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INCIDENTAL MEMORY FOR SPATIAL INFORMATION IN YOUNG
CHILDREN AS A FUNCTION OF AGE AND GENDER

A Thesis

Presented to the

Department of Psychology

and the

Faculty of the Graduate College

University of Nebraska

In Partial Fulfillment

of the Requirement for the Degree

Masters of Art

University of Nebraska at Omaha

by

Isabelle D. Cherney

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THESIS ACCEPTANCE

Acceptance for the faculty of the Graduate College,
University of Nebraska, in partial fulfillment of the
requirements for the degree of Masters of Art,
University of Nebraska at Omaha.

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INCIDENTAL MEMORY FOR SPATIAL INFORMATION IN YOUNG
CHILDREN AS A FUNCTION OF AGE AND GENDER

Isabelle D. Cherney, MA

University of Nebraska, 1999

Advisor: Dr. Brigette O. Ryalls

The purpose of the present study was to investigate Hasher and Zacks' (1979, 1984) automaticity theory of memory for spatial location information in young children using two incidental memory tasks. A total of 96 three- and five-year-olds (48 boys and 48 girls) were randomly assigned to either the "manipulation condition" (MC) or the "observation condition" (OC). In order to assess task difficulty, half of the participants manipulated a total of 18 gender-stereotyped animal toys (male, female, neutral) and half of the participants a total of 9. After a 2 minute filler task, the participants were instructed to return the animals into their original spaces. Analyses of variance indicated a main effect of age, task difficulty, and gender-stereotype of the animals. Timing of reconstruction, strategy usage as well as implications for the automaticity theory are discussed.

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Incidental Memory for Spatial Information in Young Children as a Function of Age and Gender

The present study is concerned with developmental changes in the processing of spatial location information in young boys and girls. In particular, the study was designed to focus on the automaticity of encoding spatial location information. Spatial ability is an important component of intellectual ability. In particular, spatial location memory has been shown to correlate with most subspecialties of mathematics and appears to be a critical skill for many scientific and artistic domains, such as engineering, physics, and architecture (McGuinness & Morley, 1991). Studies investigating spatial memory suggest that some spatial location information is stored in long-term memory even when people do not attend to it. That is, there is evidence that individuals encode location information under incidental learning conditions (e.g., Acredolo, Pick, & Olsen, 1975; Mandler, Seegmiller, & Day, 1977; Naveh-Benjamin, 1987; Logan, 1998). However, there is controversy over the degree to which the learning is incidental and to what degree the stimuli are automatically encoded (Naveh-Benjamin, 1987; Logan, 1998). The current study examines four factors affecting young children's spatial information memory using the automaticity theory postulated by Hasher and Zacks (1979, 1984) as a framework. The present article first describes Hasher and Zacks' automaticity theory and findings from several developmental studies based on their theory. Second, four factors believed to influence children's spatial memories are presented, and finally, implications of the results of the present study are discussed

in terms of Hasher and Zacks' (1979) and Logan's (1988) instance theory of automaticity.

Several researchers have addressed the issue of automatization (e.g. Cohen, Dunbar, & McClelland, 1990; Hasher & Zacks, 1979, 1984; Logan, 1985, 1988, 1998; Posner & Snyder, 1975). Significant developments in automaticity theory, which is commonly viewed as a special topic in the study of attention (Logan, 1988), have presented new ideas about what it means for a process to be automatic and how an automatic process can be distinguished from a non-automatic one. The first formal models of attention can be traced back to Broadbent (1958), Treisman (1960), and Kahneman (1973) who postulated that information passes through a series of stages, during one of which selective attention operates. The traditional or modal theory of automaticity links automaticity to a single-capacity model of attention with resource limitations. It considers automatic processing to occur without attention (e.g., Hasher & Zacks, 1979; Posner & Snyder, 1975). Specifically, automatic processing is assumed to be fast and effortless because it is not subject to attentional limitations, and it is assumed to be autonomous and unavailable to consciousness because consciousness is the mechanism of attention. Two proponents of the modal theory, Hasher and Zacks (1979) distinguished between automatic and effortful processing. Effortful processes, which have also been called strategies or controlled processes, are hypothesized: (a) to be available to consciousness, (b) to interfere with the execution of other effortful processes, (c) to improve with practice, and (d) to be influenced by individual differences in intelligence, motivation, and education (Hasher & Zacks, 1979). In contrast,

automatic processes are hypothesized: (a) to occur without intention and without conscious awareness, (b) not to interfere with the execution of other processes, (c) not to improve with practice, and (d) not to be influenced by individual differences in intelligence, motivation, and education. Although there are problems with this strong modal view of automaticity and its reliance on a single-capacity theory of attention and resource limitations (see Logan, 1988), most of the developmental studies about memory for location information have been guided by Hasher and Zacks' (1979, 1984) paradigm. The purpose of this study is to extend Hasher and Zacks' theory of automaticity to young children.

Hasher and Zacks (1979) postulated that frequency of occurrence, temporal order, and spatial location are automatically encoded attributes of objects. The researchers contended that the sources of these automatic processes could be biologically based, developing very early in the child, and then remaining invariant over the life span. Because automatic encoding uses minimal or no attentional resources, accuracy of recalling location information should not increase with age, should not be different under intentional and incidental conditions, and should not be affected by practice, culture, early experience, and/or intelligence. Thus, the Hasher and Zacks' model predicts that spatial information should be recalled well by children independent of their intention to remember, and independent of their age (Park & James, 1983). The present study was designed to test the Hasher and Zacks' (1979) automaticity hypothesis for memory for spatial information in young children. In particular, the participants' age, sex, and the gender-stereotype of the stimuli (male, female, neutral) were examined using two separate incidental

memory conditions: the "manipulation condition" (MC) and the "observation condition" (OC). Furthermore, the effect of the number of stimuli (i.e., task difficulty) on the children's memory performance was examined. The present study addressed the following questions: (1) Does the nature of the task affect a child's recall of location information? (2) Are there age differences in young children's spatial memory? (3) Are there sex differences in young children's spatial memory performance? (4) Do gender-stereotyped stimuli (male, female, neutral) affect a child's memory for location? and (5) How does task difficulty influence young children's spatial memory performance? Each of these will be discussed in turn below.

Nature of the task

The first question was concerned with the impact different tasks may have on a child's recall of location. According to Hasher and Zacks' (1979) automaticity theory, encoding operations vary in their attentional requirements. That is, operations that drain minimal energy from our limited-capacity attentional mechanisms involve automatic processing and therefore function at a constant level under all circumstances (Hasher & Zacks, 1979). On the other hand, effortful operations such as rehearsal and mnemonic activities require considerable capacity and therefore interfere with other cognitive activities which also require capacity. Hasher and Zacks (1979) posited that encoding spatial location information requires little or no conscious processing of the stimuli. As evidence they cited a study by Mandler et al. (1977) who investigated memory for object identity and location in adults (experiment 1) and children (experiment 2) using both intentional and

incidental learning conditions. In the "intentional" condition, the participants were instructed to remember both the objects and their locations. In the "standard incidental condition", they were asked only to remember the objects, and in the "true incidental condition" they were not given any memory instructions, but were told to price the individual objects in order to estimate the cost of the total array of stimuli. Sixteen small toys were placed on a matrix of 36 locations. The participants were instructed to study or price the items and to place them in the exact same locations. The adult participants studied/priced the items for less than a minute and the children (kindergarten, 3rd, and 6th graders) for one minute. Both adults and children had to recall the items and positions immediately thereafter, without an intermediate filler task. Mandler et al. (1977) found that both adults and children of different ages performed equally well in locating objects in the "true incidental condition", whereas they found an age difference in the recall of object identity. The researchers concluded that a great deal of spatial information is available for retrieval without attention having been directed to it. Based on their findings in the "truly incidental condition" they argued that location information is automatically encoded in the sense that active processing is not required. Furthermore, the researchers contended that the use of a truly incidental condition is essential to assess the extent to which various kinds of information are automatically coded into long-term memory. However, Mandler et al.'s (1977) experiments did not examine long-term memory of location information. The participants studied/priced the items immediately before they were asked to recall them. It is important to include a filler task between the time of encoding and time of retrieval to assess the transfer of

information into long-term memory. For this reason, the present study included a two minute filler task.

Another problem facing researchers when trying to investigate children's spatial memory performances with respect to Hasher and Zacks' (1979) theory is that often they have not used "truly" incidental tasks which require no conscious encoding and no intention to encode the stimulus information (Naveh-Benjamin, 1987). Typically, researchers instruct participants to memorize the stimuli before they are asked to identify the location of these stimuli (e.g., Golbeck, 1992; Rogoff & Waddell, 1982). Although preschoolers' ability to voluntarily use memory strategies is limited (Bjorklund, 1995), early memory strategies and effortful processing may influence the individuals' performance during these tasks. The present study was specifically designed to address this concern: two separate incidental learning conditions and no intentional learning condition were utilized. In the "manipulation condition" (MC) the experimenter showed each participant where to place each object, whereas in the "observation condition" (OC) the experimenter placed each object into its predetermined space. The children paid attention to the different locations either directly (MC) or indirectly (OC). In all cases, the children directed their attention to each location for about 5 seconds. Furthermore, they were not instructed to memorize any aspect of the stimuli prior to testing. A few studies (e.g., Dayan & Thomas, 1994; Newman, 1990) have indicated that children recall spatial locations equally well whether they are told that they will be required to recall locations of objects (intentional learning), or whether they are simply given experience that requires them to attend to objects (incidental learning). For example,

Newman (1990) investigated the difference between asking 4- to 5-year-old children to "play with" toys and to "remember" toys. The children's retention was improved when they were asked to play rather than remember the stimuli. Newman (1990) argued that the better memory performance of the children in the play condition was due to the fact that the children organized items in their play in a more sophisticated way than when instructed to remember the toys. Their recall was mediated by the organizations they spontaneously imposed on the materials by using more "functional play". These findings demonstrate that, when the task is meaningful, young children can recall objects even in the absence of explicit instructions to do so. The present study was designed to be game-like. Specifically, the MC was devised in order to examine the influence of physically manipulating the toys on the participants' memory for location.

Age

The development of memory strategies, or mnemonics, has been found to be of critical importance to age related changes in children's memory (Bjorklund, 1995). In general, the use of strategies or effortful processing such as rehearsal, organization, retrieval, and elaboration increases with age. Levels of performance are typically lower for preschoolers (who do not use strategies spontaneously) than for older children. Specifically, rudimentary rehearsal strategies appear around 5 years of age.

In order to test Hasher and Zacks' (1979) assertion that spatial location is encoded with little or no conscious processing, and in an attempt to eliminate the mnemonic advantage the 5 year-olds may have over younger children, the current

study only utilized two incidental memory conditions (i.e., MC & OC). That is, unlike most previous experiments, the participants were not instructed to remember the location of the items prior to the recall task. Moreover, few studies have examined the impact of truly incidental tasks on location information (Mandler et al., 1977). Incidental learning has been shown to be fairly invariant in young children's location memory and memory in general (Bjorklund, 1995). That is, during incidental learning tasks, very little age difference in the memory performance of young and old children is found (Newman; 1990; Schneider & Pressley, 1997).

Hasher and Zacks (1979) posited that automatic processes are expected to show limited developmental trends. If spatial memory involves automatic processing, little developmental change would be expected. Consistent with Hasher and Zacks' (1979) predictions, several studies suggest that spatial location memory is relatively well developed in young children (Drummey & Newcombe, 1995; Ellis, Katz, and Williams, 1987; Mandler, et al., 1977). In a series of studies, Ellis et al. (1987) asked 3- to 6-year-old children to view and name pictures in sets of four in a book. The children later attempted to recall the names of the objects pictured and to relocate them on blank pages. The researchers also asked elementary school children, college students, and elderly people to perform a similar task. Their results revealed that memory for location was invariant across the age groups. Ellis et al. interpreted their findings as support for the Hasher and Zacks' automaticity hypothesis. However, these and other studies (e.g. Mandler, et al., 1977; DeLoache & Brown, 1983) that found no age differences in children's

performance on spatial information memory tasks did not include a filler task to assess the transfer of spatial information into long-term memory. The current study utilized a two minute filler task to ascertain location memory transfer into long-term memory.

Contrary to Hasher and Zacks' (1979) predictions, several studies have found age differences in performance when comparing 3 to 10 year-old children (e.g., Aliotti & Rajabiun, 1991; Dayan & Thomas, 1995; Park & James, 1983; Schumann-Hengsteler, 1992; Siemens, Guttentag, & McIntyre, 1989). For example, in two experiments, Hazen and Volk-Hudson (1984) had 3- to 4-year-old children either recall pictures of familiar items which were hidden in boxes or recall toys with which they had previously played. The older children generally recalled more object locations than the younger children. In another study investigating spatial memory, Dayan and Thomas (1995) compared 2nd, 5th graders', and adults' memory for movement in different locations. The participants were randomly assigned to one of three conditions (intentional, incidental learning with spatial cues, and incidental learning without spatial cues) and had to perform exercises at four locations and later recall the exact location of each exercise. Their results showed that the accuracy of recalling the location information increased with age.

Furthermore, in a study which explored the effect of encoding instructions on children's spatial and color memory, Park and James (1983) instructed 1st, 3rd, and 5th graders to encode only the picture, the picture and its color, the picture and its position, or all three. After three acquisition tests, the participants had to

recognize the correct objects, color, and point to the spatial location. The results revealed that there was a main effect of age in the item-position condition.

Children's performance on location information improved with age when they were instructed to remember both the items and the position. The authors suggested that older children are more adept at using a left-right naming strategy in intentional learning. However, memory for location did not improve with age in the other conditions.

This study and other studies which show a main effect of age in spatial memory employed intentional learning conditions. In each experiment, the participants were instructed to name the objects, and/or remember the stimuli (or exercises) prior to the experiment. These instructions may have facilitated the encoding and retrieval processes of the children, especially the older children. In contrast, in the case of incidental learning, there is no intention to learn new information. The participants in the present study were not instructed to recall the identity of the stimuli before, during, or after the study.

Gender

In addition to examining the effects of task and age on young children's spatial location memory, the present study also investigated the effects of the participants' sex as well as the effects of the gender-stereotype of the stimuli on their performance. Although Hasher and Zacks (1979) did not include these variables in their automaticity theory, it seems reasonable to examine the impact of both the participant's sex and the gender-stereotype of the toys (i.e., animals) have on young children's memory for location, because according to Halpern (1992) the

differences in visual-spatial ability are the largest of the cognitive sex differences. Men have often been found to excel in visual-spatial, mathematical, and mechanical abilities whereas women tend to be superior in verbal fluency, perceptual speed, and spelling (Halpern, 1992; Harshman, Hampson, & Berenbaum, 1983). In particular, men tend to perform better in visual-spatial tasks involving moving, rotating objects in space. However, when investigating memory for static objects, women have been found to outperform men in incidental memory tasks that involve remembering object identity in a naturalistic setting (Eals & Silverman, 1994; Silverman & Eals, 1992), and recalling static object location (Silverman & Eals, 1992). Similar to Silverman and Eals' studies, the present study involved relatively static, three-dimensional objects. According to Eals and Silverman (1994) the female advantage in visual-spatial memory for static objects is due to evolutionary selection processes. Based on the hunter-gatherer theory of evolution this pattern of sex differences reflects our evolutionary history and the different demands placed on males and females over the past millions of years. That is, tracking and killing animals involves different spatial skills than gathering berries. Thus, adaptation would have favored diverse spatial skills between men and women (Eals & Silverman, 1994; Silverman & Eals, 1992).

In a similar study, Cherney and Ryalls (in press) investigated sex differences in adults' incidental memory for object identity and spatial information. Adult participants were asked to wait in a room filled with an equal number of gender-specific objects for two minutes. They were unaware that they would be asked to recall the items in the waiting room. The results of the study showed that,

unlike what Silverman and Eals' (1992) hunter-gatherer hypothesis would predict, overall, men and women recalled an equal number of objects and location of the objects.

Moreover, in a similar study involving young children's incidental memory, Cherney and Ryalls (in press) found that 3- to 6-year-old boys and girls also did not differ in the number of objects they recognized after playing with 18 gender-stereotyped toys in a room for 2 minutes. There was no main effect of sex in toy recall in young children. However, in both the adult and the child studies the researchers found that males and females remembered objects or toys congruent with their sex. That is, males remembered more own-sex stereotyped objects than females, whereas females recalled more own-sex stereotyped objects than males. Also, boys recalled more own-sex stereotyped toys than girls and in turn, girls remembered more own-sex stereotyped toys than boys. These results were congruent with gender-schema theory (Martin & Halverson, 1981; Signorella, Bigler, & Liben, 1997).

For the most part, researchers have not predicted sex differences in young children's spatial memory performance and thus have not designed experiments to test for them. Of the studies that have, many have not found sex differences in young children's location memory performances (e.g., Aliotti & Rajabiun, 1991; Rogoff & Waddell, 1982). Very few studies have shown a female advantage in spatial memory (e.g., Golbeck, 1992; Hale, Miller, & Stevenson, 1968) and those that have found a male advantage (e.g., Jahoda, 1979, 1980; Newcombe 1982) indicate that the male superiority emerges after preschool and only when visual cues

(e.g., pictures) are made available (DeLoache & Brown, 1983). Voyer, Voyer, & Bryden (1995) conducted a meta-analysis of sex differences in spatial ability which included 286 studies. Their report demonstrated that sex differences in spatial abilities favoring males are highly significant with an effect size of 0.37. Although the emergence of sex differences indicated a linear association between age and effect size, with sex differences showing a significant increase with age, these differences were mixed for children younger than 7 years. The source of these sex differences is unclear. In one study, Golbeck (1992) compared the memory for spatial location in 3-4 year old children and kindergarten to second graders. She designed a room to look like a grocery store. The children were instructed to remember the locations of the objects which were either arranged in an organized or an unorganized fashion. The results showed that recall was superior in the organized condition and that 4-year-old girls outperformed their male peers in the verbal recall task. This sex difference may be due to differential interest (McKelvie, 1981) and/or experience (Herrmann, Crawford, & Holdsworth, 1992). Girls may be more familiar with grocery store items than boys and may therefore retrieve the items more efficiently from long-term memory.

These mixed results suggest that it is important to investigate further and control for both the sex of the participant and the stereotype of the stimuli when investigating sex differences in location memory. As Cherney and Ryalls' (in press) studies demonstrated, when one controls for the status of the objects, males and females recall an equal number of stimuli and location information, but they recall

more objects congruent with their own gender. This study included an equal number of male, female, and neutral stereotyped animal toys.

Task Difficulty

Finally, the present study addressed how task difficulty affects children's performance on spatial location tasks. Short-term capacity determines how much can be consciously contemplated at any moment, how many pieces of information can be mentally processed at once. In that sense short-term capacity is attentional capacity. Memory capacity as measured by short-term memory span has been shown to improve with development (see Schneider & Pressley, 1997). Some of the reasons proposed for this developmental increase in short-term memory capacity have been neurological and structural changes, developmental changes in strategies (e.g., rehearsal, chunking, etc.), and speed of processing (see Schneider & Pressley, 1997, for a review). There are several models of memory capacity, three of which are discussed below.

Case, Kurland, & Goldberg (1982) proposed a unitary trade-off model. According to the researchers, an individual's total central processing resources is composed of the sum of the storage space, the capacity people have available for storing information, and of the operating space, the hypothetical amount of space individuals have for executing operations. The model assumes that there is a trade-off between the operating space and the short-term storage space within the total processing space which remains constant across development. According to Case et al. (1982), developmental increases in functional capacity are due to more efficient

processing of stimuli. That is, with increased efficiency speed of processing increases and frees up space for storage of information.

In contrast, Baddeley (1981) conceptualized working memory as a multiple component model. According to this model, working memory is subdivided into three independent components: (1) the central executive is the limited capacity control center of the system where the selection and operation of various control processes and consciousness take place, (2) the articulatory loop stores a limited number of phonologically coded information, and the memory trace decays within 2 seconds unless the material is rehearsed, and (3) the visuospatial scratchpad stores visual and spatial information. Unlike Case et al.'s (1982) unitary trade-off model, there is a central processor (central executive) that allocates additional resources to other subcomponents (articulatory loop and visuospatial scratchpad) where there is memory overload. Evidence for the multicomponent system comes from dual-task procedures where participants are asked to perform a reasoning task and either an articulatory suppression task or a visual-spatial task.

Few studies have investigated the effects of task demands and task difficulty on spatial memory (e.g., Hitch, Halliday, Schaafstal, & Schraagen, 1988; Naveh-Benjamin, 1987). Naveh-Benjamin (1987) investigated young and old adults' spatial memory engaging the participants in a digit-counting task (secondary task) while they were preparing for a test of spatial location of objects (primary task). The load of the secondary task was varied by changing the difficulty of the simultaneous counting task. The results revealed that the heavier the load of the competing task was, the worse the participants performed on the spatial location

task. Hitch et al.'s (1988) investigated immediate memory for drawings of familiar objects in 5- and 10-year-old children. Their set of five experiments revealed that the younger children's visual working memory was unaffected by a concurrent tapping task, suggesting that the children were not engaging in attention-demanding control processes.

A third model proposes that there is a common pool of cognitive resources that is used to perform various tasks that affects children's memory capacity (Kail, 1992, 1997). This pool of resources increases with development due to faster processing speed. In other words, processing speed becomes more rapid with age, thus reflecting changing limits of a hypothesized global mechanism. Consequently, processes responsible for performance on a particular task such as a spatial memory task can be executed more rapidly, resulting in superior performance. In contrast to the three models of short-term memory capacity presented in this paper, Hasher and Zacks (1979) postulated that automatic processes function at a constant level under all circumstances because they drain only minimal energy from our limited-capacity attentional system. That is, Hasher and Zacks' automaticity model predicts that, regardless of task difficulty, individuals in a spatial memory task would perform equally well because automatic processes do not interfere with other ongoing cognitive activity. However, according to Case et al. (1982) and Kail (1992) children's recall of locations should increase with age due to increased processing efficiency (Case et al., 1982) and/or speed (Kail, 1992). In order to ascertain the effects of task difficulty on the children's memory capacity, half of the participants

manipulated the full set of stimuli (high task difficulty) and half of the participants manipulated only half the stimuli (low task difficulty).

Present study

The objective of this study was to investigate developmental changes in the processing of spatial location information in young boys and girls. Similar to other developmental studies, it was in part guided by Hasher and Zacks' (1979) modal theory of automaticity. The present study was designed to examine the ways in which the accuracy of incidental memory for spatial information differs in children of various ages and sex using different procedures. Specifically, the location memory task (1) involved a short-term visual presentation of three-dimensional material, (2) was game-like and, therefore appropriate even for young children, (3) contained separable visual and spatial information, and (4) included a nonverbal response condition. In order to assess the accuracy of the data and to identify possible strategy uses by the participants, each session was videotaped and analyzed.

The purpose of this study was to address five research questions reviewed above: (1) Does the nature of the task affect a child's recall of location information? (2) Are there age differences in young children's spatial memory? (3) Are there sex differences in preschoolers' spatial memory performance? (4) Do gender-stereotyped stimuli (male, female, neutral) affect a child's memory for location? and (5) How does task difficulty influence young children's spatial memory performance? The first two questions were designed to address Hasher and Zacks' (1979) automaticity paradigm, whereas the third and fourth research questions were

intended to examine the influence of gender on spatial memory. Finally, the fifth question was intended to measure the influence of task difficulty on the tasks. To identify whether different tasks would affect a child's spatial memory performance and to avoid a mnemonic advantage for the 5 year-old children, two separate incidental memory conditions were used: the "manipulation condition" (MC) in which the experimenter showed the participant in which space the child was to place a given animal and the "observation condition" (OC) in which the child handed the researcher an animal which was placed in its respective space by the experimenter. In particular, the MC was designed to examine the influence of physical manipulation on the children's recall of location information whereas the OC examined the children's memory for location without the physical manipulation of the toys. If, as Hasher and Zacks (1979) contend, spatial location information is encoded automatically, then spatial memory performance should be equivalent following instructions to place the toy animal in a predetermined cell compared with performance following instructions to watch where the toy animal was placed in the appropriate space by the experimenter. However, if location memory performance for children involves more than differential cues, then the participants should perform differently in each condition.

Furthermore, to examine Hasher and Zacks' (1979) automaticity paradigm, 3- and 5-year-old children participated in this study. This age group was chosen because, a) children below the age of 3 may have had difficulties performing the task, and b) it is around 5 years of age that rudimentary rehearsal strategies appear. If spatial location is encoded automatically and is invariant across age, the children

in this study should perform equally well. That is, there should be no main effect of age. If spatial memory involves some effortful processing older children should perform better.

In addition, the effects of the participants' sex were investigated. If, as Eals and Silverman (1994) would argue, sex differences in location memory for static objects have evolved from the division of labor between men and women, females may remember more locations than males. On the other hand, if the toys are controlled for their stereotype, girls and boys may remember the location of the objects equally well (Cherney & Ryalls, in press). In order to control for the children's possible differential interests, 20 three- and four-year-old children (10 boys and 10 girls) classified the toy animals by gender (male, female, neutral). Because boys and girls differ in their familiarity with certain stereotyped toys, boys may remember more male stereotyped toys than female stereotyped toys and girls may recall more female stereotyped toys than male stereotyped toys.

Finally, in order to examine if task difficulty would influence children's performance in the recall tasks, half of the participants were asked to remember the whole set of animals and half of the participants were instructed to only recall half of the set. That is, in the full task difficulty condition, the children manipulated 18 animals and in the low task difficulty they manipulated only 9 animals. If spatial information is coded automatically as Hasher and Zacks (1979) argue, the task difficulty of the task should not influence the children's performance. Unlike other studies, the present study included a two minute filler task to investigate the children's long-term location memory.

All these variables were included in the present study to allow the examination of interactions and thus to provide a more comprehensive understanding of memory development. Furthermore, with respect to the treatment of the data, most previous studies dealing with memory for spatial location have utilized a single measure for characterizing participants' performance (Naveh-Benjamin, 1987). Previous studies have measured the percentage of objects whose exact position participants have recalled. Although the universal use of a single measure of this nature might be beneficial to compare results across studies, it only provides a limited picture of the participants' performance, because they are being evaluated only on the basis of their precise knowledge about the absolute position (i.e., placing the item in its correct position). Placing an object in any other place except its original position is considered an error. To avoid these limitations, the present study examined not only the children's correct and incorrect placements, but also their contiguous placements and each toy animal they placed on the correct side of the midline of the job box.

Hypotheses

(1) Congruent with previous research which demonstrated that children recall more information when they can manipulate the stimuli and the task is meaningful (e.g., Newman, 1990), it was hypothesized that the children in the MC would perform better than the participants in the OC. That is, because young children's location memory might improve when they can physically place the animals in their spaces themselves, it was predicted that children in the MC would place more animals in the correct location than children in the OC.

(2) Contrary to Hasher and Zacks' (1979) model which predicts that spatial information should be recalled equally well by children independent of their age, it was hypothesized that, based on previous research results (e.g., Aliotti & Rajabiun, 1991; Bjorklund, 1995; Cherney & Ryalls, in press, Dayan & Thomas, 1995; Park & James, 1983; Schumann-Hengsteler, 1992) older children would perform better than younger children. A main effect of age was predicted. Specifically, the 5-year-old children were expected to recall the location of the stimuli better than the 3-year-olds. Because age differences were generally found to be smaller for incidental recall than for deliberate recall (Bjorklund, 1995), the age difference was expected to be small.

(3) Based on Cherney and Ryalls' (in press) findings demonstrating that children recalled an equal number of toys in an incidental memory task when one controlled for the gender of the objects, and contrary to Silverman and Eals' (1992) evolutionary paradigm, it was hypothesized that there would be no main effect of sex. That is, boys and girls would remember an equal number of positions given equal numbers of gender specific toys. Furthermore, based on McKelvie's (1981) differential interest hypothesis it was hypothesized that boys would remember the location for male stereotyped stimuli better than female stereotyped animals whereas girls would recall the location of own-sex stereotyped animals better than other-sex stereotyped toys.

(4) Based on Case et al.'s (1982) and Kail's (1992) models of short-term memory capacity, and because young children's task difficulty and resources are more limited than that of older children (Schneider & Pressley, 1997), it was

predicted that the 3-year-old boys and girls would perform better in the low task difficulty task than in the high task difficulty task. Furthermore, it was hypothesized that the 5-year-old children would perform better in the high task difficulty condition than the 3-year-old children. That is, an interaction between task difficulty and age was expected.

Method

Participants

A total of 103 three- ($M = 39.89$ months; $SD = 3.94$; range: 35 - 47 months) and five-year-old ($M = 64.81$ months; $SD = 3.91$; range: 60 - 71 months) children participated. Seven three year-old boys' results were discarded because they did not finish the session ($n = 2$) or because they did not understand the task ($n = 5$). The final sample consisted of 96 children (24 boys and 24 girls in each age group). Ninety-four percent of the children were Caucasian, 3% African-American, 2% Asian American, and 1% racially mixed. The children were recruited from day-care centers from a mid-sized Midwestern city and were given a prize for their participation.

Materials

A wooden printer's job box (25 1/2" x 17") containing 115 individual spaces was utilized (see Fig. 2-5). The spaces varied in size. All the larger spaces (3" x 3"; 4 1/4" x 3"; 3" x 1 1/2") were situated in the front of the panel and served as "animal cages". They were covered with yellow construction paper to ensure uniformity and to cover possible irregularities within the spaces. There were a total of 26 usable spaces, 12 large square boxes (3" x 3"), one large rectangular box (3"

x 4 1/4") and 13 small rectangular spaces (3" x 1 1/2"). The remaining 89 squares were too small to contain stimuli (1" x 1"). These small spaces were covered in green construction paper. Half of the stimuli were placed in spaces to the left of the midline and half were placed to the right. A total of 18 colored plastic gender-stereotyped animal toys (6 male, 6 female, 6 neutral) were displayed in the "zoo."

In order to examine whether the plastic animals were gender-stereotyped, a pilot study involving 20 (10 girls and 10 boys) three- and four-year-old children from a Midwestern child care center was performed. Three line drawings which depicted girls (female), boys (male), or a combination of girls and boys (neutral) were placed on a table in front of each child. The female experimenter randomly picked one of the 18 animals out of a shoe box and asked each child to help her find out "whether boys, or girls, or both boys and girls would play with that animal." The participants pointed to the corresponding line drawing or said who was most likely to play with each animal. The gender-typed toy classification was based on frequency analyses. Because the animals received differential frequency scores, the six highest scores in each category (male, female, neutral) were considered. As can be seen in Appendix A, the tiger, giraffe, panther, zebra, black bear, and cheetah were considered to represent male animals. The elephant, turtle, anteater, lion, hyena, and panda were classified as female toys, and the remaining 6 animals, the brown bear, bobcat, wolf, shark, frog, and fish were identified as neutral gender-typed toys. Classifications based on the differentials between the female and male frequencies revealed a similar pattern (see Appendix A). Overall, the animals were slightly more male gender-typed than female gender-typed.

Procedures and Design

Each child was tested individually in a quiet room by the same female experimenter and was videotaped. The experiment was presented to the child as a game. The job box (the "zoo cages") was placed on the floor so that the child was able to easily see and access the individual spaces. Each child was asked to sit down on the floor and to look at the "zoo cages". The experimenter pretended to be the "zookeeper who needs help with the animals." At this point, the instructions varied, depending on to which of the two instructional conditions the child was randomly assigned. Half of the children at each developmental level participated in the MC and half of the children were assigned to the OC. Both conditions involved incidental memory, that is, none of the children were told that they would later be asked to remember the location of the animals prior to the time of test or otherwise asked to "study" the animals. In the MC, the children's attention was directed to the location by physically pointing to the space and emphasizing each animal's cage (see below). In contrast, in the OC, the children were only indirectly made aware of each animal's locations by discussing the animals' habitat (see below). In both conditions, the participants observed each space for an equal amount of time. Within each condition, half of the participants were shown all the animals ($n = 18$; high task difficulty) and half of the participants were presented with the reduced set of stimuli ($n = 9$; low task difficulty). For the low task difficulty the male animals included the tiger, giraffe, and zebra; the female animals were the elephant, turtle, and lion; the neutral animals included the brown bear, wolf, and shark. The

procedures remained identical for the participants who were presented the total number of stimuli or only half the array.

Manipulation condition. In the MC, the children were asked to help the "zookeeper" return the animals into their cages. The experimenter instructed the children to place each animal into its own space before the researcher had finished counting to 3. The investigator randomly picked an animal from the shoe box and handed it to the participant. At this point, the experimenter pointed to the animal's cage while saying "This is a (name of the animal). It belongs in THIS cage." Placing all animals into their cages took approximately 180 seconds (18 x 10 seconds) for the full set of stimuli and 90 seconds (9 x 10 seconds) for half the set. As soon as the last animal was placed into its prescribed space, the experimenter asked the participant to return the animals into the shoe box in order to "clean each cage."

Observation condition. In the OC, each child randomly picked animals from the shoe box and handed it to the experimenter before she finished counting to 3. She then showed the animal to the child and placed it into its respective cage saying: "This is a (name of the animal). It lives (e.g., in the jungle, in the woods, etc.)." The placement of each toy took approximately 10 seconds. After 180 or 90 seconds, analogous to the MC, the animals were returned to the shoe box.

During the filler task, a puppet named "Joe" was introduced. "Joe" praised the participants for a "job well done", giving them a choice of animal stickers. The children were then asked by "Joe" to help him find each animal's cage because he needed to return each animal to its own cage to feed them. He further told the participants that he had not seen where the animals' cages were, and therefore

needed their help. After this two minute filler task, each child was given the shoe box to return the animals to their respective cages. "Joe" encouraged the participants to remember the correct location. When participants were unsure where an animal's cage was, they were instructed to guess.

Results

Table 1 lists the means and standard deviations for the derived memory scores for each correct location, each contiguous location, and each correct side. To analyze the results, every correct placement received a score of 3, a score of 2 was given to each placement that was approximately correct (i.e., contiguous), a score of 1 was given to animals placed on the correct side but more than one space apart (left or right) of the job box, and a score of 0 was given for each incorrect placement (i.e. on the wrong side and more than 1 space apart). The way the animal was positioned inside the location was not considered. All derived memory scores for the male, female, and neutral animals were added separately and submitted to a 2 (sex of the participant) x 2 (condition: MC vs. OC) x 2 (age: three vs. five year olds) x 2 (task difficulty: high vs. low) x 3 (gender of animal: male, female, neutral) mixed analysis of variance (ANOVA) with sex, condition, and task difficulty as between-subject factors and gender-stereotype of the animals as repeated measures. Consistent with predictions and contrary to Hasher and Zacks' theory, there was a main effect of age, $F(1,80) = 6.61, p < .05$. Five year-olds ($M = 6.90, SD = 3.24$) had a higher location memory score than three year-olds ($M = 6.00, SD = 2.91$). There was also a main effect of task difficulty, $F(1,80) = 66.08, p < .001$. Overall, the children had a higher location memory raw score when asked

Table 1
Means and (Standard Deviations) of All Correctly Located, Contiguous, Correct Side, and Incorrect Space Placements as a Function of Age, Sex of Participant, and Task Difficulty

Age	Correct Location							
	Boys				Girls			
	LTD		HTD		LTD		HTD	
	MC	OC	MC	OC	MC	OC	MC	OC
	<u>M</u>	<u>M</u>	<u>M</u>	<u>M</u>	<u>M</u>	<u>M</u>	<u>M</u>	<u>M</u>
3	1.50 (0.55)	2.17 (1.94)	2.83 (1.33)	3.50 (3.02)	1.33 (1.86)	2.50 (1.51)	3.17 (1.60)	2.83 (1.83)
5	3.50 (2.35)	2.33 (0.82)	3.17 (1.72)	4.17 (2.71)	3.17 (2.71)	3.00 (2.0)	3.83 (1.72)	5.67 (3.08)
	Contiguous Location							
3	3.50 (1.87)	3.00 (1.41)	4.33 (3.01)	3.17 (1.83)	3.50 (0.84)	3.50 (1.64)	4.50 (1.97)	4.17 (2.14)
5	2.83 (1.72)	4.00 (2.19)	4.00 (1.41)	6.50 (2.66)	2.50 (1.76)	2.67 (1.03)	3.67 (1.51)	5.00 (1.41)
	Correct Side							
3	1.50 (1.22)	1.33 (1.03)	4.17 (1.33)	5.67 (2.80)	1.50 (1.38)	0.83 (1.17)	5.17 (1.47)	4.33 (3.44)
5	1.50 (1.38)	0.83 (0.98)	3.17 (0.75)	2.17 (1.60)	1.00 (1.26)	1.17 (0.98)	4.50 (1.38)	2.67 (1.97)
	Incorrect Location							
3	2.50 (1.22)	2.50 (1.76)	6.67 (2.73)	5.66 (3.14)	2.67 (1.21)	2.17 (1.37)	5.16 (2.71)	6.68 (1.64)
5	1.17 (0.75)	1.84 (1.53)	7.66 (2.34)	5.16 (3.31)	2.33 (1.37)	2.16 (1.33)	6.00 (1.90)	4.66 (1.21)

to do so with 18 stimuli ($M = 7.91$, $SD = 3.23$) than with 9 stimuli ($M = 4.94$, $SD = 2.14$). In addition, there was a main effect of the gender-stereotype of the toy, $F(2,160) = 9.11$, $p < 0.001$. The participants had a significantly higher memory score for male stereotyped animals ($M = 7.08$, $SD = 3.05$) than for female stereotyped animals ($M = 5.62$, $SD = 3.07$) (Tukey's HSD, $p < .05$) and neutral stereotyped animals ($M = 6.58$, $SD = 3.06$) which did not differ significantly from either the male or female memory scores. Contrary to the predictions, there was no interaction between the gender-stereotyped stimuli and the sex of the participants, $F(2,160) = 0.16$, $p = .69$, and no interaction between age and task difficulty, $F(1,80) = 0.082$, $p = .78$. Moreover, there was no main effect of condition, $F(1,80) = 2.26$, $p = .14$. Boys and girls in the MC and OC conditions performed equally (see Table 2 for a summary). In order to examine the influence of task difficulty on the participants' overall performance, a 2 (sex) x 2 (condition) x 2 (age) x 2 (task difficulty) x 3 (gender of animals) analysis of variance (ANOVA) on the percentage correct scores revealed a main effect of task difficulty, $F(1,80) = 16.96$, $p < .001$ with participants in the low task difficulty placing proportionally more objects ($M = 55.06$, $SD = 23.71$) in the correct locations than in the high task difficulty ($M = 43.42$, $SD = 18.36$) (see Fig. 1).

This initial analysis of variance was based on the children's placement of each animal in its physical location (i.e., "cage"). However, to account for the uneven sizes of the "cages," the children's records were reanalyzed to account for the distance between the spaces. That is, instead of only awarding 2 points for the placement of animals that were placed contiguously around the original space,

Table 2

Sex x Age x Condition x Task Difficulty x Gender of Toy Mixed Analysis of Variance (Raw Scores)

<u>Source</u>	<u>F-Value</u>	<u>df</u>	<u>p</u>
Sex	0.16	1	0.69
Age	6.61	1	0.01
Condition	2.26	1	0.14
Task Difficulty	66.08	1	0.0001
Gender of Toy	9.11	2	0.0002
Sex x Gender of Toy	0.66	2	0.94
Age x Task Difficulty	0.82	1	0.78

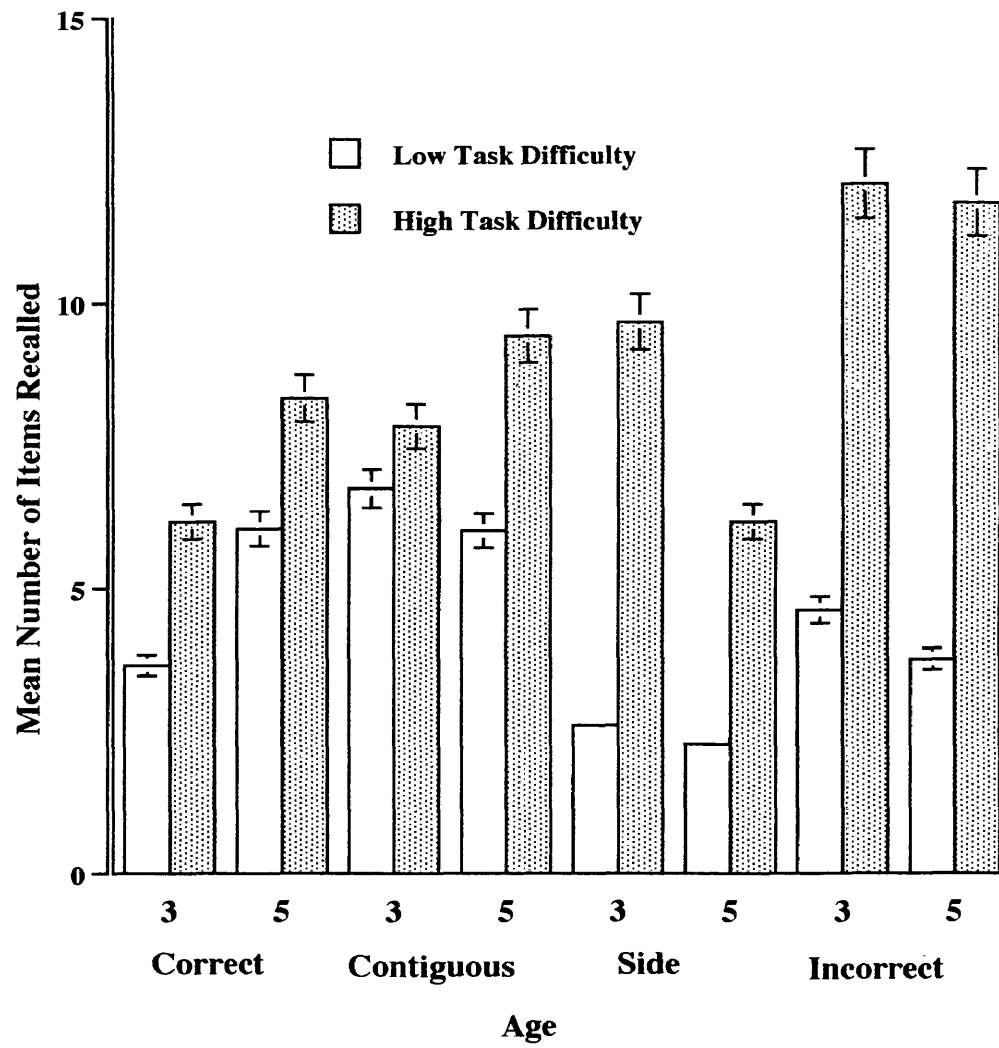


Figure 1

animals that were placed 2 small cages (i.e., two small cages equal the distance of one large space) apart from the original space received a score of 2 in this second analysis. An analysis of variance (ANOVA) with the newly calculated correct raw scores revealed the same main effects as the first analysis. That is, there was a main effect of age, $F(1,80) = 6.78, p < 0.05$, a main effect of task difficulty, $F(1,80) = 75.02, p < 0.001$, and a main effect of gender-stereotype of the animals, $F(2,160) = 8.86, p < 0.001$.

Video analyses. Each participant's videotape recording was analyzed by a trained female experimenter. The sequence in which the child placed the animals in each cage, the participant's hesitations, changes, and speech pertaining to the task were recorded. Another (male) investigator coded 20% of the video analyses. Interrater reliability was 100% on the sequencing of the animals, 95% on the timing of the reconstruction, and 89% on the hesitations, changes, and utterances. The time it took for each child from the moment s/he had picked up an animal to when s/he had placed the last animal in its space was reported for each participant. Across both task difficulty conditions, it took the 3 year-old boys and girls an average of 129 sec ($SD = 61.85$) and the 5 year-olds an average of 116 sec ($SD = 61.70$) to reconstruct the set up, $t(96) = 1.05, ns$. Younger children needed on average a few more seconds to place the animals into their spaces. Independent t tests of the reconstruction time in the high task difficulty condition revealed that boys and girls did not differ significantly in their overall reconstruction time ($M = 168$ sec) with boys ($M = 181$ sec, $SD = 51.20$) taking 25 sec longer to place the 18 stimuli in their space than girls ($M = 156$ sec, $SD = 43.51$), $t(44) = -1.75, ns$. The mean

reconstruction time for half the set of stimuli (low task difficulty) was 76 sec. The boys' ($M = 78$ sec, $SD = 29.77$) and girls' ($M = 74$ sec, $SD = 31.02$) reconstruction times did not differ from one another, $t(44) = -0.359$, *ns*.

In order to assess the participants' recollections of specific items and strategies of the location information, (1) the sequence in which each animal was placed in its cage, (2) the hesitations and (3) the changes the participants had as well as (4) their speech was analyzed separately for each participant. First, in order to examine whether particular animals and/or locations were more salient to the children, the items correctly located within the first 3 trials were tallied for each child. For each of the two task difficulty conditions, there were 2 different counterbalanced configurations (see Figures 2, 3, 4, and 5). Table 3 lists the number of times each animal was correctly placed in a cage within the first 3 trials. The frequency counts for the grand total ($n = 48$ for each task difficulty condition) revealed that, overall, the animal's location that was best remembered was that of the fish. Boys and girls each placed the fish 13 times (54%) in its correct cage in the high task difficulty condition (see Table 3). It was a particularly salient animal when it was placed in a small cage in the upper left corner ($n = 17$ out of a maximum of 24 trials) (see Fig. 3). Another animal's location that was remembered well in the high task difficulty condition was that of the cheetah ($n = 17$ out of 48 trials), with girls placing the cheetah 11 times (46%) in the correct space. It was better recalled when placed in the largest space in the middle left of the job box ($n = 14$) (see Fig. 2). The third best remembered animal toy in the high task difficulty condition was the giraffe ($n = 16$ out of 48), with girls placing it 10 (42%) times in its original

Figure 3 High Task Difficulty Condition (counterbalanced)

Table 3

Frequencies of all Animals Correctly Positioned by Sex and Task DifficultyCondition

<u>Toy Gender</u>	<u>Animals</u>	<u>High Task Difficulty</u>			<u>Low Task Difficulty</u>		
		<u>Boys</u>	<u>Girls</u>	<u>Total</u>	<u>Boys</u>	<u>Girls</u>	<u>Total</u>
<u>Male:</u>	Tiger	3	7	10	14	9	23
	Giraffe	6	10	16	8	6	14
	Zebra	5	3	8	5	8	13
	Bl. Bear	3	2	5			
	Cheetah	6	11	17			
	Panther	0	4	4			
<u>Female:</u>	Elephant	3	0	3	7	7	14
	Turtle	8	4	12	8	3	11
	Lion	1	4	5	7	5	12
	Hyena	1	1	2			
	Panda	4	4	8			
	Anteater	3	6	9			
<u>Neutral:</u>	Br. Bear	3	3	6	3	4	7
	Wolf	2	0	2	3	4	7
	Shark	7	7	14	6	8	14
	Frog	4	6	10			
	Fish	13	13	26			
	Bobcat	3	4	7			

space. As with the cheetah, the giraffe's location was recalled best when it was in the largest space in the middle left of the job box ($\underline{n} = 12$ or 50%). The frequency counts of the low task difficulty condition revealed that, overall, the tiger was placed most often in its correct space ($\underline{n} = 23$ out of 48 trials), with boys placing it 14 times (58%) correctly. The tiger's location was best recalled when it had its original space in the lower right corner ($\underline{n} = 15$ out of 24 trials) (see Fig. 4). The other animals' locations that were also well remembered were those of: the giraffe ($\underline{n} = 14$), the elephant ($\underline{n} = 14$), and the shark ($\underline{n} = 14$). None of these three animals' locations were more salient in either of the counterbalanced tasks. These results suggest that it was the combination of certain animals and their locations that was best recalled rather than the locations or the animals' identity alone.

Frequency counts on the animals' placements were performed for each participant. The results indicated that the animals that were accurately placed tended to be those that the participants positioned in the cages at the beginning of the task regardless of the condition. In other words, 60% of all accurate locations were reconstructed at the beginning of the task. Because the children could randomly pick the animal of their choice from the shoe box, the finding suggests that the participants were more likely to choose the animals whose location they remembered first. This pattern of results is similar to the primacy effect described by Dayan and Thomas (1995). The participants in their study showed the general trend of remembering the first position the best regardless of age.

In addition, hesitations were recorded whenever a child had a toy in his/her hand and was scanning the job box, but did not physically place the animal in a

space. Changes were recorded whenever a child was physically taking an animal s/he had already placed in a cage and moved it to another location. Only the participants' utterances which were relevant to the task were recorded. Two separate 2 (age) x 2 (sex of the participant) ANOVAs with the number of hesitations and the number of changes as dependent variables were performed. For the changes, there was a main effect of age, $F(1,42) = 6.08, p < .05$. Five year-old boys and girls ($M = 2.6, SD = 2.29$) were significantly more likely to change an animal's position than the three year-old boys and girls ($M = 1.29, SD = 0.64$). There was no main effect of age for hesitations. On average, 3 year-old boys had 4.81 hesitations and 1.33 changes whereas same-aged girls produced an average of 4.10 hesitations and 1.25 changes. In contrast, 5 year-old boys had on average 6.63 hesitations and 3.00 changes, while same-aged girls had on average 4.26 hesitations and 2.17 changes. Neither hesitations nor changes seemed to play a significant role in the accuracy of placements on that particular toy. That is, a child's number of hesitations or changes did not result in a correct placement. These hesitations and changes may be an indication of the children's guessing.

A qualitative analysis of the participants' utterances during the reconstruction task indicated that the children in the OC were influenced by the animals' habitat descriptions. For example, a 3 year-old boy in the OC said when placing the brown bear in its correct space that "it came from the woods", and another 3 year-old boy commented how the elephant "lives in the jungle". A 3 year-old girl in the OC compared the locations with that of other animals. For example, while placing the turtle she commented that it was "by the zebra's cage" and the

frog was "in the corner next to the fish pond in the fish's cage". Overall, the children did not talk much about the animals and their speech was unrelated to the accuracy of their reconstruction.

When participants are instructed to position various items into their original locations, they may not only have memory for locations of individual items but they may also have memory for occupied as opposed to unoccupied locations (Puglisi, Park, Smith, & Hill, 1985). This distinction between memory for occupied locations versus memory for specific item location may be important because some evidence suggests that there may be qualitative differences in the encoding of these two aspects of spatial-location information. A 2 (sex) x 2 (age) x 2 (condition) x 2 (difficulty of task) ANOVA on the total number of items positioned in a previously occupied location (occupied location scores) revealed a main effect of condition, $F(1,80) = 4.67, p < .05$. In the high task difficulty condition, 3 year-old boys and girls positioned animals 72% in occupied locations and 28% in unoccupied locations, whereas 5 year-old boys and girls placed 75% in occupied locations versus 25% in unoccupied locations. In other words, both three- and five-year-old children positioned about three fourths of the animals in previously occupied locations and one fourth in previously empty spaces. In the low task difficulty condition, where the number of unoccupied spaces increased from 8 (high task difficulty condition) to 17, three year-olds placed 65% of the animals in the occupied locations versus 35% in unoccupied spaces, whereas 5 year-olds placed 75% in the occupied locations and 25% in the unoccupied locations. That is, in the lower task difficulty condition, 5 year-old boys and girls placed 10% more stimuli

in a previously occupied location than 3 year-old boys and girls. Alternatively, the younger children placed 10% more stimuli in a previously unoccupied location than the older children. The analysis of variance also revealed no main effect of age, $F(1,80) = 2.63$, $p = 0.11$. Both 3- and 5-year-old children placed an equal number of animals into previously occupied locations. This finding suggests that memory for location information may be invariant across age.

Discussion

The purpose of this study was to investigate the impact of age and incidental memory tasks on Hasher and Zacks' (1979) automaticity paradigm for spatial memory, to examine whether boys and girls differ in their recall of spatial information, and to investigate the influence of task difficulty on the children's performance. The findings of previous studies examining Hasher and Zacks' (1979) modal theory of automaticity were inconclusive. That is, some studies found evidence for the automatic encoding of spatial information (e.g., Mandler et al., 1977) and others did not (e.g., Naveh-Benjamin, 1987). The results of this investigation challenge Hasher and Zacks' (1979) suggestion that encoding of spatial location is mediated by an automatic process. The findings of this study are congruent with previous research which has shown age differences in children's performances on spatial memory tasks (e.g., Aliotti & Rajabiun, 1991; Dayan & Thomas, 1994; 1995; Park & James, 1983; Schumann-Hegsteler, 1992). The results indicate that the 5 year-old children were able to reconstruct the spatial array more accurately than the 3 year-old participants. In other words, unlike Hasher and Zacks' contention of age invariance, the findings of this study confirm that

encoding of spatial location information is a function of participants' age. It is important to note that this developmental difference was significant despite the fact that two incidental memory tasks were utilized which, in general, attenuate age differences (Bjorklund, 1995; Newman, 1990). Other studies which found age differences compared participants' performance under intentional and under incidental conditions. In the case of intentional learning, participants pay attention and try to remember the information using various strategies, giving older children an advantage (Bjorklund, 1995). Another problem with the methodology of other studies is their inappropriate use of incidental learning conditions. Most experiments allow the participants a long time to "study" the stimuli. This extended looking time could have elicited strategy use by older children (see Naveh-Benjamin, 1987). In addition, none of the previous studies used a filler task between the learning and testing which could have prevented participants in an intentional task condition from using various organizational and rehearsal strategies. The present study prevented all children from using strategies because both conditions were truly incidental. That is, none of the participants' knew that they would be asked to recall the locations of the stimuli prior to the experiment. Furthermore, their exposure to each location was only 5 sec long. Taken together, the results of this study are at odds with a major criteria suggested by Hasher and Zacks (1979, 1984).

Hasher and Zacks postulated that the sources of automatic processes could be biologically based and develop early in childhood. One could therefore assume that these processes develop after the age of 3, the age of the youngest children in

this study. However, other studies (e.g., Dayan & Thomas, 1995; Hazen & Volk-Hudson, 1984; Schumann-Hengsteler, 1992) have found developmental changes in incidental spatial memory with older age groups.

The results of this study suggest that encoding of spatial location information may be influenced by the number of stimuli presented to young children during a spatial memory task. Automatic processes are assumed to not interfere with the execution of other processes. The finding that children regardless of their age were able to recall a proportionally larger fraction of the locations on the task with less stimuli than on the task with the full stimulus set suggests that some of the encoding processes in spatial memory may involve effortful processing. In other words, an increased task difficulty generated a decrease in the accuracy of spatial location judgments. These results are consistent with those reported by Naveh-Benjamin (1987). In his study undergraduates' accuracy on a spatial location task declined when their cognitive load was increased using a competing task. Schumann-Hengsteler (1992) who manipulated task demand by increasing the information load of her picture reconstruction task from 4 items to 7 items also found a main effect of task demand. In each age group, the mean proportion of correctly positioned stimuli declined with increased task demand. Similar to Naveh-Benjamin's (1987) study, Schumann-Hengsteler (1992) did not include raw scores to ascertain whether her 4 to 10 year-old participants remembered more correct locations in the high task difficulty compared to the low task difficulty. Consistent with the present study, Schumann-Hengsteler's (1992) findings did not reveal a significant interaction between age and task demand. The lack of interaction

between age and task demand suggests that the general pattern of increasing performance with age holds, independent of the growing task demand. In contrast to these studies, Dayan and Thomas (1994) found that task difficulty manipulation (easy and difficult) did not have any effect on the way the participants in their studies remembered the locations. They interpreted their findings as supporting the notion that the accuracy of spatial location is automatically encoded into memory. It is important to note that Dayan and Thomas' (1994) experiments involved the retention of spatial information about movement and that their youngest participants were six-years old. Furthermore, the distinction between easy and task difficulty was one of practice. That is, the participants in the easy memory load group were given the opportunity to practice each exercise until they knew them, whereas the members of the difficult memory load group did not have the opportunity to practice the exercises prior to performing them. These differences in the methodology may account for the differing results. The results of the present study are consistent with the assumption that the encoding of spatial location information may not solely involve automatic processes.

The finding that the two incidental tasks did not differentially affect the children's performance on the reconstruction task may be compatible with Hasher and Zacks' (1979) automaticity hypothesis. Neither incidental memory task required conscious processing of the stimuli and consequently they did not drain resources from the limited-capacity attentional mechanisms. The current results suggest that the process of remembering location information was equally effective under both conditions (see Dayan & Thomas, 1994). There was no difference

between the MC and OC conditions for accuracy of spatial recall, although the conditions seem to have influenced the children's memory for occupied vs. unoccupied locations. The results also suggest that the children paid equal attention to the locations regardless of the study's condition. That is, physically positioning the stimuli into their spaces or merely watching the experimenter place the stimuli into their spaces did not affect their encoding significantly to the extent that they responded equally accurately in both conditions. These results may also be compatible with the instance theory of automaticity (Logan, 1988) which relates automaticity to memorial aspects of attention. The instance theory of automaticity (Logan, 1988) assumes that encoding into memory and retrieval from memory are obligatory, unavoidable consequences of attention. Obligatory encoding and retrieval means that attention to a stimulus or event is sufficient to cause it to be stored and retrieved from memory (Logan, 1998). In other words, encoding and retrieval are linked through attention in that the same act of attention that causes encoding also affects retrieval. The theory also assumes that each stimulus is encoded, stored, and retrieved separately as an instance representation. The instance theory implies that the accumulation of separate episodic traces produce a gradual transition from algorithm-based performance to memory-based performance (Logan, 1988). The obligatory encoding and obligatory retrieval assumptions lead to the predictions that individuals should only encode things they attend to and that they should only retrieve information associated with the stimuli they attend to but not stimuli they fail to attend to. Furthermore, according to Logan (1988), processing is considered automatic only if it relies on retrieval of stored instances

which will occur only after extensive practice in a consistent environment. The present study did not include practice trials prior to testing. Future studies investigating spatial location memory should consider examining the impact of practice on young children's accuracy of recall. Because the instance theory of automaticity is a more recent theory, little developmental research has been done based on its premises.

The finding that there were no sex differences in the memory performance on the spatial memory task when one controlled for the gender-stereotypes of the objects, was congruent with previous studies (see Cherney & Ryalls, in press) even though the stimuli used in this study were not as highly stereotyped as the ones used in previous studies (e.g., Cherney & Ryalls, in press; Signorella, et al, 1997). Although, unlike what was predicted, boys did not remember the location of male gender-stereotyped objects better than that of female or neutral gender-stereotyped objects and girls did not recall the location of female gender-stereotyped objects better than that of male and neutral gender-stereotyped objects, some of the toy animals' positions were recalled better than others. Detailed analyses revealed that it was a combination of certain animals with certain positions in the job box that made the locations more salient. For example, in one configuration, when the tiger was housed in the lower right corner space, the location was recalled twice as well as when the same space was taken by the lion. Future studies may want to use poker chips to reduce the confounding and to identify the impact of the stimulus/location relationship (see Puglisi et al., 1985). Analyses conducted on the occupied/unoccupied locations suggest that the participants in this study positioned

an item in an unoccupied location about a fourth of the time. The findings also suggest that children's memory for occupied location is invariant across age. In particular, these findings suggest that the absolute number of occupied locations identified was affected by memory for the locations of individual objects, which provides a clear example of one component of spatial memory (memory for item location) influencing another component of spatial memory (memory for occupied locations) (Puglisi et al., 1985). The current results are inconsistent with a previous study by Puglisi et al. (1985) who investigated the distinction between memory for location of individual items and memory for occupied location. They found that memory for occupied location was affected by both age and the instructions to study spatial location, suggesting that memory for occupied location is an effortful, nonautomatic process.

Taken together, the present findings raise further doubt regarding automatic and effortful processes of memory as being as distinct as once portrayed. As other researchers have suggested (e.g., Naveh-Benjamin, 1987), it may be more appropriate to view the issue of automatization as a continuum that links automatic and effortful processes in varying degrees. Based on the results of the current experiment it is clear that spatial location information processing is not operating at the extremely automatic end of this continuum. On the other hand, it could also be argued that initial encoding of spatial location information might be automatic, but that other additional elaborate processes may interfere and/or support the initial coding of the information. In conclusion, Hasher and Zacks' (1979) criteria are probably too extreme and too strong to distinguish automatic from nonautomatic

processes. A weaker version of the criteria which incorporates the accumulated empirical data should be considered.

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Appendix A

Total Frequencies Obtained for each Animal (n = 18) and Differential Scores

<u>Animal</u>	<u>Male</u>	<u>Female</u>	<u>Neutral</u>	<u>Differential</u>
Anteater	5	10	5	+5 F
Black Bear	11	5	4	-6 M
Bobcat	5	8	7	+3 F
Brown Bear	8	5	7	-3 M
Cheetah	9	6	5	-3 M
Elephant	6	12	2	+6 F
Fish	8	7	5	-1 M
Frog	8	7	5	-1 M
Giraffe	10	6	4	-4 M
Hyena	5	11	4	+6 F
Lion	8	9	3	+1 F
Panda	7	9	4	+2 F
Panther	11	6	3	-5 M
Shark	6	6	8	0
Tiger	10	5	5	-5 M
Turtle	6	10	4	+4 F
Wolf	8	3	9	-5 M
Zebra	11	6	3	-5 M
Total	142	131	87	