1982

The effects of basic level category information on immediate and delayed recognition memory in two-year olds.

Carolyn Greco
University of Massachusetts Amherst

THE EFFECTS OF BASIC LEVEL CATEGORY INFORMATION ON IMMEDIATE AND DELAYED RECOGNITION MEMORY IN TWO-YEAR-OLDS

A Thesis Presented

By

CAROLYN GRECO

Submitted to the Graduate School of the
University of Massachusetts in partial fulfillment
of the requirements for the degree of

MASTER OF SCIENCE

May 1982

Psychology

THE EFFECTS OF BASIC LEVEL CATEGORY INFORMATION ON IMMEDIATE AND DELAYED RECOGNITION MEMORY IN TWO-YEAR-OLDS

A Thesis Presented

By

CAROLYN GRECO

Approved as to style and content by:

Marvin W. Daehler, Chairperson of Committee

Nancy Myers, Member

James I. Chumbley, Member

Bonnie R. Strickland, Department Head
Psychology

ACKNOWLEDGEMENT

I wish to express my gratitude to Dr. Marvin W. Daehler, my thesis advisor, for his knowledgeable contributions and continued guidance and support throughout this project. I would also like to thank Dr. Nancy A. Myers and Dr. James I. Chumbley, my committee members, for generously giving their time and valuable comments in all phases of this research. Thanks are also due to Scott Jervis and Jocelyn Pitts for their help in subject recruitment and testing. Finally, I want to thank my husband, Michael Vigorito, for his helpful comments, patient assistance with CYBER, and mostly for his constant support throughout my graduate training.

ABSTRACT

Sixty-four 24-month-old children were tested for memory of basic level category knowledge in a paired-comparison recognition task immediately and one week after familiarization with the categories. Subjects were randomly assigned to one of two familiarization conditions and one of two test conditions. In one familiarization condition (Single Exemplar) four instances of one exemplar of each of 16 basic level categories were presented. In the other (Varied Exemplar), four different exemplars of the category were presented to subjects. Test trials paired either an exemplar seen during familiarization (Familiar Exemplar Test) or an unfamiliar intracategory exemplar (Unfamiliar Exemplar Test) with a novel category stimulus. Preferences for novel over familiar categories occurred for all subjects regardless of which familiarization or test condition they experienced. More importantly, memory for the categories was evidenced by nearly all subjects even one week after the brief initial exposure to the stimuli. Subjects receiving only one exemplar of the category were able to abstract and retain information about that category for as long a period of time as subjects receiving varied exemplars of a category.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

CHAPTER I

INTRODUCTION

There is a clear consensus among researchers that infants and very young children exhibit visual recognition memory. In most cases, this conclusion has been inferred from observations of children's visual preferences for novel, previously unseen, stimuli over stimuli that have been seen before. Two paradigms that have frequently been employed to examine visual recognition memory are the habituation paradigm and the paired-comparison paradigm. In the habituation procedure subjects are exposed to repeated presentations of stimuli until a decrement to some criterion in amount of looking is attained. Recognition memory is inferred from the relative recovery of looking to novel as compared with familiar stimuli. In the paired-comparison procedure, the procedure used in the present investigation, subjects are familiarized with stimuli for some specified or subject-determined length of time. Memory test trials involve pairing previously seen stimuli with novel stimuli. Recognition memory is inferred from preferential looking at the novel stimuli. Novelty preferences, and consequent assertions of recognition memory capacity, have been obtained with stimuli as varied as faces, photographs, objects, and geometric patterns using both the habituation and paired-comparison procedures (for more extensive reviews of visual recognition memory see Cohen & Gelber, 1975; Werner & Perlmutter, 1979).

More recently, investigators have employed recognition memory paradigms to examine the conceptual as well as memorial processes that may be present in young children. For example, Fagan (1976) has demonstrated that seven-month-olds can recognize sex differences and orientation (upright vs. inverted) in photographs of human faces. In a developmental study, Cohen and Strauss (1979) reported that 30-week-old infants habituated to a "specific female face regardless of orientation" and to "female faces in general." However, infants aged 18 or 24 weeks showed little evidence of acquiring this conceptual information from photographs of faces. In a study concerned with the ability of infants and adults to abstract prototypical information, Strauss(1979) found that 10-month-olds could abstract featural information from exemplars of faces and constructed a prototype of the category by averaging the features presented. The infants in this study were familiarized with 14 schematic face drawings that varied along four features - length of face, length of nose, width of nose, and amount of separation between the eyes. Three paired-comparison recognition tests included an average prototype paired with a modal prototype, an average prototype with a totally novel face, and a modal prototype with a totally novel face. Infants showed preferential looking to the modal face in the first comparison, the novel face in the second comparison, and no preference for either face in the third comparison. These results suggested that the infants were responding to the average prototype as the familiar stimulus. The adults in this

study also appeared to be constructing an average prototype in certain conditions. These data indicate that both 10-month-olds and adults may process information similarly, at least under certain circumstances.

In other research infants have demonstrated the ability to recognize the identity of objects regardless of orientation (McGurk, 1972), the invariant form of objects (Ruff, 1978), and sex (Cornell, 1974). In addition, evidence of categorization abilities have been obtained in children one to three years of age (Daehler & O'Connor, 1980; Ross, 1980). For example, Daehler and O'Connor (1980) found greater preferences for novel stimuli unrelated to the familiar stimuli than for novel stimuli belonging to the same basic level category as the familiar stimuli. In the Ross (1980) study, habituation of looking by 12-, 18-, and 24-month-olds was found to generalize to new exemplars of the categories men, animals, food, furniture, and letters.

In all of the aforementioned studies, recognition memory was assessed immediately or shortly after familiarization with the stimuli. The focus of the present investigation was on retention of basic level category and specific exemplar information in very young children over a longer period of time. The relative lack of models of children's memory compared to models of adult's memory makes it difficult to predict what differences, if any, would result in retention for category and specific exemplar information. However, adult models of memory can provide a useful framework within which predictions about children's memory for category and specific exemplar information can be

made. For example, the levels-of-processing analysis formulated by Craik and Lockart (1972) could be interpreted to suggest that if processing occurs beyond the surface features of individual exemplars, category information should be retained for relatively longer periods of time than the specific featural information.

Other models that make similar predictions about children's recognition memory include schema models derived from Bartlett's (1932) theory of memory. These models are in broad agreement in suggesting that information from varying but related stimuli is abstracted and transformed to yield general schemas and that comprehension, and consequently retention for such schemas are improved compared to comprehension and retention for specific features of individual stimuli. Studies examining this conceptualization of memory have demonstrated that unseen prototypes are falsely recognized more often, and more rapidly categorized than exemplars that are distant transformations of the prototype which have actually been seen before (e.g., Bransford & Franks, 1971; Franks & Bransford, 1971). Moreover, prototypic information is retained longer than specific details of the stimulus materials (e.g., Posner & Keele, 1970; Strange, Keeney, Kessel, & Jenkins, 1970; Homa, Cross Cornell, Goldman, & Shwartz, 1973). For example, Posner and Keele (1970) presented four distortions of random dot prototypes to subjects and found that immediately after learning to classify the patterns, the old exemplars were recognized better than the prototypes. After a one week delay, however,

recognition of the prototypes revealed little evidence of forgetting, whereas recognition of the old distortions did reveal forgetting.

Relatively few studies have been conducted examining retention of information by infants and very young children. Moreover, researchers have primarily been concerned with determining how long after familiarization a specific stimulus can be correctly recognized. For example, Fagan (1973) found that five-month-old infants could recognize abstract black and white patterns 48 hours after familiarization, but photographs of faces were recognized up to two weeks later. These results suggest that variations in the stimulus materials can result in differential retention, but also permit the interesting speculation that face stimuli are processed in terms of category information, perhaps because they are more meaningful than the black and white patterns for which only specific features are processed.

In a more recent study it was found that six- and nine-month-olds can retain information about briefly exposed visual stimuli for at least 150 sec after familiarization even if interpolated stimuli have been shown during the retention interval (Rose, 1981). Rose found that six-month-olds displayed recognition memory 150 sec after familiarization, only with face stimuli. Nine-month-olds, on the other hand, displayed retention of other visual patterns in addition to face stimuli after a 150-sec delay. The author concluded that there are developmental changes in visual recognition memory, particularly with regard to the type of stimuli subjects are required to retain.

A few other studies also tangentially suggest there may be differential retention of category and specific exemplar information by infants and very young children. Using 10-week-old infants as subjects, Morrongiello, Rovee-Collier, Gekoski, and Fagen (Note 1) demonstrated significant retention of an infant operant foot-kick response to a mobile over 12 days when the mobile contained visually different patterns on four successive training sessions spaced 24 hours apart. While equivalent retention of the response for a mobile that was identical during each training session was obtained after seven days, the fact that performance by the group receiving varied mobiles was just as good at 12 days can be taken as indirect evidence for the superiority of prototypic cues for retention. Strauss and Cohen (Note 2) investigated differential rates of forgetting of perceptual dimensions by five-and-a-half-month-old infants. Subjects were shown a stimulus derived from one of two forms, two colors, two orientations, and two sizes. On test trials three of the dimensions remained the same while one of the dimensions changed. Recognition memory was found to be excellent for all four dimensions immediately after familiarization. However, 48 hours later only changes in form yielded a significant novelty preference. Thus, only form was remembered over the longer delay interval. The authors suggested that form may be a particularly important dimension for defining an object relative to the other dimensions that were varied. That is, form provided category identification of objects, and therefore, retention of this information was better than the specific exemplar information about the objects.

Fagan (1973), although not directly investigating differential retention of category and specific exemplar information, also obtained data relevant to this question. He examined the retroactive interference effects of face stimuli that varied in their similarity to the familiarized target. The stimuli were either different exemplars of the target face or were inverted photos of the target face. Presentation of the different exemplars of the target face did not result in loss of memory over a one minute retention interval, whereas presentation of the inverted faces did result in retroactive interference. However, these results could have been obtained if infants were abstracting a prototype of the target stimulus from the different exemplars during the intervening interference trials, and were, therefore, not receiving retroactive interference. Subsequently, Fagan (1978) replicated these results and has interpreted them in this fashion.

Although the data on infant long-term retention is limited, more extensive research with older children reveals direct support for the hypothesis that conceptually organized information is retained longer than specific exemplar information. For example, the research on story recall in children provides such evidence. Mandler (1979) found that story schemas result in improved recall relative to categorized lists of words. In a similar study, Poulsen, Kintsch, Kintsch, and Premack (1979) found that four- and six-year-olds exhibited better recall of descriptions that were integrated into a picture story, than

descriptions of a random order of the pictures in the story. Also, kindergarteners showed better retention of shape names if training consisted of associative elaboration (using the names in a story context) compared to a rehearsal paradigm (repeating the name three times) (Gallimore, Lam, Speidel, & Tharp, 1977).

Stressing the constructive aspects of children's memory, Paris (1977; 1978) has suggested that an important contributor to children's memorial processes is the ability to transform and make inferences about to-be-remembered material. According to the author, inferencing ensures greater depth-of-processing, provides more retrieval cues, and also permits improved comprehension, perhaps by relating the information to existing knowledge structures. Using children as subjects, he has obtained results consistent with the Bransford and Franks (1971) data on semantic integration, suggesting that even children are abstracting the prototypic content from verbal material.

In a study particularly relevant to the hypothesis that there is differential retention of category and specific exemplar information, Scarborough (1977) found that four-, eight-, and sixteen-year-olds made greater false recognition errors to pictures that were different exemplars of the target picture than to stimuli visually similar to the targets but depicting different objects. However, this performance difference occurred only at the longer lags. That is, when greater numbers of trials intervened between familiarization and test. The author interpreted these findings to mean that the subjects at all ages

initially relied on a visual code for picture recognition, but eventually some conceptual code became the basis of their recognition performance. Extrapolating that point one step further, it can be postulated that at the short lags both kinds of information were represented in memory, but the visual code "carried more weight". At the longer lags, however, only conceptual information remained in memory.

In summary, data from adults, infants, and children suggest that: 1) category information is abstracted from visual presentations of varying instances of events, and 2) although recognition memory for visual stimuli is very good, memory for category information is retained longer than specific exemplar information. The latter, however, has not been demonstrated with infants and very young children, and consequently, served as the major purpose of the present investigation.

This study proposed to examine the effects of presenting varied or single basic level category exemplars on retention of those categories over an extended period of time. Twenty-four-month-old children were familiarized with various exemplars of a number of basic level categories (e.g., dogs, chairs), or with a single exemplar of each of the categories. On immediate and delayed test trials, either previously presented exemplars of the category or unfamiliar exemplars were paired with unrelated novel category stimuli. It was predicted that immediately after familiarization both groups of children would

recognize previously presented exemplars, as evidenced by longer looking times for the novel stimuli with which they were paired. After a long-term delay, however, only children presented varied exemplars would display recognition of familiar exemplars. This prediction is based on the assumption that variation in exemplars will foster abstraction of basic level category information about the exemplars and this information would be retained over a relatively long delay interval. In contrast, repeated presentations of specific exemplars of the category was thought to be less likely to promote abstraction of basic level category information and retention of the specific exemplar features would be poor over a long delay interval. When tested with an unfamiliar exemplar of the basic level category, it was expected that the varied exemplar group would respond to that stimulus as familiar on both immediate and delayed tests, whereas the single exemplar group would not treat that unfamiliar intracategory stimulus as familiar either on immediate or long-term tests.

CHAPTER II

METHOD

Subjects

Thirty-two males and thirty-two females each at twenty-four months of age (Range = 22 to 26 months), served as subjects in this experiment. Five females and eight males were eliminated from the study for a variety of reasons, such as failure to complete the task (n=7), a retention interval greater than nine days (n=4), or equipment failure (n=2). All subjects were recruited from the Springfield area.

Apparatus

The apparatus used in this experiment contained two adjacent viewing windows (13.5 x 13.5 cm) 6.5 cm apart and a one-way observation mirror (20 x 26 cm) to the right of the windows. The apparatus was placed on a child-sized table such that the windows were slightly below eye level for a two-year-old seated in a child-sized chair. The windows and the mirror were embedded in a curtain that divided the room in half. A white response plaque with a small red button fixed to it was placed on the table directly below and in front of the windows to permit the child to control the duration of time objects were visible in the windows. When the response plaque was pressed, an electronic

timer activated a motor assembly which allowed a screen to be lowered behind the windows. An experimenter, located behind the curtain, inserted different objects in back of the windows before the screen was raised to begin the next trial. Looking times were recorded on a Esterline-Angus event recorder by an observer located behind the one-way mirror.

Stimuli

The stimuli used in this study consisted of real items or toy replicas of common objects (e.g., cups, houses, chairs). Four exemplars of each of 16 basic level categories were available for use during the familiarization phase of the experiment. A fifth exemplar of each of the familiarized categories was also available for use during the test phase along with exemplars for 16 novel basic level categories. The exemplars belonging to each of the familiarized basic level categories differed in size, shape, and color. For a complete list of the basic level categories included in the study see Table 1. Twenty additional stimuli, unrelated to any of the categories of stimuli already mentioned, were used on practice and filler trials. The objects were secured onto Masonite boards for ease of presentation in the apparatus.

TABLE 1

Test-trial pairings. Familiarization stimuli are underlined.

<u>Chair</u>	–	Bird
<u>Apple</u>	–	Book
T.V.	–	<u>Candle</u>
Telephone	–	<u>Baby</u>
<u>House</u>	–	Bicycle
<u>Crackers</u>	–	Umbrella
Hat	–	<u>Fork</u>
<u>Airplane</u>	–	Bathtub
Block	–	<u>Pencil</u>
Bottle	–	<u>Car</u>
Shovel	–	<u>Brush</u>
<u>Flower</u>	–	Drum
<u>Dog</u>	–	Hammer
<u>Cup</u>	–	Ring
Pail	–	<u>Shoe</u>
Clock	–	<u>Ball</u>

Design

The experiment consisted of two major phases, a familiarization phase (32 trials) and a test phase (16 trials). Eight males and eight females were randomly assigned to each of four familiarization-test conditions. For half the subjects the familiarization phase included four exemplars of each of the 16 basic level categories (Varied Exemplar Condition). For the remaining subjects a single exemplar of each of the categories was presented during familiarization (Single Exemplar Condition). An exemplar of each of the 16 categories was presented in each of the four blocks of eight trials. In each condition, three filler trials (i.e., pairs of unrelated objects) immediately followed familiarization trials, and preceded the first eight test trials. These filler trials were presented to ensure that subjects, particularly those in the Single Exemplar Condition, would still be sufficiently interested in the task to attend to the objects on test trials.

Within each of the Varied Exemplar and Single Exemplar Conditions half of the subjects were tested for recognition with one of the exemplars (Varied Exemplar Condition) or the only exemplar (Single Exemplar Condition) presented during the familiarization phase (Familiar Test Condition) and half were tested for recognition of unfamiliar intracategory exemplars (Unfamiliar Test Condition). In both test conditions, however, the familiar or unfamiliar intracategory

exemplars were paired with stimuli from a novel category. Each child received eight test trials immediately after familiarization and the remaining eight test trials one week after familiarization.

The test trial pairings were fixed for all subjects (see Table 1). This was necessary due to the unwieldy number of categories necessary to counterbalance familiar and novel categories. These pairings were determined according to data obtained in a previous unpublished study in our laboratory. In all cases, the stimulus categories choosen as novel received relatively less, or were equal in attention to the stimulus categories shown during familiarization in the present study. This ensured a bias against a novelty preference, and therefore, seemed a reasonable solution to the counterbalancing problem.

On test trials, right and left positions were balanced such that half of the familiarized category stimuli occurred on one side and half on the other. Furthermore, a constraint existed such that not more than three successive trials could have novel stimuli on one side. Order of appearance of stimulus pairs on familiarization and test trials was randomized for each child.

Procedure

All parents were contacted first with a letter of introduction explaining this research project, and next by phone to schedule appointments. Each child was brought to the Child Study Center in Springfield by a parent(s). Rapport with the child was established in

a playroom/reception area where further details of the study were described to the parent(s). The child was then invited along with his/her parent(s) to come to another room to play a game. Upon entering the room, the subject was seated in the child-sized chair with the experimenter to his/her left and a parent to his/her right. Parents were cautioned beforehand not to point to or label any of the objects during the task. Moreover, they were asked not to talk about the objects during the one week retention interval.

Training stimuli already visible in the apparatus were pointed out to the child. Subjects were instructed to look at both items and to press the plaque when "you want to see more things." The response of pressing the plaque was modeled whenever subjects appeared reticent or did not seem to understand the instructions. Two additional training trials were presented. All subjects learned to press the response plaque during these training trials. When the response plaque was pressed, the screen lowered and the experimenter behind the curtain inserted objects for the next trial. After four seconds the screen automatically lifted to reveal stimuli for the next trial. During the first three seconds of the trial the response plaque was inactive. The inactive period was included to discourage children from focusing on the response plaque without looking at the objects and to prevent accidental presses.

Following the training trials, 32 familiarization trials were presented to each child. On these trials the 16 basic level categories

were presented for familiarization in blocks of eight trials. Exemplars from two categories were paired on each trial with the constraint that once two categories had appeared together they could not be paired again (e.g., if apple was paired with candle, apple could not appear with candle again).

When subjects returned one week later for the remaining eight test trials the procedure was identical to the first visit with the exception that no familiarization trials were presented. Four warm-up trials, consisting of entirely new objects, were presented, followed by the eight remaining test trials.

The observer located behind the one-way mirror recorded the amount of time subjects looked at stimuli in the left and right windows on familiarization and test trials. Looking time was used as the dependent measure in all analyses. All comparisons between means were calculated with t-tests that used the overall within-subject error term from the analysis of variance. High interobserver reliability had been obtained in a previous study with very young children using the same apparatus (Daehler and Bukatko, 1977). Pilot testing of adult subjects in the present study found interobserver reliability to be .97 and .98 for the left and right windows, respectively.

CHAPTER III

RESULTS

Familiarization Trials

Looking times on familiarization trials were examined to determine whether there were group differences in attention over blocks of trials. A 2(Familiarization Condition) x 2(Test Condition) x 2(Sex) x 4(Trial Blocks) x 2(Left vs Right) repeated measures analysis of variance was performed on these looking times. Attention to objects decreased significantly over the four blocks of trials ($F(1,56)=8.57$, $p<.001$). Also, subjects demonstrated greater attention to objects in the Varied Exemplar Condition (2.60 sec) than in the Single Exemplar Condition (2.29 sec) ($F(1,56)=3.53$, $.05<p<.10$). Figure 1 illustrates that looking times in the Varied Exemplar Condition remained relatively stable over trial blocks, whereas amount of attention in the Single Exemplar Condition diminished over trial blocks ($F(3,168)=4.78$, $p<.005$).

Although there was no reason to expect looking times during familiarization to be affected by subsequent test condition, and while this generally was the pattern, it was true that subjects assigned to the Single Exemplar-Unfamiliar Test Condition looked more at objects during the first trial block than did subjects in all other conditions. This was reflected in a significant Familiarization Condition x Test

Fig. 1. Mean looking time in seconds during familiarization for each Trial Block in the Single Exemplar and Varied Exemplar Familiarization Conditions.

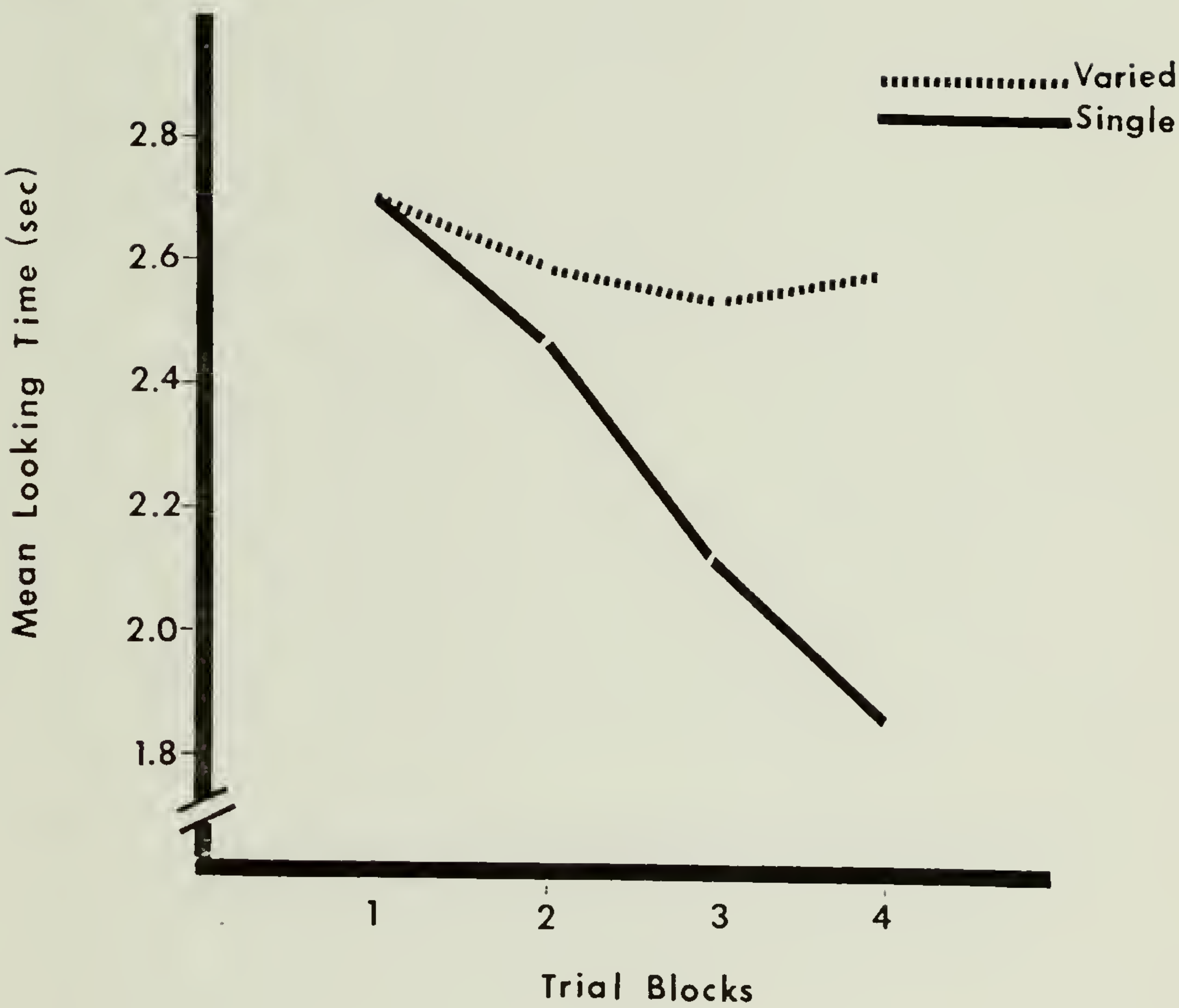

Varied
Single
Mean Looking Time (sec)
2.8
2.6
2.4
2.2
2.0
1.8
1
2
3
4
Trial Blocks

Figure 1

Condition x Trial Block interaction ($F(3,168)=2.77$, $p<.05$; see Figure 2). Examination of individual subjects' data revealed that it was only a few children that contributed to this increased looking time on the first trial block.

The mean number of seconds attending to objects in the left and right windows was 2.39 and 2.49 sec, respectively; Thus, no significant preference for looking at either the left or right window was revealed ($F(1,56)=.88$, $p>.05$). However, Left vs Right position did enter into a significant interaction with Test Condition and Trial Blocks ($F(3,168)=2.81$, $p<.05$). Figure 3 reveals that subjects in the Unfamiliar Test Condition exhibited greater attention to objects in the left window on Trial Block 1 than did subjects in the Familiar Test Condition ($p<.05$). The pattern of attention over the remaining trial blocks was similar for both groups. Again, this result appears to be due to a few subjects who were looking at the left window more than any other subjects. Since the experimenter sits to the left of the child, it was probably these children's initial interest in the experimenter that affected their looking to the left and right windows on the first trial block.

Test Trials

Test-trial data were examined to determine whether there were group differences in looking times to familiar and novel categories on

Fig. 2. Mean looking time in seconds during familiarization for each Trial Block in the Single Exemplar and Varied Exemplar Conditions as a function of Test Condition (Familiar Exemplar or Unfamiliar Test Condition).

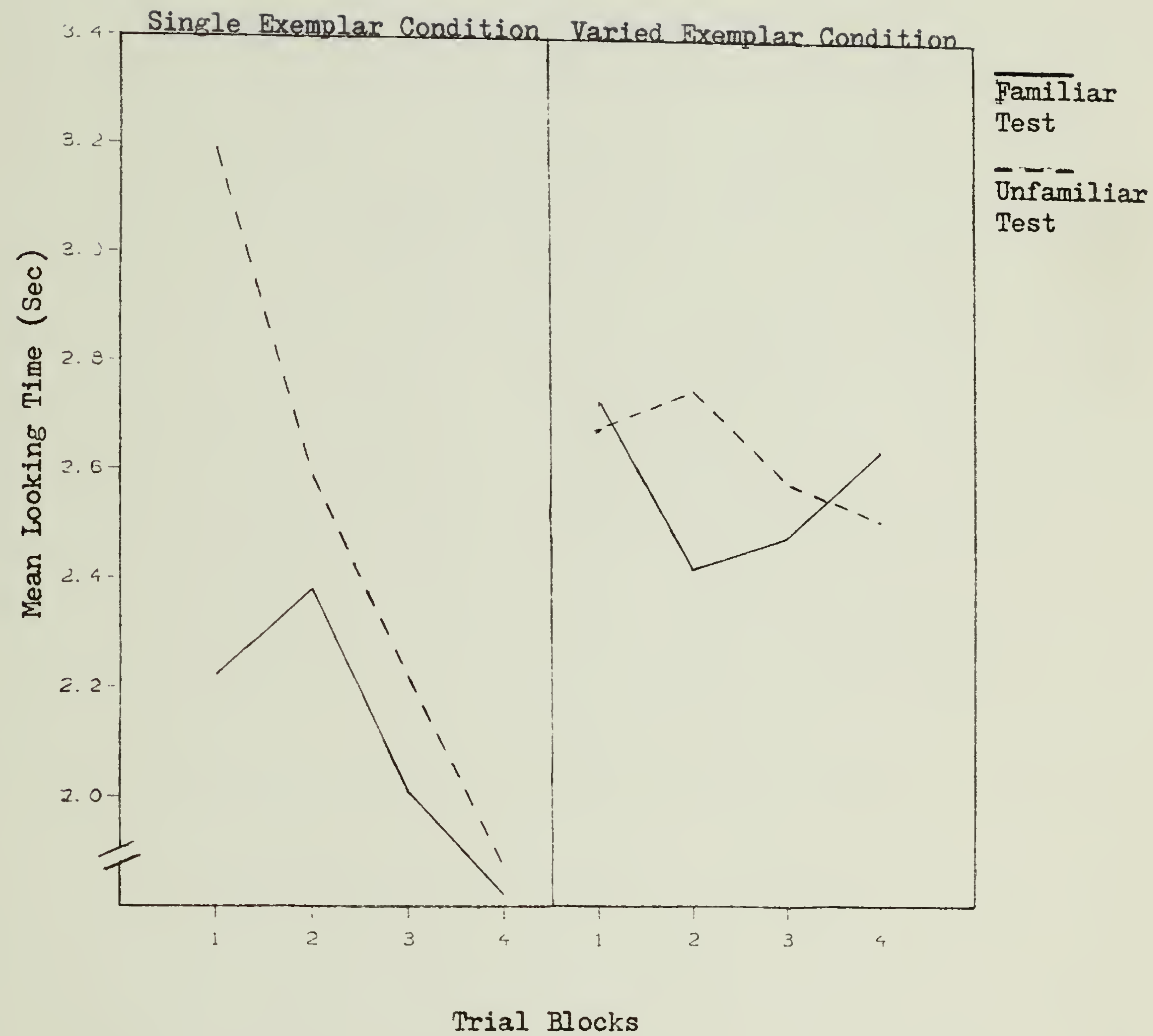
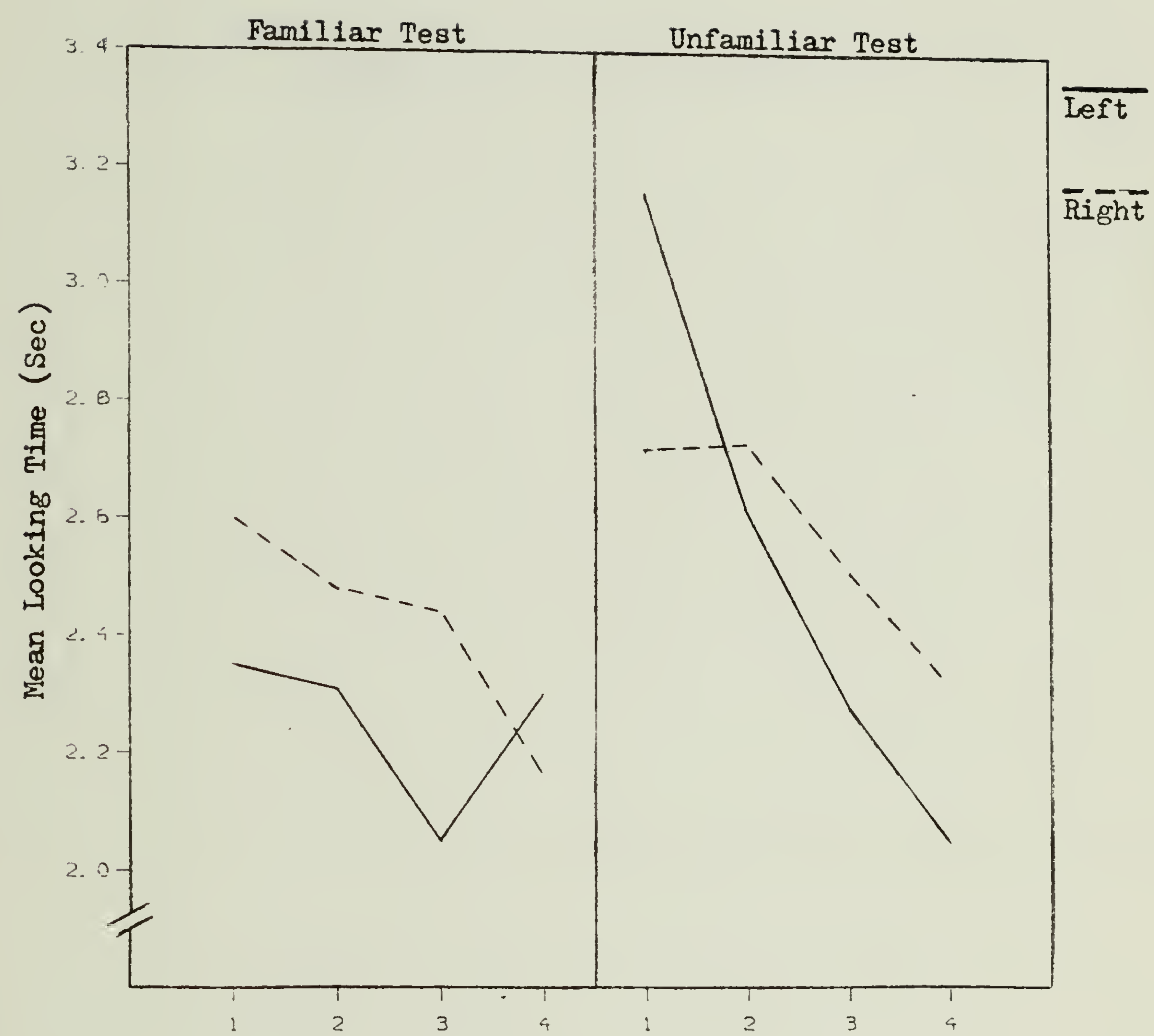

Single Exemplar Condition
Varied Exemplar Condition
Mean Looking Time (Sec)
3.4
3.2
2.8
2.6
2.4
2.2
2.0
1
2
3
4
1
2
3
4
Familiar Test
Unfamiliar Test
Trial Blocks

Figure 2

Fig. 3. Mean looking time in seconds at the left and right windows during familiarization for each Trial Block in the Familiar Exemplar and Unfamiliar Exemplar Test Conditions.



Trial Blocks

Figure 3

immediate and delayed test trials. The amount of time attending to each of the categories on test trials was entered into a 2(Familiarization Condition) x 2(Test Condition) x 2(Sex) x 2(Delay) x 2(Familiar vs Novel) repeated measures analysis of variance. Subjects demonstrated significantly longer looking times to novel (3.20 sec) than to familiar basic level categories (2.45 sec) ($F(1,56)=40.39$, $p<.001$). Also, subjects in the Single Exemplar Condition revealed significantly longer overall looking times on test trials than subjects in the Varied Exemplar Condition (3.03 and 2.62 sec, respectively) ($F(1,56)=5.32$, $p<.05$). Moreover, attention to objects was significantly greater on the one-week delay test trials than on those that followed immediately after familiarization with the stimulus categories (3.11 and 2.54 sec, respectively) ($F(1,56)=21.05$, $p<.001$).

Since the major focus of this experiment was to determine the effects of Familiarization Condition, Test Condition, and Delay on recognition memory performance, the data were further analyzed to determine whether subjects attended to novel basic level categories significantly more than familiar basic level categories in each condition and for each delay. The results can be seen in Figure 4. Novel categories were attened to significantly longer than familiar categories in all conditions except one, the Varied Exemplar-Unfamiliar Test Condition ($p>.05$). Moreover, further examination of the data revealed that it was females in this condition that did not prefer the novel categories, and then only at the delay test ($p> .05$; see Figure 5).

Fig. 4. Mean looking time in seconds at the familiar and novel categories on test trials for each condition and for each delay.

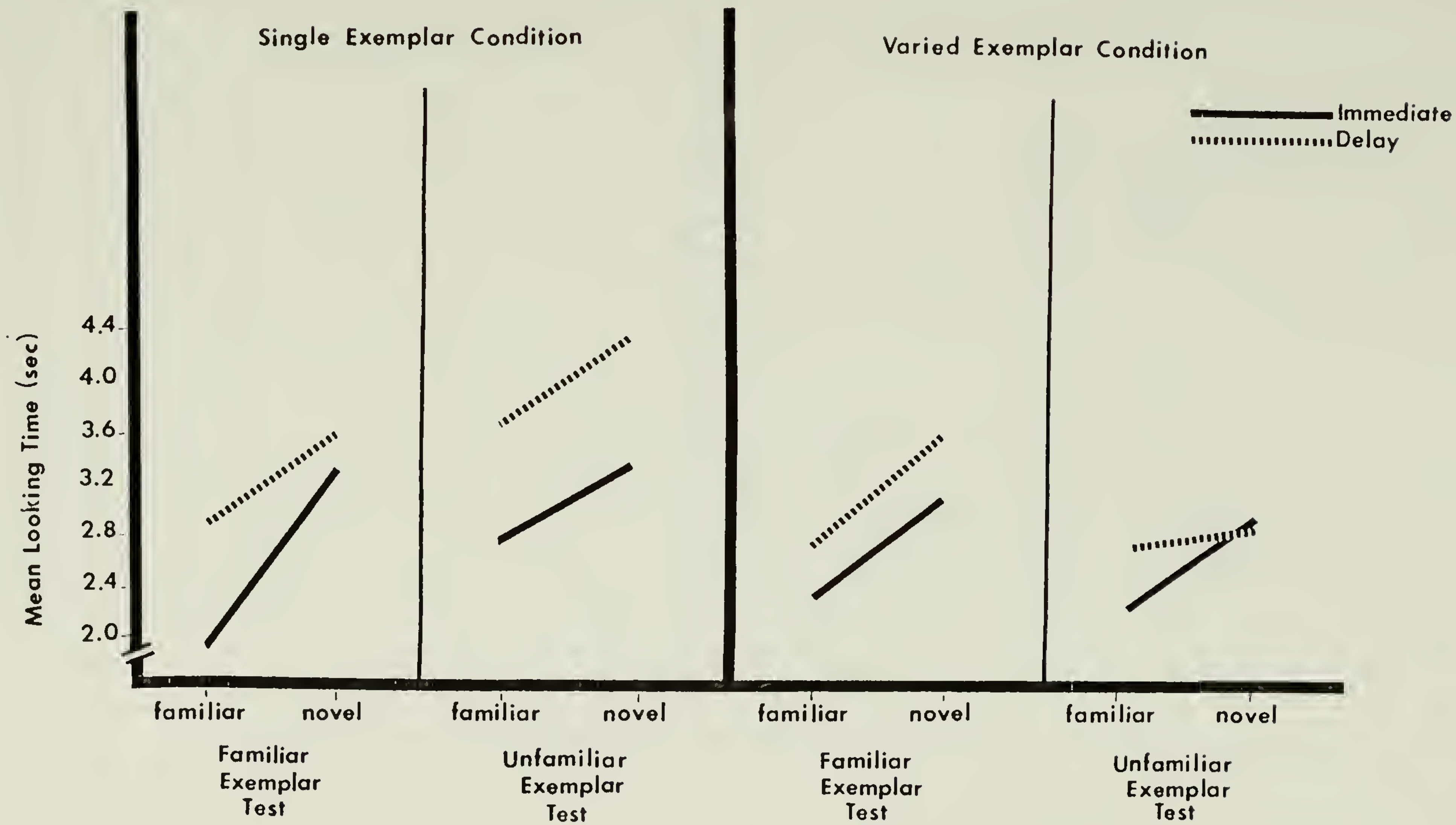

Single Exemplar Condition
Varied Exemplar Condition
Immediate
Delay
Mean Looking Time (sec)
4.4
4.0
3.6
3.2
2.8
2.4
2.0
familiar
novel
familiar
novel
familiar
novel
familiar
novel
Familiar Exemplar Test
Unfamiliar Exemplar Test
Familiar Exemplar Test
Unfamiliar Exemplar Test

Figure 4

Fig. 5. Mean looking time in seconds at the familiar and novel categories in the Varied Exemplar-Unfamiliar Exemplar Test Condition on test trials for males and females at the Immediate and Delay Test.

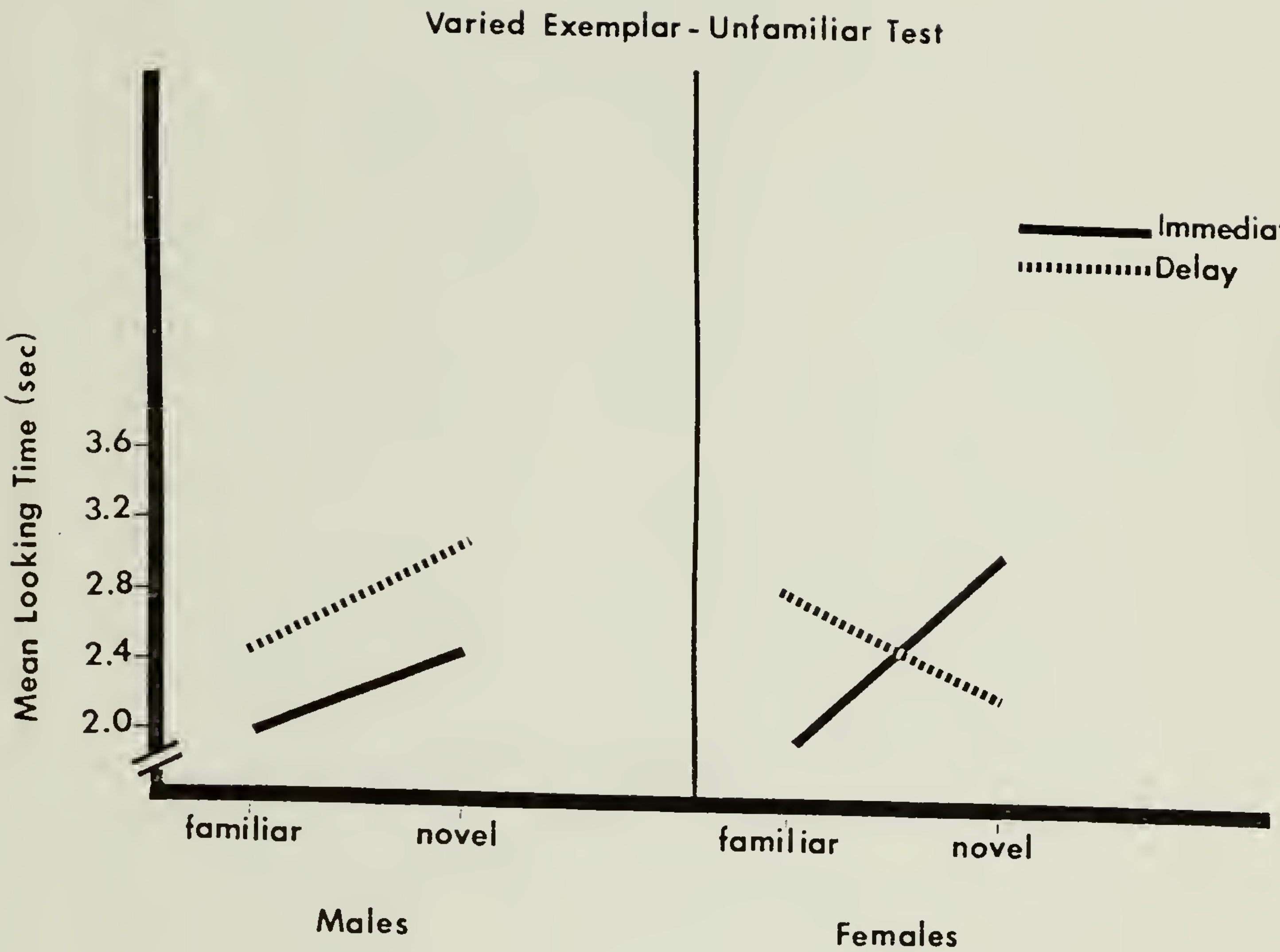
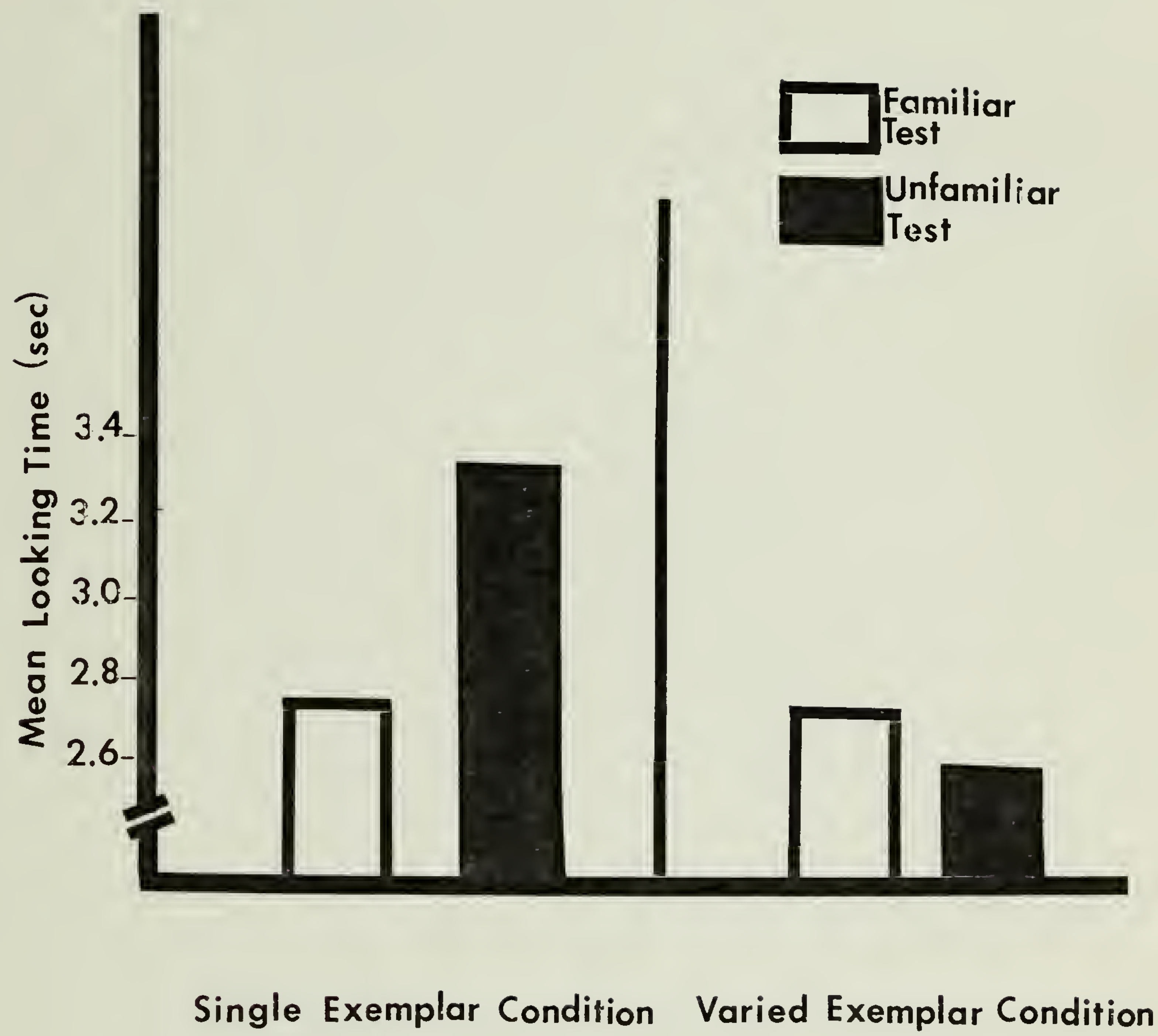

Varied Exemplar - Unfamiliar Test
Immediate
Delay
Mean Looking Time (sec)
3.6
3.2
2.8
2.4
2.0
familiar
novel
familiar
novel
Males
Females

Figure 5

Two additional higher order interactions were obtained. First, as can be seen in Figure 6, Familiarization Condition interacted significantly with Test Condition ($\underline{F}(1,56)=5.05$, $\underline{p}<.05$) revealing that for subjects in the Single Exemplar Condition, those in the Unfamiliar Test Condition attended to all stimuli on test trials longer than those in the Familiar Test Condition ($\underline{p}<.05$). Subjects in the two groups that received a Varied Exemplar Familiarization Condition did not show a difference in looking times on test trials ($\underline{p}>.05$).

Figure 7 illustrates that females in the Varied Exemplar Condition were the only group of subjects exhibiting a decrease in attention to test stimuli at the one-week delay test. This was reflected in a significant interaction between Familiarization Condition, Delay, and Sex ($\underline{F}(1,56)=4.77$, $\underline{p}<.05$). All other subjects gave greater attention to stimuli at the delayed test than they did at the immediate test (all $\underline{p}$s<.05).

Fig. 6. Mean looking time in seconds at all stimuli on test trials for each Familiarization and Test Condition.



Familiar Test
Unfamiliar Test
Mean Looking Time (sec)
3.4
3.2
3.0
2.8
2.6
Single Exemplar Condition
Varied Exemplar Condition

Figure 6

Fig. 7. Mean looking time in seconds at all stimuli on immediate and delayed test trials for males and females in the Single Exemplar and Varied Exemplar Conditions.

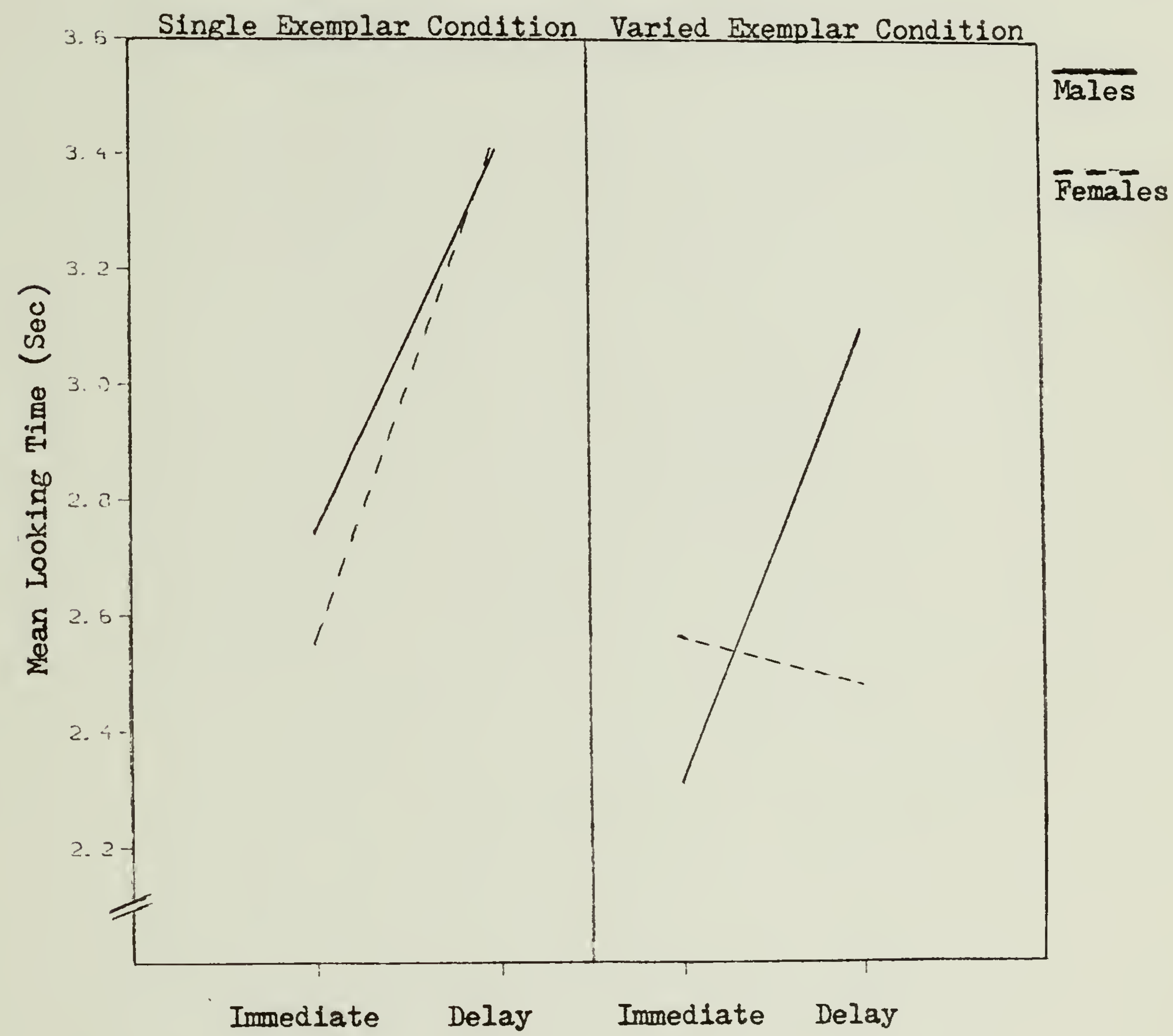

Single Exemplar Condition
Varied Exemplar Condition
Males
Females
Mean Looking Time (Sec)
3.6
3.4
3.2
3.0
2.8
2.6
2.4
2.2
Immediate
Delay
Immediate
Delay

Figure 7

CHAPTER IV

DISCUSSION

The data obtained during familiarization trials clearly reveal that the two familiarization conditions had differential effects on looking times over blocks of trials. Specifically, subjects shown the identical category exemplar in each of the four trial blocks (Single Exemplar Condition) displayed a significant decrement in attention to those stimuli. Subjects in the Varied Exemplar Condition, however, who were presented with four different exemplars from those same categories, did not show a decline in looking times over the trial blocks. The interaction between decrement in looking times and familiarization condition could be interpreted to suggest that subjects in the Varied Exemplar Condition did not recognize different exemplars as members of the same basic level categories over successive blocks of trials, and therefore, did not show any decline in attention. However, as the test trial data indicate, all but one group of subjects showed a significant preference for novel basic level categories over categories seen during familiarization on both immediate and delayed test trials.

Ross (1980) obtained results quite similar to those obtained here in her study of the categorization abilities of one- and two-year-olds. Ross found that habituation of looking occurred only when category exemplars were "perceptually most similar", such as with the categories of Ms, Os, and men, but not when the category exemplars were

"perceptually most different", such as with the categories of food and furniture. This difference in habituation, however, did not obscure the finding that for all categories her subjects displayed a significant preference for looking at stimuli from novel categories as compared with previously unseen intracategory exemplars. The results of the present study suggest that subjects in the Varied Exemplar Condition were discriminating between the various category exemplars during familiarization, and more importantly were obtaining category information from those presentations.

The interaction between Trial Block and Familiarization Condition does answer a methodological problem leveled against a number of studies concerning category knowledge in very young children. Sherman (1981) recently pointed out that in order to show categorization abilities very young children must be able to discriminate between the category exemplars presented. In other words, categorization requires that the subject detect the invariant information present in different stimuli from the same category. The data obtained from subjects in the Varied Exemplar Condition in this experiment indicate that subjects were detecting the featural differences between intracategory exemplars. These subjects did not display a decrement in attention to category stimuli on successive blocks of trials in contrast to subjects given identical stimuli across successive blocks of familiarization trials. Yet they did display a preference for novel category stimuli on test trials.

The findings from the test trials permit several major conclusions. First, subjects in both the Single Exemplar and Varied Exemplar Conditions displayed preferences for novel categories over familiar categories both immdeiately and one week after familiarization with the categories. Clearly, 24-month-olds can recognize and make judgements of familiarity based on category information. Furthermore, subjects in both the Familiar Exemplar and Unfamiliar Exemplar Test Conditions showed a preference for novel categories regardless of the type of exposure they received during familiarization trials. This result indicates that subjects in both the Single Exemplar and Varied Exemplar Conditions were using category information on test trials. Were subjects in the Single Exemplar Condition processing only featural aspects of the stimuli during familiarization, they would not have been expected to display a preference for the novel category exemplars on test trials when the test item was an unfamiliar category exemplar. Thus, 24-month-olds required only one exemplar of the category in order to make categorization recognition judgements.

By 24 months children either have available to them many of the categories used in this investigation prior to any experimental exposure, or were constructing a category based on as few as one exemplar of the category. If either of these alternatives were true subjects in the Single Exemplar Condition could make correct categorization judgements of unfamiliar intracategory exemplars. According to Rosch and Mervis (9175), the basic level is the level at

which categories "make sense," and therefore, are most easily learned. Categories at the basic level are most easily differentiated from each other, and within-category members share more features than category members at any other level. Their data indicate that children can sort objects at the basic level before sorting at the super- or subordinate level, and also that children produce basic level object names before learning to name tham at any other level (Rosch & Mervis, 1977). Furthermore, Mervis and Crisafi (1982) found that children learned to categorize artificial objects at a basic level more easily than at either the super- or subordinate level. Thus, 24-month-olds might have demonstrated differential performance in the two familiarization conditions if the category information required was less well established than basic level category information. That is, for example, if superordinate, subordinate, or artificial categories had been used. Categorization abilities need to be tested developmentally for the level of pre-existing category knowledge that young children bring to the experimental situation. For example, subjects younger than 24 months should show faster habituation to well known categories than to less known and artificial categories. With this type of examination it may be possible to examine more closely the underlying mechanisms involved in developing categorization abilities.

Another major finding of the present study was that 24-month-olds retained basic level category information for as long as one week after brief initial exposure to the category. Only one subgroup of subjects,

the eight females in the Varied Exemplar Condition, failed to show significant preferences for novel categories over familiar categories at the delayed test. The results for females in the Varied Exemplar-Unfamiliar Test Condition, who did not display the pattern of results consistent with the remaining children in the study, are not easily explained by the model proposed above. It must be stressed, however, that these subjects gave evidence for loss of category recognition only at the one-week delay interval. Immediately after familiarization they did display category knowledge. Whether loss of this information was due solely to sampling procedures, or is characteristic of this population, remains for future research to determine. However, their results subtract little from the strong evidence provided by the remaining subjects for the degree of category knowledge these children either possessed prior to, or acquired during, the experimental treatments, and subsequently made use of for making familiarity judgements in a recognition task.

Little research has been conducted with very young children to determine their retention capabilities for briefly seen visual stimuli. Recently, Strauss (1981) examined retention of face stimuli over a 15-minute interval with 10-month-olds as subjects. The results of this study replicated his earlier finding that these infants were constructing an average prototype of the stimuli presented. However, this result occurred only on test trials that followed immediately after familiarization. At the 15-minute delay test, subjects appeared

not to recognize specific exemplars, or the prototype face. The author concluded that 10-month-olds can only retain abstracted prototypical information, and then only for a very brief period of time.

Although it may be that memorial abilities improve dramaticaly between 10 and 24 months, other investigations have obtained evidence to suggest that young infants do have good recognition memory over fairly long durations. For example, Fagan (1973) reported retention of face stimuli up to two weeks following familiarization by five-month-old subjects. Further study is necessary to determine the mechanisms of storage that may be involved in the recognition memory performance of 24-month-olds.

The present investigation was not able to separate out the relative contributions of the dominant models of adult category knowledge. Exemplar models propose that each exemplar is stored as a separate memory trace. Categorization judgements are made by comparing the test stimulus to some criterion value that is computed from the frequency of occurrence of the stimulus features (e.g., Goldman & Homa, 1977). Prototype models posit that an average of the exemplar features is abstracted from the stimulus presentations, and is stored as a separate trace. The test stimulus is compared to the prototype for verification of category membership (e.g., Posner & Keele, 1970). Support for both a feature-count model (Sherman, 1981) and for a prototype-averaging model (Strauss, 1980; 1981) have been obtained with children as subjects.

In addition to the examination of categorization _per se_, future research should be aimed at defining memory and category knowledge interactions that could result from different pre-experimental levels of category knowledge. Specifically, the question addressed in this study needs to be researched further by attempting to vary the degree of category knowledge necessary to perform the task. Again, this may be accomplished either by using younger subjects, or by using category information that the child does not possess prior to the experimental manipulations, such as superordinate or artificial category information.

In summary, this investigation provides valuable information about the recognition memory abilities of the very young child. With as few as one exemplar of a basic level category, these children are making use of category information in a recognition task. Even more impressive is their ability to recognize basic level category stimuli after a one week delay with as little as 10 seconds of total familiarization time. This is further support for the excellent recognition memory abilities of the immature human organism.

NOTES

1. Morrongiello, B. A., Rovee-Collier, C. K., Gekoski, M. J., & Fagen, J. W. The use of abstracted and distinctive features as retrieval cues by 10-week-old infants. Unpublished manuscript, 1980.
2. Strauss, M. S., & Cohen, L. B. Infant immediate and delayed memory for perceptual dimensions. Unpublished manuscript, 1979.

BIBLIOGRAPHY

Bartlett, F. C. Remembering: A study in experimental and social psychology. London: Cambridge University Press, 1932.

Bransford, J. D., & Franks, J. J. Abstraction of linguistic ideas. Cognitive Psychology, 1971, 2, 331-350.

Cohen, L. B., & Gelber, E. R. Infant visual memory. In L. B. Cohen & P. Salapatek (Eds.), Infant perception: From sensation to cognition. New York: Academic Press, 1975.

Cohen, L. B., & Strauss, M. S. Concept acquisition in the human infant. Child Development, 1979, 50, 419-424.

Cornell, E. H. Infants' discrimination of photographs of faces following redundant presentations. Journal of Experimental Child Psychology, 1974, 18, 98-106.

Craik, F. I. M., & Lockhart, R. S. Levels of processing: A framework for memory research. Journal of Verbal Learning and Behavior, 1972, 11, 671-684.

Daehler, M. W., & Bukatko, D. Recognition memory for pictures in very young children: Evidence from attentional preferences using a continuous presentation procedure. Child Development, 1977, 48, 693-696.

Daehler, M. W., & O'Connor, M. P. Recognition memory for objects in very young children: The effect of shape and label similarity on preference for novel stimuli. Journal of Experimental Child Psychology, 1980, 29, 306-321.

Fagan, J. F. Infants' delayed recognition memory and forgetting. Journal of Experimental Child Psychology, 1973, 16, 424-450.

Fagan, J. F. Infant recognition memory: The effects of length of familiarization and type of discrimination task. Child Development, 1974, 45, 351-356.

Fagan, J. F. Infants' recognition of invariant features of faces. Child Development, 1976, 47, 627-638.

Fagan, J. F. Facilitation of infants' recognition memory. Child Development, 1978, 49, 1066-1075.

Franks, J. J., & Bransford, J. D. Abstraction of visual patterns. Journal of Experimental Psychology, 1971, 90, 65-74.

Gallimore, R., Lam, D. J., Speidel, G. E., & Tharp, R. G. The effects of elaboration and rehearsal on long-term retention of shape names by kindergarteners. American Educational Research Journal, 1977, 14, 471-483.

Goldman, D., & Homa, D. Integrative and metric properties of abstracted information as a function of category discriminability, instance variability, and experience. Journal of Experimental Psychology: Human Learning and Memory, 1977, 3, 375-385.

Homa, D., Cross, J., Cornell, D., Goldman, D., & Shwartz, S. Prototype abstraction and classification of new instances as a function of number of instances defining the prototype. Journal of Experimental Psychology, 1973, 101, 116-122.

Mandler, J. M. Categorical and schematic organization in memory. In C. R. Puff (Ed.), _Memory organization and structure_. New York: Academic Press, 1979.

McGurk, H. Infant discrimination of orientation. _Journal of Experimental Child Psychology_, 1972, _14_, 151-164.

Mervis, C. B., & Crisafi, M. A. Order of acquisition of subordinate-, basic-, and superordinate-level categories. _Child Development_, 1982, _53_, 258-266.

Paris, S. G., & Lindauer, B. K. Constructive aspects of children's comprehension and memory. In R. V. Kail & J. W. Hagen (Eds.), _Perspectives on the development of memory and cognition_. Hillsdale, New Jersey: Lawrence Erlbaum Associates, Inc., 1977.

Paris, S. G. The development of inference and transformation as memory operations. In P. A. Ornstein (Ed.), _Memory development in children_. Hilsdale, New Jersey: Lawrence Erlbaum Associates, Inc., 1978.

Posner, M. I., & Keele, S. W. Retention of abstract ideas. _Journal of Experimental Psychology_, 1970, _83_, 304-308.

Poulsen, D., Kintsch, E., Kintsch, W., & Premack, D. Children's comprehension and memory for stories. _Journal of Experimental Child Psychology_, 1979, _28_, 379-403.

Rosch, E., & Mervis, C. B. Family resemblances: Studies in the internal structure of categories. _Cognitive Psychology_, 1975, _7_, 573-605.

Rosch, E., & Mervis, C. B. Children's sorting: A reinterpretation based on the nature of abstraction in natural categories. In R. C. Smart & M. S. Smart (Eds.) _Readings in child development and relationships_. (2nd ed). New York: MacMillan, 1977.

Rose, S. A. Developmental changes in infants' retention of visual stimuli. _Child Development_, 1981, _52_, 227-233.

Ross, G. S. Categorization in 1- to 2-year-olds. _Developmental Psychology_, 1980 _16_, 391-396.

Ruff, H. A. Infant recognition of the invariant form of objects. _Child Development_, 1978, _49_, 293-306.

Scarborough, H. S. Development of visual, name, and conceptual memory codes for pictures. _Journal of Experimental Child Psychology_, 1977, _24_, 260-278.

Sherman, T. Categorization skills in infants. Paper presented at the meetings of the Society for Research in Child Development, Boston, MA., 1981.

Strange, W., Kenney, T., Kessel, F., & Jenkins, J. Abstraction over time of prototypes from distortions of random dot patterns. _Journal of Experimental Psychology_, 1970, _83_, 508-510.

Strauss, M. S. Abstraction of prototypical information by adults and 10-month-old infants. _Journal of Experimental Psychology_, 1979, _5_, 618-632.

Strauss, M. S. Infant memory of prototypical information. Paper presented at the meetings of the Society for Research in Child Development, Boston, MA., 1981.

Werner, J. S., & Perlmutter, M. Development of visual memory in infants. In Advances in child development and behavior, Vol. 14. New York: Academic Press, 1979.

APPENDIX

Table 2 contains the Summary Table from the Analysis of Variance on the Familiarization Trial data. F=Familiarization Condition, T=Test Condition, X=Sex, S=Subject, B=Block, R=Trial, and L=Left vs. Right.

Table 3 contains the Summary Table from the Analysis of Variance on the Test Trial data. F=Familiarization Condition, T=Test Condition, X=Sex, S=Subject, D=Delay, R=Trial, and N=Familiar vs. Novel.

TABLE 2

	SOURCE	ERROR TERM	SUM OF SQUARES	D.F.	MEAN SQUARE	F	PROB.	EXPECTED MEAN SQUARE
1	MEAN	S(FTX)	.24479E+05	1	.24479E+05	863.50	-.0000	4096(1) + 64(43)
2	FAMCOND	S(FTX)	.10013E+03	1	.10013E+03	3.53	.0654	2048(2) + 64(43)
3	TESTCOND	S(FTX)	.46453E+02	1	.46453E+02	1.64	.2058	2048(3) + 64(43)
4	X	S(FTX)	.65054E+02	1	.65054E+02	2.29	.1354	2048(4) + 64(43)
5	BLOCK	SB(FTX)	.15144E+03	3	.50479E+02	8.57	.0000	1024(5) + 16(59)
6	RIAL	SR(FTX)	.30430E+02	7	.43471E+01	1.45	.1839	512(6) + 8(60)
7	LR	SL(FTX)	.11139E+02	1	.11139E+02	.88	.3529	2048(7) + 32(61)
8	FT	S(FTX)	.22061E+02	1	.22061E+02	.78	.3815	1024(8) + 64(43)
9	FX	S(FTX)	.10300E+02	1	.10300E+02	.36	.5491	1024(9) + 64(43)
10	TX	S(FTX)	.11348E+02	1	.11348E+02	.40	.5295	1024(10) + 64(43)
11	FB	SB(FTX)	.84410E+02	3	.28137E+02	4.78	.0032	512(11) + 16(59)
12	TB	SB(FTX)	.33975E+02	3	.11325E+02	1.92	.1277	512(12) + 16(59)
13	XB	SB(FTX)	.38086E+02	3	.12695E+02	2.16	.0951	512(13) + 16(59)
14	FR	SR(FTX)	.12643E+02	7	.18062E+01	.60	.7540	256(14) + 8(60)
15	TR	SR(FTX)	.18526E+02	7	.26466E+01	.88	.5201	256(15) + 8(60)
16	XR	SR(FTX)	.14843E+02	7	.21205E+01	.71	.6659	256(16) + 8(60)
17	BR	SBR(FTX)	.56337E+02	21	.26827E+01	.89	.6050	128(17) + 2(68)
18	FL	SL(FTX)	.14631E+02	1	.14631E+02	1.15	.2876	1024(18) + 32(61)
19	TL	SL(FTX)	.37903E+01	1	.37903E+01	.30	.5869	1024(19) + 32(61)
20	XL	SL(FTX)	.32063E+01	1	.32063E+01	.25	.6172	1024(20) + 32(61)
21	BL	SBL(FTX)	.21910E+02	3	.73034E+01	1.56	.2008	512(21) + 8(69)
22	RL	SRL(FTX)	.62444E+01	7	.89206E+00	.24	.9765	256(22) + 4(70)
23	FTX	S(FTX)	.14919E+02	1	.14919E+02	.53	.4712	512(23) + 64(43)
24	FTB	SB(FTX)	.48925E+02	3	.16308E+02	2.77	.0433	256(24) + 16(59)
25	FXB	SB(FTX)	.16494E+02	3	.54980E+01	.93	.4258	256(25) + 16(59)
26	TXB	SB(FTX)	.18963E+02	3	.63211E+01	1.07	.3619	256(26) + 16(59)
27	FTR	SR(FTX)	.13363E+02	7	.19090E+01	.64	.7255	128(27) + 8(60)
28	FXR	SR(FTX)	.11575E+02	7	.16536E+01	.55	.7951	128(28) + 8(60)
29	TXR	SR(FTX)	.18744E+02	7	.26777E+01	.89	.5118	128(29) + 8(60)
30	FBR	SBR(FTX)	.60194E+02	21	.28664E+01	.95	.5239	64(30) + 2(68)
31	TBR	SBR(FTX)	.79961E+02	21	.38077E+01	1.26	.1902	64(31) + 2(68)
32	XBR	SBR(FTX)	.45894E+02	21	.21854E+01	.72	.8103	64(32) + 2(68)
33	FTL	SL(FTX)	.13369E-01	1	.13369E-01	.00	.9742	512(33) + 32(61)
34	FXL	SL(FTX)	.29194E+02	1	.29194E+02	2.30	.1350	512(34) + 32(61)
35	TXL	SL(FTX)	.13277E+02	1	.13277E+02	1.05	.3109	512(35) + 32(61)

TABLE 2 continued

36	FBL	SBL(FTX)	.13223E+02	3	.44076E+01	.94	.4217	256(36) + 8(69)
37	TBL	SBL(FTX)	.39474E+02	3	.13158E+02	2.81	.0410	256(37) + 8(69)
38	XBL	SBL(FTX)	.23676E+02	3	.78919E+01	1.69	.1718	256(38) + 8(69)
39	FRL	SRL(FTX)	.12333E+02	7	.17619E+01	.46	.8599	128(39) + 4(70)
40	TRL	SRL(FTX)	.30681E+02	7	.43830E+01	1.16	.3272	128(40) + 4(70)
41	XRL	SRL(FTX)	.23962E+02	7	.34231E+01	.90	.5041	128(41) + 4(70)
42	BRL	SBRL(FTX)	.76368E+02	21	.36366E+01	.95	.5307	64(42) + (72)
43	S(FTX)		.15875E+04	56	.28348E+02			64(43)
44	FTXB	SB(FTX)	.11939E+02	3	.39796E+01	.68	.5680	128(44) + 16(59)
45	FTXR	SR(FTX)	.17055E+02	7	.24364E+01	.81	.5772	64(45) + 8(60)
46	FTBR	SBR(FTX)	.40371E+02	21	.19224E+01	.64	.8931	32(46) + 2(68)
47	FXBR	SBR(FTX)	.84958E+02	21	.40456E+01	1.34	.1381	32(47) + 2(68)
48	TXBR	SBR(FTX)	.61768E+02	21	.29413E+01	.98	.4913	32(48) + 2(68)
49	FTXL	SL(FTX)	.14726E+02	1	.14726E+02	1.16	.2861	256(49) + 32(61)
50	FTBL	SBL(FTX)	.17276E+01	3	.57588E+00	.12	.9464	128(50) + 8(69)
51	FXBL	SBL(FTX)	.23715E+01	3	.79049E+00	.17	.9172	128(51) + 8(69)
52	TXBL	SBL(FTX)	.42479E+01	3	.14160E+01	.30	.8234	128(52) + 8(69)
53	FTRL	SRL(FTX)	.10541E+02	7	.15058E+01	.40	.9039	64(53) + 4(70)
54	FXRL	SRL(FTX)	.62757E+01	7	.89653E+00	.24	.9762	64(54) + 4(70)
55	TXRL	SRL(FTX)	.10361E+02	7	.14801E+01	.39	.9079	64(55) + 4(70)
56	FBRL	SBRL(FTX)	.12188E+03	21	.58036E+01	1.51	.0654	32(56) + (72)
57	TBRL	SBRL(FTX)	.11112E+03	21	.52912E+01	1.38	.1195	32(57) + (72)
58	XBRL	SBRL(FTX)	.97391E+02	21	.46377E+01	1.21	.2362	32(58) + (72)
59	SB(FTX)		.98929E+03	168	.58886E+01			16(59)
60	SR(FTX)		.11753E+04	392	.29982E+01			8(60)
61	SL(FTX)		.71090E+03	56	.12695E+02			32(61)
62	FTXBR	SBR(FTX)	.69125E+02	21	.32917E+01	1.09	.3498	16(62) + 2(68)
63	FTXBL	SBL(FTX)	.16852E+02	3	.56172E+01	1.20	.3112	64(63) + 8(69)
64	FTXRL	SRL(FTX)	.10727E+02	7	.15325E+01	.40	.8996	32(64) + 4(70)
65	FTBRL	SBRL(FTX)	.10846E+03	21	.51649E+01	1.34	.1375	16(65) + (72)
66	FXBRL	SBRL(FTX)	.84126E+02	21	.40060E+01	1.04	.4082	16(66) + (72)
67	TXBRL	SBRL(FTX)	.72068E+02	21	.34318E+01	.89	.6017	16(67) + (72)
68	SBR(FTX)		.35453E+04	1176	.30147E+01			2(68)
69	SBL(FTX)		.78600E+03	168	.46786E+01			8(69)
70	SRL(FTX)		.14862E+04	392	.37913E+01			4(70)
71	FTXBRL	SBRL(FTX)	.73068E+02	21	.34794E+01	.90	.5851	8(71) + (72)
72	SBRL(FTX)		.45225E+04	1176	.38456E+01			(72)

TABLE 3

	SOURCE	ERROR TERM	SUM OF SQUARES	D.F.	MEAN SQUARE	F	PROB.	EXPECTED MEAN SQUARE
1	MEAN	S(FTX)	16332.45715	1	16332.45715	976.02	.0000	2048(1) + 32(43)
2	FAMCOND	S(FTX)	88.98614	1	88.98614	5.32	.0248	1024(2) + 32(43)
3	TESTCON	S(FTX)	18.62407	1	18.62407	1.11	.2960	1024(3) + 32(43)
4	X	S(FTX)	9.58399	1	9.58399	.57	.4523	1024(4) + 32(43)
5	DELAY	SD(FTX)	162.16879	1	162.16879	21.08	.0000	1024(5) + 16(59)
6	RIAL	SR(FTX)	29.65765	7	4.23681	1.06	.3908	256(6) + 4(60)
7	NOVELTY	SN(FTX)	288.82559	1	288.82559	40.39	.0000	1024(7) + 16(61)
8	FT	S(FTX)	84.94747	1	84.94747	5.08	.0282	512(8) + 32(43)
9	FX	S(FTX)	1.12969	1	1.12969	.07	.7960	512(9) + 32(43)
10	TX	S(FTX)	16.47739	1	16.47739	.98	.3253	512(10) + 32(43)
11	FD	SD(FTX)	22.38223	1	22.38223	2.91	.0936	512(11) + 16(59)
12	TD	SD(FTX)	.17442	1	.17442	.02	.8808	512(12) + 16(59)
13	XD	SD(FTX)	13.73208	1	13.73208	1.79	.1869	512(13) + 16(59)
14	FR	SR(FTX)	48.54445	7	6.93492	1.73	.1005	128(14) + 4(60)
15	TR	SR(FTX)	21.80058	7	3.11437	.78	.6070	128(15) + 4(60)
16	XR	SR(FTX)	67.49722	7	9.64246	2.41	.0202	128(16) + 4(60)
17	DR	SDR(FTX)	58.78039	7	8.39720	1.84	.0790	128(17) + 2(68)
18	FN	SN(FTX)	9.97090	1	9.97090	1.39	.2427	512(18) + 16(61)
19	TN	SN(FTX)	18.58594	1	18.58594	2.60	.1125	512(19) + 16(61)
20	XN	SN(FTX)	2.82774	1	2.82774	.40	.5320	512(20) + 16(61)
21	DN	SDN(FTX)	10.65200	1	10.65200	1.83	.1812	512(21) + 8(69)
22	RN	SRN(FTX)	69.74062	7	9.96295	1.64	.1233	128(22) + 2(70)
23	FTX	S(FTX)	2.37211	1	2.37211	.14	.7080	256(23) + 32(43)
24	FTD	SD(FTX)	10.22368	1	10.22368	1.33	.2539	256(24) + 16(59)
25	FXD	SD(FTX)	36.68497	1	36.68497	4.77	.0332	256(25) + 16(59)
26	TXD	SD(FTX)	.33262	1	.33262	.04	.8360	256(26) + 16(59)
27	FTR	SR(FTX)	4.73140	7	.67591	.17	.9912	64(27) + 4(60)
28	FXR	SR(FTX)	13.99855	7	1.99979	.50	.8354	64(28) + 4(60)
29	TXR	SR(FTX)	6.19835	7	.88548	.22	.9804	64(29) + 4(60)
30	FDR	SDR(FTX)	17.53460	7	2.50494	.55	.7980	64(30) + 2(68)
31	TDR	SDR(FTX)	46.56492	7	6.65213	1.45	.1820	64(31) + 2(68)
32	XDR	SDR(FTX)	18.92257	7	2.70322	.59	.7632	64(32) + 2(68)
33	FTN	SN(FTX)	.20520	1	.20520	.03	.8661	256(33) + 16(61)
34	FXN	SN(FTX)	.90704	1	.90704	.13	.7231	256(34) + 16(61)
35	TXN	SN(FTX)	20.22083	1	20.22083	2.83	.0982	256(35) + 16(61)

TABLE 3 continued

36	FDN	SDN(FTX)	.20122	1	.20122	.03	.8531	256(36) + 8(69)
37	TDN	SDN(FTX)	.27426	1	.27426	.05	.8288	256(37) + 8(69)
38	XDN	SDN(FTX)	8.16333	1	8.16333	1.40	.2409	256(38) + 8(69)
39	FRN	SRN(FTX)	54.72296	7	7.81757	1.28	.2563	64(39) + 2(70)
40	TRN	SRN(FTX)	46.37480	7	6.62497	1.09	.3694	64(40) + 2(70)
41	XRN	SRN(FTX)	28.88175	7	4.12596	.68	.6906	64(41) + 2(70)
42	DRN	SDRN(FTX)	21.86515	7	3.12359	.50	.8366	64(42) + (72)
43	S(FTX)		937.08543	56	16.73367			32(43)
44	FTXD	SD(FTX)	4.66079	1	4.66079	.61	.4396	128(44) + 16(59)
45	FTXR	SR(FTX)	26.16285	7	3.73755	.93	.4812	32(45) + 4(60)
46	FTDR	SDR(FTX)	14.50550	7	2.07221	.45	.8679	32(46) + 2(68)
47	FXDR	SDR(FTX)	24.26484	7	3.46641	.76	.6228	32(47) + 2(68)
48	TXDR	SDR(FTX)	30.00125	7	4.28589	.94	.4774	32(48) + 2(68)
49	FTXN	SN(FTX)	11.41524	1	11.41524	1.60	.2117	128(49) + 16(61)
50	FTDN	SDN(FTX)	19.66821	1	19.66821	3.38	.0711	128(50) + 8(69)
51	FXDN	SDN(FTX)	12.95723	1	12.95723	2.23	.1410	128(51) + 8(69)
52	TXDN	SDN(FTX)	.99317	1	.99317	.17	.6809	128(52) + 8(69)
53	FTRN	SRN(FTX)	39.02851	7	5.57550	.92	.4935	32(53) + 2(70)
54	FXRN	SRN(FTX)	18.08761	7	2.58394	.42	.8868	32(54) + 2(70)
55	TXRN	SRN(FTX)	19.51851	7	2.78836	.46	.8644	32(55) + 2(70)
56	FDRN	SDRN(FTX)	41.36921	7	5.90989	.94	.4747	32(56) + (72)
57	TDRN	SDRN(FTX)	56.87773	7	8.12539	1.29	.2521	32(57) + (72)
58	XDRN	SDRN(FTX)	19.68367	7	2.81195	.45	.8717	32(58) + (72)
59	SD(FTX)		430.74012	56	7.69179			16(59)
60	SR(FTX)		1571.40301	392	4.00868			4(60)
61	SN(FTX)		400.45871	56	7.15105			16(61)
62	FTXDR	SDR(FTX)	13.82167	7	1.97452	.43	.8822	16(62) + 2(68)
63	FTXDN	SDN(FTX)	3.11719	1	3.11719	.54	.4670	64(63) + 8(69)
64	FTXRN	SRN(FTX)	57.18832	7	8.16976	1.34	.2286	16(64) + 2(70)
65	FTDRN	SDRN(FTX)	19.53363	7	2.79052	.44	.8740	16(65) + (72)
66	FXDRN	SDRN(FTX)	97.09429	7	13.87061	2.21	.0329	16(66) + (72)
67	TXDRN	SDRN(FTX)	17.99085	7	2.57012	.41	.8966	16(67) + (72)
68	SDR(FTX)		1792.39207	392	4.57243			2(68)
69	SDN(FTX)		325.40934	56	5.81088			8(69)
70	SRN(FTX)		2384.91723	392	6.08397			2(70)
71	FTXDRN	SDRN(FTX)	57.48917	7	8.21274	1.31	.2453	8(71) + (72)
72	SDRN(FTX)		2462.46785	392	6.28181			(72)