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Cognitive Developmental Differences in Source Monitoring

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COGNITIVE DEVELOPMENTAL DIFFERENCES IN SOURCE MONITORING

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APPROVAL SHEET

This thesis is submitted in partial fulfillment of the requirements for the degree of

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DEDICATION

This thesis is dedicated to the members of my immediate family who have willingly sacrificed our precious time together so that I could pursue my dreams. Their love, support and faith have sustained me throughout the past six years. Therefore, to my husband, Alex Cimini, Jr., son, Alex Cimini III, parents, Carl and Myrtle Broadwater, and mother-in-law, Catherine Cimini--here is the culmination of one of my dreams. Thank you!

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ABSTRACT

Source monitoring is defined as the ability to remember the source of a memory. The present study investigated cognitive developmental differences in performance on source monitoring tasks and on a memory test among 88 children in kindergarten, second, fourth and sixth grades. The source monitoring test measured the children's ability to discriminate between external (real), overt internal (imagined), and covert internal (heard) sources, as well as spatial location of the sources of real and imagined memories. The memory test assessed working memory, inhibition effects, and subjective organization. It was expected that older children would be better than younger children in discriminating external, overt and covert internal sources, and spatial location of external sources. It was also expected that on the memory test, older children would exhibit better recall, have fewer intrusions and inhibition effects, and display more organizational tendencies than younger children. The primary hypothesis was that cognitive developmental differences would be found on both the source monitoring tasks and the memory test, and that development of the cognitive functions of working memory, inhibition and subjective organization of categories would be significantly related to source monitoring abilities. The results supported all hypotheses with older children outperforming younger children on all source monitoring tasks and memory measures. The younger children had significantly less recall, more intrusions, more inhibition effects, and less subjective organizational tendencies. A significant relationship between source discrimination and cognitive functions was found. The results are discussed within a developing inhibitory mechanism framework.

COGNITIVE DEVELOPMENTAL DIFFERENCES IN SOURCE MONITORING

INTRODUCTION

Source monitoring, the ability to remember the source of a memory, has recently emerged as a topic of increasing interest to memory researchers (e.g., Cohen & Faulkner, 1989; Dywan & Jacoby, 1990). Memories can originate in perception (external source) or in thought processes (internal source) (Durso, Reardon & Jolly, 1985). Some external sources of memories are actions that have been performed, events or objects that have been seen, and words that have been written or read. Internal sources of memory include those memories originating in imaginations or fantasies, dreams or daydreams, and intentions or plans.

Because memories originate from different sources, the capacity to identify the source of specific information has important implications for competent cognitive functioning. Discrimination between external and internal sources is essential if we are to distinguish fact from fantasy, the real from the imagined, or performance from intention to perform. Accurate source monitoring is necessary if we are to confidently rely on our memories to maintain coherent order in our everyday lives. We need to remember what others said and did, what we heard or saw, and what we said, did, or thought if we are going to live without being in a state of constant confusion.

At least three types of errors can occur in source monitoring. First, an external source can be confused with another external source. A common external-external error happens when details of a conversation are remembered but Debbie is credited with saying what Ellen actually said. Secondly, two internal sources can fail to be discriminated. For example, a dream may be remembered as an imagined event. Finally, an external source can become confused with an internal source. A failure in external-internal source monitoring has occurred if Pete believes that he has locked the door when, in fact, he merely intended to lock it.

The goal of much research during the past decade has been to determine how people discriminate between external and internal sources of memories. Early studies revealed that internally and externally derived memories differ in characteristic ways (Raye & Johnson, 1980; Raye, Johnson, & Taylor, 1980). Subsequently, Johnson and Raye (1981) proposed a model of external-internal source discrimination which they termed *reality monitoring*. Reality monitoring is a subset of source monitoring and it refers to the processes by which a person identifies the source of a memory as being one of internal or external origin. According to the reality monitoring model, externally generated memories differ from internally generated memories along several dimensions. Externally generated memories are characterized as having more spatial and temporal contextual attributes, more sensory coded representations, and more semantic detail with more specific information than internally generated memories. On the other hand, internally generated memories are characterized as having more cognitive operations associated with them.

The assumptions of the model have been confirmed by research. Raye and Johnson (1980) found that discriminating between externally and internally derived memories was easier than discriminating between memories derived from two external sources. These findings confirm that externally and internally derived memories do differ. Further experimentation revealed that contextual information associated with a particular memory was generally superior for external perceptions (Johnson, Raye, Foley, & Kim, 1982) and that sensory and contextual information for perceived events are more likely to give rise to supporting memories (Suengas & Johnson, 1988). Johnson, Raye, Foley, and Foley (1981) found that increasing cognitive operations increased accuracy of reality monitoring and confirmed the generation effect (Slamecka & Graf, 1978) which proposes that self-generation of memories increases cognitive traces that serve as cues for subsequent recall of memories derived from internal sources.

Not only is accurate source monitoring important for our everyday lives, but it has also been identified as a factor in several other specific areas of interest, some of which include eyewitness testimony, stereotype maintenance, and memory deficits associated with aging. Eyewitness testimony research addresses the possibility that eyewitnesses are confused when discriminating between memories derived from different sources. Lindsay and Johnson (1989) found that even though subjects could identify the source of their memories of misleading suggestions, they still sometimes attributed the memories to being derived from the original event. Thus, source confusion could conceivably contribute to, for example, an eyewitness remembering a statement about the case that was heard on television as having been a memory of the witnessed event.

In an investigation of stereotype maintenance, Slusher and Anderson (1987) concluded that a failure in reality monitoring of imaginal processes can lead to increased association of groups with their stereotypic traits and that the resulting imaginal confirmation of the social stereotypes may, in turn, contribute to the self-perpetuating nature of these beliefs. Hess and Tate (1991) proposed that age-related deficits in reality monitoring might be conceptualized as a decrease in both the amount and spread of activation in memory, which would result in a general reduction in the strength of information in memory. The researchers related the results of this study to social cognitive factors. They propose that because older adults may be less likely than younger adults to extensively process schema-inconsistent information, it may be more difficult to break down stereotypes held by older adults. Older adults may be more prone to categorize individuals exclusively in terms of specific trait categories if they do not encode discrepant information as effectively.

Other source monitoring studies of age-related deficits have found that older adults are not as good as younger adults in judging an act as one that was carried out rather than only planned or imagined (Guttentag & Hunt, 1988), in recalling whether or not information was presented in a particular color (Park & Puglisi, 1985), in recalling if information was presented auditorily or visually (Lehman & Mellinger, 1984), in monitoring if an act had already been performed (Koriat, Ben-Zur, & Sheffer, 1988), and in discriminating words that were said from words that were thought (Hashtroudi, Johnson, & Chrosniak, 1989).

Dywan and Jacoby (1990) found that older adults are more likely than younger ones to call a previously seen face "famous" when it is encountered later, indicating faulty source attribution. Furthermore, a study by Tubi and Calev (1989) showed that older adults perform worse on visuospatial source tasks than on verbal source tasks. However, Cohen and Faulkner (1989) found no age decrement in the ability to recognize old actions, but older subjects made more false-alarm responses to actions that had never occurred at all.

In reviewing the current literature on source monitoring, it is apparent, as can be concluded from the preceding paragraphs of the present study, that from a developmental perspective, most of the research is centered on the source monitoring discrimination ability of older adults. However, there is some evidence for a developmental trend in source monitoring among children. It has been found that children have trouble discriminating what they themselves did from what they only imagined doing (Foley & Johnson, 1985) and distinguishing what they had said aloud from what they had only imagined themselves saying aloud (Johnson & Foley, 1984). However, children do not have difficulty with all source monitoring tasks. They are as good as adults in judging how many times a real picture has been seen or an imagined picture has been imagined (Johnson & Foley, 1984; Johnson, Raye, Hasher, & Chromiak, 1979). Nonetheless, few developmental studies motivated by an interest in source monitoring have examined potential developmental differences in children of different age groups. Developmental researchers have been interested primarily in comparing children's performance on source monitoring tasks to performance by older subjects (typically college students) on the same or similar tasks.

In addition, few source monitoring studies have specifically examined the effect of contextual cues such as time and location on memory for perceived and imagined events (but see Johnson, Raye, Foley, & Kim, 1982). The reality monitoring model predicts that spatial cues should be more available for memories of perceptions than for memories for imaginations. This prediction is based on Peterson's (1975) findings that, although imagined phenomena do have spatial characteristics, subjects were better able to identify the location of seen than of imagined objects.

Taken together, the cited studies indicate that errors in source monitoring occur in diverse situations differentially across the life span and may even affect our levels of knowledge and beliefs (Johnson, 1988). Although source monitoring errors are well documented, the underlying memory mechanisms and their functional importance in source monitoring are poorly understood.

In a typical source monitoring experiment, items from two or more sources are presented to subjects who are subsequently given a recognition test which measures both their ability to discriminate between the old items on the source monitoring task and new distractor items and their ability to discriminate the source of the old items. The present study employed the typical paradigm with an added feature. After the source monitoring task, but before the recognition test, subjects were given a second task designed to assess performance on several measures of memory. This study was specifically designed to investigate potential source monitoring differences in children of various age groups and to compare the childrens' ability to discriminate between the sources of memory with performance on a memory test. The following question was of particular interest: To what extent does the development of specific memory functions either facilitate or hinder accurate source monitoring?

The general predictions of the source monitoring model suggest that three memory functions may be especially important in attributing a memory to its correct source. First, in order to accurately discriminate an item, it must be recognized as an old item. In other words, there must be an accessible memory trace. Siegel and Ryan (1989) suggest that "working memory requires both the simultaneous processing of incoming information and the retrieval of other information" (p. 973). These operations are both essential for source monitoring tasks. In order to accurately discriminate between sources, incoming information must be correctly processed and other associated information retrieved. To remember who said what where, the incoming communication demands both processing in working memory and retrieval of information about the communication from long-term memory. Retrieval includes information about semantic content (what did it mean?), the communicator (it was Adrian who said it), and the context (it was said in the classroom).

A second memory process which appears to be centrally involved in source monitoring is proactive inhibition. That is, old materials block correct responses or confuse you when you try to recall the correct response (Houston, 1986). Hasher and Zacks (1989) proposed that reduced inhibitory functioning is a reasonable explanation for age-related declines in working memory. They state that "a person with reduced inhibitory functioning can be expected to show more distractibility, to make more inappropriate responses and...to be more forgetful than others" (p. 215). Bjorklund and Harnishfeger (1990) extended Hasher and Zack's model of inefficient inhibitory processes to include child development. Bjorklund and Harnishfeger propose that "inhibitory processes become more efficient over childhood, resulting in less irrelevant information entering working memory with age, yielding increased processing efficiency" (p. 62). Based on the above-cited models, it was reasonable to expect that inhibitory processing would play an important role in source monitoring. Not only does a correct source have to be identified, but irrelevant sources must be inhibited. For instance, if Larry had a dream last night that he had forgotten to turn off his iron, then that source of memory must be accurately identified and inhibited in order for Larry to remember that today he did, in fact, turn off the iron before leaving home.

Finally, an individual's ability to organize or categorize information may have an effect on source monitoring tasks. Young children have been found to divide lists into a greater number of categories with fewer members than adults (Worden, 1975). Therefore, if an unexpected member is added to that category, more confusion may occur when the child is asked to recall the items or a specific item from that category. Moely (1977) reported that young children's categorization schemes are not stable and considerable reorganization often occurs from one trial to the next in recall tests. Furthermore, Lange (1978) proposed that when items within a category are not highly associated, young children show little clustering. In a reality monitoring study, it was found that the more similar the categories for origins of memories were, the greater was the probability of confusing them (Anderson, 1984). That is, determining who said what is more difficult if two speakers are both female than if one is female and the other is male. Therefore, if the contents of the memory for perceived and imagined items are similar it may be more difficult for a child with a poorly differentiated organization strategy to discriminate between the sources of imagined and perceived memories.

The participants in this study were children in kindergarten and second, fourth, and sixth grades. All performed identical source monitoring and memory tests. There were three origins of sources: external (a real picture), overt internal (an imagined picture), and covert internal (a heard word). In addition, there was a spatial contextual source (Was the picture perceived or the object imagined on the left side or the right side?). The Rey Auditory-Verbal Learning Test (AVLT) (Rey, 1964) was used to measure immediate memory span, proactive inhibition, tendencies to confusion or confabulation on memory tasks, subjective organization, intrusions, and retention (Lezak, 1976).

The overall plan to this research was to build systematic evidence that (a) the ability to discriminate sources of memories increases monotonically with age through childhood, and (b) source monitoring abilities are associated with working memory capabilities, inhibitory efficiency and organizational strategies.

In general, it was hypothesized that developmental differences would be found in the three source discrimination categories and in the measures of memory and that there would be a significant relationship between source monitoring ability and performance on memory measures.

The following corollary hypotheses were expected to be confirmed:

1. Consistent with predictions of the source monitoring model, it was expected that children of all ages would be better at discriminating externally derived sources than internally derived sources. However, because the study was designed

to create category confusion in the imagined source, older children with better organizational strategies were expected to exhibit better internal source discrimination. It is also expected that older children would be better than younger children at discriminating external sources due to increased efficiency in working memory processes.

2. If the ability to utilize cognitive operations as cues for recall increases with age, then relative to younger children, older children were expected to be better at discriminating what they imagined from what they heard.

3. Older children were expected to be better at discriminating left and right presentations of external sources than younger children. However, left and right discriminations for the imagined source would perhaps show no developmental differences because the contextual cues are less salient for imagined sources.

4. Developmental differences in the immediate memory span test were expected to be found with older children recalling more words on all trials.

5. Measures of inhibition effects on both the memory test and the source monitoring task were expected to be greater for the younger children

than for the older children. That is, if the proposed inefficient inhibition model discussed earlier were supported, then younger children would have more intrusions in the memory test, and more misses and more false alarms in the source monitoring task than older children.

6. Subjective organization, or clustering, on the memory test was expected to be poorer for the younger children than for the older children reflecting less sophistication of organizational strategies for the younger children.

METHOD

Subjects

The participants were 88 grade school students who were enrolled at one of three elementary schools. Thirty-four of the children were enrolled in a private Christian school, 40 were enrolled in a private Catholic school and 18 were enrolled in public school. There were 22 children in each of the four grade levels: kindergarten (10 females and 12 males), second grade (9 females and 13 males), fourth grade (12 females and 10 males), and sixth grade (8 females and 14 males). The ranges and means of ages for the grade levels were: kindergarten (Range = 5.3 to 6.6, $\underline{M}$ = 5.9), second grade (Range = 7.5 to 8.10, $\underline{M}$ = 8.1), fourth grade (Range = 9.4 to 11.2, $\underline{M}$ = 10.1), and sixth grade (Range = 11.4 to 12.6, $\underline{M}$ = 11.9). After permission to conduct the study was granted by school authorities, parental consent forms, shown in Appendix A, were sent to all parents of eligible participants. All three school principals wrote cover letters stating that the study had been approved by the school officials. The cover letters accompanied the parental consent forms. Because of time constraints, not all children who volunteered and who received parental consent were selected. Consent for participation was obtained from the selected children as well as from their parents. Summaries of the completed study will be sent to all parents who indicated on the parental consent form that a copy was desired. Each child was treated in accordance with the "Ethical Principles of Psychologists" (American Psychological Association, 1990).

Materials

A source monitoring test, a memory test, and a recognition test were given to each participant. The external-internal source monitoring task consisted of 20 pictures representing common objects that are familiar to children (See Appendix B for a complete list of objects). The 20 pictures were selected from magazines and other sources and were mounted on posterboard. In addition, there were 30 blank pieces of posterboard upon which children imagined objects related to the presented pictures. One of two words provided by the experimenter was chosen by the children for the picture to be imagined. Two sets of 10 alternating pictures and blank pieces of posterboard were bound together with rings.

The Rey Auditory-Verbal Learning Test (AVLT) (Rey, 1964) was used to measure memory functions (See Appendix C for the word lists). The AVLT consists of two 15-word lists, List A and List B, and is commonly used in clinical neuropsychological assessment. It is an easily administered test and provides a measure of immediate memory span, a learning curve, elicits proactive interference, tendencies to confusion or confabulation on memory tasks, retention following an interpolated activity and subjective organization (Lezak, 1976). The children received four presentations of List A, one presentation of List B, and recalled List A.

The recognition test consisted of a list of 80 items. Appendix D contains the recognition test. Twenty items were the words representing the perceived pictures of common objects, 20 items were the imagined objects, 20 items were words that had been heard but not chosen, 10 items were taken from the AVLT, and 10 items were new neutral words. Therefore, of the 80 items, 60 represented old items from the source monitoring task, and 20 items were distractors comprising 10 items from the AVLT and 10 items that were neutral new words.

<u>Procedure</u>

All children were tested individually in unused rooms at the school during school hours. The day and time of testing for the children was randomly assigned across the four grade levels. The testing took approximately 30 minutes for each child. All tests used in this study were presented in either picture form or auditorily because of the disparity of reading abilities between groups. This procedure eliminated potential confounding that could arise, for example, by giving the recognition test in written form to the older students.

The study consisted of three phases. In the first phase, children were presented with a series of 20 pictures of common objects. Ten pictures were presented on the left side and the other 10 on the right side. The pictures were mounted on posterboard and were bound together by rings so that they could be easily flipped over. Real pictures were alternated with blank sheets of posterboard on which the children imagined the pictures which they chose.

The children were told that we are going to play a game of "Let's-pretend-something-like-me-is-here." Children were given two practice trial presentations to become familiarized with the procedure before testing began. During the practice trials the children were asked to describe the imagined picture. For example, if the imagined picture was of a store, the child would be asked, "Does it have windows?" The children were also told that for each part of the game there would be a set of three words--one for the real picture, one for the imagined picture and one for the word that they didn't choose to imagine. These instructions were intended to make the child aware that all three words were important.

When formal testing began, a picture of a common object was presented and the experimenter said the name of the object (e.g., car). After the children viewed the picture for approximately five seconds, the picture was flipped to a blank sheet of posterboard. The experimenter then named two objects from the same category (e.g., truck or airplane) as the previously presented picture and the child was asked to choose one of the two words to imagine. The children were told that they must carefully consider both words before choosing because they would not be permitted to change their minds after they had stated their choice. These instructions were intended to create a perceptual set for the children to attend to both words. The child was then asked to imagine the chosen object on the blank posterboard on either the left or the right side. The experimenter indicated the position for the imagined picture by touching the blank posterboard on the left or right side of the children. See Appendix E for order of presentation.

In the second phase of the experiment, the AVLT (Rey, 1964) was given. The AVLT consists of two 15-word lists. The children were presented with four different ordered trials of List A, one trial of List B, and were then required to recall List A. Following the procedure outlined by Taylor (1959), the children were told, "I am going to read a list of words to you. After I have finished, I want you to say them back to me. Try to listen carefully and to remember as many as you can. You do not need to say them in the order I read them." The words on List A were read with intervals of one second between words. The children were then told, "Tell me all the words you can remember." The words were recorded in the order that the child said them. When the child indicated that he or she did not know any more words, the child was instructed, "Now I am going to read the words again, and you say them all again, also, with the ones you said before." List A was read again, but in a different order, and the child's responses were recorded again in the order that they were recalled. This procedure was repeated two more times, so that List A was presented four times. After the fourth trial, List B was introduced. The child was instructed, "Now I am going to read another list of words to you, but this one I am only going to read once. Let us see how many words you can remember from this list." The list was read and the child's recalled words recorded. When the child indicated that no more words could be remembered, the child was told, "That is fine. Now let's say the other ones just one more time, the ones you had so many times before. But I won't read them again - you say them as you remember them now." Again, the child's recalled words were recorded. No penalty was given for repeated words nor for asking if a word had been said before. However, all intrusions and inappropriate responses were recorded.

The third, and final, phase of the experiment was the word recognition test. The child was told, "Now I want you to think about the pictures you saw and the pictures you pretended to see. I am going to read to you a list of words and I want you to tell me if the word was one of the pictures you saw or pretended to see of if it was a word that you heard in the game but was one that you did not choose to imagine." As is the case with most source monitoring studies, the children were not told to expect a memory test on the source items. Many of the children expressed surprise when they were told about the word recognition test. At this time the children were given a practice trial word recognition test using the practice trial items from the source monitoring task. No child proceeded to the formal word recognition test until he or she had correctly discriminated the items from the practice trials as being real items, imagined items or heard items and until the left or right presentations of the real and imagined sources had been correctly identified.

The 80 items on the recognition test were then read to the child. If the child indicated that the item was an old item, the child was asked if it was a real picture, a pretend picture, or a word that had only been heard. If the response was that it had been a presented or imagined item, the children were required to remember if it had been presented on the left or right side and to indicate the response by pointing to the left or right side. After the recognition test was completed, the child was thanked, given a pencil for his or her participation and was taken back to the classroom.

RESULTS

An ANOVA was performed to investigate if gender differences existed in source discrimination ability. Results revealed a significant main effect of grade, F (3, 80) = 53.504, $p<.001$. The main effect for gender (F (1, 80) = .046, ns) and the interaction between grade level and gender (F (3, 80) = .356, ns) were not significant. Subsequent analyses of source discrimination abilities were performed with grade levels collapsed over gender.

The first two hypotheses, that older children would exhibit better discrimination for all source categories than younger children, and that older children would be better than younger children at discriminating imagined items from heard items, were assessed by calculating and comparing source monitoring (or discrimination) scores for each individual. Means of the source discrimination scores by grade level are shown in Table 1. These scores were calculated for each child by dividing the total number of

Table 1

Means of Source Discrimination Scores by Grade Level

	Real		Imagined		Heard	
Grade	*M*	*SD*	*M*	*SD*	*M*	*SD*
Kindergarten	.746	.164	.762	.202	.247	.284
Second Grade	.879	.130	.814	.221	.691	.286
Fourth Grade	.960	.039	.934	.066	.910	.091
Sixth Grade	.975	.028	.957	.034	.966	.041

words correctly discriminated for each source by the total number of words correctly identified as old. For example, in the real items category, the source discrimination score refers to the number of words correctly identified as representing a real picture, divided by the total number of words in the real category that were correctly discriminated as old. This measure has been used in other source monitoring studies (e.g., Hashtroudi, Johnson, & Chrosniak, 1989; Raye & Johnson, 1980).

An overall 3 x 4 repeated measures analysis of variance with type of source (real, imagined, and heard) as the within subjects factor, and grade level (kindergarten, and second, fourth and sixth grades) as the between subjects factor showed a significant effect of grade level (F (3, 84) = 74.979, $p<.001$), and a significant effect of source (F (2, 168) = 34.350, $p<.001$). The interaction of grade level and source was also significant, F (6, 168) = 15.011, $p<.001$. See Figure 1 for graphed group mean comparisons of source discrimination scores. Analysis of group effects indicated an overall significant Wilks' Lambda (F (9, 199) = 16.823, $p<.001$). Univariate F tests showed significant differences in means for real, imagined and heard source variables. See Table 2 for specific F and probability values. Post hoc paired comparisons using Tukey's WSD procedure (Tukey, 1977) examined the effect of the source variables at grade levels. It was found that

Figure 1

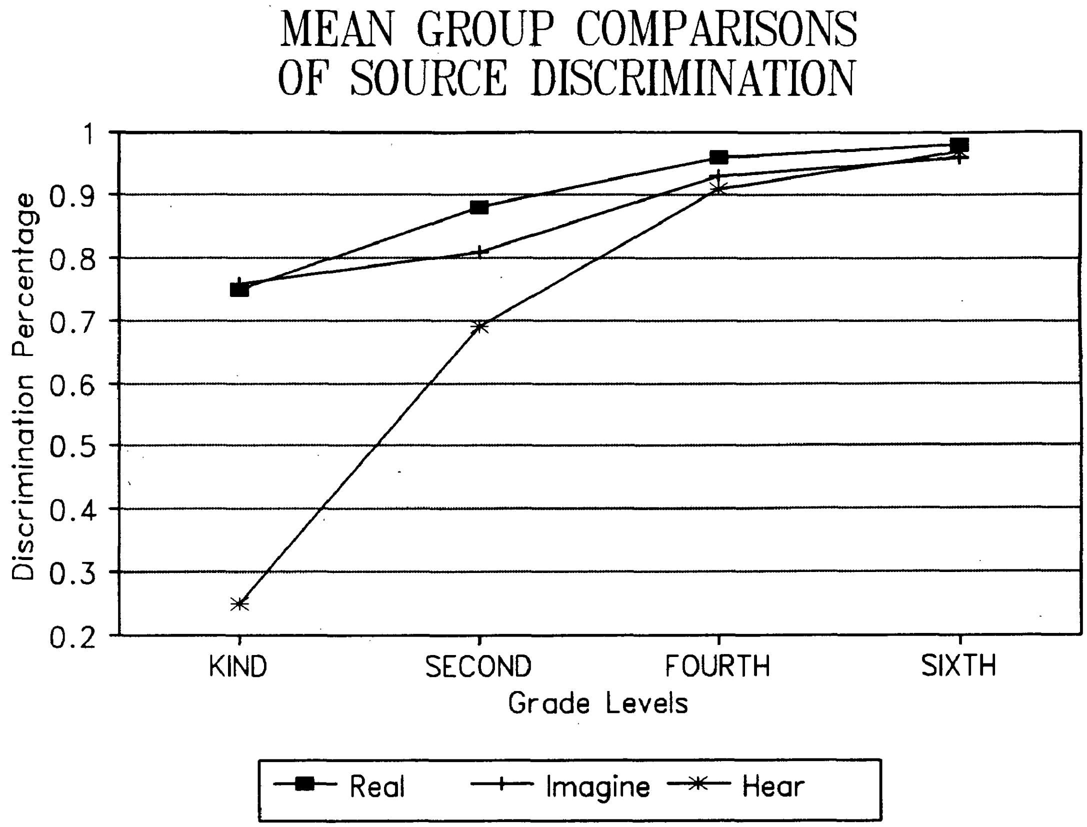

MEAN GROUP COMPARISONS
OF SOURCE DISCRIMINATION
Discrimination Percentage
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
KIND
SECOND
FOURTH
SIXTH
Grade Levels
Real
Imagine
Hear

Table 2

Group Effects Test on Source Variables

UNIVARIATE F TESTS

VARIABLE	SS	DF	MS	F
Real Items	0.721	3	0.240	20.836***
Imagined Items	0.583	3	0.194	8.141***
Heard Items	6.992	3	2.331	53.551***

*** $p<.001$

MULTIVARIATE TEST STATISTICS

Wilks' Lambda = 0.253

F-Statistic = 16.823 DF = 9, 199 $p<.001$

kindergartners and second graders discriminate real and imagined items better than heard items. However, neither kindergartners nor second graders showed differences in their ability to discriminate real and imagined items. There were no differences in source discrimination among real, imagined and heard items for fourth and sixth graders. Further post hoc paired comparisons examined the effect of grade level at each type of source. Results revealed that for discrimination of real items, sixth, fourth and second graders were better than kindergartners, and sixth graders were better than second graders. In the discrimination of imagined items, sixth and fourth graders were better than kindergartners and second graders. Finally, tests of the discrimination scores for heard items showed that sixth, fourth and second graders outperformed kindergartners, and sixth and fourth graders were better than second graders. All reported differences in the paired comparison results were significant at $p < .05$.

An overall source discrimination score was calculated for each child by summing correctly discriminated real, imagined and heard items and then dividing that sum by the total number of items for all sources correctly identified as old. A one-way ANOVA comparing the scores for the four grade levels was significant, F (3, 84) = 58.343, $p < .001$. Post hoc Tukey's WSD contrasts revealed that sixth graders, (M = .96, SD = .02) and fourth graders, (M = .93, SD = .04), were significantly better at discriminating sources of information than were second graders (M = .80, SD = .13) and kindergartners (M = .64, SD = .12). In addition, second graders were better than kindergartners, with all results significant at $p<.001$. Only fourth and sixth graders showed no significant differences in overall source discrimination ability.

These results clearly indicate that younger children have particular difficulty in discriminating words that are heard. However, there was no exhibited difference in discriminating real from imagined sources for the younger children. Older children demonstrated no differences in discriminating what was seen, imagined or heard, but there were developmental differences in source discrimination with older children performing better than younger children on all source categories. Means of discrimination errors for the types of sources are shown in Table 3.

To assess recognition of old and new items without regard to correct identification of the source, and to detect potential response biases of the participants, two nonparametric indexes of sensitivity and bias were computed. The measure of sensitivity was proposed by Pollack and Hsieh (1969) who suggest that in the absence of specific assumptions about underlying distributions, a nonparametric measure, P(I), is related to d'. The nonparametric measure of response bias, B'', was proposed by Hodos (1970).

Table 3

<u>Means of Discrimination Errors for Types of Source</u>

Source	Kind	Second	Fourth	Sixth
R Items called I	1.90	1.10	.46	.36
R items called H	1.50	.78	.23	.09
R items called N	6.30	4.59	3.45	1.54
I items called R	.78	.87	.28	.14
I items called H	2.40	1.68	.96	.68
I items called N	6.30	5.00	1.32	1.00
H items called R	.55	.23	.23	.00
H items called I	6.20	3.68	1.41	.59
H items called N	10.40	6.91	2.86	2.86
N items called R	.27	.04	.09	.09
N items called I	.68	.32	.09	.09
N items called H	.46	.27	.36	.27

R = Real Pictures

I = Imagined Pictures

H = Heard Words

N = New Words (Distractors)

Table 4

Means of Sensitivity and Bias for Source Variables

Grade	Real		Imagined		Heard	
	P(I)	B''	P(I)	B''	P(I)	B''
Kindergarten	.858	.916	.849	.610	.789	.924
Second Grade	.900	.883	.883	.807	.849	.754
Fourth Grade	.938	.908	.885	.726	.925	.703
Sixth Grade	.962	.890	.974	.681	.942	.417

Indexes of P(I) and B'' were calculated for individuals on each type of source using computing formulas derived by Grier (1971). Group means of these measures are shown in Table 4. Both P(I) and B'' are based on the probabilities of hits and false alarms. The probability of correctly identifying a source served as the probability of a hit and the probability of calling a distractor word old served as the probability of a false alarm.

An examination of the sensitivity scores with a 3 (type of source) x 4 (grade level) repeated measures ANOVA revealed a significant main effect of grade level and a significant main effect of source items. The interaction of grade level and source was not significant. The summary table of results is in Table 5 and the Univariate F tests are in Table 6. Post hoc paired comparisons using Tukey's WSD procedure revealed that, for real and heard sources, there were significant differences between all groups except fourth and sixth graders with older children exhibiting more accuracy in discrimination, $p<02$. For the imagined items, sixth graders indicated more accuracy than all other grades and fourth graders outperformed second graders and kindergartners, $p<.04$. Post hoc comparisons for source effects revealed that kindergartners and second graders could more accurately discriminate real and imagined sources than the heard source, $p<.05$. No differences in sensitivity for source items were found for fourth and sixth graders.

Table 5

Analysis of Variance Summary Table of Sensitivity Scores

Source	SS	DF	MS	F
Between Subjects				
Grade Level	0.580	3	0.193	15.818***
Error	1.027	84	0.012	
Within Subjects				
Source	0.064	2	0.032	4.234**
Interaction	0.072	6	0.012	1.593
Error	1.267	168	0.008	

**$p<.02$

***$p<.001$

Table 6

Group Effects Test for Sensitivity

UNIVARIATE F TESTS

VARIABLE	SS	DF	MS	F
Real Items	0.136	3	0.045	18.003***
Imagined Items	0.187	3	0.062	3.201**
Heard Items	0.329	3	0.110	20.777***

**$p<.03$

***$p<.001$

MULTIVARIATE TEST STATISTICS

Wilks' Lambda = 0.486

F-Statistic = 7.647   DF = 9, 199 $p<.001$

An overall sensitivity score was calculated for each individual. A one-way ANOVA of the scores for the four grade levels was significant, F (3, 84) = 24.76, p<.001. Further analyses using Tukey's paired comparisons revealed that means of all groups except fourth and sixth graders (kindergarten, M = .794, SD =.08, second graders, M = .851, SD = .08, fourth graders, M = .933, SD = .02, and sixth graders M = .950, SD = .02) were different from one another at the .01 level of significance. The results indicate that older children have greater sensitivity for the presence and absence of a source item than do the younger children.

Analysis of the response bias scores with a 3 x 4 (Source X Grade Level) ANOVA revealed that there was no main effect of group. However, both the main effect of type of source and the interaction were significant. See Table 7 for the summary table of results. Univariate F tests, contained in Table 8, revealed that although there were no significant differences in response biases for real or imagined source items, means for the heard items were significantly different. Post hoc comparisons found that sixth graders have a significantly lower response bias (p<.04) than all of the other grade levels which display no significant differences from each other.

Because all of the means are positive, these findings indicate that, for heard items, younger children are more likely than sixth graders to say that the item was not in

Table 7

Analysis of Variance Summary Table of Response Bias

Source	SS	DF	MS	F
Between Subjects				
Grade Level	1.047	3	0.349	1.276
Error	22.987	84	0.274	
Within Subjects				
Source	2.271	2	1.136	8.937***
Interaction	2.357	6	0.393	3.092**
Error	21.347	168	0.127	

**p<.01

***p<.001

Table 8

Group Effects Test for Response Bias

UNIVARIATE F TESTS

VARIABLE	SS	DF	MS	F
Real Items	0.016	3	0.005	0.072
Imagined Items	0.453	3	0.151	0.575
Heard Items	2.935	3	0.978	5.118**

** $p<.01$

MULTIVARIATE TEST STATISTICS

Wilks' Lambda = 0.799

F-Statistic = 2.141 DF = 9, 199 $p<.028$

the game when, in fact, it was a word that had been heard but not chosen to imagine. However, when overall response bias scores were calculated for all sources and were compared with a one-way ANOVA, no significant differences in response bias were found between the four grade levels.

The third hypothesis was that older children were expected to be better at discriminating left and right presentations of external sources than younger children, but no developmental differences in the discrimination of left and right presentations of imagined sources were expected. To examine this hypothesis, scores for right and left discrimination of position for real and imagined items were obtained for each individual by dividing the total number of items correctly discriminated by the total number of items called old. Means for left-right discrimination are shown in Table 9. A 2 x 4 (Source x Grade Level) repeated measures ANOVA indicated a significant main effect of grade level, $\underline{F}$ (3, 84) = 6.479, $\underline{p}<.001$, and a significant main effect of source, $\underline{F}$ (1, 84), = 210.339, $\underline{p}<.001$. The interaction between grade level and source was also significant, $\underline{F}$ (3, 84) = 4.661, $\underline{p}<.005$. Post hoc comparisons revealed that sixth and fourth graders were better than kindergartners and second graders in discriminating left and right presentations of real items, $\underline{p}<.05$. For imagined items, only sixth graders were found to significantly outperform all other grade levels, $\underline{p}<.02$.

Table 9

Means for Right-Left Discrimination Scores of Real and Imagined Pictures

	Real		Imagined	
Grade	M	SD	M	SD
Kindergarten	.789	.227	.519	.155
Second Grade	.823	.127	.507	.139
Fourth Grade	.906	.127	.567	.203
Sixth Grade	.879	.063	.727	.121

Because 8 of the imagined items were imagined on the same side as their associated real pictures and the 12 remaining items were imagined on the opposite side of the real pictures, the possibility existed that younger children could have been identifying the position of the associated real picture rather than the imagined picture. To see if there was a consistent pattern of response errors for the younger children, two discrimination error scores for position were calculated for each child by dividing the number of items whose position was incorrectly reported by the total number of items discriminated for position. A score was computed for items that were imagined on the same side as the real picture but were reported as being imagined on the opposite side (same-called-different). The second score was for items that had been imagined on the opposite side of the real picture but were reported as being imagined on the same side (different-called-same). If younger children were consistently associating the position of the imagined picture with the position of the real picture, then the different-called-same score would be significantly higher than the same-called-different score. Separate $\underline{t}$ tests revealed no significant differences between scores for kindergartners, second graders or fourth graders. The results indicated that there was no consistent pattern in discrimination errors for position of imagined items. An overall left-right discrimination score was calculated for each child by dividing the total number of correctly discriminated items by the total number of items identified as old. A one-way ANOVA revealed that there were significant differences between group means, F (3, 84) = 6.473, $p < .001$. Further analysis using Tukey's WSD method revealed that in discriminating position of real and imagined items, sixth graders (M = .80, SD = .08) and fourth graders (M = .74, SD = .15) were better than kindergartners (M = .65, SD = .14). Sixth graders also outperformed second graders (M = .68, SD = .11).

The results confirmed that older children outperform younger children in discriminating position of real pictures. However, despite the fact that contextual cues are less salient for imagined items, sixth graders were found to be better than the other groups at remembering position of the imagined items.

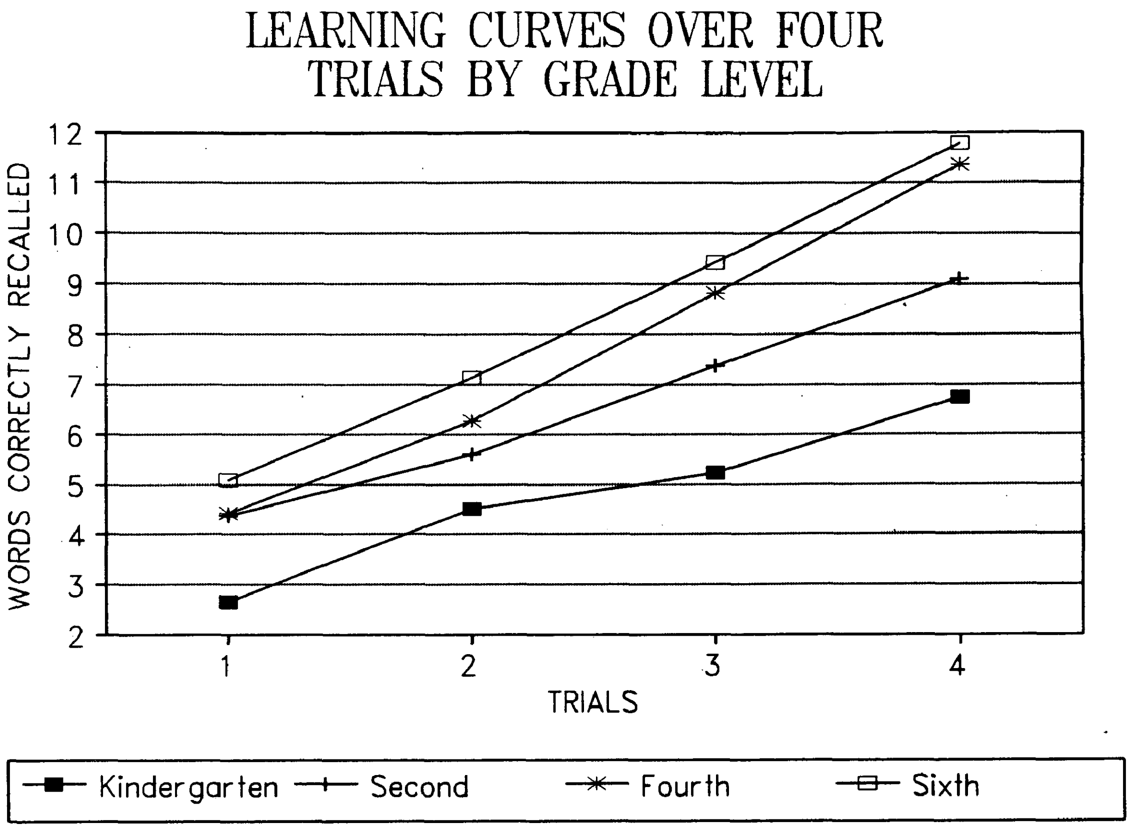
Hypotheses Four through Six were investigated by calculating several scores from Rey's Auditory-Verbal Learning Test (AVLT). Table 10 contains the means by grade level for memory test scores. It was predicted in Hypothesis Four that developmental differences would be found in the immediate memory span test with older children recalling more words than younger children on all trials. The number of correct words recalled on each of the first four trials of the word lists were tallied and learning curves for the four groups were compared. Figure 2 contains

Table 10

Means of Memory Test Scores

		Memory Score					
Grade		Words Recalled	Final Recall	Intrusions	Inhibition	ITR'S	Recognition Errors
Kindergarten	M	16.5	2.1	4.1	2.0	.46	24.4
	SD	5.6	1.8	3.0	1.3	.67	11.1
Second Grade	M	23.5	4.0	2.7	1.8	.86	17.1
	SD	6.0	2.4	1.8	1.6	.94	9.3
Fourth Grade	M	30.8	7.8	1.3	-.1	1.90	8.2
	SD	8.8	2.6	1.2	2.3	1.50	3.8
Sixth Grade	M	38.2	9.9	.5	-.8	4.80	5.8
	SD	7.1	2.7	.6	1.7	2.80	1.6

Figure 2


LEARNING CURVES OVER FOUR
TRIALS BY GRADE LEVEL
WORDS CORRECTLY RECALLED
12
11
10
9
8
7
6
5
4
3
2
1
2
3
4
TRIALS
Kindergarten
Second
Fourth
Sixth

graphed means of the learning trials. A 4 x 4 (Trials x Grade Level) repeated measures ANOVA revealed significant main effects of grade level, F (3, 84) = 42.846, $p<.001$, a significant main effect of trials, F (3, 252) = 108.99, $p<.001$, and a significant interaction, F (3, 252) = 4.849, $p<.001$. Simple effects tests of the interaction found significant differences between first trial and fourth trial scores for all groups. Nevertheless, older children outscored the younger children on all trials. All simple effect tests were significant maintaining familywise error at .0125. These results confirm Hypothesis Four.

Hypotheses Five and Six, which stated, respectively, that inhibition effects would be greater and subjective organization poorer for younger children than for older children, were examined by computing scores for the participants by the following techniques. Inhibition effects were measured by three separate scores. The first score was generated by summing intrusions on the memory test and the source monitoring task. On the memory test a response during recall was considered an intrusion if it was (a) an item from the source monitoring task presented prior to the AVLT, (b) an item from List A given during List B recall, or (c) an item from List B that was recalled during the final free recall of List A. Incorrect responses that did not meet these criteria were not counted as intrusions. On the source monitoring word recognition test a response was considered an intrusion if a participant reported that a distractor from the AVLT was a word that had been in the source monitoring task. Incorrect responses to new, neutral words were not counted as intrusions. A second measure of inhibition effects was computed for each individual by taking the difference between the average number recalled for the first four trials and the number of items in the final free recall of List A (Lezak, 1976). The third measure of inhibition was compiled from source discrimination errors. A recognition error score was calculated by adding the number of old items that were incorrectly called new (misses) and the number of new items incorrectly called old (false alarms).

Subjective organization scores were calculated by Bousfield and Bousfield's (1966) intertrial repetitions (ITR) clustering measure. Clustering was defined as the occurrence of sequences of related items in the free recall of randomly ordered stimulus lists. A unit of ITR occurred when two items appeared consecutively in recall on adjacent trials. If the number of units recalled was greater than the expected number calculated by Bousfield and Bousfield's (1966) formula, then the units were included in the ITR score. Finally, a score for retention was assigned by using the total number of words in the final recall of the first presented list.

A MANOVA was performed to determine differences between the groups in total words recalled, intrusions, inhibition, recognition errors, ITR's and final recall. It was predicted that relative to older children, younger children would recall fewer words, have more intrusions, exhibit larger inhibition effects, show less subjective organization, and retain fewer words on the final recall test. Table 11 contains the Univariate F tests for the MANOVA. The MANOVA indicated that there were significant differences between group means of all variables. Subsequent post hoc contrasts using Tukey's WSD method revealed the following differences. An examination of the means for total words recalled on the four trials indicated significant differences between all groups with older children recalling more words than younger children on all trials. The highest probability value was .001. Sixth graders and fourth graders had fewer intrusions than kindergartners and second graders ($p<.001$). Inhibition effects, as measured by the difference between the average of the four trials and the number of items on the final recall of List A, were greater for kindergartners and second graders than for fourth graders and sixth graders ($p<.015$). For recognition errors, significant differences were found among all groups except fourth graders and sixth graders ($p<.002$) with younger children making more errors than the older children. Kindergartners and second graders exhibited no differences in ITR's. However, all other differences

Table 11

MANOVA on Memory Scores

UNIVARIATE F TESTS

VARIABLE	SS	DF	MS	F
Total Words	6142.48	3	2047.49	41.31***
Final Recall	874.54	3	291.51	49.84***
Retention	162.67	3	54.22	15.37***
Intrusion	127.42	3	42.47	13.76***
ITR's	261.50	3	87.17	31.23***
Errors	4757.55	3	1593.11	28.12***

***$p<.001$

MULTIVARIATE TEST STATISTICS

Wilks' Lambda = 0.799

F-Statistic = 2.141 DF = 9, 199 $p<.028$

were significant, *p*<.05; older children displayed more subjective organizational strategy than younger children. The means for final recall were all significantly different from one another, *p*<.01, with each group of children recalling more words than groups of younger children.

To examine relationships between overall source discrimination scores, each of the memory scores and their relationships with ages of the participants, a correlation analysis was performed. The correlation matrix is shown in Table 12. All correlation coefficients were significant, *p*<.001, confirming both the conclusions of the ANOVA analyses and the hypotheses. That is, as age increases, more total words were recalled in the four trials and in the final recall of List A, more subjective organization was displayed, and fewer intrusions, inhibition effects, and recognition errors occurred.

The relationships between the dependent variable, overall source discrimination, and the predictor variables of memory scores and age, were investigated by a multiple regression analysis. Results of the regression and the correlation coefficients between overall source discrimination scores and the predictor variables are shown in Table 13. The memory scores accounted for 68 per cent of the total variation in overall source discrimination scores. When age was added to the memory scores in the regression, 72 per cent of the variability was accounted for. The

Table 12

Correlation Matrix of Memory Scores and Age

	WDS	REC	INT	INH	ITR	ERR	IO	AGE
Total Words	1.000							
Final Recall	.871	1.000						
Intrusions -.469	-.487	1.000						
Inhibition -.356	-.735	.329	1.000					
ITR's	.719	.675	-.353	-.325	1.000			
Errors	-.614	-.620	.481	.394	-.432	1.000		
IO	.700	.722	-.623	-.480	.513	-.682	1.000	
Age	.763	.788	-.597	-.548	.658	-.684	.797	1.000

$p < .001$ for all correlations

Table 13

Multiple Regression Coefficients for the Prediction of Overall Source Discrimination from Memory Variables

VARIABLE	B	SE B	T
Errors	-0.004	0.001	-3.216*
Inhibition	-0.012	0.014	-0.855
ITR	-0.001	0.006	-0.070
Intrusions	-0.019	0.005	-3.695***
Total Words	0.005	0.004	1.349
Final Recall	0.002	0.013	0.018
Age	0.027	0.008	3.293**

*$p<.05$ R^2 = .68 for memory variables with age held constant

**$p<.01$

***$p<.001$ R^2 = .72 after age is added significant predictors of overall source discrimination were recognition errors, intrusions, and age.

Separate regression analyses were performed to determine the relationships between memory variables, age and the ability to discriminate real pictures, imagined pictures, and heard words. Results of the regression analysis for real pictures is in Table 14, for imagined pictures is in Table 15, and for heard words is in Table 16. The only significant predictor for discrimination of real pictures was found to be the number of intrusions made on the memory test and the source discrimination task. The memory variables accounted for 44 per cent of the variability in real picture discrimination scores. Age added only 2 per cent to the explanation of discrimination scores. Recognition errors was the sole significant predictor of imagined pictures source discrimination. Memory variables accounted for 33 per cent of the variation in imagined pictures discrimination with age adding a negligible additional 1 per cent. Recognition errors, intrusions, and age were significant predictors of heard words discrimination ability. Memory variables explained 56 per cent of the variability in the heard source discrimination scores. Age added an additional 7 per cent to the explanation.

However, inhibition effects, as measured by taking the difference of the average of total words recalled and the

Table 14

Multiple Regression Coefficients for the Prediction of Source Discrimination of Real Pictures from Memory Variables

VARIABLE	B	SE B	T
Errors	-0.003	0.014	-1.782
Inhibition	-0.012	0.016	-0.754
ITR	-0.005	0.007	-0.724
Intrusions	-0.014	0.006	-2.409*
Total Words	0.006	0.004	1.283
Final Recall	-0.004	0.016	-0.247
Age	0.015	0.010	1.490

*$p<.02$

R^2 = .44 for memory variables with age held constant

R^2 = .46 after age is added

Table 15

Multiple Regression Coefficients for the Prediction of Source Discrimination of Imagined Pictures from Memory Variables

VARIABLE	B	SE B	T
Errors	-0.006	0.002	-2.947*
Inhibition	-0.002	0.021	-0.088
ITR	-0.002	0.009	-0.219
Intrusions	-0.012	0.008	-1.430
Total Words	0.002	0.006	-0.339
Final Rec	0.012	0.022	0.563
Age	0.007	0.138	0.472

*$p<.01$

R^2 = .33 for memory variables with age held constant

R^2 = .34 after age is added

Table 16

Multiple Regression Coefficients for the Prediction of Source Discrimination of Heard Words from Memory Variables

VARIABLE	B	SE B	T
Errors	-0.298	0.003	-3.048**
Inhibition	-0.136	0.033	-0.678
ITR	0.018	0.016	0.166
Intrusions	-0.169	0.013	-1.924*
Total Words	0.442	0.008	1.603
Final Rec	-0.108	0.033	-0.285
Age	0.527	0.021	3.711***

*$p<.05$ R^2 = .56 for memory variables with age held constant

**$p<.01$

***$p<.001$ R^2 = .63 after age is added final recall of List A, and the subjective organization scores, although significantly correlated with source discrimination scores, did not significantly add to prediction or explanation of source discrimination scores.

DISCUSSION

In general, the evidence confirmed the primary hypothesis that cognitive developmental differences would be found on both the source monitoring tasks and the memory test and that development of cognitive functions would be significantly related to source monitoring abilities. However, some of the corollary hypotheses were not confirmed. Contrary results are addressed in the ensuing discussion.

Although it was expected that kindergartners and second graders would have better discrimination scores for real items than for imagined items, no differences were found in the younger children's discrimination abilities for the two sources. The prediction that differences would be found was based on the theoretical assumption that real pictures have more sensory information and more salient and contextual cues than imagined pictures. According to the reality monitoring model, imagined pictures require more encoding cognitive operations than real pictures. Thus it was reasoned that children of all ages should remember real pictures better than imagined ones. However, none of the children in the present study had more difficulty in identifying imagined pictures (internal source) than they had in identifying real pictures (external source). Nevertheless, the obtained results are consistent with Raye and Johnson's (1980) study of college students who found it easier to identify the origin of internally versus externally derived memories than to discriminate between two external sources of memories. The younger children in the present study found it easier to discriminate between external (real pictures) and internal memories (imagined pictures) than to identify the sources of memories derived from two internal sources (imagined pictures and heard words). In addition, no source discrimination differences for the imagined items supports the generation effect (Slamecka & Graf, 1978) which proposes that cognitive traces are used as cues for recalling imagined sources.

Although younger children remembered imagined items as accurately as the real items, their source discrimination scores for the position of the imagined items indicated that remembering the imagined picture's location occurred in a random fashion. No consistent pattern of response for location of imagined items was found. Thus the possibility exists that the younger children's accurate identification of imagined items could have occurred through the use of one of two kinds of cues. The imagined items could have been remembered by using cognitive operations associated with imagining for cues in retrieval, or recall could have been a function of saying the word. Research provides support for both methods in the facilitation of internal source discrimination (Hashtroudi, Johnson, & Chrosniak, 1989; Raye & Johnson, 1980). Evidence from the present study appears to favor the cognitive operations hypothesis. This conclusion is based on indications that although younger children committed more recognition errors than older children by identifying distractors said in the AVLT as old items, younger children were more accurate than inaccurate. No child committed more than three errors of this type. Therefore, it appears that the saying of words was not the cue used for identification of imagined items. If saying the word was the retrieval cue used to identify the source of the imagined picture, then more confusion from saying words in the AVLT should have been indicated by the younger children. Additional evidence points to increased cognitive operations as the facilitating mechanism. Because the children were asked to describe the imagined picture during the practice trials, younger children tended to volunteer information about the imagined source during the formal source monitoring task. For example, comments were made about the color of trucks, cats playing with balls, pepperoni on the pizza, and so on. Thus evidence indicates that at least some of the younger children were indeed imagining the pictures.

During the practice trials and before the source monitoring task all children received specific instructions that there would be <u>three</u> words for each set of items and that they should carefully consider the two words presented for the imagining task before choosing the word. In spite of the fact that the instructions were repeatedly emphasized the younger children demonstrated extreme difficulty in identifying the heard items. Not only were the discrimination scores for the heard items significantly lower than the scores of the older children, but the younger children indicated higher response biases for saying that the heard item was not in the source monitoring task. These results are similar to those found for older adults who had difficulty discriminating memories of covert (thought) from memories of overt (said) self-generated events (Hashtroudi, Johnson, & Chrosniak, 1989).

That younger children had difficulty discriminating words that were merely heard has several important implications. In the province of child eyewitness testimony, the evidence from this study indicates that although younger children may accurately remember a portion of what they saw, testimony concerning heard sources may be more inaccurate than memories for heard information of older children. The results also support the findings of Lindsay and Johnson (1989) who, in investigations of child eyewitness testimony, found that younger children make more errors of omission than adults. For the educational field, the results support visual forms of teaching for younger children or involving the child in self-generated images rather than employing auditory methods. Finally, for parents of kindergartners and second graders, it may be prudent to eliminate certain phrases from verbal disciplinary repertoires (e.g., "How many times do I have to tell you...").

A second result contrary to expectations was that sixth graders outperformed all other grade levels in discriminating left and right positions of imagined items. No developmental differences were expected to be found on this task because contextual cues for imagined items are not as salient as they are for perceived items. However, sixth graders were moderately proficient at recalling the position of imagined items. Although the children were not told to expect a memory test on the source monitoring task, perhaps the task instructions and/or testing experiences of the older children led them to expect that they would be tested on both the source and its position. If so, they may have put more effort into remembering the position of imagined sources. Nevertheless, these speculations do not rule out the possibility that the ability to use less available contextual cues for the identification of source location is, indeed, an ability that is more developed for sixth graders.

Literature on development of the ability to perceive left-right dimensions reports that 66 to 74 per cent of children at the age of five failed to identify correctly their left and right hands; by the age of six years, 62 per cent of the girls and 56 per cent of the boys still failed to make this kind of discrimination (Cratty, 1970). By seven years, however, only 14 per cent of the girls and 16 per cent of the boys were unable to correctly identify their left and right hands. Left-right confusion may account for some of the errors made by kindergartners and second graders, but the fourth graders also performed poorly on this task. In addition, the children were only required to point to the left or right side and verbal instructions did not include the words left or right. Thus, superior performance by the sixth graders on the discrimination of position for imagined pictures does not appear to be solely attributable to development of the ability to perceive left-right dimensions. Instead it appears that development of the ability to use less salient contextual cues as a source for identification of memory is involved.

Some of the unexpected results may be attributed to distinctive problems that exist in studies in which the participants are of disparate ages and abilities. If the tasks are too difficult, the younger children cannot perform them. Conversely, tasks that are too easy result in ceiling effects for the older children. Perhaps no developmental differences for discrimination of position of imagined sources would have been found if there had been more items in the source monitoring task. However, lengthening the task to more than 30 minutes would probably have been too long for the younger children. In addition, remembering more than 60 source items may have been an insurmountable task for kindergartners. It appears that difficulties such as these are inherent in any study designed for children with the age range of kindergarten through sixth grade.

It was not surprising that older children outperformed younger children on all the memory measures derived from the AVLT or that source discrimination accuracy increased with age. Nor was it unanticipated that developmental differences would coexist for the two measures because both the AVLT and the source monitoring task assess memory functions. Consequently, the interesting inquiries concern the parallel errors made on the two tasks, how the errors decline through childhood, and what cognitive mechanism may be responsible for these phenomena.

The younger children had more difficulty in suppressing or inhibiting inappropriate old memories which was illustrated by the errors made in both memory and source monitoring tasks. Bjorklund and Harnishfeger (1990) propose that, in children, working memory becomes filled with irrelevant information which results in less efficient mental processing. It is this irrelevant information that "clutters up" working memory space, making encoding and retrieval of appropriate information less efficient.

For the purpose of examining the development of an inefficient inhibitory mechanism, three indexes of inhibition were measured on the memory and source discrimination tasks. Intrusions and recognition errors were found to significantly contribute to the explanation of variation in source discrimination scores. Although the third measure of inhibition was significantly correlated with source scores and with age, it did not provide additional explanation for the variation. Nevertheless, younger children displayed significantly more inhibition effects on all three indexes than the older children. Thus, the evidence supports the hypothesis of an inhibitory mechanism which develops in efficiency throughout childhood and subsequently contributes to accurate discrimination of memories.

According to Hasher and Zacks' (1988) model of inefficient inhibition as an explanation for memory deficits with aging, an inefficient inhibitory mechanism leads to more non-goal-path information entering into working memory. Thus, competition of mutual responses occurs at retrieval. The results of the present study clearly indicate that for younger children, who commit significantly more intrusions than older children, competition of responses are present during retrieval of memories. In addition, Logan (1985) proposed that a consequence of inefficient inhibitory functioning is a reduction in the ability to switch attention from one category of events to another. The problems that younger children exhibited in discriminating words that were heard may be directly attributable to the inability of switching attention from pictures, whether or not the pictures were real or imagined, to heard words.

Discussion of inhibitory factors compels the inclusion of activation processes as an alternative explanation of inaccuracies in source discrimination. That is, do intrusions and recognition errors occur because inappropriate responses have not been inhibited or because they have been activated by irrelevant information? Hasher and Zacks (1988) propose that both processes are involved in inaccurate encoding and retrieval of memories. Decreased inhibition leads to increased maintenance of activation of non-goal-path ideas which together result in increased competition in retrieving prior goal path ideas. This premise also accounts for the younger children's tendencies not to produce responses in the word recognition test. In addition to making more inappropriate responses, younger children had more misses (reporting that an old item was not in the source monitoring task) than older children. If there is inefficient inhibition of inappropriate responses, many potential items may be activated, but with no single item receiving enough activation to be retrieved (Bjorklund & Harnishfeger, 1990).

Personalized memories and concerns have been identified as one category of off-goal-path thoughts (Hasher & Zacks, 1988). The personalistic memories of imagined pictures indicated by the previously reported remarks made by the younger children when imagining pictures, while functioning to increase cognitive operations for recall of the imagined pictures could simultaneously be considered off-goal-path thoughts, potentially causing inaccurate discrimination for the position of the imagined source and for the retrieval of the heard source. Personalized memories and concerns, as off-goal-path thoughts, could also contribute to younger children's omissions by decreasing activation of the appropriate source. If so, the information would not be available for retrieval.

With respect to the development of an inhibitory mechanism, there are reported neurophysiological explanations that are pertinent to the evidence found in this study. Case (1985) speculated that myelinization of the association areas of the brain is closely related to efficiency in processing information. Although myelinization of sensory and motor areas of the brain is fully developed during the first two years of life, myelinization of the integrative systems is not adult-like until the teen years (Van De Graff & Fox, 1986). Maturationally paced changes in myelinization may be a physiological explanation for a developing inhibitory mechanism. Consequently, the higher rates of intrusions displayed by the younger children indicate less efficient processing of source information possibly connected to developing myelinization of neurons.

A second neurophysiological explanation for inefficient inhibition during childhood is associated with development of the frontal lobes. The frontal lobes develop slowly, reaching almost full development by about seven years of age but continuing to increase up to adulthood. Concomitant with the development of the frontal lobes are neurophysiological changes involved in attentional processes, such as the evoked potential becoming more stable, which do not reach final levels of efficiency until around 12 years of age (Luria, 1973). One of the many functions of the frontal lobes is to control inhibition of attention to irrelevant stimuli. The frontal lobes instigate attention to the relevant stimuli while inhibiting distraction (Mackworth, 1976). Anyone who has ever worked with young children appreciates how difficult it is to keep them "on task" because they are so easily distracted. This researcher is certain that the prospect of obtaining a brightly colored pencil upon completion of the task was the prime reason that some kindergartners and second graders painfully persevered with much squirming to the end of the testing.

Further evidence from the present study supports that an inhibitory mechanism may be associated with physiological maturation. Large individual differences are found in maturational development of any ability. As is indicated by the standard deviations in Tables 1 and 8, not only are younger children less accurate than older children in discriminating sources of information, but variability within the age groups dramatically decreases as the children get older, reflecting more developmental differences among younger children of the same grade levels than there are in the older same-age groups. A reasonable speculation is that differential rates of myelinization and neural maturation may be associated with the development of inhibitory mechanisms resulting in more competition in retrieving sources of memory and to increased variability within the groups of younger children. It is interesting to note here that variability in memory performance has also been reported to dramatically increase in groups of older adults (Rabbitt, 1982).

According to Dywan and Jacoby (1990), failures in source monitoring cannot be segregated from other cognitive mechanisms. In a study of older adults these researchers reported that the poorer their older adult subjects did on source monitoring tasks, the poorer they were at free recall, the poorer they were at clustering words, and the poorer they were on recognition of discrimination between familiar sources. The present study confirmed Dywan and

Jacoby's results, but from a child developmental perspective. That is, the younger the children were, the poorer they were at free recall, the poorer they were at clustering words, and the poorer they were at discriminating sources of information and location of sources. If the inefficient inhibition model proposed by Hasher and Zacks (1988) is an explanation for age-related deficits in memory and, as such, can explain the findings of Dywan and Jacoby (1990), then a developing inhibitory mechanism can reasonably be applied as an explanation for the differences found in children's source discrimination abilities in the present study.

The fact that recognition errors, intrusions, and age were found to be the significant predictors of source discrimination is very supportive of a developing inhibition mechanism. The models proposed by both Hasher and Zacks (1989) and Bjorklund and Harnishfeger (1990) predict that an inefficient inhibitory mechanism will lead to these types of errors. Of course, it is recognized that there are undoubtedly other factors which contribute to recognition errors and intrusions. However, evidence from the present study supports inefficient inhibition as a major predictor of the number and types of errors that occur on source monitoring tasks by children of different age groups.

It would have been surprising if results indicated that, relative to younger children, older children did better on the free recall test but did not do better on the subjective organization scores. Kintsch (1982) suggests that there is a causal relationship between recall learning and subjective organization, and experimental studies have found that subjective organization of a list leads to better recall (Tulving, 1962).

Whereas older children displayed more subjective organizational strategies than younger children on the AVLT, and subjective categorization was found to be related to source discrimination scores, no additional variability in source monitoring was explained by the ability to organize categories. These results may indicate that items on the AVLT list could not be easily associated with one another. Perhaps if lists designed for categorical recall had been used, older children would have displayed more organizational strategies. Also, a different method for assessing subjective organization (i.e., sorting items into categories) may have resulted in improved scores for older children. The fact that subjective organization was found to be significantly correlated with source discrimination and with age but the partial correlation in the regression analysis was not significant suggests that other factors may be important to explaining the correlation between subjective organization and source monitoring ability.

In summary, evidence confirmed that cognitive developmental differences in source monitoring exist and that these differences are associated with developing cognitive functions. In particular, an "uncluttered" working memory, an ability to inhibit inappropriate responses, and organizational strategies are associated with better source monitoring performance. Results also support that a developing inhibitory mechanism may be closely associated with the accurate identification of the origins of source information.

Further research should employ qualitative post-experimental methods focusing on determining whether or not children can report how they remember source items and investigate problems encountered during retrieval. In addition, a different method of assessing subjective organization should be employed to determine if proficiency in categorization does, in fact, predict source discrimination ability.

APPENDIX A

Parental Consent Form

Dear Parent:

As part of the requirements for receiving a Master of Arts degree from the College of William and Mary, I will soon be conducting a study on "Cognitive Developmental Differences in Source Monitoring" at your child's school. The project investigates how children of different age groups remember sources of information. The children will look at or pretend that they are looking at real pictures of common objects which will be shown to either the left or right sides of the children, and they will perform a simple word list learning task. The study will take about 30 minutes and each child will participate individually. Each child's participation is voluntary, and so your child will be told that he or she does not have to take part. Most children do volunteer because of the novelty and the attention they receive, and the task is designed to be fun for children of this age.

If you approve of your child's participation, and your child agrees to be in the study, your child's results are completely confidential. Because the purpose of the study is to compare group averages, no results for individual children will be released to parents or to school personnel. However, if you would like a summary of the completed study, please note that desire below.

Please indicate if you approve of your child's participation by completing the attached form and sending it to school in the envelope provided. I hope your child will be able to take part in the study, and I thank you for your response. If you would like further information about this project, please don't hesitate to call me at (804) 220-2864.

Thank you,
Kathy Cimini

Child's name________________________________ Birthdate________

________ Yes, I give permission for my child to participate.

________ No, I do not give permission for my child to participate.

Parent's signature____________________________ Date___________

________ I would like a summary of the completed study sent to the following address:_______________________________________

____

Appendix B

Picture List

1. Car
2. Flowers
3. Hamburger
4. Big Bird
5. Dog
6. Iron
7. Peanut butter
8. Orange
9. Pens
10. Hands
11. Bed
12. Toothpaste
13. Chair
14. Bicycle
15. Sock
16. Fork
17. Pie
18. Watch
19. Candy
20. Butterfly

Appendix C

Rey's Auditory-Verbal Learning Test

List A	List B
Drum	Desk
Curtain	Ranger
Bell	Bird
Coffee	Shoe
School	Stove
Parent	Mountain
Moon	Glasses
Garden	Towel
Hat	Cloud
Farmer	Boat
Nose	Lamb
Turkey	Gun
Color	Pencil
House	Church
River	Fish

Appendix D

Word Recognition Test

Item		Type of Source			Position	
1.	PAJAMAS	P	I	H	L	R
2.	BRACELET	P	I	H	L	R
3.	BEE	P	I	H	L	R
4.	BED	P	I	H	L	R
5.	CAKE	P	I	H	L	R
6.	BANANA	P	I	H	L	R
7.	DOG	P	I	H	L	R
8.	FACE	P	I	H	L	R
9.	CAT	P	I	H	L	R
10.	AIRPLANE	P	I	H	L	R
11.	PENS	P	I	H	L	R
12.	BUBBLE GUM	P	I	H	L	R
13.	BOOT	P	I	H	L	R
14.	PENCIL	P	I	H	L	R
15.	FLOWERS	P	I	H	L	R
16.	FEET	P	I	H	L	R
17.	RING	P	I	H	L	R
18	CAR	P	I	H	L	R
19.	TREE	P	I	H	L	R
20.	BIG BIRD	P	I	H	L	R
21.	TRUCK	P	I	H	L	R
22.	BLANKET	P	I	H	L	R
23.	TURKEY	P	I	H	L	R
24.	ARMS	P	I	H	L	R
25.	CHAIR	P	I	H	L	R
26.	CRAYONS	P	I	H	L	R
27.	HORSE	P	I	H	L	R
28.	PIE	P	I	H	L	R
29.	SCISSORS	P	I	H	L	R
30.	BARN	P	I	H	L	R
31.	BUTTERFLY	P	I	H	L	R
32.	HANDS	P	I	H	L	R
33.	SAUCER	P	I	H	L	R
34.	MOON	P	I	H	L	R
35.	TOOTHPASTE	P	I	H	L	R
36.	NOSE	P	I	H	L	R
37.	STOVE	P	I	H	L	R
38.	TRAIN	P	I	H	L	R
39.	SPOON	P	I	H	L	R
40.	BOAT	P	I	H	L	R
41.	IRON	P	I	H	L	R
42.	JELLY	P	I	H	L	R
43.	SLIPPERS	P	I	H	L	R
44.	SOFA	P	I	H	L	R
45.	HAMBURGER	P	I	H	L	R
46.	MOUTHWASH	P	I	H	L	R
47.	POPSICLE	P	I	H	L	R
48.	HOT DOG	P	I	H	L	R
49.	ERNIE	P	I	H	L	R
50.	WASHER	P	I	H	L	R
51.	APPLE	P	I	H	L	R
52.	TOOTHBRUSH	P	I	H	L	R
53.	ROLLER SKATES	P	I	H	L	R
54.	WATCH	P	I	H	L	R
55.	MOTH	P	I	H	L	R

56.	SCHOOL	P	I	H	L	R
57.	TABLE	P	I	H	L	R
58.	MARSHMALLOW	P	I	H	L	R
59.	ICE CREAM	P	I	H	L	R
60.	TOASTER	P	I	H	L	R
61.	ORANGE	P	I	H	L	R
62.	SHOE	P	I	H	L	R
63.	PILLOW	P	I	H	L	R
64.	MOTORCYCLES	P	I	H	L	R
65.	SOCK	P	I	H	L	R
66.	KNIFE	P	I	H	L	R
67.	BERT	P	I	H	L	R
68.	GRASS	P	I	H	L	R
69.	BICYCLES	P	I	H	L	R
70.	PAPER	P	I	H	L	R
71.	PIZZA	P	I	H	L	R
72.	PEANUT BUTTER	P	I	H	L	R
73.	COFFEE	P	I	H	L	R
74.	FORK	P	I	H	L	R
75.	CHICKEN	P	I	H	L	R
76.	DRUM	P	I	H	L	R
77.	HAT	P	I	H	L	R
78.	CANDY	P	I	H	L	R
79.	GLOVES	P	I	H	L	R
80.	CLOUD	P	I	H	L	R

Appendix E

Order of Presentation

Source	Position	Item	
Real	Right	Pens	
Imagine	Right	Pencil	Paper
Real	Left	Watch	
Imagine	Right	Bracelet	Ring
Real	Left	Bed	
Imagine	Left	Blanket	Pillow
Real	Right	Bicycles	
Imagine	Left	Motorcycles	Roller Skates
Real	Right	Candy	
Imagine	Right	Popsicle	Bubble Gum
Real	Left	Sock	
Imagine	Left	Shoe	Boot
Real	Left	Flowers	
Imagine	Right	Tree	Grass
Real	Right	Pie	
Imagine	Left	Cake	Ice Cream
Real	Left	Dog	
Imagine	Left	Horse	Cat
Real	Right	Toothpaste	
Imagine	Right	Mouthwash	Toothbrush
Real	Right	Peanut Butter	
Imagine	Left	Marshmallow	Jelly
Real	Left	Fork	
Imagine	Right	Spoon	Knife
Real	Right	Car	
Imagine	Left	Truck	Airplane
Real	Left	Chair	
Imagine	Right	Sofa	Table
Real	Left	Big Bird	
Imagine	Left	Ernie	Bert
Real	Right	Butterfly	
Imagine	Left	Bee	Moth
Real	Left	Orange	
Imagine	Right	Apple	Banana
Real	Right	Hamburger	
Imagine	Left	Hot Dog	Pizza
Real	Left	Hands	
Imagine	Right	Arms	Feet
Real	Right	Iron	
Imagine	Right	Toaster	Washer

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