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Research on the development of planning ability has been plagued by a lack of consensus regarding what is, or is not, planning. Haith (1997) has argued that "planning" should not be attributed to a child unless: (1) a goal has been chosen, or at least understood as the specific end-state, (2) there was more than one way of arriving at the particular goal, (3) more than one step is necessary for goal attainment, with options available for how one might progress at each step, and (4) there has been an element of conscious reflection on options for implementing the plan and the likely outcomes of each option.

The present study utilized a task that met all four of Haith's criteria to assess the development of planning in children. It was found that children younger than 5 years of age did not plan their task moves spontaneously, but that 4-year-olds could benefit from planning if prompted to do so, and that the benefits of planning on the first planning task transferred to a second planning task a week later. It was also found that individual differences in planning were related to a measure of general reflectiveness and monitoring.

THE DEVELOPMENT OF PLANNING ABILITY IN CHILDREN: THE ROLE OF META-PLANNING, TRANSFER, AND INDIVIDUAL DIFFERENCES.

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APPROVAL PAGE

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CHAPTER I

INTRODUCTION

Planning Ability

The ability to plan an organized agenda for action or to fulfill some intention may be one of the most important aspects of human higher cognitive functioning. Although planning does not take place in every situation, it is an important part of our everyday lives, whether the task is simple or multi-layered. Clearly, age changes in the ability or propensity to plan would affect functioning in a broad variety of domains. While some consider planning to be the main cognitive factor of intelligent goal-directed behavior, (Das, Kar, & Parrila, 1996), others believe planning to be a separate mental process (Friedman & Scholnick, 1997; Klahr, 1994, Simon, 1975). To be sure, planning is a complex cognitive function that utilizes and influences other cognitive abilities. Despite its importance, the topic of planning by adults has not been thoroughly researched, and the development of planning in children is even less well understood. The purpose of the present study was to address this surprisingly neglected question.

Adult Theories of Planning.

Consideration of planning emerged initially with Miller, Galanter and Pribram, who may have offered the original information-processing model regarding cognition for the analysis of planning ability in humans (Miller, Galanter, & Pribram, 1960). In their classic book, *Plans and the Structure of Behavior*, Miller, Galanter and Pribram (1960) take a cognitive approach to understanding human behavior and describe planning in adults as completing an action that coincides with a scheme. At the outset, an individual must have knowledge of a particular goal they wish to achieve. The process that brings the individual to successful achievement of this goal is through planning by a process known as TOTE. They describe the "TOTE" method, in which an individual **T**ests a goal, **O**perates to reach the goal, **T**ests to see if the goal is met, and **E**xits. In this way, one would imagine the goal that lies ahead of them, and then plan a course of their behavior necessary to complete the task. Next, the individual would attempt to physically follow the predetermined steps to reach the end state, after which it is necessary to determine if the chosen purpose was fulfilled. If so, the action is terminated, if not, the process begins again.

With the TOTE method, planning, it would seem, is a conscious behavior. Mumford and colleagues elaborated on this concept. In their review of the adult literature, they describe their version of planning as "mental simulation of actions and their outcomes" (Mumford, Schultz, & Van Doorn, 2001, p. 214). Further, this mental process would be necessary for planning a first move at the outset, then progressing through more moves to an overall goal. While the previous theories address the conscious component of planning and a possible multi-step process, a number of other general issues are not clearly addressed. One of these issues is whether well-learned behaviors to reach a goal involves must involve planning for success. An example would be making a sandwich. If one has never or rarely made a sandwich, he or she would obviously require many planned and related actions to attain the expected goal. Some say this behavior is not necessary with behaviors and actions that are familiar and practiced.

In devising a working definition of planning, Kreitler and Kreitler (1987) pose a different view than other theorists had previously offered. The authors, with the intent of their theory being less broad than problem-solving and less strict than those theories that require plans be ordered and sequenced at the outset, decided on the notion that planning “is a complex cognitive ability that occurs when no program able to regulate action is available” (p.207). This definition offers that any behavior guided by a program, like a reflex, an instinct, a cultural guided action (e.g., attending church on Sunday), is not a plan but a reaction or an expected outcome that brings about some end. These behaviors may be genetically driven, learned or even unconscious, but they are only actions, and not produced by the individual as a means to progress through steps to a goal. True planning with conscious origins, according to Kreitler and Kreitler (1987) is defined by any behavior specifically created by the individual with the intention of preparation to reach some goal, and the testing of the end state must have involved some real choice or selection.

Considering the possibilities that exist for the requirements of planning by any individual, it would seem necessary to show a conscious selection of a means for reaching a goal. Also, this selection is most likely going to be from a number of choices, possibly routes to the overall goal. If the task is a complex one, this choice may involve a progression that passes through a number of subgoals prior to reaching the final end.

Much of the research on planning ability focuses on how, when and why adults plan, or do not plan, and on the identification of the various cognitive components necessary for successful planning (Mumford, Schultz, & Van Doorn, 2001). Some have proposed that the ability to plan arises only through the combination of certain mental components such as working memory and attention (Friedman & Scholnick, 1997; Mumford et al., 2001). Das and colleagues (Das, Naglieri, & Murphy, 1995) propose a theory of planning ability, based on Luria's (1973) theory. The PASS cognitive processing model, although very much based on a brain structure model, claims that the components that combine to allow for planning are a unit of attention-arousal for selective-attention, a unit of simultaneous and successive processing that receives, analyzes and stores information, and a unit of self-monitoring and problem-solving that, when combined with the previous two components, allows for human planning (see also, Parrila, Das & Dash, 1996). Along with the literature on planning ability and the related mental operations come definitional problems and successive arguments as to what exactly constitutes planning.

Where the idea of planning is somewhat neglected in the adult literature, the concept is underrepresented and lacks cohesion in the child literature. Surprisingly, there is little or no discussion in the adult literature regarding the knowledge of the benefits of planning, and knowledge of the various situations that require planning for an adult individual to be successful. This topic has been raised to some degree in the developmental literature. Issues arise concerning the age when humans are able to successfully plan and exactly how this ability should be evaluated. A trend in the literature over the last two decades is that planning ability is ceded to younger and younger children. It is unclear how much of this research is actually planning, or some other action or intentional behavior.

Development of Planning

In this section, a discussion of the possible implications for generating hypotheses of planning in the general developmental literature will be presented. This will be followed by a review of the relevant empirical studies of planning in children.

Cognitive Developmental Theories.

Piaget. Few of the major cognitive developmental theorists discuss planning specifically. Piaget noted that goal-directed behavior shown by infants in the form of coordination of secondary circular reactions appeared during substage 4 of the sensorimotor period. If one were to take the position that all goal-directed behavior involves planning, then it could be argued that this type of behavior involves planning. However, just because a behavior was goal-directed does not mean that planning was necessary. Accidental outcomes could have just as easily been repeated through trial and error to eventually bring about these types of behavior.

According to Piaget, infants have no representation ability nor do they possess reflective ability. Moreover, equating planning with goal directedness would make the application of the term so broad that it would eventually lose its identity as a distinct process. As well, all but the simplest planful behaviors require backward thinking. Further, mature planning requires reversibility, an ability to look forward in the future to a possible goal and outcome that has yet to happen, and then to work backward to the starting point to determine what subgoals must be overcome to be successful. According to Piaget, the youngest age that children could be successful in planning would be 7 years. For very complex planning involving hypothetical reasoning with different outcomes, a child would not be successful until the formal operations period, when they could engage in self-reflection (Inhelder & Piaget, 1958).

Vygotsky. Vygotsky's social development theory discusses how social interaction affects cognitive development in children. A child's ability to plan could be influenced by the involvement of a parent or a more skilled peer. Vygotsky's zone of proximal development deals with children's problem solving ability on their own compared to what they can accomplish with help from an adult. Children should be more proficient at problem solving when assisted, and the new strategies learned can be useful on subsequent tasks. Through scaffolding, those who are more proficient at a task assist children who cannot successfully solve the problem, moving a child beyond a level of functioning that they could complete on their own. While Vygotsky did not discuss planning specifically, scaffolding could be useful to those children who do not spontaneously plan on problem-solving tasks that require such behavior. In fact, scaffolding probably often involves providing a plan or guiding the child through a plan formed by an adult.

What adults often do when scaffolding is teaching children how to plan on specific tasks. An example of a puzzle would find a child unable to put the pieces in the correct position, but they are able and consciously know to put the pieces on the board. A parent might discuss the next moves with a child, such as looking first for puzzle pieces with right angles, or searching for pieces with the same color. In this manner, one might expect planning ability emerges through cooperative problem solving.

Flavell. One of Flavell's major contributions to the developmental literature is the concept of metacognition. One mental ability that may contribute to the difference between a child who spontaneously plans and one who does not is knowledge about the need to plan, an aspect of metacognitive understanding. Kreutzer and colleagues (Kreutzer, Leonard, & Flavell, 1975) found that it was not until grade 3 and especially in grade 5, that children were planful and self-aware of their metamemory knowledge and understanding. More generally, Flavell (1987) describes that one particular change in the development of the child that might bring about metacognitive ability and understanding is an increase in planfulness by a child. In a sense, it is planful behavior and an understanding of past, present, and future actions and how they are related that brings about meta-knowledge. One would assume that with the rise of metacognition would also be a rise of knowledge about planning, or metaplanning. Flavell claims that metacognitive experiences should arise when it is important that one's decisions are correct, and actions must be closely monitored. This type of behavior would be closely related to and beneficial for successful planning, which might require metaplanning, or thinking about planning.

Empirical Research on the Development of Planning.

The literature on children's planning ability yields an inconsistent picture of the developmental trajectory of planning ability across childhood. One issue that has plagued the field has been the lack of a consistent definition of what does or does not constitute planning. Different studies have explicitly, or implicitly, defined planning in dissimilar ways, and the various tasks that have been used to assess planning in different studies have produced a broad range of estimates of the age at which planning first develops. The tasks that have been the most represented in previous research are the obstacle task, the solution task, and the errand task.

Obstacle Tasks. In a typical obstacle task, children are shown some end state and either must overcome a barrier to the goal or must remedy a glitch in the workings of the task. Bauer, Schwade, Wewerka, and Delaney (1999) tested infants 21 to 27 months of age and assessed their ability to construct a path to a goal previously shown. In this experiment, infants were shown four novel problems and each child had to go through a certain number of steps in order to achieve the goal. The obstacle was getting various pieces or parts to work together in the end-state fashion. For example, with one of the tasks used by Bauer et al., children were given the task of making a simple rattle by placing a wooden block in one half of a plastic barrel and then snapping the item shut with the other half. Children were given the two halves of the barrel and the wooden block. The obstacle that every child had to overcome was that success required that they put the block into the barrel before it was snapped together, otherwise no sound would be made. This problem was completed when the child shook the item.

With each problem, each child was shown the separate components before the experimenter assembled the items, out of sight, and demonstrated the goal-state action to the child. Then the experimenter encouraged the child to make the item. Compared to baseline trials with no demonstration, children's success toward producing some of the steps to the goal went from 8% to 45% of participants. However, these children did not necessarily complete the task. In other words, they completed some of the steps necessary for success, but not all of the steps. Bauer and colleagues do not discuss how many children actually performed the necessary final step considered the "goal" of the task. The researchers claimed that "modest increases in approximation" to the end-goal state showed evidence of planning. Further, comparison of children's performance before being shown the end state of the task and again after being shown the finished product, which showed improvement yet did not always result in completely finishing the task, was given as an indicator of planning. These findings, the authors claim, provide evidence for planning by children 21 to 27 months of age.

Using a different obstacle task, Willatts (1990) also found what was judged to be evidence of planning by infants. In one of several studies, infants were shown a unique toy that was out of reach. The toy was atop a cloth that was within reach, although an obstruction was between the child and the cloth. Planning in this study was shown if an infant could remove the hindrance to obtain a cloth that, when pulled toward the infant, would retrieve a toy. 12-month-olds were able to move an obstacle out of the way, and pull a cloth that brought the toy to them. Willatts (1990) concluded that infants are capable of planning by one year of age.

Studies of children's analogical reasoning (Brown & Kane, 1988, Holyoak, Junn, & Billman, 1984) have also employed what are essentially obstacle tasks. In the study by Holyoak et al., preschool children and fifth and sixth graders were given a task of moving gumballs from one bowl to another bowl. The "obstacle" was that the other bowl was out of reach and children were allowed to use various objects to assist with the transfer. Before attempting the task, participants were told about a genie that faced a similar problem. When preschool children were told that the genie used a magic staff to pull the second bowl to him, they were able to copy this move with an aluminum cane, although half of the subjects needed hints before completing the task. Some children were given the magic carpet story, where the genie used his rolled up carpet as a 'tube' to transfer the jewels/gumballs to the next jar/bowl. The corresponding item that children could use was a piece of paper that, when rolled up, would allow a child to slide items down the tube to the other bowl. Others were given a control scenario, where no story was used. Only one child in each of these conditions was successful. Brown and Kane (1988) used the rolled sheet, or 'tube' portion of the Holyoak et al. (1984) study, and gave preschool and kindergarten children three examples of using a tube to transfer items from one place to another. Brown and Kane (1988) also provided the children with hints, and found that children became more successful on the tube transfer of gumballs across trials. These studies are related to the planning literature in that preschool children did not spontaneously think through the given tasks, and needed hints and 'similar stories' to prompt them into successfully completing problem-solving tasks. While neither Holyoak et al. nor Brown and Kane talked about planning per se, they showed that young children were unable to complete problem-solving tasks with multiple solutions without hints or prompts, whereas the older children (10-and 11-year olds) in the Holyoak et al. study performed like adults.

Solution Tasks. Solution tasks vary, but all include some type of problem solving task as opposed to obtaining a specific goal, toy or item. The classic example is the Tower of Hanoi task. In this task, three disks are placed on top of one another, largest on the bottom, medium sized disk in the middle, smallest disk on the top, on the far-left of three pegs. The goal of the task is for the child to move the discs, one at a time, from the first peg to the third peg without placing a larger disc on top of a smaller one. The 3-disk Tower of Hanoi task is most efficiently completed in seven moves.

Klahr and Robinson (1981) claimed that the correct first move shows planning by the child. On the standard Tower of Hanoi task, they found that 6-year-old children were able to successfully complete the task in the minimum number of seven moves, suggesting that children of this age were planning on this particular game. Preschool children were shown to successfully complete the Tower of Hanoi task when three cans were used in place of the three disks (Klahr & Robinson, 1981). However, it has been found in 6-and 7-year-olds that there is no relationship between completion of the task and the first move made on the Tower of Hanoi task (Fireman, 1996). Therefore, if the first move made is not related to success on the Tower of Hanoi task, children may not be planning prior to starting the task. Children may be using a random order to complete the game, or could also be "learning as they go", and not making plans at the outset.

Another solution task, map reading to a real world scene, requires planning at the outset (Sandberg & Huttenlocher, 2001). In this experiment, only 6-year-old kindergarten children were tested. They demonstrated advance-planning skills by selecting a route to a specified location using a map. Then, the students were asked to recreate the route in the actual setting depicted on the map (a hallway and classroom area in the local high school). It was found that the children could reliably select optimally efficient routes, with 89% of trials using the shortest distance to the goal.

Errand Tasks. The errand task focuses on children's ability to recreate the steps necessary to accomplish some known goal, such as baking a cake or taking a trip. In using their task, Hudson and colleagues (Hudson & Fivush, 1991) distinguished between four "levels" of planning that a child could exhibit:

> Level 0: a plan is basically enacting a familiar and previously completed action. Level 1: single-goal event planning; using generalized event representations (GER), children are capable of planning a previously completed activity, like dressing themselves. Level 2: multiple-goal event planning; plan for multiple goals by, for example, buying usual items for dinner along with food for a party, at the grocery store. Level 3: coordinated event planning; requires the ability to breakdown the order of various events in regard to subgoals, and organize many subgoals from different separate events (Hudson & Fivush, 1991).

Level 0 might involve a child knowing what to do when the teacher says that it is snack time, having had snack time on many previous occasions. Level 1 planning might involve choosing clothes for the day, but be based on activities that will transpire later that day - an early example of future planning. Two events must be taken into consideration for Level 1 planning. At Level 2, the grocery store example is offered, where more than one meal, or other situations are taken into account, along with the trip to the store itself, these being two or more goals that a child would have to keep in mind at one time. Level 3 and higher is planning for multiple, coordinated events with unknown outcomes. Hudson and Fivush (1991) found that preschool children could create and follow through Level 1 plans, and begin to form Level 2 plans. Four and five year olds were able to plan at Level 2. Levels 3 and higher were attributed to adults.

In a study by Hudson, Shapiro, and Sosa, (1995), children were asked to describe either a trip to the beach or the grocery store. Children were assigned to either a script or a plan condition. Each child was given a model example, with the model plan stressing planning and preparation activities, and the model script described standard zoo happenings. In the “model plan” condition, an example of a trip to the zoo was described to the children, to give them an understanding of what the researchers expected of them in their story. The children were then asked to plan a trip to the beach or a trip to the grocery store. The experimenters also prompted the creation of an organized plan by asking “Tell me the first thing you have to do,” followed by, “What do you have to do next.” In the “script” condition, children were given typical zoo events as an example. Then, while talking about a beach trip (or grocery store trip), children were asked “Tell me what happens when you go to the beach (or grocery store),” and then, “Tell me the first thing you do.”

Children were then told about two mishaps and asked to remedy the situation, and then asked to give a plan that would avoid the same problem later. The mishaps were either that they were hungry but had brought no food or that a wave knocked over their sandcastle at the beach, or that they forgot their shopping list or that at checkout they did not have enough money at the grocery store. Using the Hudson and Fivush (1991) levels of planning scale, the results of the research using planned trips to the grocery store or the beach showed three and four year olds were shown to have minimal planning abilities and five year olds were able to plan in tasks with multiple goals (Hudson et al., 1995). Three- and 4-year-olds planned at Level 1, in that they could remedy mishaps, but could not prepare for future problems. Basically, these children used their general event knowledge and gave little in the way of descriptions of plans. Five-year-olds relied less on script knowledge and offered more planning actions in the plan condition. These children were also able to create plans to prevent mishaps, and were credited with planning at Level 2 and 3 on the Hudson and Fivush (1991) planning scale.

A Definition of Planning.

The findings from different studies of the development of planning ability do not paint a clear and coherent picture, in part because of the differing definitions of planning that have been used to guide various research. Partly in response to their lack of consensus about what exactly is, and is not, planning, Haith (1997) proposed that:

> Planning involves selection of a goal or a desired end state. The end state involves more than a simple change in the current state of affairs. For planning to be involved, there must be alternatives for reaching or accomplishing the goal. A decision or decisions must be made among the alternatives, perhaps even priority setting among them. Usually, a multiple-step sequence of alternatives is required for goal accomplishment. There may or may not be subgoals and requirements for adjusting the goals of subgoals. Also, the term planning refers to a process by which an individual thinks about the probable consequences of implementing each alternative and whether it will get him closer to the desired end (pp. 25-26, 1997).

Thus, according to Haith, "planning" should not be attributed to a child unless: (1) a goal has been chosen, or at least understood as the specific end-state, (2) there was more than one way of arriving at the particular goal, (3) more than one step is necessary for goal attainment, with options available for how one might progress at each step, and (4) there has been an element of conscious reflection on options for implementing the plan and the likely outcomes of each option.

None of the tasks used in previous studies meet all the criteria for planning as defined by Haith. With most obstacle tasks, children have no subgoals and need only make one decision about the path they must take to complete the task and reach the goal. Solution tasks may require no planning at all, where a "learn as you go" approach can often be just as successful as conscious planning at the outset. With errand tasks, children who show success must have prior knowledge about the steps involved in attaining a particular goal, with little need for reflection on options or subgoals. Further, one might conceptualize these other developmental studies as being precursors to what Haith calls planning in his definition. This is an open question that research may show or address at a later time.

Haith gives a definition of planning that may be too complex/mature/adult in nature, and that there are behaviors which are precursors to this that are "planful" or that are parts of what Haith calls planning. Although Haith offers a very complete and thorough definition on the concept of planning, it may be too extreme to think that very young children will be able to fully complete all the steps necessary to show planning by his definition.

Also, there are two issues that are not described by the given definition, which may be of concern when Haith's planning is tested with children. Haith makes no mention of language use and ability in relation to his definition of planning. Language use by young children is an overarching ability that has connections to many areas of performance, and planning and the related processes may be affected by language as well. This would seem to be a necessary component of successful planning and its omission may be a detriment to the theory in general.

The other issue pertaining to Haith's definition of planning deals with the idea of subgoals. There is not a standard definition of subgoal in the literature, and Haith does not define the term specifically. The definition of subgoal is a fuzzy concept. Depending on one's level of analysis, almost anything could be a subgoal. If a known goal is to pick up a ball, subgoals could be bending over, extending an arm, and closing fingers around the ball itself. However, for the discussion of planning, for a step along the path to an overall goal to be defined as a subgoal, an individual must have options and must make a conscious choice among the options before proceeding onto the next step. Any move that forces one to make a conscious decision between ways to proceed would be a subgoal. Any move that is just the next in a line of actions required to finish a task that does not require conscious decision among different options is merely a step, and not a subgoal. Haith's definition of planning does not specifically define subgoals, which might prove one limitation to the overall definition.

The Present Study

The present study used a planning game (PG) designed specifically to assess planning as defined by Haith. A picture of the PG shows the game space (see Figure 1). From the starting point, 5 paths extended outward, all ending at different points with different items at the end of each path. At the end of the middle path was a picture of a treasure chest full of gold on a patch of grass, although the grass was separated from the end of the path by a stream. At the end of the other paths were the following items: a key, a flashlight, a boat that was behind a lock, and a bicycle that was behind a lock.

Every step on each of the paths consisted of alternating colored rocks, which a bear had to step on in order to move along any path. Children were told that their bear wanted to get the gold, but that he was unable to swim, and he was not able jump over the river. The children also were told that the boat and bicycle were locked. To complete the game, a child had to move his or her bear down the path to the key, take the key and move back down that path and up the path that took them to the boat. Then, the child had to take the boat down the middle path to the river, use the boat to cross the stream, and then had to retrieve the gold.

This task was used in the present study to address four questions about planning by young children. The first question concerned the age at which children first plan spontaneously. This achievement was measured by the ability to navigate the planning game in the fewest possible moves.

A second question concerned a specific hypothesis regarding the reason why children might fail to plan their moves when playing the planning game. One possible explanation for such a failure is that young children may lack the knowledge that planning is beneficial on a broad variety of tasks. That is, children may lack the metacognitive awareness of the benefits of planning (Flavell, 1971); they may lack what has been called “metaplanning” ability.

Kreitler and Kreitler (1987) examined the development of metaplanning in a study in which they examined what children thought and knew about the idea of planning through conversations and questions. They showed that 9-year-olds understand that planning is necessary for imaginary, future possibilities (e.g., if the house catches on fire), but by age 11 children begin to understand the benefits of planning in their everyday lives (Kreitler & Kreitler, 1987). Five-year olds, in contrast, only showed evidence for an awareness of planning benefits when prompted and when describing the advantage of planning for routine actions.

In order to assess whether children in the present study who failed to plan were suffering from a metaplanning deficit, some children were told, at the outset (before attempting to complete the PG) to think about what steps were necessary to obtain the goal of the game. The children were also asked to say aloud their planned route to the goal before ever moving any pieces on the playing board. If a specific deficit in meta-planning is present in a child, the provision of a metaplanning prompt should result in planning by the child.

Transfer of Planning Knowledge.

The third question of interest for the present study concerned the possible transfer of planning knowledge. If children do perform better on the planning game with a planning prompt, it would also be of interest to determine if the effects of the planning prompt would transfer to another planning task. Accordingly, a second planning game was created, with the same dimensions and general setup as the original game, but with different game pieces. Another benefit of including a second planning game was to examine whether even the children who did not receive the planning prompt (and did not spontaneously plan) might have learned something about the need to plan from playing the first planning game.

Cognitive Correlates of Planning.

The present study also sought to determine the correlates of individual differences in planning ability in young children, as a way of possibly gaining further insight into the factors responsible for developmental change in planning.

Capacity. It is clear that planning is a capacity demanding process, requiring that the planner maintain, in working memory, information regarding the problem goal, the actual problem state, the options available at each choice part, and the relationship between the outcome of each step and goal attainment. Accordingly, it seems reasonable to hypothesize that age-related and individual differences in planning may be related to differences in working memory capacity. In order to assess working memory capacity, the present study utilized the M-Space counting span task developed by Case, Kurland and Goldberg (1982), as well as the Kaufman Assessment Battery for Children (K-ABC) number recall task.

Verbal ability. Verbal ability was also included in the present study as a possible variable related to individual differences in planning. To the extent that a language-based encoding of the task may be important for successful solution planning, individual differences in verbal ability could be related to planning ability in young children. In the present study the Peabody Picture Vocabulary Test, 3rd ed., a measure of receptive language, was used as a measure of verbal ability and general knowledge.

Executive functioning. Executive functioning has been simply defined as the "growing ability to engage in deliberate, goal-directed thought and action, which depends on such processes as selective attention, working memory, and inhibitory control" p. 167-168, (Zelazo, Craik, Booth, 2004). If it is the case that many of the abilities required to plan according to the Haith definition are related to some executive function mechanism, then it would be important to determine the relationship between planning and executive function.

Coordination of the many processes that are necessary to complete a task and reach a goal, with elements of inhibition of actions and behaviors that are unnecessary, is the basis for executive function. At least some part of this is also the essence of planning, where completing a task and reaching a goal is the bulk of planning action, while inhibition is important as well. Goal neglect and lack of execution of a goal would seem to be detriments of immature executive function. It may be this issue that is at the heart of the discussion concerning which children are able to plan, and which children are unable to plan, at least on a task such as the Planning Games 1 and 2.

Also, since subgoals may require planful behavior and the ability to inhibit looking forward to other subgoals or to the overall goal prior to completing the subgoal at hand, an element of task switching is taking place with planning as defined by Haith. The ability to move back and forth between the overall task goal, and the various subgoals that are required along the way would seem to tap into one element of executive function. Since it is still unknown just what the manner of the relationship between planning and executive function is at present, it would be beneficial to include a number of measures of executive function appropriate to the age of children tested to determine if they correlate with the measures of planning used in the study.

For the present study, two separate measures of executive functioning were employed, to assess the relationship of these processes with planning ability. A measure of children's executive function, the night and day Stroop task (Gerstadt, Hong & Diamond, 1994), measures a child's ability to focus attention on the task at hand. Two sheets contain pictures of either a day scene (a sunshine) or a night scene (stars and a moon) in random order. With this task, children completed one congruent sheet of pictures, saying day or night for the picture that the investigator was pointing to. The children were then instructed to say the opposite of what was shown in the picture on a second sheet. This focused attention would be beneficial to a child that must stay on task to an overall goal, while moving through other parts of the game. The day night Stroop task also measures a child's impulsivity, a trait that could be detrimental to planning for future events and outcomes.

The Flexible Item Selection Task was utilized to measure cognitive flexibility. In this task, a set of three cards are presented, and children are first required to pick two cards that matched on some dimension, then to pick two other cards that match on a different dimension. Jaques and Zelazo (2001) measured executive function using the FIST finding that 4-and 5-year-olds were able to match the first set of cards, but only 5-year-olds could match a second set of cards. The FIST was created to measure abstraction and cognitive flexibility, both of which affect task-switching ability, an important aspect of the PG.

CHAPTER II

METHOD

Participants

Sample

The participants were twenty-four 4-year-olds (M = 55.25 months, SD = 3.49 months), twenty-five 5-year-olds (M = 66.56 months, SD = 2.20 months), twenty-seven 6-year-olds (M = 72.22 months, SD = 1.58 months), and twenty-four 7-year-olds (M = 84.25 months, SD = 6.70 months).

Measures

Planning Games 1 & 2. The Planning Games (PG; Figure 1) were measures of planning, as defined by Haith (1997), in school age children. Different items were used in each PG, though the structure of each game was the same. Each PG consisted of 2' X 2' foam board. There was a starting area near the center bottom. From the starting point, five paths extend outward, all ending at different points with different items at the end of each path. At the end of the middle path is the goal, separated from the starting point by some obstacle. At the end of the other paths are the items that will assist the child in reaching the goal. To complete the game, one must choose a certain item, a key for PG-1 or scissors for PG-2, use that item to obtain a second item, a boat for PG-1 or a ladder for PG-2, and use that item to reach the goal. The children were allowed to choose a particular color game piece that they would like to use. Children were also told about the obstacle. PG-1 served to give a baseline score of planning ability, while PG-2 assessed transfer of training of planning ability.

Peabody Picture Vocabulary Test, 3rd edition (PPVT). The PPVT is a measure of receptive language and was used as a measure of verbal ability. On each trial of the PPVT, a label is provided to the participant by the experimenter, and the participant must indicate which picture out of four options best reflects that label.

Kaufman Assessment Battery for Children (K-ABC) Number Recall task. The number recall subtest of the K-ABC assesses forward digit span and is a measure of working memory. In this task, on each trial, the experimenter states a series of numbers, and the participant repeats the numbers in the same sequence. The length of the number sequence increases with each unit of three trials.

M-Space Span Task. The M-space span task is a measure of working memory (Case, Kurland, & Goldberg, 1982). In this task, each level contains three sets of cards. Each card is an index card, 4" X 6" with various numbers of colored dots. On level 1, each set has only 1 card. On level 2, each set has 2 cards, and so on. Children are presented with each set of colored dots on cards in a level. Each child is asked to remember previously learned amounts of these dots shown on earlier cards in the order the sets were seen. Levels increased by one added card per set until the child incorrectly recalled two or more sets in a level.

Flexible Item Selection Task. The Flexible Item Selection Task (FIST; Jacques & Zelazo, 2001) was used to measure executive functioning. In the FIST, children are presented with three cards, two of which can be matched in a certain way, and another set of two that can be matched in a different way (shape, size, color, or number). Children are asked to choose two cards that match. They are then asked to choose two other cards that match in a different way. The number of correct pairings is the child's FIST score, and a time score was kept for each child as well.

Day/Night Stroop Task. The day/night Stroop task was used in the present study as a measure of executive functioning. The task includes two separate sheets with cards of day and night scenes in randomized order. On the first sheet, children are asked to provide the congruent label for each scene (day for day scene, night for night scene). On the second sheet, children are asked to provide the incongruent label for each scene (night for day, day for night). The task is scored in terms of the total time to label all scenes and the number of correct labels.

Procedure

Child participants were tested one-on-one by an experimenter in a private, quiet location and completed all seven tasks listed in the materials section. Each child was tested in two separate sessions. The second session occurred on a separate day within two weeks of the first session. For all participants, the first session included the PG-1, the K-ABC Number Recall Task, the day/night Stroop task, and the PPVT. The second session included the PG-2, the FIST and the M-space span test.

With both planning games, children were asked to sit in front of the game board and select which color game piece they wanted to use. For PG-1, children were told that their bear wanted to get the gold, but that he was unable to swim, and he was not able jump over the river. The children also were told that the boat and bicycle were locked. For PG 2, children were told that their bear wanted to get the honey, but that he was unable to climb the tree. The children also were told that the ladder and hammer were tied down. For half of the children, those in the non-metaplanning condition, they were told to complete the game in as few of moves as possible, as fast as possible, and the stopwatch was begun.

Half of the children at each age were provided metaplanning prompts prior to proceeding with the PG-1 task. No children were provided with metaplanning prompts on PG-2. With half of the subjects, the experimenter told the children to look very closely at the board game, and think about all of the things that they must do to achieve the goal. These instructions served as the metaplanning condition. With the other half of the subjects, the hints were given and the children were allowed to proceed with the game.

As each child participated on the game, number of moves and time to completion were recorded. If a child attempted to make a non-beneficial move on the game (bicycle, flashlight, stool, hammer) they were told that either they did not need that particular item, or that that was incorrect. If a child moved to the overall goal before gaining the requisite items, they were reminded of the problem that they must overcome (water, tree). If a child went to subgoal 2 before going to subgoal 1, they were reminded of the problem at that point (lock, rope).

CHAPTER III

RESULTS

Scoring Procedures

PPVT. The standard procedure for scoring the PPVT, 3rd edition was used. For each participant, the total number of errors was subtracted from the ceiling item to create the participant's raw score. The ceiling item was designated by the last item in the "ceiling set," that is, the set during which the participant made eight or more incorrect responses.

K-ABC Number Recall task. The standard procedure for scoring the K-ABC Number Recall task was used. The Number Recall task was scored by subtracting the errors from the ceiling item to calculate the raw score. The ceiling item was designated by the last number in the ceiling set, which is the set in which the participant missed all items in the set or reached the stopping point for their age as designated by the K-ABC Number Recall task procedure.

M Space Span task. Participants were given an M space span score equal to the highest level during which they were able to recall at least two out of three sets completely, as well as a third of a point for any higher levels where they only correctly recalled all the cards from only one set at that level.

FIST. Participants were given a FIST score equal to the number of pairs they correctly picked from the possible answers. They were also given a time score for the amount of time it took to complete the task.

Day/Night Stroop task. The Stroop score was calculated as the number of correct responses given by the participant. Two Stroop scores were given: one for the number of correct items on each sheet (congruent, incongruent), and a time score indicating duration of the task for each sheet.

Planning Games 1 & 2. Participants received two scores per game. These scores were: 1) number of moves required to complete the game and 2) time to completion. For both scores, higher scores showed less competency on the task. Each participant also received a number-of-moves difference score (number of moves for PG-1 minus number of moves on PG-2), and a time difference score. Thus, each child had six scores total for the two Planning Games.

Gender effects.

A preliminary analysis assessed whether there were gender differences with respect to success on the planning game. There were no significant differences between males and females at any age for the planning game (all $p>.10$). Accordingly, gender was not included as a variable in any further analyses.

Age Differences in Performance on the Planning Game.

Descriptive statistics for time to complete the planning game and number of moves to complete the planning game broken down by age group (Age), session of game

(Game: PG 1, PG 2), and instruction condition (Meta-planning: Meta v. Non-meta) can be seen in Table 1.

Time to Completion on the Planning Game.

A 4 (Age) X 2 (Game) X 2 (Metaplanning) mixed-design ANOVA was performed to assess the effects of these variables on the amount of time to completion of the planning game. There was a significant main effect of Game, $F(1,91) = 17.1$, $p < .001$. Overall, children took less time on PG-2 ($M = 40.03$, $SD = 2.22$) than they did on PG-1 ($M = 54.23$, $SD = 3.41$). There was also a significant main effect of Age $F(3,91) = 6.7$, $p < .001$. A Tukey's post hoc analysis revealed that the 4-year-olds ($M = 63.5$, $SE = 4.6$) took significantly longer to successfully finish the PG than did the 5-year-olds ($M = 43.8$, $SE = 4.7$), $p < .01$, the 6-year-olds ($M = 46.2$, $SE = 4.6$), $p < .025$, and the 7-year-olds ($M = 35.0$, $SE = 4.6$), $p < .001$. The three older age groups did not differ significantly from each other. There was not a statistically significant main effect for the metaplanning manipulation. There were also no statistically significant 2- or 3-way interactions.

Number of Moves.

A 4 (Age) X 2 (Game) X 2 (Meta-Planning) mixed-design ANOVA was also performed to assess the effects of these variables on the number of moves for success on the planning game. There was a significant main effect of Game, $F(1,91) = 4.9$, $p < .05$.; participants used more moves in PG-1 ($M = 3.73$, $SD = .08$) than in PG-2 ($M = 3.51$, $SD = .07$). There was also a main effect of Age, $F(3,91) = 3.5$, $p < .025$. A Tukey's post hoc analysis revealed that the only significant difference among the four age groups was between the 4-year-olds (*M* = 3.9, *SE* = .1) and the 7-year-olds (*M* = 3.4, *SE* = .1), $p < .01$.

There was also a significant Age X Meta-Planning interaction, F(3,91) = 3.9, $p < .025$, and a marginally significant Age X Meta-Planning X Game interaction as well, $F(3,91) = 2.6$, $p = .056$ (see Figure 2).

Because there were ceiling effects with the two older age groups, a second set of ANOVAs was computed comparing just the youngest two age groups. A 2 (Age) X 2 (Game) X 2 (Meta-Planning) mixed-design ANOVA was performed to assess the effects of these variables on the number of moves for success on the PGs. There were no significant main effects. There was, however, a significant Age X Game interaction, $F(1,44) = 4.4$, $p = .041$. Five-year-olds performed similarly from game 1 (*M* = 3.6, *SE* = .2) to game 2 (*M* = 3.6, *SE* = .1), $F(1,23) = 0.1$, $p <1$, whereas the 4-year-olds made significantly more moves in their first game (*M* = 4.3, *SE* = .2) than in their second game (*M* = 3.7, *SE* = .1), $F(1, 23) = 6.2$, $p < .025$. The 4-year-olds in game two did not differ from game two of the 5-year-olds, $F(1,27) = 28.9$, $p < .001$.

There was also a significant Game X Meta-Planning interaction, $F(1,44) = 8.8$, $p < .01$, a significant Age X Meta-Planning interaction, $F(1, 44) = 10.4$, $p < .025$, and a significant Age X Meta-planning X Game interaction (see Figure 3), $F(1,44) = 6.2$, $p < .025$. Overall, these results show that the 4 year old children made significantly more moves when they had not received the meta-planning prompt and were playing the PG for the first time than in any of the other conditions.

First Move.

Table 2 shows percentages by age group for first move on PG 1 and PG 2. Possible first moves included gold (goal), boat (subgoal 2), key (subgoal 1), and other. A Chi Square was performed for each condition (meta, non) for each game (PG 1 & 2) to assess the relationship between first moves made by the 4 year old children compared to first moves made by the older three groups of children combined. For PG 1, Non-meta condition, the analysis revealed a significant interaction between age and nature of the first move, ($\chi2$ (3), N=48) = 16.51, $p < .001$). These results show that the youngest children significantly chose a different, and typically incorrect first move, compared with the older children, on the PG 1 in the non-meta condition.

For the PG 2, the possible first moves included honey (goal), ladder (subgoal 2), scissors (subgoal 1), or other. However, because so few children made some of the possible first moves, all first moves except for the correct first move (subgoal 1) were condensed into a single "other" category. This analysis revealed a significant age difference in the likelihood of a correct first move, ($\chi2$ (1, N=48) = 5.04, $p < .025$). These results show that significantly more 4-year-old children chose an incorrect first move on the PG 2 in the non-meta condition compared with the 5-, 6-, and 7-year-olds.

Individual Differences

Table 3 shows means and standard deviations by age groups for the individual difference measures. Table 4 contains simple correlations between age (in months), PPVT scores, K-ABC scores, M-space scores, Stroop congruent scores, Stroop congruent time, Stroop incongruent scores, Stroop incongruent time, FIST scores, and FIST time. Correlations for these individual difference measures with Age partialled out also appear in Table 4 under the diagonal.

Because the previous analyses revealed that there were few age differences in performance on the planning game beyond age 5, and because children 5 years of age and older performed near ceiling in terms of number of moves, the analyses of relationships between planning game performance and the individual difference measures focused on the two youngest age groups. Table 5 presents these correlations of the planning game measures and individual difference measures for the youngest two age groups only, along with partial correlations with Age partialled out (in parentheses). There were significant correlations between the PPVT scores and the number of moves for PG-1, $r(47) = -.41$, $p < .01$, the time to complete PG-1, $r(47) = -.41$, $p < .01$, the time to complete PG-2, $r(46) = -.46$, $p < .001$, and the difference in moves from PG-1 to PG-2, $r(46) = -.30$, $p < .05$. When age was partialled out however, the only correlation with the PPVT that remained significant was the PPVT scores with the time to complete PG-2, $r(40) = -.35$, $p < .05$. There were also significant correlations between the scores on the K-ABC task and time to complete PG-1, $r(46) = -.34$, $p < .05$, and time to complete PG-2, $r(45) = -.35$, $p < .05$. No planning measures remained significant with the K-ABC when age was partialled out.

There was a significant correlation between the M-Space task scores and time to complete PG-2, $r(46) = -.38$, $p < .01$, though this correlation did not remain significant when age was partialled out. For the Day/Night Stroop task, the only correlations found with planning game measures included a correlation with number of moves needed in

PG-1 with time to complete Stroop congruent task, $r(45) = .31$, $p < .05$, and time to complete Stroop task 2, $r(45) = .36$, $p < .05$. For significant correlations between the FIST and the planning game measures, there were significant correlations between the FIST number correct score and the time to complete PG-2, $r(46) = -.29$, $p < .05$, the time to complete the FIST and the time to complete PG-2, $r(46) = .39$, $p < .01$, and the time to complete the FIST and the difference in time scores of PG-1 and PG-2, $r(46) = -.30$, $p < .05$. When age was partialled out, the correlation between the FIST number correct score was no longer significantly related to the PG-2 time, but it was correlated with the difference in number of moves from PG-1 to PG-2, $r(40) = .34$, $p < .05$, which had not been significantly correlated before age was partialled out. The correlations between the FIST time score remained significantly related to the PG-2 time score, $r(40) = .32$, $p < .05$, and the difference score for times between the two games, $r(40) = -.32$, $p < .05$.

Because children ages 5 years and older performed near or at ceiling, the correlations of planning game measures and individual difference measures were analyzed for just the youngest age group (see Table 6). In this analysis, the only individual difference measure that was significantly correlated with planning game measures was the Day/Night Stroop task.

As shown in Table 6, the number of moves to complete PG 1 showed a marginally significant relationship with PPVT, $r(14) = -.51$, $p < .065$. Also, the number of moves to complete PG 1 was significantly correlated with number correct in the Stroop congruent condition, $r(14) = -.60$, $p < .025$, and in the Stroop incongruent condition,

$r(14) = .81$, $p < .001$, and with the time needed to complete the Stroop task in the incongruent condition, $r(14) = .61$, $p < .025$.

CHAPTER IV

DISCUSSION

Haith (1997) describes planning as a goal-state event in which an individual has to arrive at an overall goal after progressing through various steps prior to completion of the task. Haith further argued that at each step, some option must be available for planning to be required. Typically, there are two or more steps, or subgoals, before reaching the selected goal, and planning involves thinking about the probable consequences of each move required for success. Haith also argued that planning involves conscious reflection on these options and their outcomes, rather than involving automatic decisions.

The primary purpose of the present study was to investigate the developmental trajectory of planning in young children utilizing a task designed to correspond to Haith's definition. The task measured whether or not a child could plan spontaneously. It was found that children younger than 5 years of age did not plan on their own initiative. In contrast, the children 5 years of age and older exhibited clear evidence of spontaneous planning.

With the task used in the present study, the fewest number of moves necessary for success was three. For example, with the PG 1, a child would have to move the game piece first to the location of the key. Next, the key would have to be taken to the location of the boat to remove the lock. Last, the boat had to be taken to the river, across which the treasure was located.

Five-, 6- and 7-year-olds all completed the PG-1 in approximately 3.5 moves, and no significant differences were found between these age groups in number of moves. These results compare favorably to the theoretically minimum number of moves required to complete the task. Clearly, children of these ages did engage in systematic planning. In contrast, 4-year-olds in the non-meta condition required about five moves to complete the PG-1, suggesting little if any planning on their part.

The conclusion that children 5 years of age and older engaged in planning whereas 4-year-olds did not is further supported by the analysis of each participants first move. Older children often made the correct first move to subgoal 1 (key). Even in the cases in which these children did not make the correct first move, they often engaged in some planning, going first to the subgoal 2 (boat) location. In contrast, 4-year-olds in the non-meta condition most likely made a first move directly to the overall goal (gold) or made a non-productive move toward an unnecessary item rather than a move toward either of the subgoals.

A typical pattern of moves shown by 4-year-olds in the non-meta condition was to progress from the starting point straight to the river and overall goal (first move). Only when they realized that the path was blocked did they move down another path to obtain the boat (second move). Then, when they realized the boat was locked, the children had to move to get the key (third move). Once they had the key, they could then return to the boat (fourth move). When the children had the boat, they could finally move to the river and the gold (fifth move). Following this set of steps would produce a five-step solution to the game. As shown in Table 1, 4-year-olds in the non-meta condition averaged five moves on the game, suggesting that they did not engage in spontaneous planning.

The results of the present study contrast with much of the literature on planning in children. Bauer, Schwade, Wewerka, and Delaney (1999) claimed that 2-year-olds show planning with obstacle-type tasks. However, the task used in their study had no apparent subgoals, and while children did show improvement in the task after demonstrations of the end-state, not all children at this age completed the task. A similar argument can be made for the obstacle task used by Willatts (1990), in which planning is attributed to 1-year-olds.

The present findings are much more consistent with Sandberg and Huttenlocher, (2001), who looked specifically at 6 year old children's planning ability on a map reading skills task and claimed that kindergartners at this age demonstrated advance-planning skills. The task used by Sandberg and Huttenlocher incorporated many of the planning task requirements discussed by Haith. In particular there were subgoals and options at each choice point. Following the shortest distance to the goal in the Sandberg and Huttenlocher study is similar to the least moves to the goal on the PG.

One implication of the findings is that there may be degrees of planning. Some children showed evidence of planning, but did not do so perfectly, completely, or in the most direct manner. Some children seemed not to plan until after they made an incorrect first step. This was especially evident with the 4 year olds.

A child could, by chance, make the correct first move on the task, and then, at that point, realize the value of the key, and maneuver to the boat, and then to the gold. However, there are many options at the starting point of the game, with the chance of 1 in 5 of going to the right spot. However, the most common error was going directly to the overall goal, with the next most common error being going directly toward the boat. there is a low probability that a child might accidentally make the correct first move, then without planning or conscious decision, correctly choose the next two moves to complete the task. There is actually little evidence of trial and error on the tasks.

A combination of trial and error and/or partial planning could have resulted in a good if not perfect performance on the task. Some children did attempt to go directly to the 2nd subgoal, going to the boat first. Although these children did not show complete planning at the outset, this behavior may be interpreted as partial planning, suggesting it may not be appropriate to think of planning as an all or none process. 3 moves was perfect, 4 was to the boat first, which could have been development of a plan for getting the boat, as the overall goal was blocked by water.

A 5 step progression typically included a child going straight to the gold, 1st move, then going to the boat, 2nd move, then going back to the key, 3rd move, going back to the boat, 4th move, and then progressing to the gold, 5th move. In theory, yes, a child could have done the 3 required steps entirely by chance, but the move progression above suggests the children didn’t understand the goal of the game and the requirements of the task.

A second question of interest in the present study concerned the reason why young children failed to spontaneously plan. One obvious possibility is that the 4-year-olds were incapable of effective planning on the kind of task used here. An alternative possibility is that the children could plan, but did not do so spontaneously because they did not realize that planning would be an effective strategy to help to solve the task efficiently. To assess this issue, half of the children were given a meta-prompt prior to playing PG-1. For older children, there was no effect of the meta-prompt on performance, providing further support for the conclusion that they were planning spontaneously in the non-prompt condition. For the 4-year-olds, in contrast, a significant difference was found between children in the two conditions. Children receiving a meta-prompt on PG-1 needed fewer moves than did children who got no meta-prompt on the first game; children in the meta-prompt condition needed, on average, fewer than 3.5 moves to complete the game, where those in the non meta-prompt condition needed close to five moves to finish the task.

The conclusion that 4-year-olds in the meta-prompt condition engaged in planning whereas 4-year-olds in the non meta-prompt condition did not is further supported by the analysis of each participant's first move. Meta-prompt condition children often made the correct first move to subgoal 1 (key). Even in the cases in which these children did not make the correct first move, they often engaged in some planning, going first to the subgoal 2 (boat) location, with very few children making a first move toward the overall goal (gold) or to a non-productive location. In contrast, the most common first move of children in the non-meta condition were to move directly to the overall goal or to make a non-productive move toward an unnecessary item, with few children making a first move to either subgoal. When given the meta-prompt, 4-year-olds did not differ from the older age groups.

These findings suggest that 4-year-olds can plan when prompted to do so, but apparently were unaware of the benefits that would be produced by planning, or did not think about planning as an effective strategy prior to making their first move on the task. In other words, they exhibited a meta-planning deficiency.

An alternative possible explanation for the effects of the meta-planning effects is that they may have served simply as a delay mechanism. That is, rather than serving as a cue to the benefits of planning, the hints may have simply served to prevent the children from impulsively making their first move. The hints may have made the task requirements more salient or forced children to take the task more seriously. The findings regarding performance on PG 1 are insufficient to delineate which of the possibilities is correct. However, the fact that children transferred the benefit of the meta-planning hints to PG 2 argues in favor of the view that the hints did, in fact, induce conscious awareness of the children's part of the benefits of planning.

It is important to note that although 4-year-olds in the meta condition needed far fewer moves to complete PG 1 than did the same age children in the non meta-prompt condition, both groups of children needed more time to complete the game compared with the 5-, 6-, and 7-year olds. A meta-planning prompt is beneficial to the youngest children where number of moves is concerned, but this suggestion made only a minor difference on a measure of speed of task completion. These results suggest that 4-year-old children were not as efficient as their older counterparts on the task in both conditions of PG 1.

The third question of interest in the present study concerned the possible transfer of planning knowledge. In the present study, children were presented a second game similar to the first. However, no meta-prompts were provided to any of the children in any age group on the second game.

For the older children, the number of moves needed to complete the PG 2 did not differ significantly from those necessary to complete PG 1. In contrast, it was found that the 4-year-old children performed much better on the second PG than had the 4-year-olds on PG 1 in the non-meta condition. These findings suggest that the 4-year-olds transferred the knowledge that they had gained playing PG 1 to their use of planning on PG 2.

Further support for the conclusion that 4-year-olds were able to transfer planning knowledge to a second game comes from analysis of each participant’s first move on PG 2. In comparison with children in the no-prompt condition of PG 1, 4-year-olds were more likely to make either the correct first move toward subgoal 1 (scissors) or made their first move to subgoal 2 (ladder) when playing PG 2. Moreover, no 4-year-old attempted to go to the overall goal on his or her first move when playing PG 2.

When comparing performance across age with PG 2, no significant age-related differences were found with respect to number of moves. However, as was found with PG 1, even when the 4-year-olds solved the task in the same number of moves as did the older children, they were much slower than were the older children.

It is important to note that the patterns of performance described above for the 4-year-olds held true both for children who had received the meta-planning prompt when playing PG 1 and for children who had not received that prompt. Apparently, even children who did not receive the meta-prompt hint on PG 1 gained something in the way of knowledge or understanding about the benefits of planning from their experience in playing PG 1, knowledge that transferred to PG 2. One possible problem with the transfer of planning performance is that the games were not counterbalanced. PG 1 was always given first, PG 2 always followed.

These findings raise questions about just what was transferred from the first to the second PG. The most specific, low level, possibility would be that children were transferring an exact pattern of moves. This possibility can be ruled out because the board layout required that there were different game pieces for PG 2 and the pieces were set up in a different configuration from that of PG 1. The highest, most general level possibility is that what children transferred was a general understanding of the benefits of planning. A third possibility is that the 4-year-old children learned, and transferred, the knowledge that planning is beneficial on tasks very similar to PG 1. Because the present study utilized a transfer task that was very similar to PG 1, we are unable to determine which of the latter two possibilities is correct. Future studies should examine a far transfer to a different task to assess the generality of the knowledge that was transferred.

Finally, the present study also examined several possible predictors of individual and developmental change in planning. A number of measures correlated with measures of planning game performance with age left in the analysis, but when age was partialled out, very few of the measures of individual difference remained significantly correlated with planning game performance.

Because few changes in performance were found after 5 years of age, the most illuminating analyses of individual difference focused on the youngest age group. When the analyses of individual differences are reduced to only the youngest age group, the only significant correlations with planning game performance involved performance on the day/night Stroop task. Surprisingly, a relationship with planning game performance was found in both the congruent and non-congruent Stroop task conditions. Specifically, children who made more mistakes on the congruent Stroop task needed more moves to complete PG 1. Children who took more moves on PG 1 also needed more time to complete the incongruent Stroop task. One possible interpretation of these findings is that the Stroop task in general may be tapping into the degree to which the young children were reflective rather than impulsive (Kagen, Rosman, Day, Albert, & Phillips, 1964).

Kagan and colleagues make a distinction between children who respond more slowly and accurately on cognitive tasks, reflective, and those who make rapid responses, often with many errors, impulsive. It was even suggested that impulsive children may employ less sophisticated strategies during problem-solving tasks, and at the least, are less efficient on information processing tasks compared with reflective children, (Kagan, et al, 1964).

A child's cognitive style, reflective or impulsive, could relate to performance on the day/night Stroop task, as well as the planning games. It would follow that impulsive children would make more mistakes on the congruent Stroop task, and would also have a harder time with planning, hence more moves on the PG-1. the same children needed more time to complete the incongruent Stroop task, likely due to having to go back and change answers that were incorrect. The present individual difference results point to a possible connection between planning and monitoring ability in young children. The monitoring ability is evident with the children who received meta-planning prompts, and who were able to perform much like older children, where those children who did not receive such prompts showed little ability to monitor their moves on the planning game. This is also backed up by the finding that children who showed some measure of reflectiveness, as seen in the Stroop task, made fewer mistakes.

One general question raised by the present findings concerns the best way to characterize the deficiency exhibited by the young children who failed to plan spontaneously on the first planning game task. In order to address this question, it may be useful to think about planning as a strategy for finding the most efficient way to solve a problem. Research on children's use of memorization and other forms of problem-solving strategies has identified three types of strategy use deficiencies (Flavell, Miller, & Miller, 2002).

The most basic of these deficiencies is a mediation deficiency (Flavell, 1970); a child is said to have a mediation deficiency if he is simply not capable of executing a strategy. In the case the use of planning as a strategy for selecting the optimum solution to the planning game used in the present study, a mediation deficiency would characterize children who were not capable of thinking backward from the goal in order to appropriately select the correct path at earlier points in the game. The findings from the present study suggest, however, that even the youngest children should not be characterized as mediationally deficient in their use of a planning strategy. When the children were prompted to reflect on the goal and the requirements for reaching the goal prior to making their first move, even the 4-year-olds showed evidence of some degree of planning.

This pattern of results suggests the presence of a production, rather than a mediational, deficiency. A child is said to have a production deficiency for a particular strategy if he fails to produce the strategy spontaneously for reasons other than a sheer inability to execute the strategy (Flavell, 1970). Research on children's use of memory strategies has identified a lack of knowledge regarding the benefits of different memory strategies as a major contributor to memory strategy production deficiencies (Flavell & Wellman, 1977). The finding that 4-year-olds in the present study engaged in planning when prompted to think about the task suggests a similar explanation for their failure to plan spontaneously. That is, the present findings suggest that a major contributor to the failure of the four-year-olds to plan spontaneously may be a lack of knowledge on their part of the importance of planning and of the benefits to be derived from planning (Kreitler & Kreitler, 1987).

The present findings also provide some evidence for the third kind of deficiency, a utilization deficiency. A utilization deficiency is said to be present in cases in which a younger child utilizes a strategy spontaneously, but does not execute the strategy in such a manner that maximal benefit is derived from strategy use or makes use of the strategy in a less efficient manner than is the case with older children (Bjorklund, Miller, Coyle, & Slawinski, 1997; Miller, 2000). In the present study, even though no planning-related prompts were provided when the children played the second planning game, the four-year-olds in both conditions planned their moves. However, the children at this age required much more time than did older children to plan their moves. Thus, although the 4-year-olds were capable of planning their moves and executing their plan accurately, they were also significantly less efficient at planning than were the older children.

The current findings regarding children's planning may also map well onto Zelazo's Cognitive Complexity and Control Theory (Frye, D., Zelazo, P.D., Burack, J.,1998). According to Zelazo, where executive functioning and planning is concerned, children's plans for any goal correspond to rules. These "if then" rules are at different levels of embedidness in a child's knowledge and understanding. Once a child is able to reflect on the rules they know and understand, they will then be able to compare these rules with other rules, and lower level rules will eventually come to be embedded them under higher order rules (Zelazo, P.D., & Frye, D., 1998).

Zelazo uses the example "if I see a mailbox, then I need to mail this letter" to represent a lower order "if then" rule that will allow for planning. A higher order rule that includes this low order rule would be "if it is before 5pm, and if I see a mailbox, then I need to mail this letter" is only possible if a child can represent and understand the lower order rule. In the planning game, if a child knows the rule that to cross a river, I will need a boat, this rule will correspond to a single low level of planning. If a child cannot represent this rule, then he or she will be unable to comprehend the rule of needing a key to open a lock to get a boat.

Zelazo says that 3-year-olds can handle non embedded rules, but it is not until 5-years that children are able to reflect on higher order rules, with 2 or more rules embedded in them. By most straight forward analysis, the ability to establish sub-goal to sub-goal to a desired outcome would arise around 5 years of age. This result was found in the present study, where 5-year-olds were able to plan to reach an overall goal, passing through two sub-goals in the process. If the PG were to be changed to only include a two step planning process, just boat and gold, the task should prove to be diminished to the ability of 4-year-olds. To make the game more complex and to raise the ceiling of performance for older children, it might be necessary to add a second final path to the overall goal, bringing in another possible route and a further rule that must be taken into consideration prior to completion of the overall goal.

The characterization of the young children who failed to plan spontaneously as exhibiting a production deficiency fits well with the findings from the individual differences analyses suggesting that children who were relatively more reflective were more likely to plan that were children who were relatively impulsive. One of the obvious consequences of impulsiveness is that one acts without reflecting fully on the outcomes of one's action or on alternatives to the first action considered. Thus, impulsiveness might be expected to delay the process of learning about the benefits of planning, as well as decreasing the likelihood that meta-planning knowledge will be referenced prior to enacting a goal-directed course of action. It is noteworthy that in this context that a study by August (1987) showed that hyperactive boys demonstrate production deficiencies in recall. Hyperactive boys were shown to be able to use a strategy in free recall, but failed to spontaneously utilize the strategy to complete the task.

Limitations

As with any study, a small number of issues did arise that might pose limitations to the discussion of the results of the present research. One possible problem with the transfer of planning performance is that the games were not counterbalanced. PG 1 was always given first, PG 2 always followed. At an even more general level, the similarity of the two games may have allowed for ease of performance and ceiling effects for older children and for all subjects on PG 2.

One of the planning games may have provided more salient support for the children to complete the task. Having counterbalanced which game children were given on their first trial would have allowed for analysis of this information. If it were the case that game 2 was easier than game 1, there is the possibility that the transfer effect could have been a task difference effect.

Game 2 was quite similar to game 1, and we cannot determine exactly what knowledge transfers in children about planning between the two games. The question of just what was learned and transferred by the children in the study is further argued in the discussion under study question three.

The FIST may not be an appropriate measure of executive function for children of this age, or should be modified further. Much of the data collected with the FIST showed that many of the children were at ceiling on this task.

The Stroop task was not sensitive enough a measure of executive function or impulsivity, and could have benefited from single items, not all items on a page (i.e. – separate cards, not one page for congruent and another page for incongruent).

A more direct measure of reflectivity/impulsivity is necessary. Possible measures are Matching Familiar Figures Test (MFFT), the Wisconsin Card Sorting Task (WCST), and the Reinforcement of low rate responding (DRL).

Future Directions

The paper has been changed to reflect the following discussion of future directions in children's planning using the Haith (1997) definition. At the outset, a very obvious next step and follow-up to the present study is to run another study with a different game 2. This is the best option for a future direction to my research project. Due to the similarities of the two planning games, it would be useful to use a far transfer task in place of PG 2. An obvious choice for another measure of planning would be the Tower of Hanoi. This would allow for two separate measures of planning, and a better understanding of exactly what transferred from one game to the next could be determined. The age-appropriateness of the task would have to be taken into consideration, since it was the youngest children in the present study that showed the largest change with the meta-prompt, and a similar and as effective prompt would have to be created for whatever far transfer planning game was selected.

Summary

The purpose of the present study was to gain a better understanding of the development of planning in young children. It was found that 4-year-old children were able to plan in a fashion similar to older children but did not engage in this type of behavior spontaneously. The youngest age group of children needed some type of meta prompt to engage in planning on a level with older children. The present study should serve to clarify the developmental planning literature, with a more complete definition to guide further research. The research was conducted using a planning task that corresponded to Haith's 1997 definition of planning. Although it seems that the requirements of Haith's definition give the best indication of mature planning, there seems to be some level of planfulness below the minimum requirements for planning proposed by Haith. While Haith discusses the "process by which an individual thinks about the probable consequences of implementing each alternative and whether it will get him closer to the desired end" (p. 26, 1997), he does not specifically describe meta-planning as a prerequisite for his version of planning. Meta-planning is required for successful planning, according to the present study, and is an addendum to Haith's original definition. Based on the findings of the present study, it can be argued that Haith's definition is describing mature or adult planning, although some level of planfulness is possible at a level below what is required to be called planning, according to Haith.

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APPENDIX. TABLES AND FIGURES

Table 1

Means (and Standard Deviations) by Age Group for Planning Game Measures, Separated by Non-Meta and Meta Conditions

		4-year-olds	**5-year-olds**	**6-year-olds**	**7-year-olds**
Planning Game - 1					
Moves	Non	4.86 (.86)	3.44 (.63)	3.78 (.83)	3.46 (.52)
	Meta	3.40 (.52)	3.67 (.87)	3.94 (1.16)	3.27 (.47)
Time	Non	83.64 (36.67)	45.44 (23.50)	65.67 (68.28)	45.23 (23.08)
	Meta	61.90 (31.73)	52.44 (29.83)	47.44 (24.94)	32.27 (16.67)
Planning Game - 2					
Moves	Non	3.79 (.58)	3.47 (.52)	3.33 (.50)	3.46 (1.13)
	Meta	3.60 (.58)	3.78 (.83)	3.39 (.61)	3.27 (.65)
Time	Non	57.07 (25.24)	36.27 (16.40)	34.56 (17.22)	31.85 (27.56)
	Meta	51.50 (27.52)	41.33 (18.34)	36.94 (17.44)	30.73 (19.17)

Table 2

Percentages by Age Group for First Move on Planning Games 1 & 2

	Gold (Goal)	**Boat** (Subgoal 2)	**Key** (Subgoal 1)	**Other**
Planning Game - 1				
Non-Meta				
4 y.o.	36	21	7	36
5,6,7 y.o.	6	26	59	9
Meta				
4 y.o.	10	20	60	10
5,6,7 y.o.	0	18	59	23

	Honey (Goal)	**Ladder** (Subgoal 2)	**Scissors** (Subgoal 1)	**Other**
Planning Game - 2				
Non-Meta				
4 y.o.	0	64	36	0
5,6,7 y.o.	0	24	71	6
Meta				
4 y.o.	0	40	50	10
5,6,7 y.o.	0	17	74	9

Goal: third and final step required to complete game
Subgoal 2: step required to move to overall goal
Subgoal 3: correct first step, required to move to subgoal 2

Table 3

Means (and Standard Deviations) by Age Group for Individual Difference Measures

	4-year-olds	5-year-olds	6-year-olds	7-year-olds
PPVT	70.96 (11.86)	86.16 (12.43)	94.64 (15.92)	110.13 (16.60)
K-ABC	6.46 (1.14)	8.25 (2.07)	9.00 (2.22)	9.13 (1.96)
M-Space	1.13 (.48)	1.76 (.65)	1.95 (.76)	2.98 (1.05)
Stroop C.	14.63 (1.01)	14.83 (1.19)	14.42 (1.92)	15.33 (.87)
ST C time	23.92 (6.81)	21.04 (6.24)	20.73 (5.06)	16.04 (4.87)
Stroop In.	12.67 (2.39)	13.61 (1.62)	13.37 (1.80)	15.17 (1.01)
ST In time	29.63 (7.65)	25.44 (6.99)	23.92 (5.69)	19.87 (5.34)
FIST	20.71 (2.20)	21.67 (2.62)	22.25 (1.99)	22.96 (1.07)
FIST time	205.92 (74.32)	180.04 (69.29)	160.32 (52.79)	143.57 (61.19)

Table 4
Correlations of Individual Difference Measures, All Ages Included Above the Diagonal; Age Partialled Out Below the Diagonal.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1. Age	---	.73***	.43***	.69***	.17	-.43***	.49***	-.52***	.38***	-.36***
2. PPVT	---	---	.51***	.62***	.21*	-.51***	.43***	-.58***	.35***	-.38***
3. K-ABC	---	.32**	---	.41***	.10	-.31**	.31**	-.43***	.29**	-.29**
4. M-space	---	.24*	.20	---	.21*	-.45***	.48***	-.50***	.39***	-.41***
5. ST-1 score	---	.31	.03	.14	---	-.43***	.43***	-.28**	.08	-.08
6. ST-1 time	---	-.33***	-.16	-.24*	-.39***	---	-.37***	.72***	-.23*	.32**
7. ST-2 score	---	.11	.13	.22*	.40***	-.19	---	-.54***	.20~	-.22*
8. ST-2 time	---	-.34***	-.28**	-.23*	-.22*	.64***	-.36***	---	-.18	.26**
9. FIST	---	.17	.19	.24*	.02	-.09	.03	.02	---	-.70***
10. FIST time	---	-.20	-.19	-.24*	-.02	.21*	-.05	.10	-.65***	---

* p<.05
** p<.01
*** p<.001

Table 5

Correlations of Planning Game Measures and Tasks Measuring Individual Differences of Youngest Two Age Groups (Correlations with Age Partialled out in Parentheses).

PG:	1-moves	1-time	2-moves	2-time	moves-diff.	time-diff.
PPVT	-.41** (-.24)	-.41** (-.23)	-.16 (-.22)	-.46*** (-.35*)	-.30* (-.09)	-.11 (.01)
K-ABC	-.26 (-.14)	-.34* (-.17)	-.17 (-.26)	-.35* (-.28)	-.16 (.04)	-.12 (.03)
M-space	-.16 (.05)	-.19 (-.04)	-.06 (-.05)	-.38** (-.25)	-.11 (.09)	.10 (.17)
ST-1 score	-.19 (-.13)	.11 (.19)	.14 (.16)	.08 (.16)	-.27 (-.24)	.08 (.10)
ST-1 time	.31* (.22)	.16 (.07)	.20 (.20)	.15 (.07)	.18 (.09)	.07 (.03)
ST-2 score	-.28 (-.14)	-.01 (.15)	.07 (.11)	.03 (.17)	-.30* (-.21)	-.02 (.04)
ST-2 time	.36* (.19)	.12 (-.08)	.13 (.11)	.14 (-.03)	.26 (.11)	.01 (-.07)
FIST	.05 (.23)	-.00 (.11)	-.23 (-.16)	-.29* (-.19)	.20 (.34*)	.24 (.29)~
FIST time	.08 (-.03)	.02 (-.04)	.19 (.12)	.39** (.32*)	-.05 (-.12)	-.30* (-.32*)

* p<.05
** p<.01
*** p<.001

Table 6

Correlations of Planning Game Measures and Tasks Measuring Individual Differences of Youngest Age Group.

PG:	1-moves	1-time	2-moves	2-time	moves-diff.	time-diff.
PPVT	-.51~	-.04	-.06	-.21	-.41	.12
K-ABC	-.07	-.14	-.15	-.28	.03	.39
M-space	-.11	-.09	.05	-.34	-.12	.38
ST-1 score	-.60**	-.01	.15	-.21	-.60**	.16
ST-1 time	.81****	.33	-.01	.27	.71***	.17
ST-2 score	-.30	.33	.37	.18	-.47	.25
ST-2 time	.61**	.04	-.14	.11	.61**	-.05
FIST	-.15	.10	-.02	-.45	-.12	.50
FIST time	.16	-.12	.00	.39	.14	-.47

~p<.07
* p<.05
** p<.025
*** p<.01
**** p<.001

Figure 1

The Planning Game – 1

Figure 2

Mean Number of Moves for PG 1 by Age and Meta Condition