considered necessary to hold the number of items used to a minimum. Pilot data showed that teaching the subject four different item lists (separate lists for recall and recognition in each of the 1 and 6 repetition conditions) would have taken too much time. This procedure also would have resulted in excessive interference, thus compounding the time problem. The recall and recognition tests for each of the two name tasks were consequently performed using the same list of names. This arrangement of the four post-drug tasks took about 78 minutes to complete, and began 30 minutes after ingestion was finished.

Recall was always tested before recognition in order to counteract a third design problem--the serious contamination of the recall data by the previous presentation of retrieval cues. This resulted in a difficulty in interpretation because the recall vs. recognition contrast was now confounded with possible order of testing effects. An alternative solution to this problem would have used separate name lists for recall and recognition. However,

time limitations would have then forced elimination of the 6-Name task and the degree of learning variable. Because degree of learning effects had not been previously examined in humans, retaining the 6-Name task was considered to be more important.

This compromise also resulted in an additional difficulty with regard to comparability between the name and the face recognition tasks, since recall was not tested in the face task. To minimize this problem, the time intervals from learning to recognition testing for the two tasks were made equal by delaying the face recognition task appropriately.

Another possible interpretation problem in comparing the name and face recognition tasks might have occurred if there were an unequal number of name (2) and face (1) tasks in the experiment. In the absence of detailed data about differences between interference within the face items and that within the name items, it was assumed that equalizing the total number of items presented would result in approximately equal inter-item interference. A second similarly constructed face recognition task (2-Face) was therefore used to provide practice. Pilot data suggested that two repetitions were sufficient to stabilize the subjects' performance. The section on Slide Presentation Task Format and Construction (see page 36) describes the

tasks more fully, and Table 3 summarizes the timing within each task.

Session Format and Ancillary Measures

Table 2 summarizes the format of the sessions.

Session 1. The subjects were first requested to fill in the consent form, and several pre-test measures. These included the volunteer check-in sheet, which had been partially filled out during a telephone conversation, a health questionnaire, an alcohol and drug history questionnaire (both modified from Peeke, Note 5) and the handedness inventory (Oldfield, 1971). These are included in Appendix B. After the practice tasks, the Profile of Mood States (POMS; McNair, Lorr & Droppleman, 1971) was administered. This was modified to require the subjects to rate their mood for the previous 30 minutes.

Alcohol or placebo was administered, and the subjects waited for 30 minutes in order to allow the maximization of the drug effect. The four tasks (1-Name, 6-Name, 1-Face, 1-Word) were then administered in an order determined by a "diagram balanced" Latin Square (Wagenaar, 1969). This procedure allowed each of the four tasks to appear twice in each ordinal position and each to precede and succeed every other task four times for each group of eight subjects. The POMS was administered again before the conclusion of the session.

Table 2

Timing of the Sessions

Minutes	Activity
Session 1	
0	Consent form and pre-test measures.
40	Practice tasks: 2-Face, Women's Name Recall.
65	Profile of Mood States.
70	Alcohol or placebo ingestion.
90	Waiting period: 3 blood alcohol level estimates.
120	Post-drug tasks: 1-Face, 1-Name, 6-Name, 1-Word (in counterbalanced order).
195	Profile of Mood States. End of session.
Session 2	
0	Group Embedded Figures Test.
15	Practice tasks: Same as Session 1.
25	Profile of Mood States.
30	Alcohol or placebo ingestion.
50	Waiting period: Same as Session 1.
80	Post-drug tasks: Same as Session 1.
158	Profile of Mood States: Current and memory. End of session.

Session 2. This session began with the administration of a modified Group Embedded Figures Test (GEFT; Witkin, Oltman, Cox, Ehrlichman, Hamm, & Ringler, 1973; Witkin, Oltman, Raskin,& Karp, 1971). The practice tasks and the pre-drug POMS were administered before giving the subject alcohol or placebo. The administration of the four tasks (in the same order) followed the 30 minute wait. After the second POMS was administered according to the previously described method, the POMS was administered again as a test of memory for mood.

Additional measures. During each session, there was a 5 minute pause after each of the four tasks. During this break, the subjects' blood alcohol levels were estimated by an Intoxalyzer (Omicron Systems) located in another room. The blood levels were also measured at 10, 15 and 25 minutes following completion of ingestion. In this way, blood levels before and after each task were obtained. Since the first two measurements were contaminated by alcohol remaining in the subject's mouth, the highest of the last five blood levels thus measured was designated the peak blood level. The manufacturer specifies that the error of measurement in this instrument is less than .003 g/dl. However, observations from this experiment indicate that deliberate differences in breathing patterns in the same subject can increase this to about .010 g/dl; but if these

are controlled, the measurement is less variable. The subjects were also asked to provide global (0 to 100) ratings of their "high" and their interest in the experiment before each test.

Slide Presentation Task Format and Construction

The format for presentation of stimuli was identical in all four slide presentation tasks (1-Face, 2-Face, 1-Name, 6-Name). Also, recognition was tested using the same format. The formats for recall testing in the two name tasks did not differ; recall of faces was not tested. The timing for all these tasks is summarized in Table 3.

Both the learning and the recognition testing presentations used a procedure involving choice among four alternatives. Four names or four faces were arranged in a square on each slide. One of the four stimuli was indicated by a light during the learning presentation. During testing, the subjects picked one of the four choices as the one which had been previously indicated by the light, and recorded this as their answer.

The slides were presented by a Kodak Carousel projector controlled by a series of Grason-Stadtler interval timers. A black box with a square array of four lights mounted on it was located just below the image. One of the four lights was activated by a stepping relay. This was used to designate the quadrant of the stimulus that had previously

been randomly selected for learning. The instructions used in teaching the subject the practice slide task were:

> The machine will indicate which of the four faces (names) you will be asked to learn by lighting the corresponding bulb on the black square--the upper right bulb for the upper right choice, and so on. For the learning presentations, the slides with the faces (names) will be shown for about 8/10 of a second, and a blank pink slide will be shown for 2 seconds before the first item and after every item. The bulb for each item will be lit both during the exposure of the item and during the exposure of the pink slide before the item. Because the exposure is brief, I suggest that you look at the square with the bulbs during the preceeding pink slide, and shift your eyes to the appropriate position on the screen before the slide changes.

The learning presentation was repeated six times without an intervening testing trial for the 6-Name task. A learning criterion was not used in this experiment. This was to prevent degree of learning effects from being confounded by the pressure created by forcing the subject to reach a criterion.

Short exposure time during learning and specific instructions about memorization procedure were used. This

was done in order to 1) decrease stimulus selection (remembering a face by abstracting a feature such as hair color) and the verbal labelling ("the blonde") which often follows, 2) decrease the formation of inter-item associations, and 3) fix (increase the uniformity of) the rehearsal procedure. The subjects were asked to "try to memorize the names by repeating them to yourself" and to "try to memorize the faces by retaining the visual images in your mind." Similar fixed covert (silent) rehearsal instructions were used by Hall and Pierce (1974), who found that they resulted in recall of fewer words than did neutral instructions, but that they did not affect recognition. In this experiment, fixed covert rehearsal was considered preferable to the fixed overt (aloud) rehearsal used with verbal material by Darley et al. (1974), Fischler, Rundus, and Atkinson (1970), Glanzer and Meinzer (1967) and Mechanic (1964) because faces cannot be rehearsed aloud without the use of verbal mediators. Data from these experiments also indicate that specifying repetitive rehearsal after each item is presented resulted in less recall than if rehearsal procedure were unspecified. Glanzer and Meinzer (1967) and Tulving (1968) hypothesized that repetition prevents the subject from using the time to produce inter-item associations which facilitate recall by organizing the list. Hall and Pierce (1974) have experimentally confirmed the expected decrease in

associations. Similarly, recognition memory for random shapes is impaired by requiring subjects to do a digit addition task in the interval between stimuli during learning (Kelley & Martin, 1974). Despite the fact that the use of specific rehearsal instructions had not previously been reported with a face recognition task, it was thought best to use them here. Permitting unspecified rehearsal would have resulted in confounding the degree of learning variable with effects resulting from a greater opportunity to form inter-item associations.

Table 3

Timing of the Post-Drug Slide Presentation Tasks--Session 1

Timings listed are for each of the name recall and recognition tasks. A change necessary for the face recognition task is listed in parentheses.

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1. Learning instructions: 20 seconds.
   Learning presentation: 20 items.
   .8 second for each item.
   3.7 seconds between items (and before first item).
   1 or 6 repetitions: 1.7 minutes per repetition.
2. "Restrained break": 2 minutes.
3. Recall instructions, "high" rating, and interest rating: 45 seconds.
   Recall test: 4 minutes. (Recall instructions and test replaced by a "restrained break" for the 1-Face task.)
4. Recognition instructions, "high" rating, and interest rating: 30 seconds.
   Recognition test: 20 items.
   2.3 seconds for each item.
   10.7 seconds between items (and before first item).
   Total time for testing: 4.7 minutes.
5. Pause for blood alcohol level estimate: 5 minutes.

For all tasks during Session 1, there was a 2 minute interval ("restrained break") between learning and testing, in which the subjects were instructed to stay in place, remain silent, and not rehearse the items. This interval was designed to eliminate recall of those items that were still being actively rehearsed at the time of the test. Eliminating rehearsal was considered important because of the possibility that alcohol's effect on short-term memory tests is specific to those items that are no longer undergoing rehearsal (Ryback, 1971).

Filling this interval with a formal activity intended to prevent rehearsal was not considered advisable. Difficult interpolated activity may decrease subsequent recall more than simpler tasks (Hall, 1971; Talland, 1967). This finding indicates that the total capacity of the cognitive processing system may be inadequate to perform optimally on both item memory and interpolated activity (Kahneman, 1973). Since a sedative-hypnotic such as alcohol can further decrease total capacity (van Tharp, Rundell, Lester, & Williams, 1974), an interpolated activity might have confounded alcohol effects on the post-drug tasks. Selecting an interpolated activity which would interfere equally with all the tasks would have also posed a difficult problem. In addition, interpolated activity was not considered essential to prevent rehearsal-mediated retention

here. A minimum of 2 3/4 minutes elapsed between the presentation and recall testing of an item. (This included the interval, instructions, "high" rating, and interest rating.) In contrast, the typical short-term memory experiment (in which interpolated activity is used) shows recall to decline asymptotically over a much shorter period, typically 30 seconds (Hall, 1971).

Interpolated activity was therefore omitted. The strategy that was used in this experiment was to request that the subject not rehearse after the learning presentation(s) or between sessions. Underwood and Keppel (1962) found that although this request decreased the subject's reports of inter-trial rehearsal, it had no consistent effect on their subsequent re-learning scores.

In Session 2, this restrained break was extended to include the time occupied by learning in Session 1, in order to keep the relationship between the blood alcohol levels and task sequence as similar as possible from session to session in the alcohol-alcohol group. To check on the effectiveness of this precaution, the highest of the five valid blood alcohol levels taken in each session was noted. The ordinal position (1 to 5) of this peak level for each subject in Session 1 was rank-order correlated with its counterpart in Session 2. The low correlation observed (.17) indicated that the precaution did not achieve its

purpose. A similar magnitude of variability in blood alcohol levels in the same subject from session to session was also observed by Freund and O'Hollaren (1965).

After 45 seconds of instructions and ratings, there was a 4 minute interval in which name recall was tested. For the 1-Face task, the restrained break was extended by 5 1/4 minutes to replace the recall test and instructions, which were not used with the faces. Before the name recall tests, the subjects were requested to write down all the names that they could currently remember, without regard to which task they thought a particular name belonged to. These instructions effectively prevented the subjects from failing to record names which they recalled but erroneously believed were members of the other list of stimuli. Only 4.0% of the recall answers appeared solely on the incorrect answer sheet. Failure to recall an answer during the correct test (rather than failure to record it) probably accounts for many of these errors.

The subjects indicated their answers during recognition testing by marking the position choice on a cross on their answer sheet. Copies of the answer sheets for recognition and recall are included in Appendix B. For testing, each item was shown for 2.3 seconds, with the blank pink slide between items shown for 10.7 seconds, to allow the subjects time to record their answers. Some features of both the

learning and testing were designed to optimize EEG measurements of laterality, which may be performed in a subsequent experiment. Both 1) the short duration of presentation of stimuli during learning and testing and 2) the manner of transfer of choices to and from the subject were meant to minimize the verbal processing of the faces.

Subjects were requested to rate their confidence in each answer during both recognition and recall tests. The confidence rating scale ranged from 1 ("guessing") to 3 ("certain"). During the recognition testing presentations, the subjects were instructed to "use a rating of 2 or 'probable' even if you can only eliminate one alternative, and are guessing between (sic) the other three". This permitted the guesses to be treated separately in scoring the tests. The subjects were requested to use the confidence ratings to indicate their certainty that the answer was both correct and on the right list. This request assumes some practical importance only in the interpretation of the name recall data, because list membership was obvious in testing recognition. These certainty ratings were gathered here for their value in refining the current data analysis. In future research involving EEG measurements of hemispheric differences, this response activity, which is probably localized in the left hemisphere, could be eliminated.

The construction of stimulus slides is described in detail in Appendices C and D, and only summarized here. The Caucasian male faces were selected from two college yearbooks. Several procedures for selecting and matching faces were developed in order to minimize stimulus selection and verbal labelling, and to decrease stimulus isolation (remembering an unusual face more strongly). In particular, the faces on each slide were selected in order to produce no single face with obviously different hair color, facial hair, hair texture, hair length, location of part, hair style, direction of gaze, skin tone, or head size and shape. Selections which would have produced only one face with glasses, an open-mouth smile, a large beard, or a very unusual costume were also eliminated. Male first names or nicknames of seven letters or less were obtained from frequency of occurrence distributions derived from the Berkeley Blue and Gold (1969-71), Thorndike and Lorge (1944) and Newton (1920). The names on each slide were matched as to frequency, and only one name with a given first letter appeared on a slide.

The 40 name slides and the 40 face slides were distributed randomly between the two name and the two face tasks, respectively. The name slides in each task were matched with respect to frequency of occurrence of the names in determining this distribution. To decrease inter-task

interference, white frames were used for the slides for one name and one face task, and black frames for the other two tasks. For each task, different random orders of the items in each presentation were produced for the learning and each of the testing presentations. Unique random arrangements of the four stimuli on each slide were used for each presentation.

Auditory Presentation Task Format and Construction

The free recall task (1-Word) which was used was modified from Weingartner and Faillace (1971). One of the word lists used in that experiment was read to the subjects once, with 2 seconds between words. After a 2 minute restrained break and 45 seconds of instructions, the subjects were given a 4 minute recall test. "High" ratings and interest ratings were obtained before the test, and confidence ratings were assigned to each answer. The women's name recall task used for practice with this format was shorter (5 items, 1 minute recall test) but otherwise similar. To conform with Weingartner and Faillace's (1971) methodology, the subjects were informed that no specific instructions about memorization procedure were in effect for the 1-Word or women's name recall tasks.

Statistical Treatment of Data

The specific analyses are described in detail in the Results chapter. Among the methods used were analysis of

variance (Keppel, 1973), t-tests, and correlations (Winer, 1971). The Biomedical Computer Programs of the Health Sciences Computer Facility, UCLA (Dixon, 1975) were used in the analysis, particularly program BMDP2V, "Analysis of Variance and Covariance, Including Repeated Measures".

CHAPTER 3: RESULTS

Overview

Three statistical problems have to be resolved before analysis can proceed. The first concerns which data (with or without guesses) is more proper to use for analysis, and the second pertains to which analyses (with or without the order factor) are to be reported. The third involves resolving a series of questions raised by unanticipated differences between similarly treated groups with regard to Session 1 degree of learning.

Data from and analyses of individual tests are then presented and summarized. Finally, important contrasts between tests are evaluated, and some combined analyses are presented.

Guessing and Reliability

The use of the subjective confidence ratings in all of the memory tests increases the flexibility of the possible analyses, in that the data may be analyzed with the results of guessed answers (those with confidence ratings of 1) both included or excluded. In order to select the most appropriate analysis, the reliabilities of the two measurements were compared.

The comparison (Appendix E) concludes that measurements excluding guesses should be used for greatest reliability. The 1-Name recall test is an exception to this conclusion. In reporting the results of this test, measurements both with and without guesses are used. The reliabilities of the two measurements in this test are approximately equal, but the two measurements convey different information about the subject's memory for the stimulus and test situation. This difference stems from the confidence rating procedure, in which the subjects were asked to rate their confidence in a combination of two things: the correctness of their answer, and whether or not the answer they were currently recording was a member of the same word list (test) they were currently being queried about. Information about list membership was obvious for the word recall test, and for all the recognition tests (since the stimuli were presented during testing). The data with guesses included and excluded could only convey different information about the subject's memory in the 1-Name and 6-Name recall tests. However, there were so few guesses in the 6-Name recall data (2.0% of all correct answers) that presenting the data that includes guesses is not necessary. In contrast, guesses constituted 11.8% of the correct answers in the 1-Name recall test. The analysis of variance tables for the

recognition tests with guesses included are presented as Appendix F.

Order Effects and Analysis Proceedures

Four different orders of test presentation were included in this experiment to control for a possible order effect. Each analysis was therefore performed using three between-subject grouping factors--a) drug state in Session 1, b) drug state in Session 2, and c) order. There were 2, 2, and 4 levels of these factors respectively, and 2 subjects per cell. The trial factors, which were repeated across subjects, were sessions (2) and tests (if more than one test was included in the particular analysis).

Analysis of the scores with guesses excluded for the entire design reveals that the order effect is not significant, $F(3,16) = .53$, $p = .67$. None of the interactions of order with other factors approach significance. When a control factor such as order produces insignificant effects and when all of its interactions with other factors are insignificant, there is divided opinion in the literature as to whether it is appropriate to re-analyze the data without the control variable. Keppel (1973) considers that this double analysis, although traditionally used, is "statistical opportunism", while other authors (Bozovitch, Bancroft and Hartley, 1956; Green and Tukey, 1960; Winer, 1971) approve of or even recommend the

practice. The policy adopted here is to report the statistics derived from collapsing over (ignoring) order, and to include the non-collapsed statistics for major analyses (such as drug state effects, additional consolidation deficits, and SDL) if they are different enough from the collapsed statistics to change the significance level across either of two traditional boundaries: $p < .05$ or .01.

For evaluating changes across sessions or interactions with the sessions variable, the subjects x sessions interaction, which indicates how much the relative performance of subjects within groups changes across sessions, is used as the error term. Similarly, all mean squares involving test comparisons are evaluated against the tests x subjects mean square; all terms involving both repeated measures (tests and sessions) use the tests x sessions x subjects interaction. All other terms use the within groups mean square as the denominator. Analyses of variance which contrast some, but not all, of the four groups employ the error term which combines all four groups, in order to achieve greater stability (Keppel, 1973). More specific details for individual analyses will be explained as the first analysis of each type is encountered.

All p values listed are one tailed, unless otherwise stated (eg. unpredicted differences). For the unplanned

comparisons presented later in this section, unadjusted significance levels are reported. Possible adjustments and interpretations for these comparisons are suggested as they are reported, but it should be noted that the literature here does not offer definite guidance about the treatment of unplanned comparisons (see Keppel, 1973). All analyses of variance over repeated measures have been corrected for possible non-homogeneity of covariance by the conservative method of Greenhouse and Geisser (1959).

First Session Degree of Learning Differences

Several unanticipated differences between groups that were treated alike (given alcohol or given placebo) in the first session are apparent in the summarized data, which will be presented in the analyses of the individual tests (pages 65-90). The purpose of this section is to explore the problems in analysis and interpretation that these differences (failures of equivalence) cause.

Failure of Equivalence

This experiment used only a very small number of subjects per condition, as did most of the previous SDL experiments. The variability in the statistical measures that this introduces, in combination with the large variability in motivations and expectations of subjects which may be produced in an experiment employing a psychoactive drug, makes first session learning differences

between similarly treated groups--placebo-placebo (P-P) and placebo-alcohol (P-A), alcohol-alcohol (A-A) and alcohol-placebo (A-P)--possible. This failure of equivalence did occur (at the .05 level, two tailed) in two of the tests in this study (1-Face recognition, 6-Name recall). One other test (1-Name recall) showed a nonsignificant trend towards failure of equivalence.

Failure of equivalence raises two issues, which will be dealt with separately here.

1. Do the significant first session differences in two of the tests imply that the four groups were not drawn from the same population, thus violating the assumptions of analysis of variance?

2. In those tests in which there are significant initial differences between similarly treated groups, does failure of equivalence make it impossible to draw any conclusions about SDL?

Population differences and assumptions. There are four arguments which support a negative answer to the first question. These arguments are drawn largely from Keppel (1973; Note 6).

First, if there is sufficient evidence to suspect that the groups were drawn from different populations, there is still the possibility that this evidence could have arisen by chance--that despite drawing from the same population,

chance differences between the Session 1 scores of the groups in that test produced a significant p level. If this occurs, one is obligated to carefully re-examine the procedure of random assignment to groups. If one can establish that this process had no procedural imperfections, one is then entitled to continue with the analysis of variance.

In this experiment, the following procedure was used. Slips of paper with two group assignments each written on them were prepared. These denoted the participants in one sequence of two sessions. The participants in each sequence were drawn from different drug groups. Only one order of presentation was used in each session; this was also written on the slip. These slips of paper were placed in sealed envelopes, and the envelopes thoroughly shuffled. Two subject numbers were written on each envelope. When a subject called, he was given an initial three page interview over the phone. If he qualified, a time was set up, and his name was written next to the subject number on the envelope assigned to that time. When both subjects had been recruited, the envelope was opened. If a subject had to be dropped before completing the experiment, the group and order combination was placed on a list, and these conditions were reassigned at the end of the experiment, using the same

procedure. In practice, no exceptions to the procedure were made.

Second, if the group differences in initial performance reflect real population differences in ability to perform on this type of test, then they should be expected to affect all five tests during the first session similarly. If all five tests are analyzed together, the differences between groups should be consistent and significant. A consistent difference has not occurred here, as the two cases of failure of equivalence affected different groups--one affected Session 1 alcohol, one occurred with Session 1 placebo.

Four different analyses to test the significance of this possible population difference were carried out, and none were significant. The group differences in first session scores (guesses excluded) were examined by doing an analysis of variance using tests as a repeated measure. Two separate analyses, including and excluding order as a factor, were performed. Both the effects of Session 2 drug state and the Session 1 drug state x Session 2 drug state interaction were examined. (These "effects" really refer to differences between groups that were similarly treated in Session 1, since no Session 2 data were analyzed here.) Further analyses of Session 2 drug state "effects" on Session 1 scores were performed individually for the Session

1 alcohol and Session 1 placebo groups, with order included. The smallest *p* for a Session 2 effect is .202, and the smallest two-way interaction *p* is .123. This finding therefore suggests that there are no real group differences in intrinsic ability to perform on the type of tests used in this experiment. However, task-specific differences in ability and/or motivation are not ruled out by this analysis.

Put another way, each of the analyses of individual tests should be formally regarded as a sub-analysis of the analysis of the entire experiment. Unplanned comparisons such as those for failure of equivalence should first be made on the analysis of the entire experiment; only if this *F* is significant can individual test comparisons be made. If these analyses are insignificant, as they are here, then one can infer that differences in intrinsic ability between groups in the entire experiment do not exist.

Third, if the first session group differences from test to test were due to a real task-specific difference, then the variation in these differences across tests should not be at a chance level. This was also tested by four analyses of the entire experiment, and the resulting *F*'s were not significant. To examine this, the interaction of both the terms mentioned above with the test factor was examined in the manner previously specified. The smallest two-way

interaction *p* is .063, and the smallest *p* for a three way interaction is .227.

Fourth, one or more differences of this kind may be expected in this experiment. The reason for this is that a large number of unplanned comparisons were made in examining all the first session differences--two comparisons for each of five tests. For each of these comparisons, the chance of making a Type 1 error (rejecting the null hypothesis when it is really true) is .05. But the chance of making at least one Type 1 error in the experiment (the 10 comparisons) is actually .40, according to a formula given in in Keppel (1973, pg. 88). A new criterion for significance (per-comparison error rate) is needed in order to maintain the 5% probability of making one Type 1 error in the entire experiment. The same formula can be used to calculate the corrected per-comparison error rate; the new criterion for significance is .005 (two-tailed). Examining all of the *t*-tests done for first session differences using this corrected criterion, one finds that none approaches significance. The lowest *p* is .023.

It is therefore unlikely that these two cases of failure of equivalence reflect real differences in the population from which the groups were drawn.

Failure of equivalence and state dependence. The three-way interaction used to evaluate SDL is affected only

by changes in performance across sessions. Thus, it provides protection against the influence of the initial learning differences on the significance level of SDL which the previously employed two-way interaction did not.

However, if this interaction term is used (and is significant), initial learning differences may still call into question the existence of SDL in two different ways: If two groups with the same treatment in Session 1 differ significantly in their initial mean scores, the Session 2 mean scores can either reflect an increase or decrease in this difference. If the difference is increased (the initially better group retains more), then one suspects that this is due to the effect of a real difference in initial learning level on subsequent retention. This experiment did not produce any results of this kind.

If this difference decreases, then one suspects that the failure of equivalence is not real, but may possibly be a transitory effect due to the temporary learning of a larger number of the difficult items by the "better" group. In other words, this represents a momentary statistical fluctuation in performance (a peak in one group, and a valley in the other) which would be expected to regress toward the population mean in the second session test, whether or not drug was given or state was changed.

The subject of statistical regression, or regression towards the mean (which is not the same as linear regression) was discussed in Neale and Liebert (1973) and Hays (1963). It results from the fact that "the more extreme scores on a particular distribution measured in a particular way contain more measurement error than do the less extreme scores. Since measurement error is a random process, extremely high scorers will decrease somewhat and extremely low scorers will increase somewhat simply as a function of random variation" (Neale & Liebert, 1973, p. 39).

Because the differences in means do show changes in the appropriate direction in this experiment, it is important to test further to see if statistical regression is taking place. The third alternative (the null hypothesis), that failure of equivalence was due to chance fluctuations in performance and did not influence the changes in performance across sessions, must be rejected by statistical procedures.

If the null hypothesis is rejected, then one must be concerned about interpreting significant three-way interactions as SDL. If the fluctuations are not random, then the first session degree of learning differences may possibly be explained as a result of statistical regression. This would provide a possible answer for the question about

the origin of these differences that was raised in the previous section (pages 53-57).

Effects of Failure of Equivalence on Retention

Methods of analysis. Two methods of checking for statistical regression are used in evaluating those tests in which failure of equivalence might be a problem. The first method equalizes the Session 1 performance of the two similarly treated groups by discarding the highest performers in the high scoring group and the lowest performers in the low scoring group. The difference between the inter-session retention (percentages retrieved) of the two reduced groups is then examined. If forcing equivalence decreases this difference considerably, then systematic regression of the higher scores should be suspected. The results obtained by forcing equivalence will be reported in the next several pages.

The second method, a more formal way of checking for statistical regression, is to examine the correlation between the Session 1 score of each subject and the percentage of Session 1 learning he retrieves in Session 2. The known effect of degree of learning predicts a positive correlation--those subjects who learn more should retrieve more. If statistical regression is taking place, momentary peak performance in Session 1 should both increase the scores of some subjects and decrease their percentages

retrieved. As a result, higher first session scores should accompany lower percentages retrieved, and the correlation should be negative. This situation is similar for the momentary valleys, and these also should cause negative correlations. Here, rank-order correlations (corrected for ties) are used because the percentage retrieved measure can not be assumed to be normally distributed, and is especially variable with low scores. To compensate for the loss of power of this non-parametric test and the negative bias brought about by the effect of degree of learning on retention, a significant negative correlation (.714 for p = .05) will not be considered necessary to cause interpretation to be reserved. Rather, any significant difference in Session 1 performance between similarly treated groups. which is accompanied by a correlation of -.3 or below will be considered grounds for suspecting statistical regression and reserving interpretation about SDL. Conversely, in this experiment, failure to meet these conditions probably means that statistical regression is not taking place. The ad hoc nature of this approach is necessary because no statistical tests for the difference between two non-parametric correlations are known; therefore the difference between the negative correlations due to regression and the positive ones normally expected cannot be precisely tested. However, since the average positive

correlation in this experiment seems to be about .45, and the sample size (eight subjects per group) is small, a criterion of -.3 seems reasonable. The reader is cautioned, however, that this is a question of interpretation involving new and inexact methods of analysis, and there may be differences of opinion as to how much caution should be exercised in these interpretations.

The three tests in which significant or almost significant failure of equivalence occurs will next be reviewed individually.

Face recognition test. The Session 1 placebo groups significantly differ in Session 1 performance (6.75 vs. 10.25), $t(14) = 2.31$, $p = .036$ (two-tailed), with the changed state group (P-A), doing better initially and losing more between sessions. This loss could hypothetically have been due to either SDL or statistical regression.

The score to percentage retrieved correlation is negative (-.805) for the P-A group and the P-P group (-.655), and both are significant by the criterion established here. The first session failure of equivalence and the large loss between sessions shown by the P-A group may be due to statistical regression. This was confirmed by the method of eliminating subjects to force equivalence described above.

It is also interesting that the A-P group also showed a negative correlation (-.381). The fact that three of the four groups showed negative correlations may be related to the post-experimental interview finding that, to the subjects, this test was the most interesting. A novelty effect during Session 1 may have spurred some of the subjects to a peak performance which they did not repeat during the second session.

Six repetition name recall test. The A-P group initially acquired significantly more than the A-A group (11.75 vs. 8.00), t (14) = 2.55, p = .023. The better-performing group also lost more items between sessions, although in terms of percentages retrieved, the loss was less. The score to percentage retrieved correlations for the two groups are positive, indicating that statistical regression did not cause failure of equivalence or influence retention. This was confirmed by forcing equivalence by eliminating subjects.

One repetition name recall test. This test will be reported below both including and excluding guesses, and both these results are reported here. In this test, none of the four individual t-tests showed significant failure of equivalence between the two Session 1 alcohol groups and the two Session 1 placebo groups. The p's ranged between .10 and .25.

Although failure of equivalence did not occur here, what is of concern is the fact that both changed state groups learned more initially and lost more between sessions than their same state counterparts. Statistical regression might still pose an interpretation problem. For both measurements, the initial learning differences were examined by analysis of variance, evaluating a specific contrast between the two pairs of groups (changed and unchanged). Both contrasts are not significant, $F(1,28) = 2.28$, $p = .14$, and $F(1,28) = 2.06$, $p = .16$, with the guesses excluded and included, respectively. An additional analysis of first session performance differences among all four groups, the Session 1 drug state x Session 2 drug state interaction, is more nearly significant for both measurements, $F(1,28) = 4.01$, $p = .055$, and $F(1,28) = 3.65$, $p = .066$, respectively. However, this analysis was unplanned, so these trends must be regarded with caution.

Only one group (A-A) of the four showed negative correlations of score to percentage loss, and these were quite small (-.013 and -.038 respectively). Statistical regression probably did not occur here. Correlations for the other groups were positive but nonsignificant--the largest was .651. The nonsignificant failure of equivalence, and the lack of evidence of statistical

regression create the impression that reservations about interpretation of these results should not be serious.

Analyses of Individual Tests

Interpreting tables and figures. The results of the one repetition face recognition test are presented in Table 4 and graphed in Figure 1. The top part of the table presents the means and standard deviations of the scores (number correct) of each group during each session. The percentage of Session 1 learning which is correctly retrieved during Session 2 (Session 2 score x 100/Session 1 score) is also listed there, as in Weingartner and Faillace (1971). In the bottom part of the table, the two percentages from groups which did not change state across sessions ("same state") are averaged, and the two "changed state" percentages are combined. By subtracting the changed state percentage from the same state percentage, one can obtain a net percentage difference, which is an approximate measure of SDL. Comparison with the results of the analyses of variance suggests that only limited trust be placed in this percentage.

In contrast, the graphic method of presenting results emphasizes the absolute differences in performance, rather than percentage change. Presentation of both figures and tables is, therefore, important for understanding these results.

Face Recognition

Summarized data. From Figure 1 and Table 4, it is apparent that the magnitude of SDL in this test is small. The P-A group is largely responsible for the 4.2% net percentage of SDL.

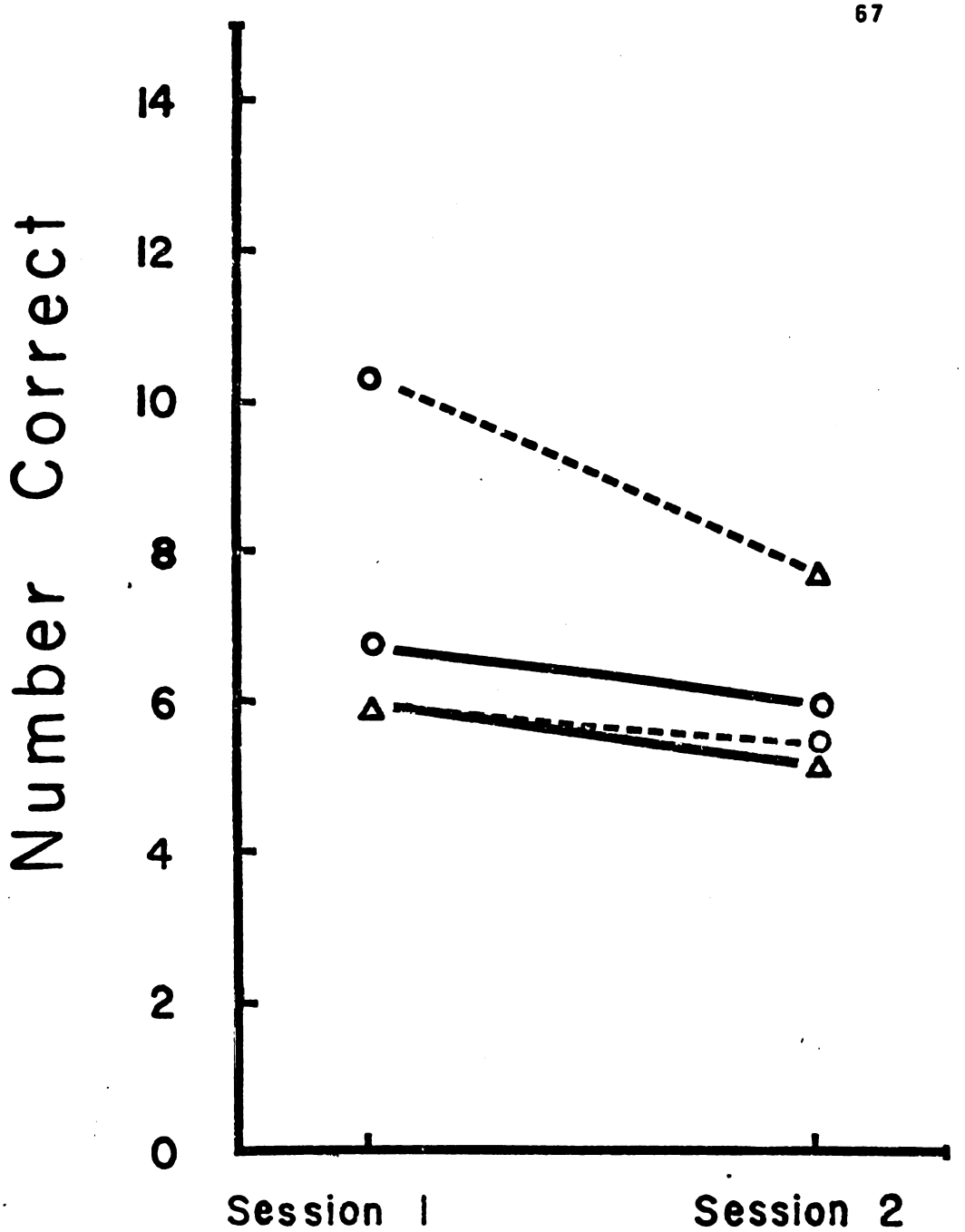

Figure 1: Scores of the one repetition face recognition test, guesses excluded. (Key to figure: circles = placebo, triangles = alcohol, solid lines = same state across sessions, dashed lines = changed state across sessions.)

Table 4

Group Means and Standard Deviations for the One Repetition Face Recognition Test, Guesses Excluded

Group	Session 1		Session 2		Percent Retrieved
	$\bar{X}$	s	$\bar{X}$	s	
Placebo--Placebo	6.75	3.28	5.88	3.09	87.0
Placebo--Alcohol	10.25	2.76	7.63	1.41	74.4
Alcohol--Alcohol	5.88	1.81	5.13	1.96	87.2
Alcohol--Placebo	5.88	4.45	5.38	4.53	91.5

	States		
	Same	Changed	Difference
Percent Retrieved	87.1	82.9	4.2

First session differences. A detailed examination of the first session learning differences between the two placebo groups concluded that failure of equivalence may present difficulties in interpretation.

Forgetting. Partially as a result of the P-A group's larger loss, there was a highly significant decrease in retention for all four groups across sessions, $F(1,28)$, p =

.004. Since forgetting does occur here, the lack of drug effects on recognition (to be described) cannot easily be attributed to an insensitive design.

Short term memory deficit. The analysis of variance reveals a nearly significant effect of Session 1 drug condition on the combined results of both sessions, $F(1,28) = 3.99$, $p = .055$. If the scores are not collapsed across the order factor, the predicted alcohol-induced deficit is significant, $F(1,16) = 6.14$, $p = .025$.

The Session 1 scores alone are significantly affected by Session 1 drug state, reflecting an alcohol effect on short term memory, $t(30) = 2.21$, $p = .018$. The Session 1 tests were not done immediately after the learning presentation, but rather delayed 2.75-8.25 minutes for recall, and 8.75-13.5 minutes for recognition. Any alcohol-induced deficit in Session 1 may therefore be due to effects on both learning and consolidation; Session 2 test results also presumably reflect both. For clarity, the term "short term memory deficit" will be used to reflect Session 1 drug state effects on either Session 1 results or both sessions' data.

Additional consolidation deficit. The Session 1 state x sessions interaction is not significant, $F(1,28) = 2.18$, $p = .15$. If significant, this interaction indicates an additional retention loss between sessions resulting from

carry-over effects of alcohol given during the first session, possibly due to a drug induced additional consolidation deficit. To simplify further presentation, this interaction will be referred to as an "additional consolidation deficit". Much of the loss due to consolidation may be incorporated in the first session test results. Unless it is significant at the .05 level, the additional consolidation deficit will be omitted from further test summaries.

Session 2 performance effect. The between-group difference in the deficit between Session 1 and Session 2 resulting from the drug state in Session 2--the Session 2 drug state x sessions interaction--is the proper way to evaluate the effect of alcohol on performance during Session 2. The simple effect of Session 2 drug state, which might also seem appropriate, is not optimal because it incorporates variance due to the pre-experimental inequality of the Session 2 alcohol (P-A and A-A) and Session 2 placebo (P-P and A-P) groups. This interaction term was significant only in one of the test contrasts described below; it did not approach significance in any of the individual test analyses. Examining the analysis of the entire experiment reveals that even when all five tests are combined, this interaction term is small, $F(1,28) = 0.26$, $p = .613$. This lack of effect indicates that, as hypothesized, alcohol does

not impair retrieval mechanisms. For ease of exposition, presentation of this result is therefore omitted unless it is significant at the .05 level.

State dependence. Although the highly significant change in retrieval of the P-A group, $t(7) = 4.65$, $p = .001$, and the positive same--changed state difference support an initial impression of assymmetrical SDL, the Session 1 state x Session 2 state x sessions interaction is not significant, $F(1,28) = .97$, $p = .33$; the differences between the four groups did not significantly change across sessions.

One Repetition Name Recognition Test

Summarized data. The scores for the one repetition name recognition test (Table 5) show a negative (-8.9%) percentage of SDL, because the same state groups forgot less between sessions than the changed state groups.

Second session differences. Figure 2 reveals that this is largely due to an anomalous small gain in number correct across sessions by the P-A group. An unplanned comparison between the P-A group's gain and the P-P group's loss between sessions was significant at the .031 level, $F(1,14) = 5.76$, $p = .031$. A similar contrast between the P-A group and the other three groups across sessions is more clearly significant, $F(1,28) = 6.15$, $p = .019$. This relatively steady performance level, which contrasts sharply with the same group's marked decrease in performance in the face

recognition test, may be an effect of novelty. The experience of having alcohol for the first time in the experiment may facilitate performance by releasing the subject's strong expectations of an enjoyable alcohol experience. The presence of these expectations was supported by observations of the subjects' behavior and the subjects' answers during the postexperimental debriefing. This possible novelty effect should be kept in mind in interpreting all of the contrasts involving the name recognition test.

Forgetting. Despite this anomalous increase, there is a significant decrease in retention across sessions, $F(1,28) = 7.92$, $p = .009$, indicating that this, too, is a sensitive task.

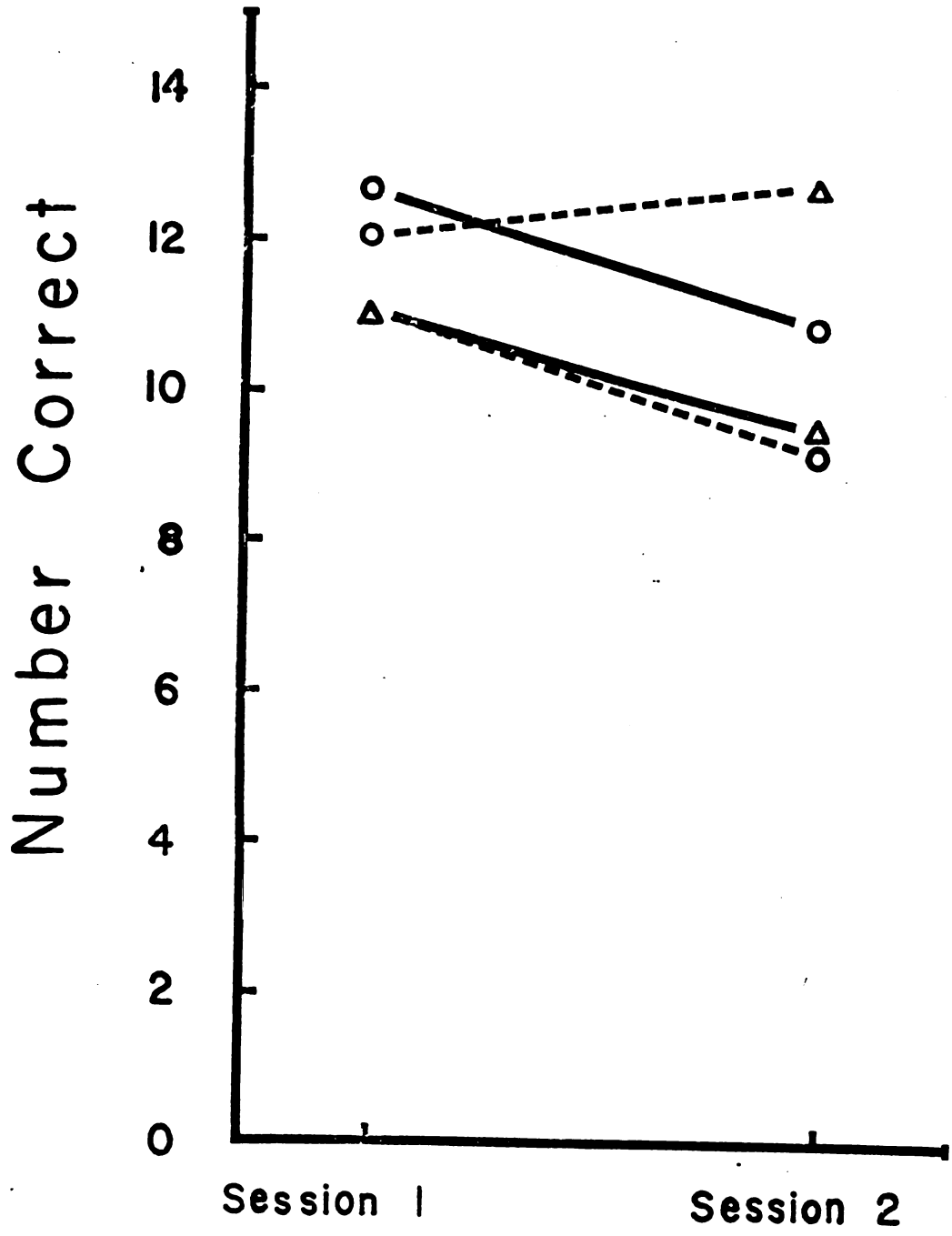

Figure 2: Scores of the one repetition name recognition task, guesses excluded. (Key same as Figure 1.)

Table 5

Group Means and Standard Deviations for the

One Repetition Name Recognition Test, Guesses Excluded

Group	Session 1		Session 2		Percent
	$\bar{X}$	s	$\bar{X}$	s	Retrieved
Placebo--Placebo	12.63	2.72	10.75	4.13	85.1
Placebo--Alcohol	12.00	3.38	12.63	3.25	105.2
Alcohol--Alcohol	11.00	3.38	9.38	4.69	85.2
Alcohol--Placebo	11.00	3.93	9.13	4.36	94.1

	States		
	Same	Changed	Difference
Percent Retrieved	85.2	94.1	-8.9

Drug effects. The effect of drug state during Session 1 on performance during both sessions is, as expected, not significant, $F(1,28) = 2.19$, $p = .15$, and a t-test on Session 1 scores confirms the small size of the alcohol effect on short term memory, $t(30) = 1.13$, $p = .13$. The "negative SDL" is also insignificant, $F(1,28) = 1.78$, $p = .19$. This is in accord with the previous literature, which

concluded that SDL does not occur with recognition or cued recall.

Face and name recognition will be compared later in this section.

Six Repetition Name Recognition Test

The results of this test showed a pronounced ceiling effect (a restriction of the variability of the scores because the highest possible score is too low). Further analysis was not performed on these data.

One Repetition Name Recall Test, Guesses Excluded

Summarized data. Strong positive SDL (12.6%) is displayed in Table 6. Symmetrical SDL is apparent in Figure 3, as both changed state groups lose more items between sessions than their same state counterparts.

There is a possibility of a small basement effect in this task, particularly in the two first session alcohol groups. Although no subject had first session scores of 0 or 1, there were five scores of 2--two in the A-A group, and two in the A-P group. In the second session, there were seven scores of 0 (three A-A, three A-P, and one P-A), five scores of 1 (two A-P, two P-P, and one P-A), and three scores of 2 (one A-A, two P-P). In both sessions, the low scores were fairly evenly distributed between groups with similar first session drug states, thus minimizing any systematic basement effects, but the possibility of

difficulties in interpretation should be kept in mind. It is recommended that any subsequent similar experiments should avoid this pitfall.

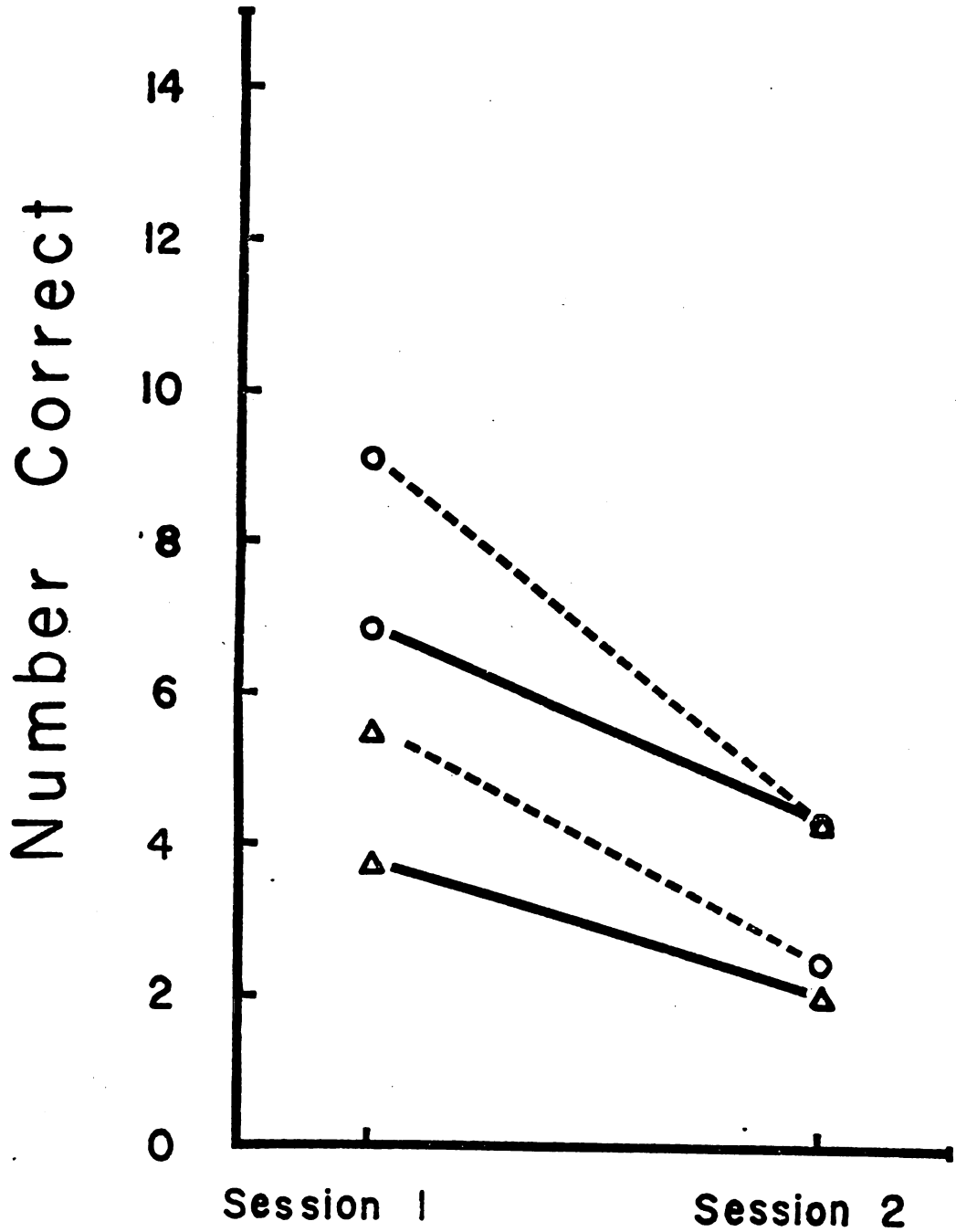

Figure 3: Scores of the one repetition name recall test, guesses excluded. (Key same as Figure 1.)

Table 6

Group Means and Standard Deviations for the One Repetition Name Recall Test, Guesses Excluded

Group	Session 1		Session 2		Percent Retrieved
	$\bar{X}$	s	$\bar{X}$	s	
Placebo--Placebo	6.75	2.60	4.13	3.14	61.1
Placebo--Alcohol	9.00	2.78	4.13	3.40	45.8
Alcohol--Alcohol	3.63	1.60	1.88	1.64	51.7
Alcohol--Placebo	5.38	3.85	2.25	2.60	43.8

	States		
	Same	Changed	Difference
Percent Retrieved	56.4	43.8	12.6

First session differences. Figure 3 also shows a pre-experimental difference between changed and same state groups in Session 1 performance; however, ex post facto examination (above) suggested that this was probably not an interpretation problem.

Forgetting. Between session forgetting in this and all the recall tests was, as expected, highly significant (*p*'s all < .001), and will not be commented on further here.

Drug effects. Drug state in the first session has a strong effect on both sessions' results, $F(1,28) = 8.41$, $p = .007$, or $F(1,16) = 6.13$, $p = .025$, with the order factor included. The first session short term memory difference between the alcohol and placebo groups is also highly significant, $t(30) = 3.27$, $p = .001$. This is in contrast to the recognition test that used the same set of names. These findings follow closely the predictions in the Introduction. The additional consolidation deficit, although marginal, is significant, $F(1,28) = 4.23$, $p = .049$, but this changes if the results are not collapsed across order, $F(1,16) = 3.47$, $p = .081$. The observed SDL is, as hypothesized, highly significant here, $F(1,28) = 6.62$, $p = .008$, or $F(1,16) = 6.62$, $p = .020$, with order included. Recall vs. recognition comparisons using the data described here will not be presented, as the scores including guesses are considered to form a more legitimate contrast.

One Repetition Name Recall Test, Guesses Included

Summarized data. Figure 4 and Table 7 demonstrate that the exclusion of information about list membership (inclusion of guesses) does not appreciably change the form of the results on this test; however, the magnitude of

several of the effects is altered. The percentage of SDL is reduced to 8.3%.

When the data are analyzed with guesses included, the basement effect is smaller. Only one subject in each of the first session alcohol groups had a score of 2. In the second session, four subjects in each of the first session alcohol groups had scores of 2 or below, with one 0 occurring in each group. Two subjects in the P-P group scored 2 during Session 2.

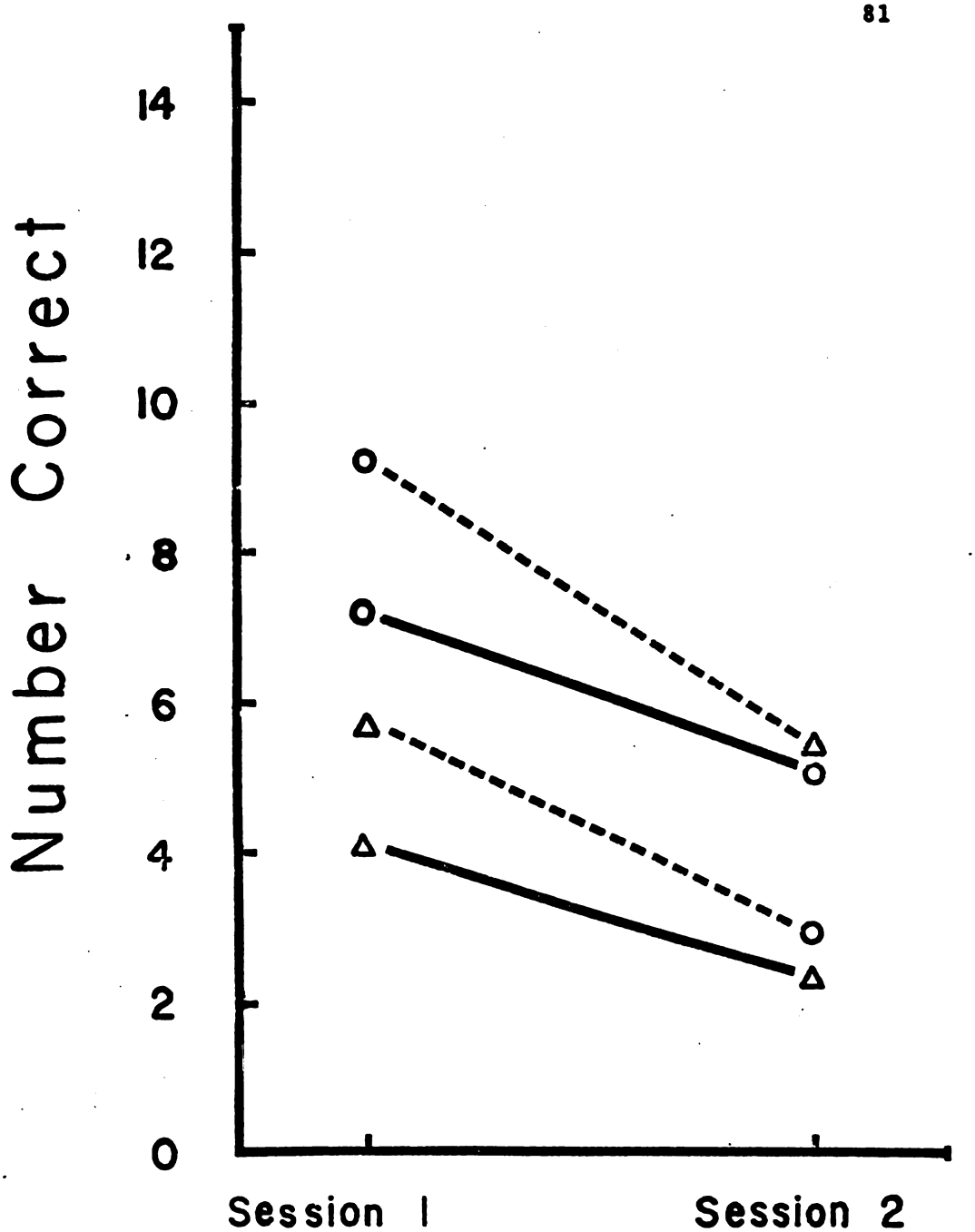

Figure 4: Scores of the one repetition name recall test, guesses included. (Key same as Figure 1.)

Table 7

Group Means and Standard Deviations for the One Repetition Name Recall Test, Guesses Included

Group	Session 1		Session 2		Percent
	$\bar{X}$	s	$\bar{X}$	s	Retrieved
Placebo--Placebo	7.25	2.55	5.13	3.04	70.7
Placebo--Alcohol	9.25	2.71	5.50	3.38	59.5
Alcohol--Alcohol	4.13	1.46	2.38	1.85	57.6
Alcohol--Placebo	5.75	3.58	3.00	2.14	52.2

	States		
	Same	Changed	Difference
Percent Retrieved	64.1	55.8	8.3

First session differences. Again, as discussed in detail above, Session 1 differences between changed and same state groups do not appear to pose a problem here.

Drug effects. The hypothesized effect of alcohol given during the first session on the results of both sessions (the short term memory deficit) is more significant than in the guess-free data, $F(1,28) = 11.05$, $p = .002$, or, with the

order factor included, $F(1,16) = 8.02$, $p = .012$. The difference between alcohol and placebo first session scores is about the same, $t(30) = 3.39$, $p = .001$. However, the predicted SDL is reduced in magnitude, $F(1,28) = 4.32$, $p = .047$. If the analysis is not collapsed over order, SDL is no longer significant, $F(1,16) = 3.77$, $p = .070$. The strong contrasts between recall and recognition results with regard to short term memory deficits and SDL will be considered later in this section.

Six Repetition Name Recall Test

Summarized data. Table 8 and Figure 5 give different impressions about the data from this test. The low percentage of SDL (2.2%) from the table contrasts with the impression of symmetrical SDL revealed by the figure. This contrast is partly due to the fact that the A-P group loses more items between sessions than the A-A group, but because of first session differences, the A-P group shows a higher percentage retrieved.

The high level of initial learning raises the possibility of a ceiling effect (a restriction in the variability of the scores because the highest possible score is too low) here. This does not appear to be so. During the first session, only one of the 32 subjects recalled all 20 items. Three of the subjects scored 19, and none had 18

correct. Of these four, only one (19) lost less than four items from Session 1 to Session 2.

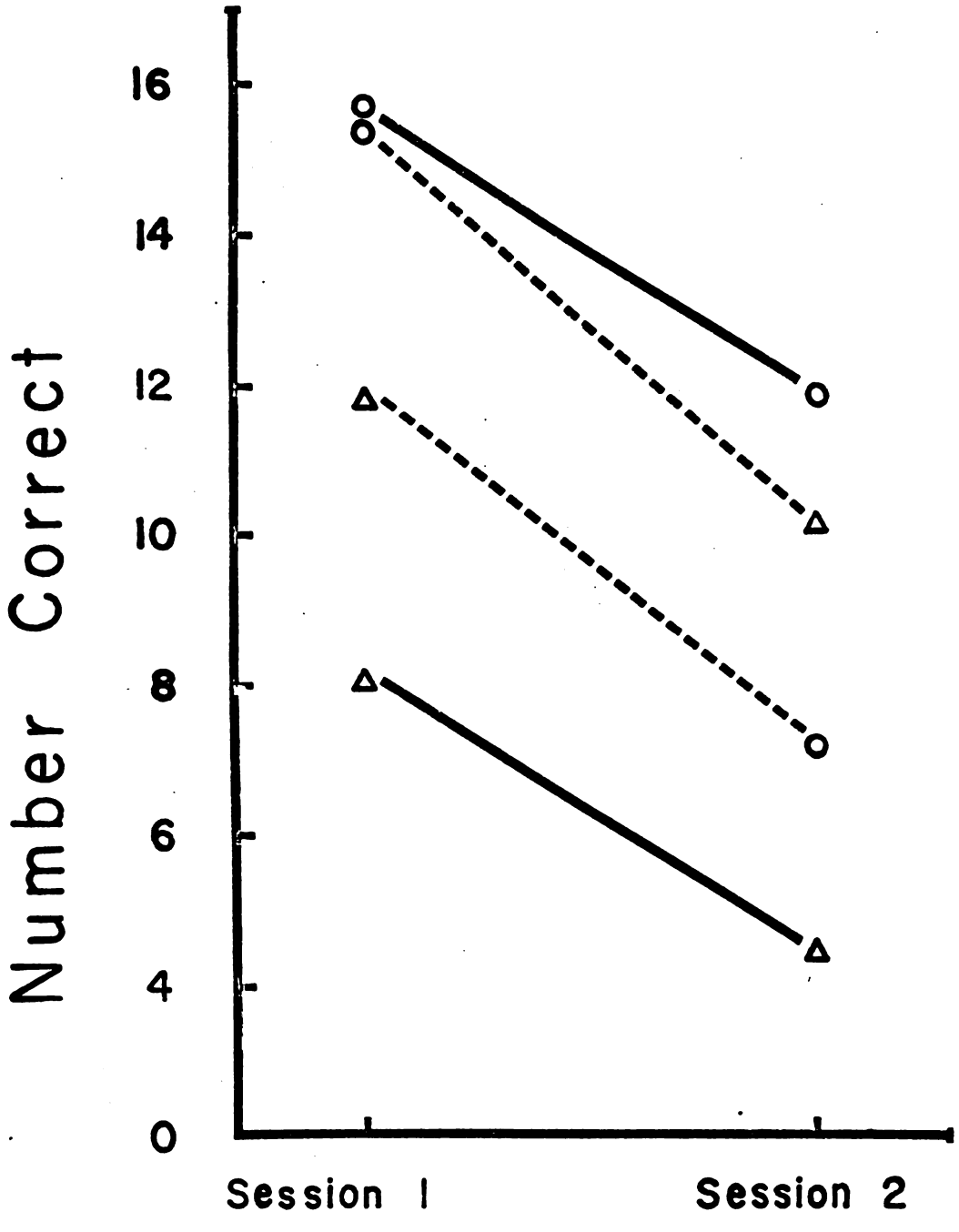

Figure 5: Scores of the six repetition name recall test, guesses excluded. (Key same as Figure 1.)

Table 8

Group Means and Standard Deviations for the Six Repetition Name Recall Test, Guesses Excluded

Group	Session 1		Session 2		Percent
	$\bar{X}$	s	$\bar{X}$	s	Retrieved
Placebo--Placebo	15.63	3.85	11.75	3.99	75.2
Placebo--Alcohol	15.38	2.20	10.00	4.04	65.0
Alcohol--Alcohol	8.00	3.02	4.38	3.54	54.7
Alcohol--Placebo	11.75	2.87	7.13	3.48	60.6

	States		
	Same	Changed	Difference
Percent Retrieved	65.0	62.8	2.2

First session differences. Detailed consideration of the first session differences between the two alcohol groups led to the suggestion that failure of equivalence does not seem to pose a serious problem in this task.

Drug effects. The drug state during Session 1 did cause the expected highly significant short term memory deficit on performance during both sessions, $F(1,28)$ =

22.38, $p < .001$, and during Session 1 alone, $t(30) = 4.90$, $p < .001$. SDL does not reach significance, $F(1,28) = 2.21$, $p = .15$. At first glance, it appears that repetition does not strongly reduce SDL. Contrasts between this test and the one repetition name recall test will be considered later in this section, and pooled results are also described where appropriate.

Word Recall Test

Summarized data. Both Table 9 and Figure 6 indicate a small amount (3.4%) of assymmetrical SDL for this test; the P-A group lost more words from Session 1 to Session 2 than the P-P group.

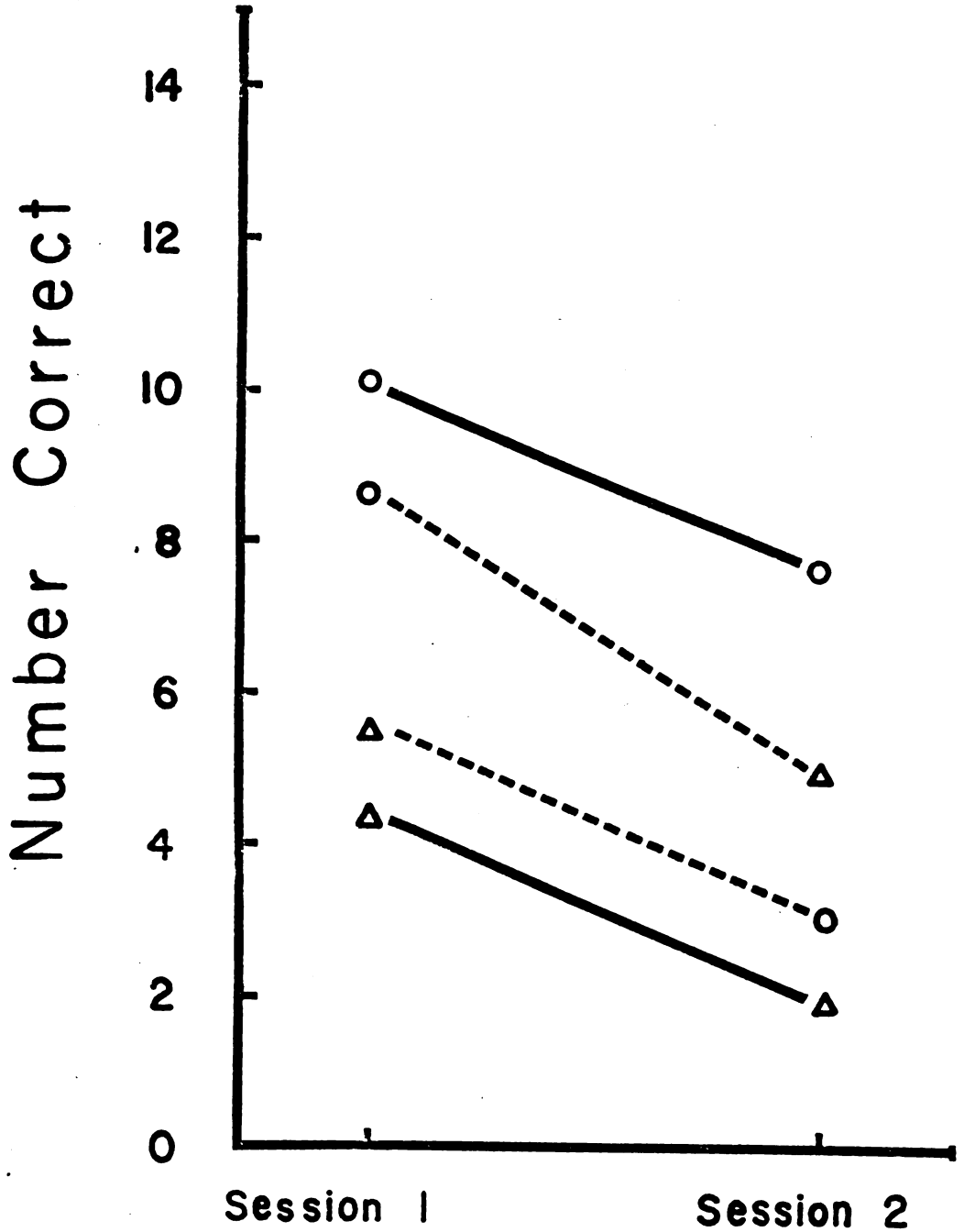

Figure 6: Scores of the one repetition word recall test, guesses excluded. (Key same as Figure 1.)

Table 9

Group Means and Standard Deviations for the One Repetition Word Recall Test, Guesses Excluded

Group	Session 1		Session 2		Percent
	$\bar{X}$	s	$\bar{X}$	s	Retrieved
Placebo--Placebo	10.00	3.12	7.50	4.60	75.0
Placebo--Alcohol	8.50	3.07	4.75	2.43	55.9
Alcohol--Alcohol	4.25	3.54	1.75	2.25	41.2
Alcohol--Placebo	5.38	1.77	2.88	2.30	53.5

	States		
	Same	Changed	Difference
Percent Retrieved	58.1	54.7	3.4

Drug effects. A highly significant effect of alcohol during learning is noted in both the first session results, $t(30) = 4.29$, $p < .001$, and data from the two sessions, $F(1,28) = 16.77$, $p < .001$. Despite the strong effect on short term memory, SDL is not significant, $F(1,28) = .86$, $p = .36$. This is in contrast to Weingartner and Faillace's (1971) results for a similar word list. A comparison

between the 1-Name recall test, which was developed for this experiment, and this test, which was modified from Weingartner and Faillace (1971) is included as Appendix G. The comparison indicates that there are few significant differences.

Summary of Individual Tests

Table 10 summarizes the significance levels of the two most important effects for the five tests which were reported above. The order factor is not included, and guesses are excluded with the exception of the one repetition name recall test, where analyses with and without guesses have been reported.

Table 10

Summary of the Six Analyses

Test	Significance Level of Short Term Memory Deficit	Significance Level of SDL
Face recognition	.055	.33
Name recognition	.15	.19[a]
One repetition name recall	.007	.008
One repetition name recall	.002[b]	.047[b]
Six repetition name recall	<.001	.15
Word recall	<.001	.36

Note. All probabilities reported are planned comparisons, order factor excluded. Short term memory deficit refers to the effect of Session 1 drug state on both sessions' results.

[a]Changes not in the correct direction for SDL.

[b]Guesses included. All other tests have guesses excluded.

Short term memory deficit. Alcohol given during the first session has a stronger effect on recall than recognition, as the short term memory deficits for both session's results make apparent. This selective deficit is

what was predicted; a specific test of the magnitude of this difference will be performed below.

State dependence. The "negative SDL" (same state groups forgetting more, rather than less, than the changed state groups) for name recognition stands in marked contrast to the significant SDL for the one repetition name recall test, which used the same word list. The difference between the one and six repetition name recall tests does not appear to be as large, and neither does the difference between face and name recognition tests. These differences will all be tested as specific contrasts below.

Test Contrasts and Combinations

Face and Name Recognition

General pattern. The positive (4.2%) percentage of SDL for the face recognition test stands in strong contrast to the negative (-8.9%) SDL observed with its most clear analogue, the name recognition test. It was noted that the P-A group behaved very inconsistently in these tests, showing a strong loss of memory between sessions in the face recognition test, and a surprising gain in the name recognition test.

Group differences. Figures 1 and 2 reveal that three of the groups (P-P, A-A, and A-P) behaved almost identically on both tests; Tables 8 and 9 confirm that the percentage retrieved for the three groups is remarkably similar for

both names and faces. The average percentage retrieved for the three groups is 88.6% for the faces, and 88.1% for the names. The ranking of the groups within tests is identical. As this implies, the unplanned comparison of the three groups' deficits between tests is not significant, $F(1,21) = 2.73$, $p = .113$. In the face of this similarity, the difference in percentages retrieved for the P-A group--74.4% for the faces vs. 105.2% for the names--is unexpected. Using an (unplanned) analysis of variance on the P-A group, the significance of this difference (the tests x sessions interaction) in the P-A group was tested, $F(1,7) = 7.82$, $p = .027$.

It is perhaps possible to understand this pattern of results as a combination of two or three component effects. One of these is the previously discussed effect of failure of equivalence in the 1-Face task. Another may be a difference in novelty effects on the P-A group. The face task may have been more novel in Session 1, causing a peak performance, which then declined. The name recognition task here may reflect the novelty of the alcohol during the second session. Greater (assymmetric) SDL for the face recognition task also remains a possibility. Some tentative interpretations of these results are suggested in the Discussion (pages 104-111).

Test differences. Additional analyses revealed that the overall superiority of name recognition to face recognition (test effect) is apparent, $F(1,28) = 31.53$, $p < .001$. However, there seems to be no inter-test difference in forgetting (tests x sessions interaction) between sessions, $F(1,28) = 0.00$, $p = 1.00$, even considering the relatively small confounding introduced by the novelty effect.

Drug effects. The difference between tests with respect to the (Session 1) alcohol-induced short term memory deficit in the results of both sessions (tests x Session 1 drug state interaction) is not at all significant, $F(1,28) = .013$, $p = .91$. Combining the short term memory deficits from these two tests, the Session 1 alcohol effect on recognition (Session 1 drug state effect on combined tests), $F(1,28) = 5.51$, $p = .026$, is found to be not much stronger than the alcohol effect on face recognition alone.

The tests differ significantly with respect to both additional consolidation deficit (tests x Session 1 state x sessions interaction), $F(1,28) = 4.60$, $p = .041$, and Session 2 drug state effect on Session 2 performance (tests x Session 2 state x sessions interaction), $F(1,28) = 5.13$, $p = .031$. The name recognition test appears to show less additional consolidation deficit, and an alcohol-induced performance facilitation in Session 2. The significance of both of these effects decreased if results are not collapsed

over order, $F(1,16) = 3.54$, $p = .078$, and $F(1,16) = 3.95$, $p = .064$, respectively.

Inspection of Figures 1 and 2 reveals that these differences are almost completely due to the P-A group's unusual performance, as was previously discussed. Isolating the other three groups and examining the differences between tests in the groups x sessions interaction (evaluating the tests x groups x sessions term) demonstrates that test differences in this combination of additional consolidation deficit and performance facilitation is very insignificant, $F(2,21) = .052$, $p = .95$. One could interpret the significant interactions as test differences in alcohol-induced additional consolidation deficit or Session 2 performance facilitation. However, this interpretation is inconsistent with the simpler view in which these significant terms are seen as an effect of novelty and/or failure of equivalence.

The hypothesized difference between tests with respect to SDL (the tests x Session 1 state x Session 2 state x sessions interaction) is marginal, $F(1,28) = 3.20$, $p = .085$, and interpretation is complicated by the failure of equivalence in the 1-Face task, and the possible novelty effect in the 1-Name recognition test.

One Repetition Name Recall and Recognition

Proper comparison. As it was necessary to summarize the 1-Name recall test both including and excluding guesses, these contrasts are also amenable to analysis both with and without the inclusion of guesses for that test. Because the subjects were asked to rate both their confidence in their answers and their confidence that the answers were written on the test they were originally presented in by using the same rating, including recall guesses excludes information based on uncertainty about list membership. The recognition test implicitly includes correct list membership information in giving the subject four choices during testing. There is no uncertainty about list membership during recognition testing. Therefore, the more legitimate comparison appears to be with the recall data which excludes information based on uncertainty about list membership--the data which includes guesses. The contrasts which include recall guesses (and exclude recognition guesses) are the only ones presented here.

It is probably safe to assume that novelty effect differences between recall and recognition are fairly small, because the two tests here were given consecutively and employed the same name list. Novelty effects may even be greater on the recall test, which occurred first.

Test differences. The obvious difference in difficulty between these tests is highly significant, $F(1,28) = 193.5$, $p < .001$, as is the difference in overall percentage retrieved in Session 2 (forgetting), $F(1,28) = 7.54$, $p = .010$. Including order as a factor in the analysis slightly decreases the latter figure, $F(1,16) = 5.84$, $p = .028$.

Drug effects. Surprisingly, the predicted inter-test difference in Session 1 alcohol effects on the results of both sessions (short term memory deficit) is statistically not significant, $F(1,28) = 1.74$, $p = .20$. However, analyzing only the Session 1 data reveals a significant test difference in alcohol effect, $F(1,28) = 4.40$, $p = .045$. The error terms for the two analyses, 5.47 and 3.63 (respectively), differ considerably, and this is partly responsible for the difference between the analyses.

Since the recognition test occurred after the recall test, and alcohol is known to produce sharp drops in retention within this interval, the expected recall-recognition difference is quite possibly underestimated as a consequence of this timing difference. The pattern of results here seems to indicate a selective deficit in recall induced by alcohol.

As expected, SDL was significantly greater with recall than recognition, $F(1,28) = 5.66$, $p = .024$, although the analysis which did not collapse over order only bordered on

significance, $F(1,16) = 4.38$, $p = .053$. As was predicted, supplying retrieval cues does seem to decrease SDL.

One and Six Repetition Name Recall

Proper comparison. The two modes of analysis of the 1-Name recall test--with and without guesses--necessitate the duplicate presentation of the results of the following test comparisons. An argument for the validity of both contrasts can be made. The contrast of 6-Name excluding guesses with 1-Name including guesses is reasonable because the 6-Name results do not contain a large amount of information regarding list membership, and are therefore comparable to the 1-Name results, which also lack list membership information. The contrast excluding guesses is legitimate because both tests were given with the same instructions about using confidence ratings to denote list membership, and should therefore contain equivalent information about retrieval of the "name plus list membership information" compound stimulus. The results excluding guesses on both tests will be discussed first.

Test differences. The sizeable difference between the tests in number recalled during both sessions is highly significant, $F(1,28) = 130.08$, $p < .001$. The tests x sessions interaction is also significant, $F(1,28) = 5.36$, $p = .028$, confirming the apparently larger average percentage retrieved in the 6-Name results. The larger degree of

learning has increased retention. The greater percentage retrieved could possibly have been interpreted as a ceiling effect on the 6-Name test during the first session, but the raw data for the 6-Name test does not strongly support the ceiling effect hypothesis.

The inadequacy of any recall measure as a reflection of the amount of learning in situations (common to any test of verbal learning) where there are differences between difficulties of items for each individual may be partly responsible for the apparent effect of degree of learning on retention. The degree of an individual's learning of the subset of easy items may be underestimated by the all or nothing (right or wrong) recall scores (Underwood, 1964), particularly in the first session, when the strength (of learning) of the easy subset is presumed to be highest. Repetition during learning may increase the pool of items whose strength is underestimated as a result of this inevitable problem. These more strongly learned items should be harder to lose. Alternatively, or in addition, there may be an effect of repetition on the retention of all items--easy or difficult--for all subjects. This effect may be particularly strong with the more thoroughly learned (easier) items, as a result of the effect of initial learning level on retention.

Drug effects. The results indicate a larger short term memory deficit for both sessions produced by Session 1 alcohol in the 1-Name test; the overall ratios of correct responses by Session 1 placebo groups (P-P and P-A) to correct responses by Session 1 alcohol groups (A-A and A-P) are 1.83 for the 1-Name test and 1.69 for the 6-Name test. This difference is significant, $F(1,28) = 6.68$, $p = .015$. Session 1 alcohol effects on Session 1 results considered separately also differ between the tests, $F(1,28) = 4.52$, $p = .042$. It is possible that, as hypothesized, alcohol selectively disrupts the retention of less well learned items.

The predicted difference between tests with respect to dissociation, although it appears to be large on the basis of the inspection of the percentage retrieved analyses (12.6% vs. 2.2%), does not approach significance, $F(1,28) = .26$, $p = .62$. This is in reasonable agreement with the similarity of patterns shown in Figures 3 and 5, which may be a better indicator of SDL than the percentages. The error terms for 1-Name and 6-Name recall are surprisingly different, 1.62 and 2.83, respectively. This helps to account for the original discrepancy in significance between the two tests. In calculating the significance of the four way interaction (the test contrast), the two error terms were averaged, and the difference disappeared. It appears

that repetition during learning is not a very important determinant of the degree of SDL.

If an analysis which combines both test's results is performed, the two name recall tests strikingly reinforce the initial impression of SDL, $F(1,28) = 9.34$, $p = .005$. If this analysis is not collapsed over the order factor, the significance level of this effect diminishes slightly, $F(1,16) = 7.98$, $p = .012$.

Guesses included. If guesses during the 1-Name test are included in the analysis, differences between tests are less pronounced, with only one exception. The difference between tests in total performance is smaller, although hardly worrisome, $F(1,28) = 102.8$, $p < .001$. However, the difficult to interpret tests x sessions interaction is appreciably larger, $F(1,28) = 5.50$, $p = .026$.

All drug effects and their interactions are reduced by the inclusion of guesses during 1-Name recall. The inter-test difference in Session 1 drug effect on the scores for both sessions remains significant, $F(1,28) = 5.50$, $p = .026$, as does the Session 1 drug effect on the Session 1 scores alone, $F(1,28) = 4.48$, $p = .043$.

The expected SDL difference between tests is even less important, $F(1,28) = .004$, $p = .95$, and the combined state dependence remains significant, although smaller, $F(1,28) = 5.87$, $p = .022$. The error term difference (1.60 vs. 2.83)

is again partly responsible for the apparent significance of only the 1-Name recall test.

CHAPTER 4: DISCUSSION

Overview

The experimental results regarding SDL will be used in order to answer the three fundamental questions raised in the Introduction (page 2):

1. Can this phenomenon be reliably demonstrated with alcohol in man?

2. Do some types of learning tasks show more evidence of SDL than others?

3. Can SDL be demonstrated with tasks that may be relevant to skills used in social interaction?

In addition, a separate section will discuss the findings about the effects of alcohol on learning and memory. Before taking up these issues, the difficulties posed by the first session degree of learning differences will be summarized and interpreted. Their implications for the interpretation of this data and for future studies will be explored.

First Session Degree of Learning Differences

General conclusions. In some tests, groups that were treated alike in the first session showed unanticipated differences in degree of learning. Two pairs of groups

showed failure of equivalence that was significant at the .05 level: the P-P and P-A groups in the 1-Face recognition test, and the A-A and A-P groups in the 6-Name recall test. Failure of equivalence in the 1-Name recall test did not prove significant.

A number of alternate explanations for these differences were considered. Statistical methods were used to test the possibility that these differences were due to real group differences in ability to perform on this type of test (pages 55-56), task-specific group differences in ability or motivation (pages 56-57), statistical regression (pages 59-64), or chance fluctuations in performance (page 57). The conclusions suggested were:

1. The failure of equivalence in the 6-Name recall test was due to chance fluctuations in performance, and poses no problem in interpreting these results.

2. Statistical regression was partly responsible for failure of equivalence in the 1-Face test. Interpretation of the findings about SDL in this test and its contrasts with other tests should be qualified.

Implications for design. Several steps can be taken to minimize the effects of failure of equivalence between similarly treated groups. The same-subject design (in which the same subjects are used in all four groups) or any design which allows performance to stabilize by using practice

tests should decrease these differences. The same-subject design could not have been used here because of the limited number of items that were available. Perhaps the best defense against degree of learning differences is to match the groups with respect to first session performance by not assigning subjects to Session 2 drug conditions until after Session 1. The major practical problem with this strategy occurs in experiments such as this one, in which a large number of dissimilar tests are used.

Fundamental Issues

Reliability of SDL

Can this phenomenon be reliably demonstrated with alcohol in man?

The results of this experiment suggest an affirmative answer to this question. In particular, the similarity between the pattern of results in the 1-Name and 6-Name recall tests (Figures 3, 4, and 5) demonstrates the reliability of SDL. SDL proved to be significant for the 1-Name recall test, but the analysis of the 6_name recall test indicated a significance level of only .15. When the results of the two tests were combined, the analysis indicated that pronounced SDL was present.

The third recall test, a modification of the word recall test that showed SDL when used by Weingartner and Faillace (1971), produced no SDL in this experiment. This

may be related to the fact that Weingartner and Faillace used a same-subject design, which is probably more sensitive than the design used here. It is also possible that their positive results were partly due to failure of equivalence and/or the use of an incorrect analysis; the data presented in the report are insufficient to decide the question (see Cowan, Note 3).

Several studies (see page 9) claimed to have demonstrated SDL using verbal free recall tasks with alcohol or other agents. However, none of these studies used the three-way analysis of variance. This, in combination with the insufficiency of the data presented in some of the reports, produces reservations about accepting their conclusions (Cowan, Note 3). The consistency of the results from the name recall tests in this experiment and the use of the more accurate method of analysis here lend support to the existence of the phenomenon of SDL when the recall paradigm is used.

Task Differences

Do some types of learning tasks show more evidence of SDL than others?

Three hypotheses about specific test differences in SDL were put forward in the Introduction (pages 9-21) and summarized at the end of that chapter (page 24).

Name recall vs. recognition. The only hypothesis that was supported by the results obtained here was the proposition that name recall would show more evidence of SDL than name recognition. In contrast to the recall test that employed the same word list, the 1-Name recognition test produced no SDL. The test x SDL (Session 1 drug state x Session 2 drug state x sessions) interaction was significant, verifying that recall showed more evidence of SDL than did recognition. This conclusion confirms (with improved statistics and a complete factorial design) that of three previous experiments (pages 10-11), which indicated that supplying retrieval cues by employing cued recall or recognition designs decreases or eliminates the SDL shown in free recall.

Retrieval cues can be considered to be elements of "cognitive context", the context that a word gains by being a part of a complex thought (Tulving, 1968; Tulving & Thompson, 1973). It has been firmly established that similarity between cognitive contexts during learning and retrieval maximizes retrieval (for reviews see Tulving & Thompson, 1973; Tulving, 1974); other studies have demonstrated context dependence for external contexts such as testing rooms and their contents (Bilodeau & Schlosberg, 1951; Greenspoon & Ranyard, 1957). The present finding--that supplying a context during retrieval that is similar to

the context during learning decreases the necessity to supply similar states during learning and retrieval in order to produce maximum retrieval--may indicate that state dependence and context dependence interact in determining how information is stored and retrieved. Several authors (Eich et al, 1975; Petersen, Note 7; Weingartner, Adefris, Eich, & Murphy, 1976) have sought to explain SDL as one form of cognitive context dependence. However, evidence drawn from neurophysiological experiments and animal studies of SDL suggests the consideration of a less simplistic explanation. In this explanation, a combination of drug effects on the cell assemblies (patterns of neural excitation and inhibition) that store information in the central nervous system (see John, 1967) and drug-induced context changes is considered to cause SDL (Cowan, 1976; Note 8).

Degree of learning. No effect of degree of learning on SDL was apparent in this experiment. The magnitude of the SDL contrast between the 1-Name and 6-Name recall tests minimized the possibility that this effect is in reality a major one. If one can assume that this failure to find a significant effect indicates that degree of learning really has little effect on SDL, there are two important consequences. First, SDL may be of some importance in many situations encountered in life, in which behavior patterns

such as drug responses have been thoroughly learned. Second, in designing future SDL studies, experimenters need not be overly concerned about minimizing the subject's degree of learning at the risk of producing basement effects.

This insignificant effect of degree of learning forms a marked contrast with previous animal studies (Bliss, 1973; Iwehara & Noguchi, 1972) and with the clinical data which indicate that essential information (such as one's name) is not easily forgotten if the drug state is changed. Several explanations for this apparent contradiction can be suggested. First, a weak effect on SDL--one that would not be evident here because of the limited manipulation of degree of learning that was possible--is, of course, still conceivable. Second, because of the short duration of drug action in the Bliss (1973) study, generalization across drug states could have taken place. Overlearned items may generalize more completely. Third, essential information is no doubt represented in multiple higher order units (because of its occurrence in many contexts), some of which will be less affected by drug state change than others. Only one of these units need be activated with sufficient strength to produce retrieval. In this experiment, learning was done during a short period (12 minutes); in the animal studies practice was distributed over several days (and several

contexts). Fourth, essential information is more thoroughly attended to during learning. It has been suggested that more intense and focussed attention to a particular aspect of an event (elementary information unit) may attenuate SDL of that aspect (Cowan, 1975). The reward or punishment used in teaching the animals may have intensified and focussed their attention. These alternatives will be discussed in detail in a forthcoming publication (Cowan, Note 8); it will suggest that the third and fourth explanations are the more plausible.

Face vs. name recognition. Neither face nor name recognition produced significant SDL here. Although there was some indication from the test contrast that face recognition showed greater SDL, the problems posed by failure of equivalence, novelty effects, and nonsignificant SDL (in either test) support the argument that this statistical trend should not be interpreted as indicating a real difference. The most plausible reason for this negative finding is the lack of sensitivity inherent in the recognition format. Unfortunately, employing the more sensitive recall format for this test contrast involves several serious practical problems (pages 19-20).

Relevance to Skills Used in Social Interaction

Can SDL be demonstrated with tasks that may be relevant to skills used in social interaction?

SDL was apparent in one (or possibly both) of the name recall tests in this experiment. Although name recall is more relevant to social interaction than recall of nonsense syllables, isolated words, or paired associates, participants in social interaction are usually supplied with retrieval cues such as faces or voices when seeking to remember names. Supplying a very powerful retrieval cue, a copy of the name itself (during recognition testing) did eliminate SDL. Tests which simulate the cued recall situation encountered in social interaction may prove to be of intermediate sensitivity. It would seem advisable that laboratory tasks in which faces and/or voices are used as retrieval cues for name recall be developed and used in future SDL experiments.

In contrast, faces are usually recognized in social situations. The 1-Face recognition test showed little evidence of SDL. This failure to demonstrate SDL may indicate that SDL is minimal in situations where face recognition is required. More generally, the results with name and face recognition suggest that SDL is minimal if effective retrieval cues form part of the external or cognitive environment at the time of retrieval. Tests that are relevant to social interaction which use a recall format may be more sensitive to SDL. Further research should concentrate on their development.

Mechanism of Action of Alcohol on Memory

Interpretation of results. Three important results which were predicted in the Introduction were found in this experiment.

First, alcohol given during learning selectively depressed recall, but did not strongly affect recognition. This was apparent in the results from all the individual tests. The summarized data suggest that the selective depression of recall in the 1-Name recall tests occurred in both sessions, although the contrast between tests was only significant in the analysis of the data from the first session. The test contrast that combined both sessions did not show significance. Since one cannot determine which is the better estimate of significance, perhaps the recall--recognition difference is best interpreted as a strong trend. However, recognition was tested five minutes after recall in this experiment. Ryback, Weinert and Fozzard (1970) have shown that forced choice recognition for pictures by subjects given alcohol decreased considerably more than controls in the interval from two to to nine minutes post initial exposure. It is therefore probably safe to assume that the recall-recognition difference is underestimated in this experiment, and is a real effect. It should be noted that supplying retrieval cues also decreased

alcohol's effect in Petersen's (1974) contrast of free and category-cued recall.

Second, retrieval mechanisms do not appear to be impaired by alcohol. None of the Session 2 drug state x sessions interactions for any of the individual tests were significant, indicating that alcohol given during Session 2 did not affect performance, as would have been expected if there was an alcohol-induced impairment of retrieval. Neither the combination of the two name recall tests nor the analysis of the entire experiment show this interaction term as approaching significance. This confirms Jones' (1973) observation that alcohol did not impair retrieval mechanisms in a verbal recall test. Therefore, it is likely that alcohol affects either learning or consolidation during Session 1, rather than retrieval mechanisms.

Third, alcohol selectively blocked the recall of less well learned items (1-Name recall) during both sessions. This, too, is consistent with the hypothesis that alcohol blocks learning or consolidation. Recall can be thought of as sequentially combining search for the previously stored information and the detection of similarity or coincidence between current experience and previous memory (John, 1967; Kintsch, 1970). Retrieval cues supplied during recognition limit the need for search procedures. Weaker traces are differentially affected because they are more easily

disrupted and their strength is closer to the coincidence detection threshold.

Also, although the additional consolidation deficits approached significance only in the 1-Name recall test, all three of the recall tests show a consistent pattern. The combined first session alcohol groups show a greater percentage of forgetting between sessions than the combined placebo groups. This difference, which averages 13.3%, indicates that first session alcohol may be continuing to affect consolidation after the recall test. The recognition tests, as expected, do not seem to be similarly affected--on the average, there is no difference--but this is more difficult to interpret because of the effects of novelty on the second session of 1-Name recognition and failure of equivalence in the 1-Face recognition test. The larger degree of learning difference between placebo and alcohol groups on the recall test may account for some or all of the additional-consolidation difference between recall and recognition. Novelty effects (on the first session) may also complicate interpretation.

Theoretical interpretation. This evidence, in combination with that from previous studies, is best rationalized by hypothesizing that alcohol blocks memory consolidation. Because the shortest study-test interval in this experiment was 2.75 minutes, it is impossible to differentiate here between an alcohol effect on immediate

(seconds) memory and a short term (several minutes) memory deficit, which may involve consolidation effects as well as learning. Both Ryback, Weinert and Fozard (1970) and Jones (1973) found that the alcohol-induced memory deficit increased with time in the 0-10 minute interval, implicating an effect on consolidation. Ryback's (1971) review strengthened this impression. Seven studies were cited in which alcohol had no effect at all on tasks such as digit span, in which the subject is only required to recall the last few items. These items may still be undergoing active rehearsal.

Basing his argument on his data, and Tewari and Noble's (1971) finding that alcohol inhibits brain protein synthesis, Jones (1973) argued that one of alcohol's major effects might be to block the transformation of electrically mediated immediate memory to biochemically coded short and long term storage-- the process of consolidation. Although Tewari and Noble's study demonstrated protein synthesis inhibition only in chronically intoxicated rats, any other acute consolidation-blocking mechanism might be responsible.

Tulving (1968) has suggested a reconceptualization of the unit of memory in an experiment. Although a particular word, name, or face may be all that is given by the experimenter, the subject will encode this elementary unit along with elements of the external and cognitive contexts.

He will encode a whole event, or a "higher order unit". The particular higher order unit mediates the selection of a set of neurons--the cell assembly--which are excited or inhibited, and consequently store the unit. The hypothesized consolidation-blocking effect of alcohol should decrease the coherence and extensiveness of the cell assembly, and therefore lower the strength of all the associations which hold together the higher order unit, causing it to "fragment" into smaller units.

During the search process in recall, the subject can be thought of as starting with a self-generated retrieval cue and using the associative links in a higher order unit which contains that cue to move from element to element until the desired piece of information is located. If the higher order unit is fragmented by alcohol given during learning, subsequent search for a particular aspect of it should be strongly hampered, and search with appropriate retrieval cues less so. Presentation of the strongest retrieval cue, the word itself, in a recognition paradigm, should produce results that are least affected by alcohol. This would account for the observed selective impairment of recall with respect to recognition that resulted from giving alcohol during Session 1 learning, and for Petersen's (1974) similar results.

This hypothesis does not require that alcohol affect retrieval mechanisms, and the possible alcohol-induced additional consolidation deficit observed here might be expected, depending upon hypothetical estimates of consolidation time.

There is a strong similarity between the pattern of alcohol's acute effects on learning and memory (which is apparent in the laboratory experiments that employ medium doses) and the phenomenology of the alcohol-induced "blackout" (which usually occur at higher doses). Blackouts are amnesias which are not state dependent--in the extreme case, the subject cannot recall what happened to him when he was drinking, even if alcohol is given again. Ryback's (1970) report under laboratory conditions established that "subjects could carry on a conversation during the amnestic state, but could not remember what they said or did 5 minutes earlier" (Ryback, 1971, pg. 1003). This finding and the observations by Tamerin, Weiner, Poppen, Steinglass, and Mendelson (1971) indicate a concurrent, and perhaps causal, short term memory deficit similar to that observed in the medium dose experiments. Goodwin (1974) described both "en bloc" blackouts and "fragmentary" memory gaps which can be restored by providing retrieval cues, further strengthening the possibility that a blackout is merely a more complete consolidation block. During the blackout, memory for remote

events (those that occurred before drinking started) is not noticeably impaired; retrieval mechanisms are not affected.

Goodwin, Crane, and Guze (1969a) found that blackouts were associated with high doses of alcohol and with "gulping" drinks, which produces a rapid rate of rise of blood alcohol level (also see Goodwin, Othmer, Halikas, & Freeman, 1970; Ryback, 1970). Stein, Niles and Ludwig (1968) found that blackouts occurred more frequently among binge drinkers, who consume a considerable amount in a short time. Jellinek's (1952) idea that the occurrence of blackouts marks the prodromal phase of alcoholism has come under a good deal of criticism (Goodwin, Crane, & Guze, 1969b). Several subjects interviewed for this study reported their only blackout as occurring during their first major drinking experience. They did not seem to fit the other diagnostic criteria for alcoholism when they were interviewed, several years after the blackout. However, there is evidence of some association between blackouts and the duration and severity of alcohol-related problems (Goodwin et al, 1969b).

Other investigators (Goodwin et al, 1969b; Parker, Alkana, Birnbaum, Hartley, & Noble, 1974; Ryback, 1971) have proposed that several of alcohol's effects on memory may share a common mechanism. The similarity between the effects of a medium dose of alcohol and the phenomenology of

the blackout leads to the hypothesis that the impairment of memory consolidation is responsible for both of these actions.

Implications for research. The suggestion that alcohol blocks memory consolidation opens up the possibility of studying a process in humans which could previously only be approached in animals by using very toxic agents. For this reason, the additional experiments necessary to test this hypothesis may well prove worthwhile. More definitive studies of the time course of alcohol's action on recall, and further investigations in which alcohol's effects on recall, cued recall, and recognition are compared may be reasonable ways in which this problem can be pursued.

APPENDIX A: INSTRUCTIONS TO SUBJECTS

Session 1

Introduction and practice tasks. In the next few hours, I will be asking you to learn several groups of faces, names and words, and testing your memory for them immediately afterwards. I will also test your memory for the faces, names and words 48 hours from now, when you return. Please make sure that you can be here at that time.

A written copy of these instructions is in front of you. Reading along may help make things clearer.

During the next few minutes, please fill out the consent form. I will act as the required witness. Next, check over the "Volunteer Check-In Sheet" which I filled out during our talk on the phone to make sure it is complete and correct. Fill in any blank spaces you see.

(The tape was stopped until the forms were completed.)

Now, complete the health questionnaire, alcohol and drug history questionnaire, and handedness questionnaire I will give you. To help maintain confidentiality, I will give you a number to use in place of your name. From now on, write it in place of your name on every form where your name is called for. Do not fill in your address and phone

number on this health questionnaire. Feel free to ask me about anything which is not clear to you. However, I would appreciate it if you did not talk to or interact with the other volunteer who is being tested with you until the end of the experiment, as I would rather not have you influence his mood, attitude or memory.

(The tape was stopped until the forms were completed.)

You will learn and be tested on four separate tasks today. These involve memory for three different types of things. There will be two men's name tasks and one face task which I will present to you using slides, and one word memorization task which I will present via the headphones. In order to familiarize you with the tasks and methods of presentation, I will give you a practice task using each method of presentation shortly. Please try to pay equal attention to all of the tasks today.

We will now begin the practice task for the slide presentations. You will be shown a series of slides with four names or four faces on them. There will be 20 slides per task. (The subject was shown two pre-practice slides each of names, faces.) The practice task will use face slides similar to this. There will be three non-practice slide tasks--two for men's names and one for faces. Changing the background color on the slides is merely to make them less confusing.

One of the four faces will be designated as the one you will try to remember. Notice the black square with four bulbs on it just below the screen. The machine will indicate which of the four faces you will be asked to learn by lighting the corresponding bulb on the black square--the upper right bulb for the upper right choice, and so on.

For the learning presentations, the slides with the faces will be shown for about 0.8 second, and a blank pink slide will be shown for 2 seconds before the first item and after every item. The bulb for each item will be lit both during the exposure of the item and during the exposure of the pink slide before the item. Because the exposure is brief, I suggest that you look at the square with the bulbs during the preceeding pink slide, and shift your eyes to the appropriate position on the screen before the slide changes. Pay attention only to the face in that position.

Each slide task will have specific instructions about how you are to remember the items. Please follow these instructions as closely as you can, even though they may be difficult at first. Please try to memorize the faces by retaining the visual images in your mind.

These slide presentation tasks will also include testing presentations in which I will again show you slides to prompt your memory. It will not help you to try to remember an item by its order in the learning presentation

or its position on a slide. Both of these will be changed between the learning presentation and the first testing presentation, and between that test and the second testing presentation, 48 hours later. In the time between learning any item and the final test for that item, please try not to think about or rehearse the item.

Please leave your headphones on to minimize distractions. I will show you the learning presentation twice for the practice task. Are there any questions before we begin?

(The tape was stopped while the 20 item learning presentation was shown twice.)

We'll take a 2 minute break now. Please leave your headphones on and relax silently, in order to conserve your energy, and to make sure that all volunteers do the same thing. Please do not think about the faces. Don't read anything--magazines or instructions--during the breaks, unless I say that you can.

(The tape contained 2 minutes of silence here.)

At this point during the name tasks, I will ask you to recall, or write down, the names I will have just shown you. We'll omit this now, and go on to the recognition test.

Please fill in your number on the answer sheet. This is Task #310, Session #1. Please write down the present time in the blank marked "time".

Let me explain what I mean by "interest rating". I'd like to know how interested in this experiment you are at this moment. Would you rate yourself on an interest scale of 0 to 100? Let's call 0 "I am totally uninterested in doing this experiment" and 100 "I have never been as interested in doing anything in my life". Please pick the number which corresponds to how interested you are now and write it down in the blank.

The "high rating" is done in a similar manner. I will want you to describe how strongly you feel like you are high on alcohol, using a 0 to 100 scale--0 for "not at all" to 100 for "as high as I've ever been". Remember that sometimes you do not actually have to drink alcohol to feel high. With that in mind, why don't you rate yourself now?

I will be asking you to rate yourself on these scales before every test. Try to use these scales as consistently and sensitively as you can throughout this experiment, noting even a slight change by changing your ratings.

When I show you this set of slides, please pick out the faces which you were previously asked to remember. During the testing presentations, the lights on the black box will not operate. Notice the crosses on your answer sheet. The four corners of each cross correspond to the four choices which you will see on each slide. Only one of the four faces was pointed out by the light during the learning

presentation. As each slide is shown, pick the choice which you remember as the one previously indicated by the light. For each item, indicate your choice or answer by marking the corresponding position on the cross on your answer sheet--the lower left position for lower left choice, and so forth. Mark your answer with a small x.

Look at the confidence rating scale on your answer sheet. I am interested in finding out how sure you are of each answer. I would like you to estimate how sure you are of each answer by placing a one, two, or three in the position corresponding to the question in the "confidence rating" column on the answer sheet. Since there is no penalty for guessing, mark your answer in the cross when you are guessing, and use a confidence rating of one. Use a rating of two or "probable" even if you can only eliminate one alternative, and are guessing between the other three. Try to be as consistent in using the confidence ratings from task to task as you can.

For the recognition testing presentations, the slides with the faces will be shown for slightly more than 2 seconds, and the blank pink slides will be shown for 10 seconds. To make sure that you are marking your answer opposite the right number, I will count out the item numbers. I'll do that at about the time when you should be

marking your answer, after I've finished showing each item. Are there any questions before we begin?

(The tape contained synchronized counting from 1 to 20 here.)

Would you please hand in your answer sheet?

We will now begin the practice task for the auditory presentation--the word recall task. Rather than confusing you by using 20 words, I am going to read a list of five women's names to you, just to familiarize you with the format. I will read them once for the practice task. Afterwards, I will ask you to write down the names in any order. There are no specific instructions about how you are to remember either of the auditory presentations. Here are the names: Kathy, Diane, Susan, Nancy, Linda. (The names were read with a 2 second interval between them.)

We'll take a 2 minute break now. Please leave your headphones on and relax silently. Please do not think about the names. Do not read anything during these 2 minute breaks.

(The tape contained 2 minutes of silence here.)

Please fill in your number, the time, interest rating, and high rating on the answer sheet. This is Task #810, Session #1. Please ignore the blank marked "Repetition" for all tests.

When I tell you to begin, you will have 1 minute to write down as many of the women's names I read to you before as you can. For the recall tests of the 20 item lists of words and men's names, you will have 4 minutes to do this. Write them down in any order. Since there is no penalty for guessing, please write down a name, even if you are not sure I said it. In future name tests, I will want you to write down a name, even if you are not sure it came from the list you will be being tested on. That's why there are more than 20 blanks on the answer sheet. As before, please assign each answer a confidence rating from one to three, being as consistent as you can. Any questions? Begin.

(The tape contained 1 minute of silence here.)

Please hand in your answer sheet now.

Here is a sheet which will help me to understand how your mood changes throughout this experiment. I will ask you to fill this out twice during this session, and twice during the second session. Please try to be as honest as possible. Fill this sheet out in pencil each time. Write your number in the space, and place the number "one" in the space marked "date". Follow the rest of the directions.

(The tape was stopped until the subjects completed the POMS.)

I will now give you your tomato juice with or without alcohol. There will be two cups for each of you. Please

drink both to the last drop in the next 20 minutes. Try not to leave a lot for the final minutes. Shake the cups occasionally. Do not let either me or the other volunteer know whether you think you had alcohol or not, except via the high ratings. Please try not to interact with your fellow volunteer, and to keep your interaction with me to a minimum, except if you don't understand something. You may relax or read a magazine during the waiting time.

(The tape was stopped for 20 minutes here.)

We will now wait 30 minutes for the alcohol to take effect. I will measure your blood alcohol level three times during the interval, by using the Intoxalyzer down the hall. I will test you one at a time, and will ask the other volunteer to sit outside the Intoxalyzer room while you are being tested. I would appreciate it if you did not try to find out your blood alcohol levels, as these may influence your high ratings. I will gladly discuss these with you after the second session. To help keep track of the results, the volunteer with the lower number will always be measured first.

You will have to breathe through the mouthpiece strongly enough to keep a green light lit until a yellow light comes on. This is difficult. Don't try to breathe more strongly than is necessary to keep the green light on. You may have to take two breaths. Make sure that both

breaths are deep ones and that you exhale completely, so that you will exhale air from the bottom of your lungs. If you have to take a second breath, please hold it for a count of three before exhaling. Try to keep your breathing pattern as consistent as possible throughout the experiment.

(The tape was stopped for 30 minutes here. A blood alcohol measurement followed immediately, and blood alcohol measurements were taken at 10 and 25 minutes after the end of the interval.)

Before we begin, let me briefly review an important point. For the slide presentation tasks, the red light on the black box will indicate which of the four names or faces to remember. Pay attention only to that name or face.

(The tape ended here. The order of the four succeeding tasks was varied across subjects, by recording them on separate tapes.)

Name recognition and recall task: One repetition. This task will consist of a series of slides of men's names, which will be presented for learning once. Please try to memorize the names by repeating them to yourself. Later, I will test both your recall and recognition of these names. Ready to begin?

(The tape was stopped here while the 20 item learning presentation was shown once.)

We'll take a 2 minute break now. Please leave the headphones on and relax silently. Please try not to think about the names.

(The tape contained 2 minutes of silence here.)

Please fill in your number, the time, interest rating, and high rating on the answer sheet. This is the recall test for Task #510, Session #1.

When I tell you to begin, you will have 4 minutes to write down as many of the names I just showed you as you can, in any order. Please assign each answer a confidence rating. Remember to write down all the names which might possibly have been on the set of slides with the white background, as there is no penalty for guessing. Begin.

(The tape contained 4 minutes of silence here.)

Please hand in your answer sheet.

Fill this answer sheet out with your number, the time, and the ratings. This is the recognition test for Task #510, Session #1. Ready?

(The tape contained synchronized counting from 1 to 20 here.)

We'll take a 5 minute break and measure your blood alcohol now.

Name recognition and recall task: Six repetitions. This task will consist of a series of slides of men's names, which will be presented for learning six times. Please try

to memorize the names by repeating them to yourself. Later, I will test both your recall and recognition of these names. Ready to begin?

(The tape was stopped here while the 20 item learning presentation was shown six times.)

We'll take a 2 minute break now. Please leave the headphones on and relax silently. Please try not to think about the names.

(The tape contained 2 minutes of silence here.)

Please fill in your number, the time, interest rating, and high rating on the answer sheet. This is the recall test for Task #610, Session #1.

When I tell you to begin, you will have 4 minutes to write down as many of the names I just showed you as you can, in any order. Please assign each answer a confidence rating. Remember to write down all the names which might possibly have been on the set of slides with the black background, as there is no penalty for guessing. Begin.

(The tape contained 4 minutes of silence here.)

Please hand in your answer sheet.

Fill this answer sheet out with your number, the time, and the ratings. This is the recognition test for Task #610, Session #1. Ready?

(The tape contained synchronized counting from 1 to 20 here.)

We'll take a 5 minute break and measure your blood alcohol now.

Word recall task: One repetition. This task will consist of a series of 20 words. I am going to read them to you once. Afterwards, I will ask you to write down the words in any order. Here are the words: Amount, railway, prince, hole, child, salary, village, justice, product, rain, portion, skirt, deal, stair, plate, surprise, key, river, shadow, family. (The words were read with a 2 second interval between them.)

You may relax silently during this 2 minute break. Please don't think about the words.

(The tape contained 2 minutes of silence here.)

Please fill in your number, the time, interest rating, and high rating on the answer sheet. This is Task #910, Session #1.

When I tell you to begin, you will have 4 minutes to write down as many of the words I just read to you as you can, in any order. Please assign each answer a confidence rating. Remember to write down all the words which might possibly have been on the list, as there is no penalty for guessing. Begin.

(The tape contained 4 minutes of silence here.)

Please hand in your answer sheet. There will be a 5 minute break, and a blood alcohol measurement now.

Face recognition task: One repetition. This task will consist of a series of slides of men's faces, which will be presented for learning once. Please try to memorize the faces by retaining the visual images in your mind. Later, I will test your recognition of these faces. Ready to begin?

(The tape was stopped here while the 20 item learning presentation was shown once.)

We'll take a 7 minute and 15 second break now, in place of a recall test. Please leave the headphones on and relax silently. Please try not to think about the faces.

(The tape contained 7 minutes and 15 seconds of silence here.)

Fill this answer sheet out with your number, the time, interest rating, and high rating. This is the recognition test for Task #410, Session #1. Ready?

(The tape contained synchronized counting from 1 to 20 here.)

We'll take a 5 minute break and measure your blood alcohol now.

Conclusion. I'd like you to fill in the mood description sheet again now. Please use a pencil. Place the number "two" in the space marked "date".

(The tape was stopped until the subjects completed the POMS.)

Although this is the end of today's session, I have several requests to make before you go. Please don't use any drug which might conceivably change your performance between now and next session, particularly right before the session. Try to be adequately rested for the session. And remember the restrictions on eating, using mouth sprays, and using coffee, Coke, or tea for three hours before the next session. Please try not to think about the words, names, or faces between now and next session.

If you wish to suggest to any of your friends that he be a volunteer, please tell him as little as possible about the experiment. In particular, don't tell him anything about what you think the experiment is trying to show, or about your reaction to the experiment. I'd rather not have this influence his performance on the tests.

Those of you who are drunk will have to stay until your blood alcohol level is low enough so that I can release you.

Thanks for participating in this experiment.

Session 2

Introduction and practice tasks. During this session, you will be tested on the four tasks and two practice tasks you learned last time, in the same order they were given. There will be nothing new to learn. The general procedure will be the same as the testing presentations during last session. The time occupied by the learning presentations

last time will be filled by longer breaks, except during the practice tasks. For the recognition tasks, the position of the items on the slides and the sequence of the slides have been rearranged again. In doing the men's name recall tests, I want you to be sure to write down every name that you remember on both tests. People are often wrong about which set of slides a name appeared on, even if they think they are very sure.

Before we begin today's memory tests, I'd like you to take this Embedded Figures Test. Please fill in your number on the booklet, using a pencil.

Now start reading the Directions, which include two practice problems for you to do. When you get to the end of the directions on Page 3, please stop. Do not go beyond Page 3.

(The tape was stopped until the subjects finished the directions.)

I will give you a second test booklet, back cover up, so that you can refer to it, rather than looking at the back cover of your booklet. Write only in your booklet.

Before I give the signal to start, let me review the points to keep in mind: Look at the simple forms as often as necessary. Erase all mistakes. Do the problems in order. Don't skip a problem unless you are absolutely "stuck" on it. Trace only one simple form in each problem.

You may see more than one, but just trace one of them. Trace it completely, including any inner lines. The simple form is always present in the complex figure in the same size, the same proportions, and facing in the same direction as it appears on the back cover of the booklet.

Are there any questions about the directions?

When I give the signal, you will have 2 minutes for the seven problems in the First Section. Stop when you reach the end of this section. Go ahead!

(The tape contained 2 minutes of silence here.)

Stop--whether you have finished or not. When I give the signal, turn the page and start the Second Section. You will have 4 minutes for the nine problems of the Second Section. You may not finish all of them, but work as quickly and accurately as you can. Ready? Go ahead.

(The tape contained 4 minutes of silence here.)

Stop--whether you have finished or not. When I give the signal, turn the page and start the Third Section. You will have 4 minutes for the nine problems in the Third Section. Ready? Go ahead.

(The tape contained 4 minutes of silence here.)

Stop--whether you have finished or not. Please close your test booklet and hand both booklets in.

We will now begin the practice tasks. Please try to pay equal attention to all the tasks today. I will test

your recognition of the white framed faces that you learned last session. Please fill in your number, the time, and the ratings on the answer sheet. Remember to be as consistent and sensitive with the ratings as is possible. Please mark your answer on the cross and write down a confidence rating for each answer. This is Task #310, Session #2. Ready?

(The tape contained synchronized counting from 1 to 20 here.)

Would you please hand in your answer sheet?

I will now test your recall of the practice women's names that you learned last time. Please fill in your number, the time, and the ratings on the answer sheet. This is Task #810, Session #2.

You will have 1 minute to write down as many of the five women's names I read to you as you can, in any order. Please assign each answer a confidence rating. Please write down all the names which might possibly have been on the practice list, as there is no penalty for guessing. Begin.

(The tape contained 1 minute of silence here.)

Please stop now and hand in your answer sheet.

I'd like you to fill in the mood description sheet now. Please use a pencil. Place the number "three" in the space marked "date".

(The tape was stopped until the subjects completed the POMS.)

I will now give you your two cups of tomato juice with or without alcohol. Please drink both to the last drop in the next 20 minutes. Shake the cups occasionally. Again, do not let either me or the other volunteer know whether you think you had alcohol or not. Please try not to interact with your fellow volunteer, and to keep your interaction with me to a minimum. You may relax or read a magazine during the waiting time.

(The tape was stopped for 20 minutes here.)

We will wait 30 minutes for the alcohol to take effect. I will measure your blood alcohol level three times during the interval. I would appreciate it if you did not try to find out your blood alcohol levels, as these may influence your high ratings. I will gladly discuss these with you at the end of the session. Remember that the volunteer with the lower number is always tested first. Try to use the same consistent pattern of deep breathing you did last time. Exhale as completely as you can.

(The tape ended here. The intervals for blood alcohol measurements were the same as during Session 1.

The order of the four succeeding tasks was varied across subjects, by recording them on separate tapes.)

Name recognition and recall task: One repetition. In order to keep the timing of tasks comparable between sessions, we will take a 4 minute break before this task.

You may either read or sit silently. Please leave your headphones on. Try not to think about the test items.

(The tape contained 4 minutes of silence here.)

I will now test your memory for the series of slides of men's names which were shown to you once last session--the ones with the white background.

Please fill in your number, the time, interest rating, and high rating on the answer sheet. This is the recall test for Task #510, Session #2.

You will have 4 minutes to write down as many of the names as you can, in any order. Please include every name which you can remember, even if you're sure it was not on these slides. You can use the confidence ratings to indicate both your certainty about whether the name was there at all, and whether it was on the white slides. Begin.

(The tape contained 4 minutes of silence here.)

Please hand in your answer sheet.

Please fill this sheet out with your number, the time, and the ratings. This is the recognition test for Task #510, Session #2. Ready?

(The tape contained synchronized counting from 1 to 20 here.)

During the next 5 minutes, I will measure your blood alcohol level.

Name recognition and recall task: Six repetitions. In order to keep the timing of tasks comparable between sessions, we will take an 11 minute and 40 second break before this task. You may either read or sit silently. Please leave your headphones on. Try not to think about the test items.

(The tape contained 11 minutes and 40 seconds of silence here.)

I will now test your memory for the series of slides of men's names which were shown to you six times last session--the ones with the black background.

Please fill in your number, the time, interest rating, and high rating on the answer sheet. This is the recall test for Task #610, Session #2.

You will have 4 minutes to write down as many of the names as you can, in any order. Please include every name which you can remember, even if you're sure it was not on these slides. You can use the confidence ratings to indicate both your certainty about whether the name was there at all, and whether it was on the black slides. Begin.

(The tape contained 4 minutes of silence here.)

Please hand in your answer sheet.

Please fill this sheet out with your number, the time, and the ratings. This is the recognition test for Task #610, Session #2. Ready?

(The tape contained synchronized counting from 1 to 20 here.)

During the next 5 minutes, I will measure your blood alcohol level.

Word recall task: One repetition. In order to keep the timing of tasks comparable between sessions, we will take a 3 minute and 20 second break before this task. You may either read or sit silently. Please leave the headphones on. Try not to think about the test items.

(The tape contained 3 minutes and 20 seconds of silence here.)

I will now test your recall for the series of words I read to you last session. Please fill in your number, the time, and the ratings on the answer sheet. This is Task #910, Session #2.

You will have 4 minutes to write down as many of the words as you can, in any order. Please include all words which might possibly have been on the list, and remember to use confidence ratings. Begin.

(The tape contained 4 minutes of silence here.)

Please stop now. During the next 5 minutes, I will measure your blood alcohol level.

Face recognition task: One repetition. In order to keep the timing of tasks comparable between sessions, we will take a 9 minute and 10 second break before this task. You may either read or sit silently. Please leave your headphones on. Try not to think about the test items.

(The tape contained 9 minutes and 10 seconds of silence here.)

I will now test your memory for the series of slides of men's faces which were shown to you once last session--the ones with the black background.

Please fill this sheet out with your number, the time, and the ratings. This is the recognition test for Task #410, Session #2. Ready?

(The tape contained synchronized counting from 1 to 20 here.)

During the next 5 minutes, I will measure your blood alcohol level.

Conclusion. I'd like you to fill out the mood description sheet now. Please use a pencil. Place the number "four" in the space marked "date".

(The tape was stopped until the subjects completed the POMS.)

I'd like to try something different with the mood description sheet before we finish. Please try now to recall as accurately as possible the mood you were in last session

at this time. When you fill out the mood sheet this time, try to duplicate last session's ratings exactly. Place the number "five" in the space marked "date".

(The tape was stopped until the subjects completed the POMS.)

Although this is the end of the formal testing, there is a series of questions I would like to ask you after these reminders.

First, don't let me forget to pay you. Once again, if you have a friend who may be interested in volunteering for this experiment, please try to be as vague as possible with him. In particular, don't tell him anything about what the experiment is trying to show, or about your reactions to the experiment.

Unfortunately, it is necessary for me to remain ignorant of how you scored until all the testing is finished, so that this doesn't influence the way I treat future volunteers. Therefore, I can't tell you how you scored until the experiment is completed. I can, however, review your blood alcohol levels with you. If you are curious about your scores, you can call me after the experiment is over and I'll be glad to tell you.

Those of you who are drunk will have to stay until your blood alcohol level is low enough so I can release you.

Thanks once again for participating.

APPENDIX B: FORMS AND ANSWER SHEETS USED

VOLUNTEER CHECK-IN SHEET

1. Name_____
2. Phone Number_____
3. Age_____
4. How did you hear about this experiment?_____
5. What is the highest year of school you have completed? _____ Are you currently studying?_____

   Area of study_____
6. Which hand do you use primarily?_____

   Do you usually do anything important with your left hand in preference to your right hand?_____
7. Are you Caucasian (white)?_____
8. Do you have any significant medical problems?_____

   Have you had any significant medical problems?_____

   If yes, what?_____
9. Do you regularly take any drug or medication for a health problem?_____ If yes, what?_____
10. Do you currently have a cold or flu?_____

    Have you had one in the last week?_____
11. Are you presently taking any drugs such as cough syrup, cold or allergy tablets, diet pills, tranquilizers, etc.?_____ If yes, what?_____
12. Do you smoke cigarettes?_____ How often?_____
13. Do you use any illegal drugs frequently?_____

    If yes, what?_____ How often?_____

14. What is the maximum amount you drink on one occasion?

    Beer_____ Wine_____

    Liquor/Mixed Drinks_____

15. What is the average total amount consumed per week?

    Beer_____ Wine_____

    Liquor/Mixed Drinks_____

16. Have you ever had occasions when you couldn't remember what happened while drinking?_____

17. Has a doctor ever told you not to drink?_____

18. Have you ever been in a fight while drinking?_____

19. Is it difficult for you to stop drinking after one or two drinks?_____

20. Have you ever had a hang-over?_____ What percentage of the time after consuming alcohol do you get hang-overs?_____ How long does the hang-over last?_____ Do you drink to "cure" a hang-over?_____

21. Why are you interested in this experiment?_____ _____ Do you think that you will find it hard to maintain your concentration while drunk or sober at a structured task that you may not be that interested in?_____ Do you agree to pay very careful attention throughout the experiment?_____

22. Were provisions for payment and bonuses explained to you?_____

23. Precisely how much is your current weight?_____

24. Are there any limits on your availability?_____

25. Dates of testing_____ Hour(s)_____

26. Were you given the address and emergency phone numbers?

_____

27. Were you asked not to eat, use mouth spray, drink tea, coffee, or cola for 3 hours before the experiment? Not to use alcohol or drugs for 48 hours before the experiment?_____ Did you follow the request?_____

If not, what exceptions?_____

28. Were provisions for dinner explained to you?_____

29. Were you asked to get adequate rest?_____

Are you adequately rested?_____

30. Were you asked not to drive or bike to the experiment?

_____ Did you?_____

Department of Psychiatry
UNIVERSITY OF CALIFORNIA
San Francisco, California

CONSENT TO ACT AS A SUBJECT FOR
RESEARCH AND INVESTIGATIONS

Project #720107A

Subject's Name:_____Date:_____

1. I hereby authorize Jonathan Cowan or Dr. Paul Ekman and any staff assistants selected by them to perform the following proceedures and investigations:
   To administer various doses (3-5 shots) of alcohol or a placebo.
   To take a history of my health, handedness, and alcohol and drug use for use in the experiment only.
   To study my memory for faces, names, and words, my mood, and my performance on the Embedded Figures Test.
   To determine blood levels of alcohol by using an Intoxalyzer or Breathalyzer test.

2. The proceedures and investigations listed in paragraph #1 have been explained to me by Jonathan Cowan, and I understand that he, Dr. Paul Ekman, and the laboratory staff will answer any inquiries I have at any time concerning them.

3. I understand that this study is for experimental purposes only and is not part of any treatment program. I understand that participation in this study involves the following possible risks and discomforts:
   Alcohol may cause nausea, loss of inhibitions, occasional impulsive and agressive behavior, drowsiness and impaired coordination after administration, and even after the termination of each session. I agree to remain under observation until it is felt to be safe and in my best interests to leave the laboratory, even if this is longer than the amount of time originally specified for the experiment (see below). I agree to abstain from driving and operating mechanical equipment except when given permission by the experimenter. If I should have a severe reaction to the alcohol, I understand that facilities in Langley Porter Neuropsychiatric Institute will be made available for my care.

4. I understand that this experiment will further knowledge of drug effects on human memory and consciousness.

5. I understand that my full participation in this experiment will require attendance at two sessions, each to be held at Langley Porter Neuropsychiatric Institute. These sessions will last approximately 3 1/2 or 6 hours each, depending on whether I am given placebo or alcohol, respectively; I realize that I will have no choice as to which I will be given. I am aware that the time interval between the two sessions is of critical importance. I have discussed my schedule with the laboratory staff, and appropriate times have been agreed upon. I am aware of the restrictions placed upon my between-session drug taking, and agree to abide by them. I understand that I may terminate my participation in the study at any time without incurring the predjudice of the investigators, and that the investigators may terminate my participation at any time. I understand that my participation in both of the specified sessions at the specified times will entitle me to compensation of $16, $22, or $28 for my time and effort, depending on whether I am given alcohol or placebo at each session. In the event that my participation is terminated by me or the investigator, I will be entitled to $2 an hour for each hour of actual experimentation.

6. I certify that my current age is _____.

7. I understand that medical treatment records are subject to subpoena. Although the investigators will expend every effort to maintain the anonymity of the subject and the confidentiality of the data, these cannot be guaranteed since records of research programs are subject to subpoena.

_____

Subject's Signature

_____

Witness

ALCOHOL AND DRUG QUESTIONNAIRE

Please fill out the following chart for all drugs that affect the mind, legal or illegal, prescribed or not, which you have used. For each kind of drug listed, fill in underneath it the specific drugs or forms which you usually use(d), including drugs such as LSD or MDA, and forms such as "grass" or "hash". List more than one drug or form wherever it is necessary, and use the space under "Others" if you run out of room.

For each drug or form, please indicate the year you started to use the drug, the year your use peaked, and the year it ended, using the following form: '67/'70/'73. Use a dash to fill in the spaces when the question is not relevant--if your use has not really peaked, or if you are still using the drug or form: '67/---/---. Indicate the approximate frequency of use per week during the peak period and now by a similar form, but include the units (cups, joints, cigarettes, pills, lines, shots, etc.) wherever possible for each drug or form: 10 joints/4 joints. If you use(d) the drug or form less than once a week, give the approximate frequency per year, and indicate this by writing "per year". Any information which you can write in this column about average dose per use will be appreciated.

Under the column marked "Sensitivity", rate your present sensitivity to the effects of the drug or form compared to men of your approximate age and weight. Have you noticed that you are particularly sensitive to the drug or form? Have you built up a tolerance to it? Indicate this by using a 1 to 5 scale: 1 for "very sensitive", 2 for "sensitive", 3 for "average", 4 for "insensitive", and 5 for "very insensitive".

Please ask if you have any questions.

DRUG OR FORM:	YEAR STARTED PEAKED/ENDED	FREQUENCY PEAK/NOW	SENSI-TIVITY
Stimulants:			
Coffee			
Tea			
Cola			
Cocoa			

DRUG OR FORM:	YEAR STARTED PEAKED/ENDED	FREQUENCY PEAK/NOW	SENSI-TIVITY
Nicotine:			
Psychedelics:			
Sedatives or Tranquillizers:			
Narcotics:			
Alcohol: Beer			
Wine			
Liquor/Mixed			
Marijuana:			
Others:			

1. How much do you drink at a time on the average?

   Beer_____ Wine_____

   Liquor/Mixed Drinks_____

2. What is the average total amount consumed per week?

   Beer_____ Wine_____

   Liquor/Mixed Drinks_____

3. Have you used more or less in the last six months than you used previously?_____

4. Have you ever had so much to drink that you became "sick to your stomach"?_____

   If yes, how much was that?_____

   How often?_____

6. Have you ever passed out from drinking?_____

7. Have you ever had occasions when you couldn't remember what happened while drinking?_____

8. Have you ever been in a fight while drinking?_____

9. Have you ever been arrested for drunken driving or for being drunk?_____

10. Is it difficult for you to stop drinking after you have had one or two drinks?_____

11. Have you ever had a hang-over?_____ What percentage of the time after consuming alcohol do you get hang-overs?_____ How long does the hang-over last?_____ Do you drink to "cure" a hang-over?_____

12. Have you ever felt that you were "allergic" to alcohol (had unusual symptoms as a result of drinking)?_____

13. Have you ever noticed changes in your memory brought about by drug use which lasted after the drug had worn off?_____ If yes, which drug?_____

    How long did it last?_____

HANDEDNESS QUESTIONNAIRE

Name_____

Please indicate your preferences in the use of hands for the following activities by putting a + in the appropriate column. Where the preference is so strong that you would never try to use the other hand unless absolutely forced to, put a ++. If in any case you are really indifferent put a ++ in both columns.

Some of the activities require both hands. In these cases the part of the task or the object for which hand preference is wanted is indicated in parentheses.

Please try to answer all the questions, and to only leave a blank if you have no experience at all with the object or task.

	LEFT	RIGHT
1. Writing		
2. Drawing		
3. Throwing		
4. Scissors		
5. Toothbrush		
6. Knife (without fork)		
7. Spoon		
8. Broom (upper hand)		
9. Striking Match (match)		
10. Opening Box (lid)		
I. Which foot do you prefer to kick with?		
II. Which eye do you use when using only one?		

HEALTH QUESTIONNAIRE

Name_____ Age_____

Address_____ Birthdate_____

_____ Height_____

Phone Number_____ Weight_____

1. Are you employed? Full-time_____ Part-time_____ Student_____ No_____ What kind of work do you do? _____ What kinds of work have you previously done?_____

2. What is the highest year of school you have completed? _____year of_____(high school, college, graduate school, professional school, other). What was the highest degree awarded to you?_____ Are you currently studying? Full-time_____ Part-time _____ Your area of study?_____

3. What other activities or hobbies have you had in the last five years?_____

_____

4. Have you ever had an EEG exam or had brain waves recorded?_____ If yes, why?_____

5. Do you wear glasses or contact lenses?_____ If yes, are you near sighted or far-sighted?_____ Is the problem perfectly corrected?_____ Do you have any other problems with your vision?_____ If yes, explain_____

6. Do you have any hearing problems?_____ If yes, explain_____

7. Do you experience fainting spells?_____ Epilepsy or convulsions?_____ If yes, how often?_____

8. Have you ever had: Any disease of the nervous system? _____ Any major head injuries?_____ Heart trouble or stroke?_____ Brain tumor?_____ Diabetes?_____ Peptic or other ulcers?_____ Paralysis?_____ Balance or control difficulties? _____ If yes, explain_____

9. Have you ever been hospitalized for psychiatric problems or suffered a "nervous breakdown"?_____

10. Do you regularly take any drug or medication (prescribed or not) for a health problem?_____ If yes, what?_____

11. Do you currently have a "cold" or "flu"?_____ Have you had one in the past week?_____

12. Are you presently taking any drugs such as cold tablets, cough syrup, diet pills, tranquilizers, etc? _____ If yes, what?_____

13. Are you presently on a restricted diet (salt-free, high protein, macrobiotic, etc.)?_____

14. Do you have any health problems I have failed to ask about?_____

RECALL TEST

Name_____ Time_____ Task #_____

Interest Rating (0 to 100)_____ Session #_____

High Rating (0 to 100)_____ Repetition #_____

Please write down the word or name and indicate your confidence that that answer is both correct and on the right list by using the following scale:

1 = I am guessing that both are true.

2 = It is probable that both are true.

3 = I am certain that both are true.

Word or Name:	Confidence Rating:	Word or Name:	Confidence Rating:

RECOGNITION TEST

Name_____ Time_____

Interest Rating (0 to 100)_____ Task #_____

High Rating (0 to 100)_____ Session #_____

Please mark the position of the cross corresponding to your answer and indicate your confidence in that answer by using the following scale:

1 = I am guessing that this is the correct answer.

2 = It is probable that this is the correct answer.

3 = I am certain that this is the correct answer.

	Answer:	Confidence Rating:		Answer:	Confidence Rating:
1.	+	_____	11.	+	_____
2.	+	_____	12.	+	_____
3.	+	_____	13.	+	_____
4.	+	_____	14.	+	_____
5.	+	_____	15.	+	_____
6.	+	_____	16.	+	_____
7.	+	_____	17.	+	_____
8.	+	_____	18.	+	_____
9.	+	_____	19.	+	_____
10.	+	_____	20.	+	_____

APPENDIX C: DEVELOPMENT OF FACE RECOGNITION TASKS

Picture Selection

As employed in the study described in this dissertation, the 1-Face task and the practice task (2-Face) were both composed of 20 items. The items were developed in two stages, because the pilot test data forced an increase in the number of items. Thirty-two items were selected from the University of California, Berkeley yearbook, the Blue and Gold for 1971. Because there were no further suitable pictures available, the second group of eight items was selected from the Stanford University Quad for 1970. At each stage, the items selected were distributed equally and randomly between the 1-Face and 2-Face tasks, to minimize any differences between item sets.

To maximize right--left hemisphere porcessing differences between these tasks and the name tasks, it was considered important to develop items with four choices selected and matched so as to decrease the likelihood that the subjects could learn the faces successfully by using the strategy of verbally coding the differences among them. In order to minimize stimulus selection (remembering a face by abstracting a feature such as hair color) and the verbal

coding ("the blonde") which often results, and stimulus isolation (remembering a distinctive face more strongly), several procedures for selecting and matching the faces were developed.

First, only male pictures were used. Preliminary work confirmed Witryol and Kaess' (1957) finding that there is an ipsisexual superiority in facial recognition. Also, differences between the sexes in the distribution of alcohol are likely because males have a lower proportion of body fat, in which alcohol is only slightly soluble. This forced the study to be limited to one sex or the other. Therefore, the subjects and photographs in the study were limited to males. For similar reasons, detailed in Chapter 2, both subjects and photographs were further limited to Caucasians. Photos which were found to be too uniquely distinctive because of unusual hair style, huge beards, or strange costumes that could not be eliminated by tightly framing the photographs were eliminated from selection for these items.

Item Construction

The remaining photographs had a number of characteristics which might be easily selected and verbally encoded. These included hair color, presence or absence of glasses, presence or absence of facial hair, hair length and preparation, texture of hair (wavy, kinky, straight, etc.), location of part, direction of gaze, presence or absence of

an open-mouth smile, skin tone, attractiveness, and head size and shape. The basic procedure that was followed was to select and match the stimuli in each item so that either none, two, or four of the four faces had each of the attributes detailed above.

The three attributes which seemed to be the most obvious--hair color, glasses, and facial hair--were simultaneously paired across faces. The stimulus photographs were initially sorted according to hair color (light or dark). Each of these groups was then subdivided into those with or without glasses, and these groups further subdivided into those with or without facial hair. To match the photographs in each item, two pairs were selected, each pair from one of the eight resulting groups. The distribution of faces in these groups was strongly skewed; it was therefore impossible to use any simple random procedure to pick which groups the two pairs were to be selected from. A simple random procedure would have caused the smaller groups to be exhausted first, leading to differences in homogeneity of stimuli between those items completed earlier and later in the matching process. The 1-Face and 2-Face tasks might have become less comparable in difficulty as a result. More complex objective randomization procedures for group selection would not have permitted enough flexibility to satisfy the other matching

criteria without great difficulty. A subjective randomization procedure was therefore used. An effort was made to use the larger groups of faces at a more rapid rate, and to vary the pairing of groups from which the pairs were selected.

The other distinguishing characteristics were paired by two methods. In picking the pair of faces from each group, particular care was taken to create similarities in hair length, preparation, texture, kind of facial hair (mustaches or beards), attractiveness, and general appearance. After both pairs had been selected, the four photos were checked to make sure that there were no photos in the set that were unique in direction facing, location of part, open mouth smile, or skin tone.

Black and white frames were constructed so that each of the faces occupied one corner of an approximately square 2x2 array. Each set of stimulus photos was mounted on an index card, and aligned with the frame so that only the area from the chin line up could be photographed. This was done in order to minimize the use of costume cues. Each set was photographed with the faces in three different orders, one for each of the three presentations planned. The rearrangements were random, with the restriction that any rearrangement which resulted in two or more faces being in

the same position as a previous arrangement was not permitted.

Four items derived from the Stanford pictures and 16 derived from the Berkeley pictures were assigned to each task randomly. In order to decrease intertask interference, the slides for the 2-Face task were photographed with the white frames and those for the 1-Face task were photographed with the black frames.

The half-tone yearbook pictures were photographed using a continuous tone Polaroid process, and mounted in 2" x 2" metal slide mounts. To produce a square projected image, black tape was placed on the slide mounts so that it covered the blank area of each slide.

The Stanford photographs had been selected because they were approximately the same in quality and finish as those from Berkeley, with only a slight difference in size. By adjusting the scale of the Stanford frames, and applying a greater reduction in photographing the Stanford slides, the Stanford items were made indistinguishable from the Berkeley items.

Item Ordering

Previous literature (summarized in Hall, 1971), and the results of preliminary pilot studies, indicated that there was a strong possibility of a serial order effect during both the learning and testing presentations. In serial

anticipation verbal learning experiments, which are somewhat similar to the recognition paradigm, it is generally found that items near the beginning and end of both the learning and testing presentations tend to be learned or recalled more strongly than those from the middle of the presentations. In order to avoid compounding these item order effects between the learning and testing presentations, and to allow the study of serial position effects separately in both presentations, a special method of ordering the items was devised. This special ordering was done for both facial recognition tasks.

Items 1-8 and 19-20 in a given presentation were designated "high recognition" items, and items 9-18 were designated "low recognition" items, as the literature indicated that this is the anticipated result. Items from the high recognition and the low recognition sets during the learning presentation were alternated in ordering the items for the testing presentation. Analogously, the odd items during the learning presentation became the low recognition sets during the testing presentations, and the even items became the high recognition sets.

Insuring Uniform Processing

To further minimize the possibility of both stimulus selection and verbal coding, two additional steps were taken. Minimizing the presentation time of each slide

decreases the subjects' chance to select a facial feature and encode it verbally. The presentation time for learning was reduced to 0.8 second. This was found to be sufficient for the subjects to perceive the stimulus, but additional time was necessary to inform the subjects which stimulus they were to learn. Accordingly, a series of blank slides were constructed by framing pink stage lighting gelatin. These blank slides were placed before each of the items in the set, and after the last item. The pink slide was shown for 2 seconds, and the chosen stimulus communicated to the subjects by the procedure described in Chapter 2.

The special instructions about memorization which were devised in order to minimize stimulus selection and verbal coding were also described in Chapter 2.

APPENDIX D: DEVELOPMENT OF NAME RECALL AND RECOGNITION TASKS

Name Selection

The 40 items for the 1-Name and 6-Name tasks were constructed in three stages--two stages of 16 items each, and a third stage in which an additional eight items were developed. The methods for selecting the male names differed slightly for each stage.

Two major considerations restricted the selection of names: frequency of occurrence and name length. Frequency of occurrence in language is known to affect both recall and recognition of words (for a review, see Hall, 1971). Differences in length between names used in an item may conceivably serve as a reason for stimulus isolation or an obvious recognition cue. The names were therefore matched on frequency of occurrence in present day Caucasian America. The names used for the first two stages of item construction were limited to names or nicknames of one syllable.

First selection. There were two sources of frequency of occurrence data for the first selection of names. These were a frequency distribution of male, one syllable names derived from the names of the yearbook photographs in the

University of California, Berkeley yearbook, the Blue and Gold, for 1969-71, and a compilation of the most popular names for children by Newton, which appeared in the 1921 World Almanac and Encyclopedia (Newton, 1920). The frequency distribution from the Berkeley Blue and Gold consisted of a limited sample of about 1,500 names. Although small, this sample had the advantage of being from a group of people very similar to the subjects used in this experiment. Newton's list was compiled from 100,000 names in biographical dictionaries, Army and Navy registers, Masonic rosters, and the Detroit City Directory. The sample size was large, but the list was rather dated, and was used with discretion.

The 64 names that were necessary were therefore divided into four quartiles in order of descending frequency of occurrence. The criteria for membership in each quartile were set in such a way that more than half of the names were selected because of their frequency of occurrence in the Berkeley list, and the rest were chosen from Newton, after duplicates were eliminated. All appropriate names which occurred two or more times on the Berkeley list and most of the usable names from Newton's list were exhausted by this procedure.

In selecting the names from these lists, the most commonly used version of the name or nickname was chosen,

within the syllable limitiation. This was frequently a matter of judgement. Another problem occurred if a commonly used name was associated with an uncommonly used one syllable nickname (eg. Chuck with Charles) or even two nicknames (eg. Dick and Rick for Richard). The use of similar names or nicknames was allowed if they sounded differently (eg. Dick, Rick), but not if they were just spelled differently (eg. John, Jon). Names that were both masculine and feminine (eg. Pat, Chris) were eliminated from the lists.

Second selection. The second selection of 16 additional items was drawn from those names which occurred once in the Berkeley list and all names which occurred more than once per 4,000,000 entries in the compilation of Thorndike and Lorge (1944). Frequency data from Thorndike and Lorge had to be corrected because many first names are also used for last names and for other language functions (eg. Grant). The names or nicknames were divided into frequency quartiles by using the Thorndike-Lorge data and a subjective impression of how the popularity of names has changed since then.

Third selection. In order to add the eight additional items required for the third selection, it was necessary to remove the restriction against names of more than one syllable. Names of more than one syllable but less than

eight letters were obtained from the Berkeley, Newton, or Thorndike-Lorge lists, after those names which had been previously used (as nicknames) had been eliminated. From the combined list of names and frequencies, the 32 names with the highest frequency of occurrence were selected and arranged according to frequency. Two lists of 16 two or more syllable names or nicknames were obtained by this procedure.

Item Construction

These lists, as well as the eight 16-word "frequency quartiles" from the previous stages, were converted into four items apiece. This was done by using a randomized matching procedure designed to assure that the names in each item were not clustered alphabetically, as clustering may also provide cues for memory. As part of this procedure, two names which began with the same letter were excluded from forming part of the same item.

Each of the four items was typed on an index card, with the names arranged in a square 2x2 array, similar to that used in arranging the faces. Three arrangements of each item were typed, with the restrictions on rearrangement the same as those described in Appendix C for the faces. The index cards were photographed using a high contrast Polaroid process, and mounted in 2" x 2" metal slide mounts. Black

tape was again placed on each slide mount to produce a square image.

Eight items from the first stage, eight from the second stage, and four from the third stage were randomly assigned to each task. Each group of four items originating from the frequency quartiles was equally divided between the tasks. To reduce inter-task interference, a black frame was constructed and used in photographing all slides for the 6-Name task. The slides for the 1-Name task were photographed with the white background provided by the index card.

Item Ordering

In order to examine name frequency effects, and to minimize their interaction with item order effects, the following procedure was employed. The name items in both tasks were divided into "frequent" and "infrequent" subgroups. The frequent subgroups consisted of items constructed from the three most frequent quartiles of the first stage, the most frequent quartile of the second stage, and the most frequent half of the third stage. The infrequent subgroups were composed of the remaining items. Because a simple alternation of frequent and infrequent items would confound the frequent-infrequent difference with an order effect, a slightly more sophisticated ordering was employed for all three presentations of both tasks. Pairs of frequent and infrequent items were formed, and the pairs

were placed in a random order. The order of the items within the pairs was then randomly determined, with the restriction that five pairs in each presentation were arranged "frequent-infrequent" and the remainder "infrequent-frequent".

Insuring Uniform Processing

In order to minimize the possibility that the subject would form images of people (friends, etc.) or other verbal or non-verbal associations, and use these as mediators, several precautions similar to those described for the faces were taken. The steps taken to reduce exposure time were described in Appendix C, and the special memorization instructions were quoted in Chapter 2.

APPENDIX E: GUESSING AND RELIABILITY

The use of the subjective confidence ratings in all of the memory tests increases the flexibility of the possible analyses, in that the data may be analyzed both including and excluding the results of guessed answers (those with confidence ratings of 1). In order to select the most appropriate analysis, the reliability of the two measurements was compared. Split half reliabilities were calculated for the results of the first session of each test, because immediate test-retest measures were not available for all tests. Alternating split halves were used in the name recognition and recall tests. Because the arrangements of items that were used in the face recognition tests were related in a non-random manner to the arrangements in the learning presentation (see Appendix C), pairs of item numbers were alternated between halves to produce the random relationship between halves that is required. All reliabilities that are reported have been corrected to 20 items by use of the Spearman-Brown formula. As it is possible that alcohol given during the first session may affect the reliability of the measurements, the most appropriate method for comparing reliabilities across

scoring methods is to combine separately calculated split half reliabilities for the alcohol and the placebo groups. Fischer's (1958) z transformation (z here is distinct from the standard score) was used to normalize the distribution of the correlation coefficient, the two z transformations were averaged, and a combined reliability was calculated.

Recognition Tests

Face recognition. The split half reliabilities and Fischer's z's of the measurements (number correct) with and without guesses for the face recognition test are shown in Table 11.

Table 11

Reliabilities and Fischer's *z* Transformations for Two Measurements of the One Repetition Face Recognition Test

Score	Placebo	Alcohol	Combined
Including guesses			
r	.334	-.019	.158
z	.337	-.018	.160
Excluding guesses			
r	.685	.540	.605
z	.816	.587	.702

The average Fischer's *z* for the scores including guesses is .160, corresponding to a reliability of .158; the average *z* for the measurement excluding guesses is .702, which corresponds to a reliability of .605. Error variances for the two measurements are .975 and .634, respectively. Excluding guesses produces a considerable improvement. The standard error of the average *z*, which depends only on the number of observations in the pooled groups, is .139. Although there is no exact test for comparing reliabilities or their *z* transformations in the same sample, the *z* differ-

ence of .542 seems not insignificant in comparison with the standard error of an individual measurement.

Name recognition. Table 12 shows the corresponding figures for the 1-Name recognition test.

Table 12

Reliabilities and Fischer's *z* Transformations for Two Measurements of the One Repetition Name Recognition Test

Score	Placebo	Alcohol	Combined
Including guesses			
r	.135	.715	.466
z	.132	.879	.505
Excluding guesses			
r	.720	.702	.710
z	.888	.855	.871

The average Fischer's *z* for the measurement including guesses is .505. This corresponds to a reliability of .466. Once again, the measurement without guesses is more reliable (average *z* = .871, *r* = .710), and the *z* difference (.366) is substantial in comparison to the standard error. The error variances are .783 and .505, respectively.

Conclusion. It is possible that part of the reason that the measurements which exclude guesses are more reliable is a result of the subject's consistency in the process of guessing, rather than the improvement in mensuration that excluding guesses produces. Also, the reliability of the measurements excluding guesses may be slightly inflated due to possible tendencies for the subjects who are doing well to adopt a strict criterion (say that they are guessing less) and for those who are doing badly to adopt a loose criterion (be less confident than their answers warrant). However, it seems unlikely that these two effects are responsible for all of the considerable improvement realized by excluding guesses. It is also difficult to imagine that changing or not changing states will influence the process of labelling guesses, although alcohol itself may do so. Therefore, measurements which excluded guesses were used in further analysis. Analysis of variance tables for the important effects with guesses included are found in Appendix F.

Recall Tests

There is very little difference between the measurements with and without guesses for two of the recall tests, the 1-Word recall test and the 6-Name recall test. Correct guesses comprise only 1.6% and 2.0% (respectively) of the total correct answers, indicating that the measures

are nearly equivalent, and making the choice of measures arbitrary. The scores with guesses excluded were used for further analyses.

One repetition name recall. In contrast, 11.8% of the correct answers to the 1-Name recall test were labelled as guesses by the subjects. This probably indicates that the subjects were less certain of the identity of the list on which the names for this test were presented. The alternate hypothesis, that the subjects marked lower confidence ratings because they were less sure that the names had been used as stimuli, is inconsistent with the much smaller percentage of correct guesses during the 1-Word recall test, in which subjects were sure about list membership. Therefore, the scores including and excluding guesses may represent theoretically different measurements. The measurement excluding guesses may contain information about the subjects' memory of the list membership of the names, in addition to information about their memory for the names.

The reliabilities and Fischer's z's of the scores with and without guessing are shown in Table 13.

Table 13

Reliabilities and Fischer's *z* Transformations for Two Measurements of the One Repetition Name Recall Test

Score	Placebo	Alcohol	Combined
Including guesses			
r	.574	.807	.700
z	.638	1.097	.868
Excluding guesses			
r	.549	.810	.693
z	.603	1.107	.855

Average Fischer's *z*'s for the measurements with and without guesses were .868 and .855, respectively. These correspond to reliabilities of .700 and .693, and error variances of .510 and .520. The difference between the *z* transformations (.013) is very small compared to the standard error of .139. Because of the size of the difference and the possibility that the two measurements are theoretically different, it seems most appropriate to include both sets of measurements in presenting results from this test.

APPENDIX F: ANALYSIS OF VARIANCE TABLES FOR THE RECOGNITION MEASUREMENTS INCLUDING GUESSES

The order factor is not included here, except as noted. There is 1 degree of freedom in the numerator; the denominator has 28 without order, 16 with order.

	F Ratio	Significance Level
Face Recognition Test		
Drug State - Session 1	2.45	.128
(with order included)	5.35	.034
Drug State - Session 2	4.14	.051
(with order included)	5.90	.027
Additional Consolidation Deficit	2.19	.150
Forgetting	7.70	.010
SDL	1.23	.276
Name Recognition Test		
Drug State - Session 1	1.82	.187
Drug State - Session 2	.07	.793
Additional Consolidation Deficit	1.76	.195
Forgetting	7.05	.013
SDL	.63	.432

APPENDIX G: CONTRASTS BETWEEN THE ONE REPETITION NAME AND WORD RECALL TESTS

Despite the marked differences in the stimuli and mode of presentation used, there are no significant differences between the newly constructed 1-Name recall test, and the 1-Word recall test, which was modified from Weingartner and Faillace (1971). This is true even if the scores which exclude guesses are examined, as is done here. Excluding guesses should tend to maximize any differences between the tests, since only in the 1-Name test can guesses be indicated because the subject is uncertain about list membership.

Test differences. The overall difference between the pattern of scores on the two tests approaches significance more closely than any other comparison, $F(1,28) = 3.08$, $p = .090$.

Drug effects. The effect of alcohol given during Session 1 on the results of both sessions does not differ between tests, $F(1,28) = 1.57$, $p = .22$. The contrast between the two additional consolidation deficits is not significant, $F(1,28) = .52$, $p = .47$, as is the contrast between the two Session 2 drug effects, $F(1,28) = .03$, $p =$

.84. Although only the 1-Name test produced significant SDL, the SDL difference between the tests is not significant, $F(1,28) = 1.57$, $p = .22$.

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