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A comparative investigation of young children's recall memory proficiency in naturalistic and laboratory settings

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The University of North Carolina at Greensboro, 1986

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A COMPARATIVE INVESTIGATION OF YOUNG CHILDREN'S RECALL MEMORY PROFICIENCY IN NATURALISTIC AND LABORATORY SETTINGS

by

Robert E. Nida

A Dissertation Submitted to
the Faculty of the Graduate School at
The University of North Carolina at Greensboro
in Partial Fulfillment
of the Requirements for the Degree
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Approved by

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APPROVAL PAGE

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The present study was designed to compare young children's recall-memory proficiency in naturalistic settings of the home and preschool classroom with their performance in the laboratory setting. The study also focused on the reliability of children's recall performance within each of these settings.

Seventy-two 4-year-old children deemed by teachers to be of average intellectual and social maturity were exposed to three different but comparable sets of 12 stimulus pictures comprised of six functional (child's world) and six neutral objects. Each child was shown one picture set each day by the presenter in a testing room and then later in the day tested for recall of the object names either by the experimenter in the testing room (one day), by the child's preschool teacher in the preschool classroom (another day), or by the child's mother at home (another day). Thus, over the three testing days the children were tested for recall by three different adults, each interacting with the child in an appropriate context.

The subjects were assigned randomly to one of four experimental groups. Two groups received an immediate recall test by the experimenter each day prior to a delayed recall test by the same or another adult depending on the tester designated that day. The other two groups did not receive an immediate recall test. Furthermore, the pretest and no-pretest groups were tested under either intentional or incidental memory instructions.

Contextual comparisons revealed that the children achieved comparable levels of delayed recall regardless of who served as the tester. Within-day comparisons of subjects' immediate recall with the experimenter and delayed recall later in the day with either the experimenter, mother, or teacher indicated that children remembered very few new items on the delayed recall test. Therefore, the children demonstrated remarkable recall consistency across the various experimenters and contextual settings, as well as across within-day recall trials. The results of the study also showed that children recalled functional and neutral stimulus items equally well. Children receiving the intentional memory instructions demonstrated significantly better recall than children receiving incidental instructions. A consistent sex difference in recall was found throughout the study, favoring girls.

The failure of the present study to show contextual effects on children's recall memory proficiency may have to do with the standardized laboratory procedure used by all the experimenters. The inconsistency of this procedure with routine behaviors of teachers and parents, as well as its failure to capitalize on spontaneous memory reports of young children, may have underestimated young children's recall-memory proficiency in real-world settings.

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CHAPTER I

INTRODUCTION

Since Flavell's initial investigations of children's use of mnemonic strategies in the late 1960's, a great deal of research has been directed to the study of early memory development in children. Nearly all of this research has shown that younger children perform recall memory tasks very poorly relative to older children. The majority of investigators have sought to explain these poor memory performances of young children on the basis of their failures to employ the kinds of mnemonic strategies (e.g., stimulus organization and verbal rehearsal) used spontaneously by older children and adults. Some of this research will be discussed below. However, an alternative view is that recall memory proficiency of younger children has been systematically underestimated by restricting assessments to children's performance in unfamiliar laboratory settings with unfamiliar experimenters, and by failing to examine children's retrieval proficiency in "real world" remembering environments interacting with familiar people. Thus, the primary purpose of the present study is to examine children's recall proficiency in home and preschool environments as well as in the laboratory environment. A second purpose of the present research is to examine the reliability of children's recall performance in unfamiliar, laboratory settings.

Early Investigations of Children's Recall Memory Proficiency

Prior to the 1960s, researchers drew from a limited theoretical knowledge base in their attempts to account for memory performances among children. While these investigations consistently found age-related improvements in children's recall memory, few explanations were available to determine the basis of these mnemonic improvements. A "capacity limitation theory" became the dominant explanation. Young children were said to have a limited memory capacity which increases with age, allowing greater retention. According to Brown and Deloache (1978), "the underlying metaphor was the mind as a container; little people have little boxes or jars in their heads and bigger people have bigger ones" (p. 4).

Not until the pioneering work of Flavell, Beach, and Chinsky (1966) did researchers begin to systematically investigate theoretical explanations of memory development in children. Interestingly this initial investigation, and a subsequent study by Keeney, Cannizzo, and Flavell (1967), may not have been intended to examine memory development directly. These investigations appear to have been primarily concerned with the more general issue of developmental changes in children's capacity to use symbolic-conceptual skills as mediators of cognitive task performance. As such they were designed to contrast two theoretical explanations of the onset of mediated (covert) behaviors in children; namely, the "production deficiency" hypothesis and the "mediational deficiency" hypothesis. The "mediational deficiency" hypothesis (Reese, 1962) states that children lack the ability to use various

symbolic skills (e.g., concepts, relationships, verbal symbols) to mediate or guide task performance. The "production deficiency" hypothesis (Flavell, Beach, & Chinsky, 1966) asserts that children are able to use symbolic skills to guide learning behavior, but fail to produce these cognitive responses at appropriate times and in appropriate task situations.

Flavell, Beach, and Chinsky (1966) examined these hypotheses with children from grades K, 2, and 5. The children were administered a serial recall task during which pictures of common objects were presented. The children were asked to remember the presentation order of a given subset of them (e.g., three). Several trained experimenters observed and recorded children's lip movements, indicating rehearsal verbalizations of the stimulus names. The older children were found to use verbal rehearsal spontaneously, whereas, few of the younger children did so. Although the study showed increasing developmental trends in the tendency to produce rehearsal behavior, it failed to provide conclusive evidence that rehearsal was an effective mediator (i.e., facilitator) of recall.

Shortly thereafter, Keeney, Cannizzo, and Flavell (1967) sought to determine the mediational facilitation of spontaneous verbal rehearsal in children by dividing 6-year-olds (i.e., a transitional age group) into those who spontaneously rehearsed and those who did not. The results of the study showed that (1) children who spontaneously rehearsed recalled the sequences of pictures better than those who failed to do so, (2) nonrehearsers easily learned to rehearse with minimal instruction, (3) when instructed to rehearse, the

nonrehearsers' recall scores approached those of spontaneous rehearsers, and (4) when subsequently given the option of rehearsing or not rehearsing on later trials, more than half of the instructed subjects abandoned the rehearsal strategy. These findings tended to support a production deficiency explanation of children's early memory functioning, suggesting that young children's poor memory performance could be attributed to their failures to produce appropriate mediators rather than their inability to use mediators (i.e., the "mediational deficiency" hypothesis). Keeney et al. concluded:

> We find it plausible to imagine, in other words, that for any given problem ("problem" broadly defined) and any given subject there could be a longer or shorter period in the subject's childhood when the component means (verbal or nonverbal) are well developed in themselves and yet tend not to get spontaneously recruited and integrated into the problem-solving sequence. (p. 965)

Remaining within the genre of mediational activity, a group of related studies (Corsini, Pick, & Flavell, 1968; Daehler, Horowitz, Wynns, & Flavell, 1969; Moely, Olson, Halwes, & Flavell, 1969) were undertaken to examine whether or not young children exhibit production or mediational deficiencies with task materials of different stimulus modalities (i.e., verbal, iconic, and enactive). While providing an interesting composite of age related patterns of behavior across a variety of cognitive tasks, these studies were consistent in their findings that (1) children's tendencies to employ appropriate symbolic mediators spontaneously increases sharply between kindergarten and fifth grades, and (2) mediational instructions have facilitating effects on the performance of children (particularly young children) who fail to use mediators spontaneously. Based on these works, Flavell (1970)

advanced the "production deficiency" hypothesis as the leading theoretical explanation of age trends in children's mediated task performance over a varied assortment of cognitive activities. As Brown, Bransford, Ferrara, and Campione (1983) noted, Flavell extended the concept

> . . . beyond the simple cue-producing responses to which it had been limited in the Hull-Spence theory and applied it to mnemonic strategies and other complex cognitive operations, making it much more consistent with Vygotsky's usage. (p. 86)

To summarize, the postulation of "production deficiency" hypothesis and the early investigations of symbolic mediation that followed proved to be of significant heuristic value to the field of developmental memory. These events precipitated a great deal of research during the 1970s and early 1980s on developmental changes in children's tendencies to use mnemonic strategies to augment learning and remembering and on the effects of mediational training on children's memory performance. Much of the recent research on deliberate and strategic recall memory behavior in children has tended to concentrate on verbal rehearsal and stimulus organization as mnemonic (strategic) control processes. Some of the most notable work is summarized below.

Recent Theory and Research on Children's Recall Memory Proficiency

Strategic verbal rehearsal processes. Flavell's initial investigations of rehearsal processes cited above amply documented that the frequency of spontaneous rehearsal in memory tasks increases significantly with age and that younger children who did not spontaneously

rehearse can be induced to do so, which in turn enhances their recall. Even after rehearsal instruction, however, younger children's recall failed to reach the levels of those of older children. Soon thereafter, some researchers began to focus on developmental changes in the quality of children's rehearsal, not just the probability of its occurrence (Cuvo, 1975; Kellas, McCauly, & MacFarland, 1975; Ornstein, Naus, & Libety, 1975). These researchers found that older children rehearsed more actively while young children rehearsed in a more passive fashion. For example, Ornstein et al. examined both the frequency of item rehearsal and the content of the rehearsal sets (items rehearsed at the same time) in relation to differences in recall. These investigators asked 8-, 11-, and 13-year-olds to rehearse aloud after the presentation of each word in a list. Analyses of the contents of the rehearsal sets indicated that different age groups of children were rehearsing in quite different ways. Third graders typically rehearsed items one-at-a-time or in small combinations. For example, after seeing each of the items "cat," "man," "desk," "yard," they would say "cat, cat, cat;" "man, man, man;" "desk, desk, desk;" etc. The eighth graders, by contrast, were much more active combining several words with the newly presented word. That is, after seeing these words they would spontaneously rehearse in the following way, "cat, man, desk," "cat, man, desk," "cat, man, desk."

Improvements in young children's verbal rehearsal activity have also been related to characteristics of the rehearsal environment such as the amount of processing time allowed, and the training procedures

and list types used. Naus, Ornstein, and Aivano (1977) examined the effects of processing time by allowing third and sixth graders additional time (10 seconds compared to 5 seconds) to study lists of 18 unrelated words for several study/recall trials. These researchers reasoned that younger children might spontaneously rehearse more actively when provided with additional study time. The findings showed that only the 3rd-grade girls and not the boys were able to benefit from the additional time. The unexpected sex difference was interpreted in terms of Maccoby and Jacklin's (1974) conclusion that elementary girls demonstrate greater facility in dealing with verbal materials.

Training children to utilize rehearsal strategies with the intent to improve free recall (i.e., the number of items recalled) provided more robust findings than did additional processing time. Naus, Ornstein, and Aivano (1977) and Ornstein, Naus, and Stone (1977) instructed children to use different rehearsal strategies in an attempt to examine direct relationships between the quality of rehearsal strategies and recall. Naus et al. found little difference in the recall of third and sixth graders when both groups were trained to use a three-item rehearsal strategy (i.e., including three different items in each rehearsal training techniques to include one-item, two-item, and many-item strategies for second and sixth graders. The performance of these groups were compared to a spontaneous group not given a rehearsal strategy at each of the age levels. The results indicated that second graders in the spontaneous group rehearsed in a manner that was similar to the one- and two-item conditions, whereas, sixth graders in the spontaneous group rehearsed in a similar fashion to subjects in the

many-item instruction condition. Taken together, these investigations provided substantial evidence for a direct relationship between age, strategy sophistication, and superior recall performance.

With increasing age, children not only refine the pattern of their rehearsal activity, but also become more sensitive to the presence of conceptual organization in to-be-remembered lists (Ornstein et al., 1975; Ornstein, Naus, & Miller, 1977). Ornstein et al. (1977) investigated the joint effects of list organization and rehearsal strategy. The materials differed in terms of the salience of the list organization; unrelated items or categorized items (e.g., animals, foods, etc.) presented in a random order, or categorized items blocked by category at the time of presentation. Under both active and passive rehearsal conditions, recall varied as a function of the organization of the stimulus materials with subjects in the categorized blocked conditions exhibiting superior recall. Most striking were differences between the two rehearsal techniques in relation to the list types. The superiority of active rehearsal was clearly displayed with the unrelated and categorized items presented randomly, whereas difference was minimal for the related blocked items. Thus, when the organization of to-be-remembered materials is made salient (i.e., through blocking), organization itself may influence recall directly, and rehearsal factors may be less important (Ornstein & Naus, 1978).

Strategic stimulus organizational processes. Children's tendencies to cluster (organize) same-category items at the time they recall the items has been found to increase with chronological age in a manner

similar to the developmental findings of rehearsal strategies. However, the age at which strategic organization becomes evident, and indeed a deliberate mnemonic strategy, has been a point of contention among certain organizational researchers. Two distinctively different patterns of developmental findings have been obtained in category clustering studies with children. Some investigators have reported that a reliance on organizational strategies appears in very young children and increases in a relatively gradual and linear manner with age (e.g., Moely et al., 1969; Neimark, Slotnik, & Ulrich, 1970; Rossi & Rossi, 1965; Vaughan, 1968). Young children between the ages of two to five have been observed to demonstrate above chance levels of category clustering in free recall (Rossi & Rossi, 1965; Rossi & Whitrock, 1971). In the Rossi and Rossi study, both recall and the amount of clustering increased as a function of age, and even the 2-year-olds clustered at above chance levels. Upon presenting young children with word pairs consisting of either phonemically similar (sun, fun), syntactically related (dogs, bark) or taxonomically related (peach, apple) instances, Rossi and Whitrock found phonemic clustering dominant for the 2-year-olds and taxanomic clustering dominant from ages three to five. Other investigators (Moely et al., 1969; Neimark et al., 1971; Vaughan, 1968) reported a consistent development progression in organization among older children ranging from kindergarten to seventh grade.

Lange (1973; 1978) questioned whether young children's clustering of related words is best described as an organizational strategy.

Lange argued that in previous studies (e.g., Rossi, 1964; Vaughan, 1968), investigators failed to control for the associated relatedness of stimulus items. The items in the Rossi (1964) study were high frequency associates for young children; the clothing category contained the items "hat," "coat," "dress," and "belt." Similarly, Vaughan (1968) included the following clothing items: "hat," "coat," "skirt," and "belt." Lange proposed that:

> it would seem that under such conditions, observed clustering may largely be a result of the children's reliance upon highly practiced word associations and not necessarily indicative of the children's tendency to employ higher-order conceptual strategies whereby items are organized and retrieved for recall on the basis of superordinate concept symbols. (p. 395)

Lange (1973) presented lists of 16 items to 5½-, 11-, and 15-year-old children. The lists contained four conceptual categories but the items within each category were of low associative relatedness. For example, pants, scarf, glove, and dress are all from the same category (clothing) but are not highly associated. Under these circumstances, Lange found that only the 15-year-olds demonstrated clustering significantly higher than would be expected by chance. He concluded that previous demonstrations of "categorical clustering" in very young children (e.g., Rossi, 1964; Rossi & Whitrock, 1971) may instead, "reflect skills of a lower cognitive order than has been assumed" (p. 403).

A variety of methodological conditions, varying in their degree of inducement, have produced notable variations in children's organizational behaviors. Children's organizational skills have been improved by enhancing the child's sensitivity to the presence of

conceptual relationships with such methods as blocking and cuing stimulus items. When items are blocked (i.e., conceptually related items are presented contiguously rather than randomly) younger and older children increase their clustering and recall (Bjorklund & Ornstein, 1976; Cole, Frankel, & Sharp, 1971; Kobasigawa & Middleton, 1972; Perlmutter & Myers, 1979; Perlmutter & Ricks, 1979). The availability of category cues (e.g., presenting the category labels at the time of recall) has been an effective mediator of children's recall (Scribner & Cole, 1972; Halperin, 1974). As children become older they become increasingly likely to make use of retrieval cues spontaneously and effectively (Kobasigawa, 1974). Preschoolers have also been found to profit from category cuing at the time of recall (Perlmutter & Myers, 1979; Perlmutter & Ricks, 1979).

However, training procedures have produced relatively weak effects on children's organizational behaviors. Unlike the benefits received from labeling the category items at the time of recall, children make little use of the information received when items and categories are labeled for them at the time of study (Furth & Milgram, 1973; Kobasigawa & Middleton, 1972; Lange, 1973: Moely et al., 1969). For a case in point, Kobasigawa and Middleton's (1972) data showed that even category labeling provided little additional facilitation of recall beyond that of blocking category items. Furth and Milgram concluded that "the most pronounced organizing effects of labeling on free recall were found in the older rather than younger children" (p. 517). Similar results have occurred when researchers have tried to induce better recall organization through direct teaching of organizational

skills. According to Bjorklund, Ornstein, and Haig (1977), direct teaching of organizational skills only becomes effective for children during the 8- to 11-year age period.

Subjective organization studies have yielded developmental patterns similar to those just mentioned. Subjective organization paradigms supply the subject with lists of unrelated materials and examine whether the subject imposes a structure of his own (Hagen, Jongeward, & Kail, 1975). Organization is inferred on the basis of the child's tendency to structure the order of his recall identically on adjacent trials. In subjective organization studies, 5- to 12-year-olds typically show little inclination to organize recall, and what small amounts of trial-to-trial consistency they do show bears no relation to recall (Laurence, 1966; Ornstein, Hale, & Morgan, 1977; Rosner, 1971).

Explanations of Recall Memory Development in Very Young Children

While much of the research on mnemonic strategy development has been designed to demonstrate strategy transitions during the early school-age years, relatively little memory research has focused on children younger than school age. However, two predominant lines of research with younger children have appeared in the literature. One of these relates poor remembering in very young children to a restricted semantic knowledge base; the other to the young child's lack of familiarity with laboratory types of memory tasks and standardized testing procedures.

Perlmutter and associates (Goldberg, Perlmutter, & Myers, 1974; Perlmutter & Myers, 1979; Perlmutter & Ricks, 1979) have attributed recall memory improvements in preschool children to semantic development rather than to strategy development. In their investigations, young children between the ages of 2 and 4 years have been found to (1) recall semantically related lists better than unrelated lists, (2) exhibit shorter latencies between recalled items that are from the same semantic category, (3) produce above chance levels of category clustering, and (4) demonstrate developmental increases in recall. On the basis of these findings, Perlmutter and colleagues (e.g., Myers & Perlmutter, 1978; Perlmutter & Myers, 1979) argued that even young children are capable of encoding items in terms of semantic properties despite their lack of strategy usage prior to 5 years of age. This explanation may well account for similar age related recall improvements among preschool children found by Rossi (1964), Rossi and Rossi (1965) and Vaughan (1968), which Lange (1973) attributed to highly practiced word associations.

An alternative explanation of the Perlmutter et al. findings is that subjects in these investigations participated in tasks of a more meaningful, real-world nature. A close examination of Perlmutter and Myers' (1978) study (see also, Perlmutter & Ricks, 1979) revealed an obvious attempt to make the memory tasks more simple and realistic than those used in previous laboratory investigations. For example, their preschool subjects were (1) told that they would be taking part in a "remembering game," (2) provided stimulus materials comprised of small attractive and familiar objects (e.g., boat, car, plane) rather than

pictures, and (3) informed that they could keep whatever objects they remembered. A parent of each of the younger children was present during the experimental session as well. Furthermore, considerable effort was made to enhance recall by (1) reducing the length of the stimulus lists to contain only nine items, (2) presenting several practice trials, and (3) providing external stimulus supports such as a memory box in which stimulus items could be placed at the time of study and used as a location retrieval cue at the time of recall. By providing a more "real world" remembering environment, although remaining within a laboratory setting, these provisions may have served as important contributing factors to the recall competencies found in 3- and 4-year-olds by Perlmutter and her colleagues.

While the tasks in the Perlmutter et al. studies yielded evidence of more proficient preschool memory in meaningful task situations, they do not show evidence of strategy usage among these young subjects. In contrast, other investigations have sought to identify conditions under which young children exhibit strategic and proficient memory prior to the school-age period. Such an approach assumes that although full-fledged, adult-like forms of rehearsal and stimulus organization are not likely to appear before ages 6 or 7, rudimentary forms of planful and deliberate memory can be found in naturalistic settings which are related to memory proficiency. Istomina (1975), reporting on research conducted in 1943, provided an informative picture of young children's use of mnemonic strategies in naturalistic settings. The experimental task required children to remember a list of items either to be bought at a play grocery store (i.e., repeated to the grocer) or simply to be

repeated back to the experimenter. In other words, Istomina was able to compare children's recall for lists of words in a typical laboratory learning setting versus their memory for the same words embedded in a meaningful activity within a preschool classroom (i.e., shopping at the grocery store). The children's recall was far superior in the game situation. Istomina attributed the superior memory in the shopping condition to the fact that the goal of the activity was more salient and motivating to the child. Interestingly, even the 4-year-olds in the grocery store condition were found rehearsing the grocery list of items as they made their way to the play store.

Wellman and his colleagues (e.g., Wellman, 1977; Wellman, Ritter, & Flavell, 1975; Wellman, Somerville, & Haake, 1979) have also shown evidence of strategic mnemonic behavior in very young children. They designed research settings which would more readily provide evidence of early planfulness than would be the case with laboratory free recall tasks. They concerned themselves with such problems as memory for future activities, preparations for future retrieval demands, and search strategies. A central example of this approach is a study by Wellman et al. (1975). Children of 2 and 3 years of age were presented a story about a dog which ended with the dog being hidden under one of four containers. After hiding the dog, the experimenter left the room instructing one half of the children to "wait with the dog" and the other half to remember "where the dog is." During the experimenter's absence, their behavior was observed via a one-way mirror. The 2-year-olds were unable to wait for the experimenter to return; they went ahead and looked for the dog hidden under one of the containers.

However, the 3-year-olds in the memory condition displayed a variety of mnemonic strategies. Those in the instructed-to-remember group engaged in more looking at and touching the hiding place (baited container or cup). While looking fixedly at the target cup, the 3-year-olds often nodded "yes" while nodding "no" at the nontargeted containers. Children also moved closer to the target container and/or rested their hand on it or moved it to a salient point. Children who engaged in these behaviors demonstrated superior memory than those who did not.

Wellman and his colleagues have also turned their attention to logical search strategies in young children. An object might be lost in a particular location in their playground and the children's attempts to retrace their steps in logical fashion are measured. For example, Wellman et al. (1979) examined search strategies in young children in which they looked for a camera lost in 1 of 8 locations on a playground. Children as young as 3½ years of age retraced their steps logically in attempts at locating the target object at the last place the camera had been used. Preschoolers have also been found to recall the location of an object or event more accurately when they are told beforehand that they will be asked to do so and when the environment is more familiar as opposed to unfamiliar (Acredolo, Pick, & Olson, 1975).

Theoretical Rationale and Purpose of the Study

The studies cited above have provided evidence that young children's recall memory proficiency, and in some cases (e.g., Istomina, 1975; Wellman, 1977) their tendencies to exhibit strategic memory

behaviors, may be more apparent in naturalistic settings. As has been noted, children's memory performance, under a number of conditions has been found to vary with the familiarity of the setting, meaningfulness of the task, and instructional format. Bronfenbrenner (1979) has proposed an ecological framework which may account for these findings. Bronfenbrenner argues that certain environmental structures and elements exert considerable influence on children's task performance. However, he has noted that the ecological orientation has been absent in research on human development. He has taken issue with the developmentalist's preference to conduct research in artificial laboratory settings to the exclusion or more "ecologically valid" environments. Bronfenbrenner, as well as Brown and Deloache (1978) and Brown et al. (1983) have called for comparative research to be undertaken that measures children's task performance within different settings. Bronfenbrenner contended that:

> the understanding of human development demands more than the direct observation of behavior on part of one or two persons in the same place; it requires examination of multiperson systems of interaction not limited to a single setting and must take into account aspects of the environment beyond the immediate situation containing the subjects. In the absence of such a broadened perspective, much of contemporary research can be characterized as the study of development out of context. (p. 21)

Similarly, Brown and Deloache (1978) stated that estimates of children's competencies are sometimes drastically changed when considered in naturally occurring situations. Addressing the importance of ecological validity and the development of cognitive skills, they cautioned:

> If, therefore, we are in the business of delineating the cognitive competencies of the 4-year-old, we will have a distorted picture if we see the 4-year-old only in a laboratory setting. Of course, the 4-year-old's laboratory performance is informative, but it is only one side of

> the picture. We also need to consider the other side, how our 4-year-old functions in the world around him, outside the confines of the laboratory. (p. 27)

Explicit in Bronfenbrenner's work is the idea that various ecological factors give rise to distinctive behavior patterns among children. For example, children behave very differently depending upon different elements in the environment such as their familiarity with the setting and the people with whom they interact within the setting. Interpersonal structures within the setting, particularly the primary learning context or the "primary dyad" has received special status within the ecological perspective. The primary dyad consists of two people (e.g., parent and child) who form strong enduring bonds to each other and are objects of strong emotional feelings and influence each other's behavior even when apart. Such dyads are viewed as exerting a powerful force in motivating learning and steering the course of development. Both mothers and preschool teachers fall under this rubric. Furthermore, he hypothesized that children will perform better on various tasks with the mother and the teacher due to the familiarity and the emotional bond that has been established as compared to a stranger.

Contextual factors such as these described by Bronfenbrenner (1979) serve as a tenable explanation of variations in children's recall memory performance. Yet, little research conducted to date has focused on relationships between children's recall performance and qualities of the surroundings or context within which memory is tested (i.e., familiarity of the setting, interpersonal dyadic functions) or the stability with which the same child performs across different settings.

Therefore, the primary purpose of the present study was to examine the consistency of children's recall proficiency in different settings. On the basis of ideas set forth by Bronfenbrenner, young children were expected to perform most proficiently when tested by familiar adults (i.e., mothers and teachers) in familiar settings; namely, home and school settings as opposed to unfamiliar laboratory settings. While attempting to improve upon the ecological validity of memory testing among young children, an attempt was also made to avoid ecological distortion. Bronfenbrenner stated:

> There exists, however, the danger of creating an "ecological distortion" by injecting into a natural situation elements that are unfamiliar and hence disorienting and disruptive of the patterns of activity and relations that normally occur in the setting. (p.123)

The transfer of laboratory procedures into natural settings can lead to unnatural conditions and prove disruptive. Therefore, in the present study the children were always presented with the stimulus items in a laboratory setting and then asked to recall these same materials later either at home, in the preschool classroom, or in the laboratory where they were originally presented.

Secondly, very little research has assessed the reliability of children's recall performance within the laboratory setting and across various locations--hence the second purpose of the present investigation. The validity of recall memory research, heretofore conducted largely in laboratory settings, depends first and foremost on the reliability of the recall measure. And if in fact children perform more poorly under unfamiliar conditions, their recall is likely to be less reliable in those situations. Notwithstanding all of the work that has

been done on children's verbal recall, there is little if any available evidence that children's verbal recall is reliable. Some data suggest, to the contrary, that children's verbal recall is not reliable. For example, Lange, Kienapple, Sullivan, and Allen (1981), found a lack of stability in preschooler's study behaviors and recall scores in laboratory task settings. Furthermore, after testing these same children, Lange et al. received occasional informal reports from parents that some children more than doubled their initial (laboratory) recall when describing the stimuli in the memory tasks to their parents after they had returned home. Both the reported differences between parental reports, although anecdotal and unsystematically obtained, and the initial memory protocols, coupled with findings of inconsistent recall performances over trials, raise questions as to the stability of young children's recall and the role of environmental factors.

Paris (1978) has provided direct evidence of the instability of children's recall memory. School-age children were presented with a list of taxonomically related words in a free recall test. Multiple recall trials followed the initial presentation of words so that changes in memory organization could be assessed over recall attempts. The results showed that children remembered many new words on later recall trials that they had not remembered on the first trial. Moreover, younger children forgot many words during repeated recall trials whereas the older children did not. Paris concluded that "children often remember a great deal of information that may not be immediately accessible or measured by a single recall trial" (p. 1050), suggesting that

young children encode far more information than they are able to retrieve in any given situation (cf., Kobasigawa, 1974, 1977).

Objectives and Hypotheses of the Present Study

The major objective of the study was to perform contextual comparisons of children's recall proficiency in laboratory, home, and school environments. Two forms of analyses were brought to bear on these objectives. In the first case, overall recall (i.e., number of items recalled), as well as children's tendencies recall and organize lists at recall into taxanomic categories (functional or child's world items as opposed to neutral items that typically comprise standard laboratory stimulus lists) were compared as between groups factors across the three days of the child's performance. In the second case, the child's performance in the laboratory was compared on a within-day basis with performance at home and at school. In each case recall proficiency as well as the tendency to organize the materials recalled was expected to be greater for home and school tests than for laboratory tests. This latter means of analysis was pertinent only to the pretest groups.

Consistent with the findings of Paris (1978), it was expected that the content of recall would differ systematically over the three settings whereby children would tend to recall more home related items in home testing conditions, more school related items in the school testing conditions, and more neutral adult-like items in the laboratory testing conditions. Consistent with findings of Lange et al. (1981),

subjects were not expected to exhibit reliable recall scores in the experimental laboratory setting nor between the laboratory setting and other settings. In this regard, it was expected that both the numbers and the content of items recalled will vary.

CHAPTER II

METHOD

Subjects

Seventy-two children (36 boys, 36 girls) between the ages of 4 and 5 years were selected from the Early Childhood Programs in the Cleveland Heights/University Heights City School District. Their ages ranged from 4.2 years to 5.3 years; the average age being 4.7 years. The children were judged by teachers to be of average to above average intellectual and social maturity, and represented families of middle- or upper-middle-class educational and occupational status.

Design

All subjects studied and recalled three different sets of taxonomically-related pictures over the course of three days with the constraint that no child would be presented the stimuli less than three days apart or more than six days apart. The child was shown one picture set each day by the presenter in a testing room, and then later in the day tested for recall of the picture names either by the experimenter in the testing room (one day), by the child's preschool teacher in an empty corner of the classroom (one day), or by the child's mother at home (one day). Thus, over the three-day period the child was tested for recall by three different adults, each interacting with the child in an appropriate context. The order in which subjects were tested in the three contexts, and the order in which stimulus sets were

assigned to each test order condition, were counterbalanced yielding equal numbers of subjects in each of 18 test order X set order combinations (see Table 1). These combinations ensured that (1) equal numbers of subjects were tested by the experimenter, teacher, and parent on each of the first, second, and third days of the time sequence, and (2) that equal numbers of subjects were exposed to stimulus sets A, B, and C on each of the three days of the time sequence.

The four subjects receiving each test order by stimulus set combination were assigned randomly, one to each of four experimental groups. Two groups received a memory pretest by the experimenter each day prior to a later test by the same or another adult, depending on the tester designated that day. The other two groups were not pretested. One pretest group and one no-pretest group was told at the time of stimulus presentation that their recall would be tested by someone later that day (intentional memory groups). The remaining groups were not forewarned of the subsequent memory test (incidental memory groups).

Since subjects were recruited from seven preschool classrooms, each housed in a different elementary school, an attempt was made to ensure that relatively comparable proportions of subjects in each school were assigned to the instructional-by-pretest condition combinations. These four instructional-by-pretest conditions were further divided by sex. Therefore, the basic design of the study was a four-factor ANOVA with pretest condition (pretest, no-pretest), recall instructions (intentional, incidental), and sex (male, female) serving as between subjects factors and the test context (experimenter, teacher,

Table 1

Number of Subjects Assigned to Each Test-Order by Stimulus-Set Order Condition

Stimulus Set Order (Day 1,2,3)	Experimenter Order (Day 1,2,3)					
	$E_1T_2P_3$[a]	$E_1P_2T_3$	$T_1P_2E_3$	$T_1E_2P_3$	$P_1E_2T_3$	$P_1T_2E_3$
A_1 B_2 C_3	n = 4	n = 4	n = 4	n = 4	n = 4	n = 4
B_1 C_2 A_3	n = 4	n = 4	n = 4	n = 4	n = 4	n = 4
C_1 A_2 B_3	n = 4	n = 4	n = 4	n = 4	n = 4	n = 4

[a] E = Experimenter

T = Teacher

P = Parent

parent) constituting a within subjects factor (see Table 2). Preliminary analyses were performed to assess the contributions of stimulus sets (A, B, C) and test times (Day 1, Day 2, Day 3).

Table 3 shows the measures that were available for subjects in each of the four experimental groups. Although the table is based only on subjects assigned to an E, T, P testing sequence, the measures were the same for subjects in all test context sequences. As can be seen, the two pretest conditions allowed for context comparisons to be made both within days (i.e., relative differences between subjects' immediate- and delayed-test scores compared across days) and across days (i.e., absolute differences in delayed-test scores across the three

Table 2

Number of Subjects Assigned at Random to Testing, Recall Instructions and Test Context Conditions

Test Contexts (Within-Subjects)	Recall Conditions (Between-Subjects)			
	Intentional		Incidental	
	Immediate	Delayed	Immediate	Delayed
Experimenter (testing room)	n = 18	n = 18	n = 18	n = 18
Teacher (preschool classroom)	n = 18	n = 18	n = 18	n = 18
Parent (home)	n = 18	n = 18	n = 18	n = 18

days). These conditions also enabled an analysis of the reliability of subjects' initial test scores with the experimenter (i.e., the pretest) as compared with a second test conducted by the experimenter later in the day. The no-pretest conditions allowed for context comparisons to be made only across days, but in this case unconfounded by experimenter pretests.

The presentation of the stimulus sets were always administered by the same presenter. The experimenter, teachers, and mothers were blind to the conditions of the study. They were blind insofar as knowing the names of the stimulus items and the numbers of items that comprised each of the three stimulus lists.

Table 3

Measures Available for One Exemplary $E_1T_2P_3$ Subject in Each of the Four Experimental Conditions

Condition	Sequence and Source of the Stimulus Presentation and Test		
Intentional/pretest			
Day 1	P presents	E pretests	E tests
Day 2	P presents	E pretests	T tests
Day 3	P presents	E pretests	P tests
Intentional/no pretest			
Day 1	P presents		E tests
Day 2	P presents		T tests
Day 3	P presents		P tests
Incidental/pretest			
Day 1	P presents	E pretests	E tests
Day 2	P presents	E pretests	T tests
Day 3	P presents	E pretests	P tests
Incidental/no pretest			
Day 1	P presents		E tests
Day 2	P presents		T tests
Day 3	P presents		P tests

Materials

Three separate but comparable stimulus sets were used. Each set was comprised of 12 color line drawings depicting either functional (child's world) or neutral items. The 4½" x 4½" pictures were drawn on 5" x 5" white cardboard blanks. List A included swing, feather, teddy bear, sun, letter, wagon, basket, crayon, ball, pitcher, drum, and heart. List B was comprised of watch, flower, doll, rope, needle, balloon, pipe, train, rocking horse, key, scissors, and candle. List C was composed of leaf, slide, clock, paintbrush, blocks, spoon, tricycle, lamp, dress, kite, window, and book.

General Procedure

The presentation of the three stimulus sets were administered in a quiet testing room located in the school building. The children were ushered into the testing room, individually, and seated next to the presenter before a table. The introductory remarks and task instructions given to the child varied depending upon the testing conditions to which the children had been assigned.

Stimulus presentation. All subjects were presented their appropriate stimulus sets in the same manner. The presenter spread out the 12-item set of stimuli on the table in a 3 x 4 array. The stimulus items were assigned to the positions in the 3 x 4 array randomly with the constraint that no two successive items, vertically or horizontally, would be exemplars from the same category (i.e., functional and neutral). The presenter then stated, "I would like to see how well you can name

some pictures for me." To ensure that the child knew the label for each picture, the presenter pointed to each item, beginning in the upper left-hand corner and asked, "Can you tell me what this is?" Following the naming period, all subjects were asked to view the stimulus pictures for 60 seconds under the following instructions.

Procedure for the No-Pretest Groups

Incidental group. Following the naming procedure, the presenter stated, "Now, you may look at the pictures as many times as you wish, and in any order that you like. You will have some time to look at the pictures and then I am going to have to take them away." No further instructions were administered. The subjects were thanked for their willingness to come and name the pictures and not cued to the subsequent recall test.

Intentional group. Following the naming procedure, the presenter stated, "Now, look closely at all the pictures as many times as you wish and in any order that you would like. You will have some time to look at the pictures and then I am going to have to take them away. Look at the pictures carefully because later today someone will ask you to remember the names of the picutres that you see here." After the 60-second viewing period the children were thanked for their willingness to participate.

Procedure for Pretest Groups

Incidental group. Following the naming task the presenter stated, "Now, look closely at all the pictures as many times as you wish and in any order that you would like. You will have some time to

look at the pictures and then I am going to have to take them away." Following the presentation period, the presenter removed the stimuli from the table and administered a number counting task. The children were asked to count to seven (lasting approximately 20 seconds). The distractor task was used to ensure that whatever was recalled subsequently was from long-term rather than short-term memory. After the number counting naming task, a female experimenter entered the room and the presenter introduced the experimenter to the child, indicating that the experimenter had come to see how well the child could remember the names of the pictures. The presenter stated the following to the child "This is Ms. _____. She has come to see how well you can remember the names of the pictures. I am going to leave now, and Ms. _____ will spend a few minutes working with you." The presenter then left the room, and the experimenter instructed the child as follows: "I would like for you to tell me the names of as many of the pictures as you can remember, and in any order that you would like." This group was not cued to any subsequent recall beyond the immediate recall task.

Intentional group. Following the naming task the presenter stated, "Now, look closely at all the pictures as many times as you wish and in any order that you like. You will have some time to look at the pictures and then I am going to have to take them away. Look at the pictures carefully because Ms. _____ is going to come in in a few minutes to ask you to remember as many of the pictures as you can. And later today someone will ask you again to remember the names of the pictures that you see here."

After the number counting task, a female experimenter entered the room, and the presenter introduced the experimenter to the child and stated the following, "This is Ms. _____. She has come to see how well you can remember the names of the pictures. I am going to leave now, and Ms. _____ will spend a few minutes working with you." The presenter then left the room and the experimenter instructed the child as follows: "I would like for you to tell me the names of as many of the pictures as you can remember and in any order that you would like."

The pretest recall period with the unfamiliar female experimenter in the testing room lasted for 75 seconds and was not terminated until the full 75 seconds had elapsed. After each 15-second period of silence throughout the 75-second period the child was prompted ("can you remember any more of the things you saw?"). After recording the responses during the 75-second free recall period, the experimenter ended the session by thanking the children for their willingness to participate.

Procedure for Delayed Recall by the Three Examiners

Instructions requesting recall by the three examiners varied depending on the contextual conditions. They were as follows:

Laboratory context. The child was ushered to the testing room and instructed by the experimenter as follows: "Earlier today you saw some pictures of things with Mr. Nida. Will you try really hard to tell me the names of the pictures you saw--just the ones you saw today with Mr. Nida."

Classroom context. The teacher located the child in the classroom and escorted the child to a designated table in a quiet corner of the classroom and stated the following: "Earlier today you saw some pictures of things with Mr. Mida. Will you try really hard to tell me the names of the pictures you saw--just the ones you saw today with Mr. Nida?"

Home context. At the mother's convenience within the 5:00 to 8:00 p.m. time period, she stated the following to the child: "While you were at school today you saw some pictures of things with Mr. Nida. Will you try really hard to tell me the names of the pictures you saw--just the ones you saw today with Mr. Nida?"

In all three contexts the subjects were given the full 75 seconds to recall the items. After each 15-second period of silence throughout the 75-second period the child was prompted ("can you remember any more names of the things you saw?"). After recording the responses during the 75-second free recall period, the respective examiners terminated the session. Examples of the recording sheets for all three testers is provided in Appendix A.

The experimenter's presentation of each set of materials occurred between 9:00 and 11:30 in the morning. The delayed recall tests administered by the experimenter and teachers took place from 3:00 to 4:00 in the afternoon. The mothers asked their children to recall the items shortly after dinner. The mothers were encouraged to plan the recall period during a time that did not interfere with an important or potentially conflicting evening activity.

Prior to the experiment, the nursery school teachers were visited individually by the presenter; the mothers were contacted by phone. They were told of the importance of their roles in the study, instructed how to administer the recall test, and taught how to record the responses from the child. They were told that children in this age group are not able to freely recall large numbers of stimuli, and that they should not become concerned if the child did not remember much of what he/she saw earlier in the day. Neither parents nor teachers were told how many items comprise each stimulus set.

CHAPTER III

RESULTS

The results summarized in this chapter include preliminary analyses of list and day effects on immediate and delayed recall scores as well as the principal analyses of tester effects, pretest effects, and instructional condition (intentional, incidental) effects. Additional analyses of children's organization and recall of functional (child's world) and neutral items, as well as within-day assessments of the content consistency of recall over two testings in the pretest condition will be reported. Total recall scores represent the total number of nonredundant object names freely recalled by the child. Functional and neutral recall scores represent the number of nonredundant functional or neutral items freely recalled by the child.

Preliminary Analyses

Preliminary analyses of children's immediate and delayed recall scores were undertaken to determine whether there were reliable performance differences in response to the three stimulus lists (A, B, C) and the day of testing (day 1, 2, 3). One-way repeated measures analyses of variance (ANOVAS) were conducted to assess list effects for subjects' total recall scores. The ANOVA performed on immediate-test recall means ($\overline{X}$ list A = 4.66, $\overline{X}$ list B = 4.69, $\overline{X}$ list C = 4.42) failed to yield a reliable list effect, F (2,35) = 0.48, $p > .05$. The ANOVA performed on delayed recall means ($\overline{X}$ list A = 2.94, $\overline{X}$ list B = 2.68,

$\bar{X}$ list C = 2.87) also failed to yield a list effect, F (2,71) = 0.60, $p > .05$. A summary of these analyses is presented in Tables B-1 and B-2, Appendix B.

One-way repeated measures ANOVAS were also employed to assess day effects for subjects' immediate and delayed total recall means. Summaries of these analyses can be found in Tables B-3 and B-4, Appendix B. The ANOVA performed on immediate test total recall means ($\bar{X}$ day 1 = 4.97, $\bar{X}$ day 2 = 4.50, $\bar{X}$ day 3 = 4.31) failed to yield a significant day effect, F (2,32) = 2.56, $p > .05$. The ANOVA performed on delayed recall means ($\bar{X}$ day 1 = 3.61, $\bar{X}$ day 2 = 2.47, $\bar{X}$ day 3 = 2.40) did produce a significant day effect, F (2,71) = 18.11, $p < .001$. Tukey's student range test performed on these means indicated that delayed recall on day 1 was superior to that of days 2 and 3 ($p < .05$) which did not differ significantly from one another ($p > .05$). However, since counterbalancing procedures equated day effects for all tester, pretest, and instructional conditions, the day effect for delayed recall does not affect interpretations of the results that follow.

Primary Analyses

The main purpose of the present study was to examine children's recall proficiency for functional (child's world) and neutral stimulus items in familiar and unfamiliar testing environments. Initial analyses of immediate and delayed recall failed to yield main effects or interactions associated with stimulus type ($p > .05$). On the average, subjects recalled 2.19 functional items and 2.40 neutral items on the immediate test, and 1.36 functional items and 1.47 neutral items on the

delayed test. Thus, the means for functional and neutral items were combined and examined as total recall scores in all subsequent analyses. A summary of these results is presented in Tables B-5 and B-6, Appendix B.

Primary analyses of immediate total recall took the form of three-factor ANOVAS with sex (boys, girls) and instructional condition (intentional, incidental) as between-subjects factors, and days (day 1, 2, 3) as a within-subjects factor. Primary analyses of delayed total recall took the form of four-factor ANOVAS with sex (boys, girls), pretest condition (pretest, no-pretest) and instructional condition (intentional, incidental) as between-subjects factors, and tester condition (experimenter, teacher, parent) as a within-subjects factor.

Mean total recall scores for the immediate test are shown in Table 4. The three-factor ANOVA performed on these means yielded a significant main effect for instructional condition, $\underline{F}$ (1,32) = 9.01, $\underline{p} < .01$, favoring intentional-recall subjects, and a marginally significant main effect for sex of subject, $\underline{F}$ (1,32) = 3.83, $\underline{p} < .06$, favoring girls. No other main effects or interactions were statistically significant (see Table B-7, Appendix B). Mean total recall scores for the delayed test are shown in Table 5. The four-factor ANOVA performed on delayed recall means yielded a significant main effect only for sex, $\underline{F}$ (1,64) = 8.08, $\underline{p} < .01$, favoring girls and no interaction effects ($\underline{p} > .05$). A summary of the analysis of these data is presented in Table B-8, Appendix B.

Table 4

Means and Standard Deviations of Children's Total Recall Scores on the Immediate Test

Sex of Subject	Intentional Recall			Incidental Recall		
	Day 1	Day 2	Day 3	Day 1	Day 2	Day 3
Boys						
Mean	4.78	4.44	4.78	4.44	3.89	3.56
S.D.	1.20	1.67	1.09	2.35	.78	1.33
Girls						
Mean	6.01	5.33	4.78	4.67	4.33	4.11
S.D.	1.32	1.12	1.20	.87	1.50	1.36

To further examine the existence of tester effects, an additional analysis of immediate and delayed total recall scores was performed on pretest subjects only (n = 36). In this case, the ANOVA consisted of sex and instructional condition as between-subjects factors, and tester (experimenter, teacher, parent) and time of recall (immediate, delayed) as within-subjects factors. The ANOVA resulted in significant main effects for sex, F (1,32) = 5.25, $p < .05$, favoring girls, for instructional condition, F (1,32) = 5.98, $p < .05$, favoring intentional subjects, and for time of test, F (1,32) = 132.52, $p < .001$, favoring recall on the immediate test. The results of the analysis, summarized in Table B-9, Appendix B, failed to produce the expected effects for tester and for the tester X time of recall interaction ($p > .05$). As can be seen from comparisons of the means in Tables 4 and 5, declines

Table 5

Means and Standard Deviations of Children's Total Recall Scores on the Delayed Test

Test Condition and Sex of Subject	Intentional Recall			Incidental Recall		
	E[a]	T[b]	P[c]	E	T	P
Pretest						
Boys						
Mean	2.78	2.89	2.78	2.00	2.44	3.00
S.D.	1.59	1.49	.65	1.19	1.62	1.88
Girls						
Mean	3.00	3.67	3.44	3.11	2.78	3.22
S.D.	1.61	2.00	1.29	1.41	1.98	1.26
No Pretest						
Girls						
Mean	2.67	2.44	2.33	2.11	2.56	2.33
S.D.	1.53	1.54	1.68	1.32	1.88	1.45
Girls						
Mean	3.33	2.78	3.22	2.78	3.22	3.11
S.D.	2.06	1.06	1.35	1.06	1.17	1.49

[a] E = Experimenter

[b] T = Teacher

[c] P = Parent

in recall from the immediate to the delayed tests were as pronounced for children given delayed tests by parents and teachers as for those given delayed tests by the experimenter. Parents and teachers produced no better delayed recall for the children relative to the pretest than did the experimenter. In other words, neither the between-day comparisons of delayed recall nor the within-day pre- and postcomparisons for pretest subjects provided reliable differences favoring parent and teacher testers.

Content Consistency of Immediate and Delayed Recall

An additional question addressed through this research concerned whether children would recall the same stimuli on the immediate and delayed tests. Content-change scores were derived as percentages of additional items recalled on the posttest, i.e., the number of new items recalled at the posttest divided by the total number of items recalled at the immediate test. Mean content change scores are shown in Table 6. As can be seen from the small percentages shown in the table, very few additional items were recalled in the delayed test that had not been recalled earlier in the immediate test. In fact, of the 36 children in the pretest group, on average each testing day, only one fourth of these subjects recalled one or more new items at the delayed test. The mean number of new items recalled per child was .25. The ANOVA performed on these percentage means yielded no main or interactive effects associated with sex, instructional condition or tester ($p > .05$). The results of the analysis is presented in Table B-10, Appendix B.

Table 6

Means and Standard Deviations of Children's Percentages of Content Change Scores Between the Immediate and Delayed Tests

Sex of Subject	Intentional Recall			Incidental Recall		
	E[a]	T[b]	P[c]	E	T	P
Boys						
Mean	.11	.04	.02	.08	.01	.12
S.D.	.19	.08	.07	.13	.05	.25
Girls						
Mean	.08	.03	.07	.10	.03	.02
S.D.	.11	.06	.12	.12	.08	.06

Organization of Recall

Children's tendencies to organize their recall according to stimulus type, i.e., functional verses neutral, were examined through the ratio of repetition (RR) measure of recall clustering, i.e., tendencies to order verbal free-recall of same-category (functional or neutral) items adjacently. RR is defined as the number of same category repetitions in recall divided by the total number of items recalled minus one, i.e., RR = # of reps/n - 1. RR scores for the immediate and delayed testing sessions are shown in Tables 7 and 8, respectively. As indicated in these tables, subjects cluster approximately 40% of their recall according to functional and neutral stimulus categories on the immediate test and less than 30% on the delayed test. A sex X

Table 7

Means and Standard Deviations of Children's Recall Clustering Scores on the Immediate Test

Sex of Subject	Intentional Recall			Incidental Recall		
	Day 1	Day 2	Day 3	Day 1	Day 2	Day 3
Boys						
Mean	.40	.38	.44	.37	.70	.37
S.D.	.24	.27	.24	.28	.23	.34
Girls						
Mean	.53	.48	.41	.44	.36	.31
S.D.	.26	.21	.27	.21	.21	.23

instructional condition X day ANOVA performed on immediate-test RR scores yielded no significant main effects or interactions ($p > .05$). Similarly, the ANOVA performed on delayed-test RR scores failed to yield significant effects attributable to sex, pretest condition, instructional condition, or testers ($p > .05$). A summary of both analyses are provided in Tables B-11 and B-12, Appendix B.

Table 8

Means and Standard Deviations of Children's Recall Clustering Scores on the Delayed Test

Test Condition and Sex of Subject	Intentional Recall			Incidental Recall		
	E[a]	T[b]	P[c]	E	T	P
Pretest						
Boys						
Means	.30	.36	.42	.22	.21	.49
S.D.	.29	.37	.43	.36	.35	.38
Girls						
Means	.33	.39	.28	.39	.16	.23
S.D.	.37	.35	.22	.34	.35	.23
No Pretest						
Boys						
Means	.27	.27	.19	.09	.23	.19
S.D.	.36	.28	.34	.19	.23	.39
Girls						
Means	.32	.23	.32	.31	.18	.34
S.D.	.40	.34	.36	.36	.22	.32

[a] E = Experimenter

[b] T = Teacher

[c] P = Parent

CHAPTER IV

DISCUSSION

The present investigation was designed to examine the influence of selected contextual factors on preschool children's recall proficiency under intentional and incidental recall instructions. In doing so, the study sought to extend what is known about preschoolers' free recall beyond traditional laboratory settings into real world remembering environments. Very little has been learned from previous laboratory studies about how children remember in naturalistic environments, such as at school and in the home, despite the fact that it is in these naturalistic settings that children spend most of their time and are most often called upon to remember what they have seen and heard. Moreover, there is some evidence to suggest that the results of laboratory studies conducted to date have underestimated young children's performance and are not generalizable to naturalistic contexts.

Children's Recall Proficiency Under Intentional and Incidental Recall Conditions

As children grow older they develop an increasing awareness of the need to remember and become more sensitive to instructions and cues that may facilitate their performance in memory tasks. Young children rarely use mnemonic strategies to aid their recall, and they often fail to respond in a planful and deliberate manner to memory instructions given to them. For example, at times they may not behave strategically

when told explicitly that they will have to recall materials from memory at a later time. On other occasions, they may exhibit some appearances of strategic remembering when told simply to look at the materials. Thus, the phrase "try to remember the names of these pictures" does not necessarily lead to a distinct class of mnemonic activities designed to aid memorization. Measuring young children's responses to awareness of recall memory task requirements has been accomplished by comparing children's recall memory performance in "intentional" and "incidental" recall conditions. In the intentional condition they are given explicit instructions to remember the stimuli and are often told that they will be tested subsequently; in the incidental condition, stimuli are introduced with instructions that do not mention retention. To the extent that recall in the intentional condition exceeds that of the incidental condition, explanations that instructions to remember have some distinct cognitive implications for the child can be made (Kail & Hagen, 1982).

There is conflicting research evidence concerning young children's sensitivity to these two types of recall instructions. Appel, Cooper, McCarrell, Sims-Knight, Yussen, and Flavell (1972) presented 4-, 7-, and 11-year-olds with two sets of pictures, one with instructions to "look at them" and one with instructions to "remember the pictures." The older children exhibited more mnemonic study activity (e.g., rehearsal, categorization) following instructions to remember than to look at the stimuli, and their recall was higher as well. The 4-year-olds, in contrast, studied and recalled similarly in the two conditions. Wellman, Ritter, and Flavell (1975), on the other hand,

found that young children performed differently when presented with intentional and incidental memory task instructions. Three-year-olds were either instructed to remember or received no instructions to remember the location of a hidden object. The instructed-to-remember group engaged in more memory strategies (i.e., looking and pointing at the to-be-remembered information), and in turn, demonstrated superior location memory than their no-instruction counterparts. Acredolo, Pick, and Olson (1975) also found that young children respond differentially to intentional and incidental instructions in a memory for location task.

The children in the present study either received explicit instructions to remember the names of the pictures for a subsequent test (intentional group) or were simply told to look at the pictures (incidental group). The results of the present study revealed a significant difference favoring the intentional recall group. However, the recall difference between the incidental and intentional groups only occurred in the immediate recall condition; the retrieval advantage of intentional subjects did not persist over the delayed period. Despite the Appel et al. (1972) failure to find instructional differences in preschoolers' recall memory performances, the present study clearly found differences between the two groups, at least for immediate recall, which would suggest the use of deliberate mnemonic activities among the intentional subjects.

Sex Differences in Recall

In contrast to much of the previous research which has found little if any evidence of sex differences in recall memory (c.f., Myers & Perlmutter, 1978; Ornstein, 1978), sex differences favoring girls were found consistently in the present investigation. In both the immediate and delayed recall trials, girls demonstrated superior recall to that of boys. While these results are not consistent with the majority of previous studies of children's free-recall, such findings are consistent with some memory research in which girls demonstrate greater facility than boys in dealing with verbal materials. Naus, Ornstein, and Aivano (1977) also attributed unexpected sex differences in recall memory among third graders to greater verbal fluency (c.f., Maccoby & Jacklin, 1974).

Expectations of Tester Effects

The primary purpose of the present investigation was to compare children's recall performance in an unfamiliar testing setting with an unfamiliar tester with their performance in two familiar environments; namely, in the home and preschool classroom with mother and teacher, respectively, serving as the familiar testers. The rationale for these comparisons was that young children are likely to perform optimally when the surroundings and interpersonal relationships are familiar and meaningful (Bronfenbrenner, 1979). Bronfenbrenner has argued that "primary" dyadic relationships are more meaningful and motivating for children in learning encounters. He has also emphasized the importance of the child's familiarity with the performance setting, positing that

"systematic differences" in behavior result from the significance the child attaches to a particular setting. Based on this view, it was reasoned that the child is more likely to exhibit optimal task performance in naturalistic contexts with familiar persons than in unfamiliar settings with unfamiliar persons, i.e., an unfamiliar experimenter in a laboratory.

An additional rationale for examining tester effects stems from Lange et al.'s (1981) anecdotal findings. Lange et al. reported that when some children spontaneously described their memory task experiences to a parent (usually the mother) after returning home from a morning at preschool, they generated recall protocols that differed (in some cases considerably) from those recorded earlier in the day at the laboratory. Thus, based on suggestions that children may have better or poorer retrieval performance with different individuals and under differing degrees of familiarity within the behavioral setting, it was expected that delayed tests administered by parents and teachers would produce better recall performance than either the immediate or delayed tests administered by an unfamiliar experimenter. In view of the observations of Lange et al. (1981), and Paris's (1978) findings that across recall trials children remembered many new words on later recall trials that they had not remembered on the initial trial, it was also expected that differences in the content of recall would be evident between immediate and delayed trials regardless of the experimenter administering the delayed recall test.

A further assessment of ecological influences was incorporated in the study by varying the stimulus materials; namely, by presenting

some materials that are functional in nature and routinely experienced by children in real-world environments, and others equally familiar to children, but less functional and less likely to be encountered directly on an everyday basis. It was expected that subjects would demonstrate better recall for functional items than for less functional items which typically comprise stimulus lists in laboratory experiments of young children's free recall.

Consistency of Recall Across Testers

Contrary to the expectations outlined above, analyses of the present data failed to show evidence of main or interactive effects associated with the tester variable. Children achieved comparable levels of delayed recall regardless of who was serving as the tester. Moreover, within-day comparisons between children's initial recall with an experimenter and their delayed recall later in the day with either the experimenter, a teacher, or a parent did not favor the teacher and parent conditions. The fact of the matter is that the numbers of items recalled by children in the delayed tests were nearly identical in the three testing contexts. The results were the same for separate analyses of functional (child's world) and neutral stimulus items. Children's mean recall for each stimulus type was nearly identical across the three tester situations.

Despite the apparent discrepancies of these findings with Bronfenbrenner's theoretical viewpoint, the results of the study are consistent with those of a study by Kienapple and Lange (1983) who employed similar procedures in examining children's recall at home and

in the laboratory. These investigators examined preschooler's study-recall performance where the experimenter and task setting were both familiar and unfamiliar to the child. Four study-recall testing sessions were employed, combining two levels of experimenter variation (parent, stranger) and test location variation (home, laboratory). It was reasoned that preschoolers would show greater study-recall performance when tested by a parent than by an unfamiliar adult, and greater performance when tested in a familiar room at home than in the laboratory. The results revealed a composite effect for experimenter and testing environment. That is, significantly better recall performance was evidenced in conditions in which both experimenter and parent functioned in their natural environments. Recall means for the parent-home and stranger-laboratory conditions were 5.25 and 5.00, respectively, whereas, the stranger-home and parent-laboratory conditions produced significantly lower mean scores of 4.50 and 3.81 items recalled, respectively. There were no significant differences between the conditions in which testers functioned in their appropriate contexts (i.e., parent at home and stranger in the laboratory), which is consistent with the results of the present study.

The similarity of item content recalled by pretest subjects in the immediate and delayed tests lends further support to the conclusion that young children's verbal free recall is consistent across testing situations regardless of tester differences where standard free-recall instructions are employed. Within-day comparisons of subjects' protocols showed children remembering an average of only .25 new items on the delayed test that were not previously recalled on the immediate test.

Interpretations of the Present Findings

Since stimulus lists, day of testing, and sequence of tester across days were counterbalanced across all tester conditions, and since sex of tester was constant in all tester conditions, the absence of tester effects found in the present study is not attributable to these factors. Nevertheless, since the delayed tests administered by the teachers and parents typically occurred later in the day than those administered by the experimenter, it can be argued that the predicted advantages associated with teacher and parent testings may have been offset by memory decay. Were this the case, however, subjects should have shown consistently poorer recall performance with parents since these tests were always administered later in the day (i.e., before bedtime at home) than those of experimenters and teachers.

A more plausible interpretation of inconsistencies between expected and actual findings of the present study may have to do with the nature of the testing procedure used consistently across the testing situations. The particular format chosen for this study was based on several lines of reasoning. First, it was believed that the recall-test procedure was a close approximation to that which provided the recall phenomenon reported by Lange et al. (1981). Second, based on the research findings of Lange et al. (1981) and Paris (1978), it was assumed that children often encode more stimulus items than they are able to retrieve in a single recall session. Having testers ask the children what they had seen earlier in the day would provide an additional opportunity for recall of additional stimulus items. Third, it was believed that the procedure was methodologically sound and at the

same time ecologically valid. That is, it remained consistent with previous recall memory formats while at the same time approached what was believed to be an ecologically valid experiment. The mother's recall task was thought to be similar to routine behaviors that occur at home, in which mothers often question their children about learnings and happenings at preschool earlier in the day. An alternative to the procedural format utilized here would have been to employ the same procedure used by Keinapple and Lange (1983). In this case, have the parents, teachers, and experimenters present the stimuli and test for recall immediately and later in the day in their appropriate contexts. By restricting the stimulus presentation to the experimental laboratory, and thereby having parents and teachers elicit recall subsequently in their appropriate contexts, the procedure was thought to avoid what Bronfenbrenner (1979) refers to as "ecological distortion," i.e., injecting into a natural situation elements (in this case a recall task) that would be unfamiliar and disruptive to the child.

Nevertheless, the procedure used in the present study may be criticized on several grounds. On the one hand, the task may have been perceived to be incongruent with previous experiences and expectations of the behaviors that naturally comprise a particular context. Bronfenbrenner (1979) makes the distinction between artificially contrived interactions which are uncommon to a setting, and naturally occurring interaction patterns appropriate for a given location or microsystem. By 4 years of age, children acquire a great deal of knowledge about routine events, develop sets of expectations for behaviors within various settings, and become sensitive to changes within these

settings. One can assume that when 4- and 5-year-olds enter an experimental setting, they bring with them a repertoire of performance expectations, albeit limited, based on previous encounters in related environments. When faced with a memory task administered by an experimenter in an unfamiliar setting even a young child would, in all likelihood, view the task as an appropriate activity. Notwithstanding the present attempt to naturalize the test method, the same procedure employed by mothers to elicit recall in the present study may have been perceived by children to be inconsistent with routine occurrences and, therefore, out of context with interactions that occur at home. Such a violation of routine procedings may have offset any added familiarity with tne testing occasion. This conclusion is similar to that proposed by Kienapple and Lange (1983) who found young children exhibiting better recall performance for conditions in which both the experimenter and the parent functioned in their appropriate contexts.

The second potential problem with the present procedure concerns its lack of spontaneity for child and adult participants. Regardless of how congruent or incongruent the procedure may have been, it probably failed to afford a free flow of interaction that is naturally characteristic of personal dyads. To further illustrate this point, Lange et al.'s (1981) observations that some preschoolers recalled different stimuli at home than in the laboratory were based on spontaneous reports of the children to their parents occurring within routine conversations. More specifically, children at times and in places of their own choosing, volunteered their recall-task experiences to their parents. In the present study, parents and teachers using a standardized laboratory-like

testing format, determined the time and place of testing and formally asked the child to name the pictures she/he saw earlier in the day with the presenter. Thus, responses received from the children in this case, and in the case of Kienapple and Lange (1983), were elicited by parents and teachers and not emitted by children spontaneously as was the case reported by Lange et al. (1981). It is still possible and, in fact likely, that children do encode a great deal more than they retrieve--but the phenomenon described by Lange et al. did not appear under the testing procedure utilized by the testers in the present study. Perhaps the only way to obtain tester effects would be to utilize a procedure that allows for free flowing spontaneous interchanges. However, this would appear to be a very difficult assessment to obtain due to the child's personal involvement of time and place, if chosen at all.

There is an optimistic side to the present findings inasmuch as they suggest that standard laboratory procedures used to assess young children's recall in previous research are replicable for different testers and different testing situations. The familiarity of the tester then does not seem to be an influential factor, at least not in assessing children's free-recall memory with standard procedures. Children appear to be remarkably stable regardless of where they are tested, who they are tested by, and what types of stimulus items they receive.

Conclusions and Recommendations

A fairly clear characterization of preschoolers' free recall in varied contexts emerged from this investigation. The children's recall

memory was highly consistent across the three testing environments. Within-day comparisons of the immediate and delayed recall protocols revealed remarkable stability as well. The fact that children failed to yield different patterns of recall was unexpected, given the extent to which both familiar and unfamiliar properties of the testing environment were manipulated. Furthermore, children recalled functional (i.e., child's world) and neutral stimulus items equally well; a findings also contrary to expectations. Based on the results of this study, it would appear that young children are not susceptable to contextual influences that might otherwise alter their recall proficiency, nor do they appear to indicate differential memory proficiency for stimulus materials differing on functional grounds.

However, it would be premature to conclude from the present study that young children's free recall behaviors are impervious to contextual influences. As previously mentioned, the recall task utilized here constituted a standardized laboratory procedure. The inconsistency of this procedure with routine behaviors of teachers and parents, as well as its failure to capitalize on spontaneous memory reports of young children (c.f., Lange et al., 1981), may have underestimated young children's recall memory proficiency in real-world settings.

Future memory research investigating the effects of contextual factors on young children's memory would be well advised to procede along at least two methodological avenues. As previously mentioned, the recall format should allow for the natural flow of conversation before the actual recall task occurs. Mothers and teachers might engage the child in conversation about their daily activities at school

before pursuing the names of the pictures the children had seen earlier in the day. Gradually inducing the child to talk about his/her activities may encourage spontaneous reports of their recall task experiences. If children fail to volunteer this information spontaneously under such conditions, allowing then a chance to talk about their day may serve as an easier transition before the recall task is administered. Secondly, future studies of children's recall must take into account the meaningfulness of the task as well as the goals that make the task meaningful. Perhaps under these conditions, documented evidence will emerge that young children do in fact remember a great deal more of the information presented to them than has been found in previous research.

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APPENDIX A

DATA COLLECTION FORMS

Recording Sheet - Pretest

ID number

Name _____ _____

Sex of child B G

Test order E T P

List order A B C B C A C A B

Time of day _____

Date of test _____

Birthdate _____

Age (in mos.) _____

Intentional

Incidental

Directions-- please state the following to the child:

"I would like for you to tell me the names of as many of the pictures as you can remember, and in any order that you would like."

Allow 75 seconds for the child to remember the names. After each 15-second period of silence throughout the 75-second period you should prompt the child by saying, "can you remember any more names of the things you saw?"

Please write the names of things your child saw in the same order in which the items are remembered in the spaces below. List only those items the child said in the 75 second period.

_____

_____

_____

_____

_____

_____

_____

_____

_____

Recording Sheet - Experimenter

Name: _____ _____

Date: _____

Directions-- please state the following to the child:

"Earlier today you saw some pictures of things with Mr. Nida. Will you try really hard to tell me the names of the pictures you saw-- just the one you saw today with Mr. Nida."

Allow 75 seconds for the child to remember the names. After each 15-second period of silence throughout the 75-second period you should prompt the child by saying, "can you remember any more names of te things you saw?"

Please write in the names of things the child saw in the same order in which the items are remembered in the spaces below. List only those items the child said in the 75 second period.

_____

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Recording Sheet - Teacher

Name: _____ _____

Date: _____

Directions-- please state the following to your pupil:

"Earlier today you saw some new pictures of things with Mr. Nida. Will you try really hard to tell me the names of the pictures you saw-- just the ones you saw today with Mr. Nida."

Allow for 75 seconds for your pupil to remember the names. After each 15-second period of silence throughout the 75-second period you should prompt your pupil by saying, "can you remember any more names of the things you saw?"

Please write the names of things your pupil saw in the same order in which the items are remembered in the spaces below. List only those items your pupil said in *the 75 second period.*

_____

_____

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Recording Sheet - Mother

Name: _____ _____

Date: _____

Directions-- please state the following to your child:

"When you were at school this morning, did Mr. Nida show you some new pictures of things? Will you try really hard to tell me the names of the pictures you saw--just the ones you saw today with Mr. Nida."

Allow 75 seconds for your child to remember the names. After each 15-second period of silence throughout the 75-second period you should prompt your child by saying, "can you remember any more names of the things you saw?"

The information you provide will be kept confidential.

Please write the names of things your child saw in the same order in which the items are remembered in the spaces below. List only those items your child said in the 75 second period.

_____

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APPENDIX B

TABLES

Table B-1

Summary of the One-Way Repeated Measures Analysis of Variance of Immediate Recall Scores for Stimulus Lists A, B, C

Source	df	MS	F
Subject	35		
List (A,B,C)	2	.85	.48
Error	70	1.75	

Table B-2

Summary of the One-Way Repeated Measures Analysis of Variance of Delayed Recall Scores for Stimulus Lists A, B, C

Source	df	MS	F
Subject	71		
List	2	1.34	.60
Error	142	2.25	

Table B-3

Summary of the One-Way Repeated Measures Analysis of Variance of Immediate Recall Scores for Day of Testing 1, 2, 3

Source	df	MS	F
Subject	35		
Day 1, 2, 3	2	4.23	2.56
Error	70	1.65	

Table B-4

Summary of the One-Way Repeated Measures Analysis of Variance of Delayed Recall Scores for Day of Testing 1, 2, 3

Source	df	MS	F
Subject	71		
Day	2	32.79	18.11[a]
Error	142	1.81	

[a] $p < .001$

Table B-5

Summary of the Four-Way Repeated Measures Analysis of Variance of Immediate Recall Scores for Functional and Neutral Stimulus Items

Source	df	MS	F
Between Factors			
(A) Sex	1	4.17	3.83[a]
(B) Instructional Conditions	1	9.79	9.01[b]
A x B	1	.29	.34
Error	32	1.09	
Within Factors			
(C Day	2	2.12	2.43
(D) Stimulus Type	1	2.24	2.38
A x C	2	.27	.30
A x D	1	2.67	2.83
B x C	2	.03	.04
B x D	1	1.19	1.26
C x D	2	.09	.09
A x B x C	2	.69	.80
A x C x D	2	.29	.31
B x C x D	2	.78	.83
A x B x C x D	3	1.63	.83
Error	64	.87	
Error	96	.94	

[a] $p < .06$

[b] $p < .01$

Table B-6

Summary of the Five-Way Repeated Measures Analysis of Variance of Delayed Recall Scores for Functional and Neutral Stimulus Items

Source	df	MS	F
Between Factors			
(A) Sex	1	10.08	8.08[a]
(B) Pretest Condition	1	.93	.74
(C) Instructional Condition	1	1.33	1.07
A x B	1	.08	.07
A x C	1	.01	.01
B x C	1	.33	.27
A x B x C	1	.09	.39
Error	64	1.25	
Within Factors			
(D) Tester	2	.40	.46
(E) Stimulus Type	1	1.12	1.30
A x D	2	.05	.04
A x E	1	1.12	.39
B x D	2	.30	.24
B x E	1	.01	.01
C x D	2	.40	.33
C x E	1	.01	.01
D x E	2	.32	.37
A x B x D	2	.31	.25
A x C x D	2	.13	.15
A x D x E	2	.63	.73
A x C x E	1	.30	.69
A x B x E	1	.92	1.08
B x C x D	2	.90	.74
B x C x E	1	.01	.01
B x D x E	2	.19	.21
C x D x E	2	.35	.41

Table B-6 (continued)

Source	df	MS	F
A x B x C x D	2	.42	.34
A x B x C x E	1	4.50	2.62
A x B x D x E	2	1.47	1.71
A x C x D x E	2	.17	.39
B x C x D x E	2	2.24	2.60
A x B x C x D x E	2	.77	.90
Error	128	1.22	
Error	192	.86	

[a] $p < .001$

Table B-7

Summary of the Three-Way Repeated Measures Analysis of Variance of Immediate Total Recall Scores

Source	df	MS	F
Between Factors			
(A) Sex	1	8.33	3.83[a]
(B) Instructional Conditions	1	19.59	9.01[b]
A x B	1	.59	.27
Error	32	2.17	
Within Factors			
(C) Day of Testing	2	4.23	2.43
A x C	2	.53	.30
B x C	2	.07	.04
A x B x C	2	1.40	.80
Error	64	1.74	

[a] $p < .06$

[b] $p < .01$

Table B-8

Summary of the Four-Way Repeated Measures Analysis of Variance of Delayed Total Recall Scores

Source	df	MS	F
Between Factors			
(A) Sex	1	20.17	8.08[a]
(B) Pretest Conditions	1	1.85	.74
(C) Instructional Conditions	1	2.67	1.07
A x B	1	.17	.07
A x C	1	.02	.01
B x C	1	.67	.27
A x B x C	1	.02	.01
Error	64	2.50	
Within Factors			
(D) Testers	2	.79	.33
A x D	2	.10	.04
B x D	2	.59	.24
C x D	2	.79	.33
A x B x D	2	.27	.11
A x C x D	2	.62	.25
B x C x D	2	1.79	.74
A x B x C x D	2	.84	.34
Error	128	2.43	

[a] $p < .01$

Table B-9

Summary of the Four-Way Repeated Measures Analysis of Variance of Comparison Between Immediate and Delayed Recall

Source	df	MS	F
Between Factors			
(A) Sex	1	16.67	5.25[a]
(B) Instructional Conditions	1	18.96	5.98[b]
A x B	1	.29	.09
Error	32	3.17	
Within Factors			
(C) Testers	2	2.20	.67
(D) Time of Test	1	150.00	132.52[b]
A x C	2	.52	.16
A x D	1	.01	.00
B x C	2	5.28	1.60
B x D	1	3.63	3.21
C x D	2	.13	.11
A x B x C	2	.17	.05
A x B x D	1	.29	.26
A x C x D	2	.68	.60
B x C x D	2	.78	.69
A x B x C x D	2	1.61	1.43
Error	64	3.29	
Error	96	1.13	

[a] $p < .05$

[b] $p < .001$

Table B-10

Summary of the Three-Way Repeated Measures Analysis of Variance of Content Change Scores Between Immediate and Delayed Recall for the Pretest Subjects

Source	df	MS	F
Between Factors			
(A) Sex	1	.003	.20
(B) Instructional Conditions	1	.001	.01
A x B	1	.006	.42
Error	32	.015	
Within Factors			
(C) Testers	2	.04	2.31
A x C	2	.002	.13
B x C	2	.003	.22
A x B x C	2	.030	1.83
Error	64	.015	

Table B-11

Summary of the Three-Way Repeated Measures Analysis of Variance of Immediate RR Clustering Scores

Source	df	MS	F
Between Factors			
(A) Sex	1	.01	.20
(B) Instructional Conditions	1	.004	.06
A x B	1	.21	2.96
Error	32	.07	
Within Factors			
(C) Day	2	.09	1.39
A x C	2	.12	1.82
B x C	2	.10	1.58
A x B x C	2	.12	1.90
Error	64	.06	

Table B-12

Summary of the Four-Way Repeated Measures Analysis of Variance of Delayed RR Clustering Scores

Source	df	MS	F
Between Factors			
(A) Sex	1	.02	.17
(b) Pretest Conditions	1	.28	2.30
(C) Instructional Conditions	1	.15	1.19
A x B	1	.18	1.53
A x C	1	.003	.03
B x C	1	.005	.05
A x B x C	1	.02	.14
Error	64	.12	
Within Factors			
(D) Testers	2	.05	.49
A x D	2	.10	1.78
B x D	2	.01	.08
C x D	2	.08	.77
A x B x D	2	.07	.60
A x C x D	2	.19	1.80
B x C x D	2	.06	.57
A x B x C x D	2	.01	.03
Error	128	.11	