COOPERATIVE PLAY AND PROBLEM SOLVING IN PRESCHOOL CHILDREN

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The effects of setting on cooperative play and problem solving in preschool children were examined. The study investigated whether a cooperative problem-solving setting that was more like informal social play promoted more effective cooperation and problem solving than a setting that was more structured, and whether the benefits of the play-like setting generalized to another problem solving task. The study also examined the development of cooperative problem solving skills across the preschool years. Four- and five-year-old same-age, same-sex dyads were randomly assigned to complete a problem solving building task in a more play-like, flexible, and child-driven setting or in a more structured and adult-driven setting. The older children built more complete, complex structures with a greater number of blocks than younger children. Children in the play-like setting built more complex structures and utilized observational learning more than children in the structured condition, although no significant condition differences emerged for cooperative behavior and communication. Performance differences also carried over into a subsequent joint problem solving task. Across both settings, individual differences in cooperative skills were related to children's task performance. The results suggest that problem solving skills develop through the preschool years, and that cooperative problem solving in age-appropriate play-like settings is an effective way to promote and investigate both cooperative behavior and cooperative learning in young children.

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1. INTRODUCTION

Shared activities with peers provide children with opportunities to learn, practice, and develop their communicative, interactive, and social skills (Rogoff, 1998; Rubin, Bukowski, & Parker, 1998). Cooperative problem-solving, when two children work together to solve an external problem (Ashley & Tomasello, 1998), can also increase children's understanding within the problem domain, and thereby contribute to learning and cognitive development. Many classrooms encourage cooperative interactions to promote learning and cognitive development because children teach, guide, and assist one another when solving problems and completing tasks together (Slavin, 1987). Previous research has found that in experimental settings that mimic traditional classrooms and classroom activities, joint interactions with peers increase school-age children's understanding of problems and their problem solving skills (Doise & Mugny, 1979; Phelps & Damon, 1989; Teasley, 1995). However, even before children enter formal schooling, preschool children spend large amounts of time interacting with peers, and cooperating and solving problems together (Howes, Unger, & Matheson, 1992). Research suggests, however, that when preschool children are solving formal problems in experimental settings, those who work with a peer perform no differently than children working alone (Azmitia, 1988; Perlmutter, Behrend, Kuo, & Muller, 1989), and their planning and problem solving abilities do not necessarily improve when they cooperate on a task (Gauvain & Rogoff, 1989). Thus, although cooperative problem solving and peer interactions facilitate social and cognitive development among older children, preschoolers' cognitive understanding and growth seem unaffected by similar cooperative problem solving and interactions with peers.

Nevertheless, researchers and theorists agree that in the context of informal social play, cooperative peer interactions may benefit preschoolers' cognitive development (Howes et al., 1992; Rogoff, 1998; Vygotsky, 1976) and many preschool curricula encourage joint interactions during play to promote interests and skills in mathematics, reading, and problem solving (Moyles, 1998; NCTM, 2001). Although instances of cooperative problem solving among young children often occur naturally during informal social play, no experimental research has capitalized on informal play contexts. The study of cooperative problem solving in formal experimental contexts may provide an incomplete or inaccurate picture of preschool children's joint problem solving abilities, thereby underestimating their ability both to solve problems cooperatively with peers, and to benefit from such cooperative interactions.

The purpose of this research is to investigate how informal social play with peers supports preschool-age children's cooperation and problem solving skills. The study will investigate whether integrating features of social play into the study of cooperative problem solving will strengthen research on early cooperative problem solving both methodologically and conceptually. The findings from this research will provide a fuller understanding of the nature and development of cooperative problem solving.

The following literature review will first briefly present theoretical perspectives on cooperative problem solving and then empirical work on cooperative problem solving in formal, experimental contexts in school-age children and in toddlers and preschoolers. The next section will compare preschoolers' task performance and learning to that of school-age children and identify age-related and task-related factors that may limit the effectiveness of cooperative problem solving in formal settings for young children. Next, preschool children's social play and problem solving behavior will be addressed to demonstrate that children utilize cooperation and problem solving skills in play settings. The review will then identify distinctive features of young children's social play from the literature and propose how they may enhance cooperative problem solving and learning in young children in formal problem solving settings as well. The current study will utilize these features of play to investigate a new cooperative problem solving setting with unique tasks to determine what and how young children learn from cooperating with their peers, and to provide a synthesis of cognitive and social development in preschool-age children.

1.1. Theoretical Perspectives

Several theoretical approaches to cognitive development posit that peer interactions are critical for children's cognitive growth. This first section will briefly discuss the more influential theoretical approaches that stress the importance of children's social interactions for cognitive development. The theoretical work of Vygotsky and Piaget has influenced much of the work on the role of peer interactions on children's cognitive development, and each suggests joint interactions, such as cooperative problem solving, are important for children's learning and cognitive growth.

From the sociohistorical perspective, Vygotsky (1962; 1978) has argued that children develop cognitive skills by interacting with more advanced partners, such as more skilled peers or adults. When interacting with a more advanced partner, children are challenged to participate in more advanced problem solving than they would normally be capable of independently. Children then internalize these skills for use in future problem solving situations (Tudge & Rogoff, 1989). Piaget (1932) suggested, however, that peers of equal status or abilities provide children with unique opportunities to learn, practice, and develop cognitive concepts and skills. When peers of equal ability solve problems together, they must understand each other's views to reach a joint solution. Through discussion children attempt to resolve their differing perspectives and in doing so they may advance their understanding of difficult problems.

Several contemporary theorists also emphasize the importance of social interactions with partners of equal or more advanced skills, as well as the importance of different social contexts for promoting learning and cognitive development. For example, Rogoff (1990; 1998) suggests that children's development is like an apprenticeship where children play an active role in their own social and cognitive growth by using the support of both equal and more advanced partners during social interactions. During routine interactions, more advanced partners like parents, siblings, or more skilled peers, have many opportunities for guiding and assisting children to solve everyday problems (Gauvain, 2001; Rogoff, 1990). These common, informal interactions, such as reading books and visiting museums together, may promote children's problem solving, reasoning, and planning skills (Crowley & Jacobs, 2002; Rogoff & Gardner, 1984). In other informal settings, such as play, peers of equal ability or achievement may be ideal partners for promoting children's cognitive development (Hartup, 1996; Johnson, 1990). More advanced partners may be more likely to control situations, while peers of equal ability may provide more opportunities to engage in joint problem solving (Rogoff, 1990; 1998). Thus, peers may be better partners when the goal of the interaction is to encourage a change of perspective, while adults may be better partners for situations that involve the acquisition of new skills. That is, although adults may teach and guide children's learning and problem solving, peers may provide children with unique opportunities to engage in and solve problems in ways that are not utilized when interacting with adults or more advanced partners. Although these theoretical perspectives posit different mechanisms involved in promoting children’s cognitive growth, each approach emphasizes the importance of children's cooperative interactions to solve problems. The outcomes of these joint activities may be influenced by the partner involved in the interaction, as well as the setting where the interaction takes place.

1.2. Cooperative Planning and Problem solving in School Age versus Preschool Children

The next section will briefly review the empirical work on school-age children's cooperative problem solving to provide a summary of the major findings on how children’s knowledge of problems and problem solving strategies, as well as their task performance, often improves during and after cooperative problem solving.

1.2.1. Cooperative problem solving in school-age children

Cooperative problem solving in school age children has been widely studied and has yielded a variety of findings and conclusions. Overall, however, cooperative problem solving benefits school-age children’s learning about problems and problem solving strategies. In particular, when compared to children working alone on a task, children who work with a peer are often more likely to solve a problem, enjoy the task, and complete a task more successfully and efficiently (Blaye, Light, Joiner, & Sheldon, 1991; Doise & Mugny, 1984; Glachan & Light, 1982; Golbeck, 1998; Light & Glachan, 1985; Phelps & Damon, 1989). For example, in formal classroom-like settings school-age children working on math problems solved problems significantly faster in dyads than did children working individually (Phelps & Damon, 1989). Cooperation also allows school-age children to solve other difficult and complicated tasks in formal settings. For example, 11-year-olds working together on computer-based planning problems were approximately two times more likely to solve the problems than children working alone (Blaye et al., 1991). Furthermore, after cooperative interactions, school-age children tend to have a better understanding of problems (Azmitia & Montgomery, 1993), are better able to generate relevant hypotheses about a problem (Teasley, 1995) and show more knowledge change and acquisition (Golbeck, 1998). Even when school-age children are tested individually several weeks after a dyadic interaction, they seem to retain the knowledge gained from the cooperative problem solving interaction (Tudge et al, 1996). In sum, cooperative interactions for school-age children can influence cognitive change by improving children's task performance, knowledge, and understanding.

Cooperative problem solving increases children's performance on a wide variety of tasks. The most extensive research on cooperative problem solving in school-age children has been conducted on Piagetian conservation problems (Ames & Murray, 1982; Botvin & Murray, 1975; Miller & Brownell, 1975; Golbeck, 1998; Perret-Clermont, 1980). Cooperative problem solving also improves school-age children's task performance on spatial reasoning tasks (Doise, Mugny, & Perret-Clermont, 1975; Doise & Mugny, 1979; Mugny & Doise, 1978), moral reasoning tasks (Damon & Killen, 1982; Kruger, 1992; Kruger & Tomasello, 1986; Walker, 1983), and autonomous motion problems (Levin & Druyan, 1993). School-age children's planning skills also benefit from working with a peer on traditional tasks such as Tower of Hanoi (Glachan & Light, 1982), or adventure games on the computer (Blaye et al., 1991).

Cooperative problem solving interactions, however, do not increase children's knowledge and task performance on all types of tasks. Children learn more from dyadic interactions when completing tasks that involve reasoning and discussion (Azmitia & Montgomery, 1993; Kruger, 1992), such as problems that involve spatial-perspective taking, as opposed to rote learning tasks, such as multiplication problems (Phelps & Damon, 1989). Furthermore, when a task is too difficult or advanced for school-age children, they may not learn more about how to solve a task or about its properties when working with a peer (Azmitia & Perlmutter, 1989; Tudge, 1989).

Thus, for school-age children cooperative problem solving can increase their knowledge of a large range of topics and concepts.

When cooperative problem solving increases school-age children's task performance and knowledge, several underlying mechanisms may be involved. First, working with a peer can be motivating for school-age children to attempt difficult and intimidating problems, and may reduce frustration on challenging problems (Azmitia, 1996; Azmitia & Perlmutter, 1989; Gauvain, 2001; Rogoff, 1998; Slavin, 1987). Second, children can gain new knowledge about problems and problem solving strategies by observing one another and imitating their actions (Azmitia, 1996; Bandura, 1977; Botvin & Murray, 1975). Third, cooperative problem solving allows children to discuss their perspectives on a problem, which often leads to conflict, negotiation, and co-construction (Azmitia, 1996; Kruger, 1992; Forman, 1992; Piaget, 1932; Tudge & Rogoff, 1989). When children approach problems from different perspectives, they may try to reach a consensus through discussion, integrate their perspectives, construct a new perspective and thus have a better understanding of the task than before the interaction (Forman & McPhail, 1993; Perret-Clermont & Brossard, 1985). Finally, peer interactions influence cognitive development when a more expert peer assists, tutors, or teaches a less advanced peer. If a more advanced partner is able to instruct and guide the less-advanced partner at an appropriate skill level, then both partners may build or revise knowledge from the interaction (Forman & Cazden, 1985; Tudge & Rogoff, 1989; Vygotsky, 1978).

In sum, although the empirical work on cooperative problem solving in school-age children has yielded a range of findings, the majority of the research suggests that joint interactions with peers in experimental or school settings increase school-age children's understanding of problems and their problem solving skills. The above review also suggests that school age children learn from cooperative interactions on a range of tasks from conservation, to math, to moral reasoning problems. Overall, for older children peer interactions on formal tasks may play an important role in learning and task performance, as the theorists highlighted earlier have argued.

1.2.2. Cooperative problem solving in preschool-age children

Although cooperative problem solving improves school-age children's task success and learning, the current research suggests that working with a peer in experimental settings is not as consistently helpful for younger children's dyadic task performance and learning. Fewer studies have investigated cooperative problem solving in preschoolers and several of these studies may not have taken into account important developmental differences in the way preschool children interact, the appropriate contexts and activities for measuring preschool peer interactions, and what they gain from cooperative peer interactions as compared to older children. For example, a few studies have focused on age-related differences in cooperative problem solving in young children and suggest that preschool children possess many skills needed for successful cooperative problem solving (Ashley & Tomasello, 1998; Brownell & Carriger, 1990; 1991; Cooper, 1980). Other studies, however, have compared cooperative problem solving in older children to preschool age children. These studies have found that preschool children do not learn about tasks, task concepts, or problem solving strategies from cooperative interactions to the same degree that school-age children do (Gauvain & Rogoff, 1989; Perret-Clermont, 1980), even if young children possess many of the skills needed for successful cooperation. This suggests that the tasks, the way that success is measured, or the context itself, may not be as appropriate for younger children as it is for older children.

The types of tasks that are used in the preschool cooperative problem solving literature are more limited than in the school-age literature, but task performance is often measured in similar ways. Some tasks are similar to the scientific reasoning problems given to school-age children, such as balancing a scale with weights, but preschoolers are also given tasks that are simplified or age-appropriate variations of the school-age tasks. These include variations of computer games or Piagetian conservation tasks. A few tasks that address the development of cooperative problem solving involve preschool dyads manipulating tools to solve simple problems. Other tasks involve slightly more familiar activities or routines, such as model building or planning a shopping trip, that also require joint problem solving and planning. Performance on these tasks is often measured by efficiency, accuracy, or number of correct responses given. Dyadic task performance is often compared to children's individual performance prior to the cooperative interaction to measure whether working with a peer improves individual performance on a task. Additionally, individual pre- and posttest measures are often compared after participation in a cooperative interaction to examine the knowledge a child gained about task concepts or problem solving strategies from the joint interaction.

Despite the similarity in procedures and measures for preschool and older children, the empirical work on preschool children’s cooperative problem solving may not be methodologically appropriate to provide an accurate picture of young children's cooperative problem solving skills. The first issue is whether the experimental setting under which preschool children’s cooperative skills are being measured may be too unfamiliar and restrictive, which may influence the way young children cooperate and interact with one another. The second issue is whether the tasks, even though they are age-appropriate, may be too structured for young children to successfully complete. The third issue is whether the knowledge children gain from cooperative interaction is being measured appropriately. That is, the cognitive and social knowledge that children gain from cooperative interactions may not necessarily carry over into individual learning and performance, but may carry over into later dyadic interactions.

The following section will review empirical work on cooperative problem solving in preschool children and then discuss several setting, task and measurement factors that may influence preschool children's cooperative problem solving.

1.2.2.1. **Development of cooperative problem solving**

Research on cooperative problem solving in formal, experimental settings suggests that preschoolers are developing and demonstrating several skills that are crucial for effective cooperative problem solving. First, even toddlers can sometimes cooperate to solve simple problems by coordinating their actions with a peer. For example, Brownell & Carriger (1990; 1991) investigated toddler dyads' abilities to work together on a cooperative problem solving task that required one child to manipulate a lever on a toy that would release a reward, while the other child retrieved it. Twelve-month-olds were not successful on the task, and the 18 month-olds only occasionally solved the problem often accidentally and unsystematically. By 24 months, however, dyads were consistently successful at retrieving the reward (Brownell & Carriger, 1990; 1991). Ashley & Tomasello (1998) presented 2- to 3 ½-year old dyads with a slightly more difficult task that required the coordination of complementary roles on a novel toy to obtain a prize. Although the 2-year-old children were not successful on this problem solving task, 3½-year-old dyads were able to retrieve the prize consistently. Across the two studies, they found that 2- and 3-year-old children spent time on-task, attending to and focusing on the task and task materials (Ashley & Tomasello, 1998; Brownell & Carriger; 1990; 1991). Children also observed their partners' actions and provided a complementary action or imitated their partner's actions to solve the problem (Ashley & Tomasello, 1998; Brownell & Carriger, 1991).

Young children also demonstrate effective communication with a partner about a task during cooperative interactions. On the problem-solving tasks described above, the young dyads used both verbal and nonverbal directives to communicate with and assist each other (Ashley & Tomasello, 1998; Brownell & Carriger; 1990; 1991) On a pan balance scale task used in a different study, 3-and 4-year-old children worked together to identify pairs of blocks that were the same weight. During the interactions, the dyads asked each other questions to achieve greater understanding about the task or their partner's thoughts or actions. The preschoolers also provided their partners with explanations and made relevant task comments about their own actions or the task, such as evaluating the results of placing two blocks on the scale (Cooper, 1980). Thus, the literature suggests that preschool children exhibit skills in coordinating behavior and communicating with a partner to solve a problem.

1.2.2.2. Preschool children's cooperative problem solving

Several studies suggest, however, that even though preschoolers possess a number of fundamental cooperative problem solving skills, their dyadic task performance and individual knowledge about a problem do not necessarily improve after working with a peer in experimental settings, even for age-appropriate problems. For example, Perret-Clermont (1980) presented 5-year-old children with a variation of the conservation of number task (Piaget, 1952). Dyads were presented with a pile of candy and two plates with a line of circles on each plate for the candy. The lines were of equal length, but had a different number of circles on each (both 17 cm long, but with 5 and 7 circles). The dyads were to divide up the candy equally on the plates, but using the circles for the candy was optional. Even though all children interacted with one another by asking questions, making comments, and providing explanations, the children did not perform any differently on individual versions of the conservation tasks after the cooperative interaction than before the interaction. When some dyads had difficulty with the task, they requested interventions from the experimenter and asked her for advice, instead of discussing the problem with each other. Furthermore, many dyads did not actually work together; one child simply divided up the candy for both children or each child just took his/her own candy. This suggests that even when tasks are age-appropriate in formal settings, preschool children have difficulty cooperating to solve them.

In a series of three studies, Perlmutter et al. (1989) found that cooperative problem solving did not increase preschool children's task performance and knowledge, motivation, or enjoyment of computer tasks. Specifically, Perlmutter et al. found that the dyads provided correct verbal instruction and assistance to each other by directing one another, and engaged in many cooperative problem solving behaviors, such as setting goals and prioritizing actions. However, only the 5-year-old dyads produced more correct responses and at a faster rate than children working alone. Although the 4-year-old dyads spent more time working on the tasks than did individual children, they produced fewer correct responses and were no more efficient than were children working alone. Furthermore, 4-year-olds dyads were not necessarily more motivated nor did they display more positive affect or rate their enjoyment higher than children who worked alone. Moreover, neither the younger nor the older dyads scored higher on the individual transfer tasks than individual children. Overall, the three studies suggest that even though preschool dyads displayed many cooperative problem solving behaviors, their interactions did not consistently increase individual learning about the computer games, or improve dyadic task performance or motivation.

In another study in an experimental setting, Bearison, Magzamen, & Filardo (1986) used Piaget's three mountain tasks (Piaget & Inhelder, 1956) adapted for cooperative problem solving in young children (Doise et al., 1975). In the task, children were shown models of three houses on a base and asked to construct replicas of the original models on an identical but rotated base. Like Perlmutter et al. (1989), Bearison et al. found no difference between dyads' and individual 5-year-olds' task performance, such as their ability to correctly place all three houses on the models. Cooperative problem solving also did not improve children's spatial perceptive taking abilities on this task, even though dyads engaged in many discussions and disagreements about the task. That is, there was no difference in children's pretest to posttest scores between children who had worked with a peer and children who worked individually.

In sum, these studies in experimental settings have shown that although preschoolers engage in many cooperative problem solving behaviors, their dyadic task performance and individual knowledge about a problem do not necessarily improve after working with a peer, even for age-appropriate problems. Preschoolers spent time together working on tasks and coordinating their actions (Bearison et al., 1986; Perlmutter et al., 1989), and had discussions about the task materials, the steps to complete the task, and task solutions (Bearison et al., 1986; Perlmutter et al., 1989; Perret-Clermont, 1980). Despite engaging in these cooperation and problem solving behaviors, the preschool dyads' task performance was often no better than individual children's (Azmitia, 1988; Bearison et al., 1986; Perlmutter et al., 1989), and they rarely generalized their knowledge to later tasks (Bearison et al., 1986; Perlmutter et al., 1989; Perret-Clermont, 1980). These differences cannot simply be attributed to methodological differences, since procedures and measures were quite similar to those used with older children.

Perhaps preschoolers learn from one another using different mechanisms. The next section addresses this possibility.

1.2.2.3. Mechanisms of cooperative problem solving in preschoolers

Disagreement and conflict have been proposed as mechanisms through which school age children's knowledge increases from peer interaction (Azmitia, 1996; Tudge & Rogoff, 1989). Several studies suggest, however, that other mechanisms may be involved in how preschool children learn about problems from cooperative interactions (Bearison et al., 1986; Azmitia, 1988). For example, in the study by Bearison et al. (1986) previously described, greater conflict was not related to whether children's task performance or learning improved from the cooperative interactions. Specifically, the results showed that enactive disagreements, such as one child changing the orientation of the house that was previously placed by the other child, did not relate to later task knowledge. Furthermore, verbal disagreements, such as contradicting a partner's preceding statement also did not relate to task knowledge, unless the partner also explained why they disagreed, a social skill perhaps out of reach for most preschoolers. Thus, unless preschool children can and do explain why they do not agree with their partners, conflict and disagreement may not influence preschool children's cooperative problem solving.

Other studies using model-building tasks also suggest that conflict is not related to improvements in preschool children’s dyadic task performance and individual learning or problem solving strategies. Azmitia (1988) investigated whether task performance and learning about the task increases when working with a peer or individually. Five-year-old children were asked to build an exact copy of a Lego model of a house, which required children to represent spatial relations mentally and break a complex structure into its parts. When two children of the same ability worked together (i.e., two novices or two experts), their building accuracy did not improve from the cooperative interactions. Even though the dyads engaged in discussions, disagreements and conflicts about the task, there was no difference between dyads or children working alone on individual posttests of building accuracy. Children in mixed-ability dyads, however, built their models more accurately than novice dyads and children working alone. The experts may have been better partners because they displayed more advanced cooperative problem solving skills, such as spending more time on-task and providing more correct explanations to their partners compared to the novice peers. Similarly, Verba (1998) conducted a study in which preschool children were paired with more advanced partners and showed that preschoolers benefit when working closely with helpful, instructive advanced partners. When the 5-year-old children worked with more advanced peers, the less advanced peer's task performance improved and they were able to generalize these skills to later problems solved individually. During the cooperative interaction the expert peer helped and instructed the novices by giving feedback and explaining the problem. The results of these studies suggest that conflict may not be the important mechanism through which young children gain knowledge from peer interactions. Instead, other cooperative skills, such as providing explanations about a problem and working closely with a peer, may improve problem solving.

Research in experimental settings has also investigated preschool children's cooperative problem solving on a task requiring scientific reasoning. Tudge (1992) gave children a mathematical balance beam task and asked them to predict whether the balance beam would stay balanced, tip one way, or tip the other way when different weights were placed at various distances from the fulcrum. The task aimed to elicit discussions and conflict in the children by requiring them to make predictions they agreed upon, but they were not given any feedback by either the materials or the experimenter. The results showed that the 5-year-old dyads did not use more sophisticated rules or reasoning when making predictions about the weights than children working alone. Also, children working with a partner of equal ability were not likely to change their level of reasoning on individual posttests. That is, cooperative problem solving did not lead to more advanced reasoning on individual problems after the cooperative session.

Overall, the results of these studies suggest that preschool children's conflict and discussion may not be as important a mechanism of cognitive change in cooperative interactions as it is for school-age children (Azmitia, 1988; Bearison et al., 1986; Tudge, 1992). Other processes, such as observational learning and guidance, may more likely be involved in influencing preschool children's task knowledge (Azmitia & Perlmutter, 1996). For example, preschool children seem to learn about model building skills and strategies from the guidance that expert peers provide during cooperative interactions (Azmitia, 1988; Verba, 1998). Azmitia (1988) found that the novices in the mixed-ability dyads spent more time looking at the model and at their partner than did two novices working together. Less advanced children also compare their behavior with the more advanced partner, which may be useful for children to understand which problem solving behaviors are successful (Duran & Gauvain, 1993). Thus, for preschool children discussion, disagreement, negotiation, and cognitive conflict may not be important mechanisms of cognitive growth. Instead**,** tasks that allow children to use more observation and imitation, and less conflict may be more useful for young children to gain new knowledge about problems and problem solving strategies.

Furthermore, when working with a peer of equal ability, it may be important for children to work closely together and share responsibility on the task, and to find the task mutually engaging and motivating. Gauvain & Rogoff (1989) presented 5-and 9-year-olds with a model grocery store and asked them to plan shopping routes to obtain all the groceries on a list. Although dyads of both ages created and executed their plans more quickly than individual children, a subset of preschool dyads demonstrated more advanced cooperation skills than others of their age. For example, some dyads shared greater task responsibility, such as both partners simultaneously looking for an item. These dyads planned more efficient routes than preschoolers who did not work as closely with their partners. These children also planned more efficient routes on individual planning posttests. But only children who shared responsibility and worked closely with their partner learned about the task from the dyadic interaction. This suggests that simply working with a partner did not influence children's understanding of the task, but working closely and sharing responsibility with a partner improved task knowledge.

Similarly, Duran & Gauvain (1993) found that task involvement during a cooperative interaction is related to preschool children's learning from planning tasks. Similar to the grocery planning task, children were to design routes for a delivery truck, which required advanced planning of the sequence of events. Five-year-old novice planners were paired with a more experienced planner, who was either 5- or 7-years-old. Novices paired with a same age expert were more involved in the planning and executing of task actions than children paired with an older expert. The 5-year-old experts also provided their partners with more guidance and positive support. As a result, children who worked with a same-age expert were more likely to plan efficient routes individually after the cooperative interaction than children who worked with an older advanced planner. These results suggest that the preschoolers had greater opportunities for task involvement and sharing responsibility when working with a same-age partner of more advanced ability, which likely influenced how well they learned about planning in the task.

In sum, research on cooperative problem solving in formal, experimental settings suggests that during the toddler and preschool years, children's abilities to coordinate actions to solve problems are increasing. Preschool children are also developing other important cooperative skills, such as communication and negotiation with peers. Despite these developing abilities, cooperative problem solving does not seem to improve preschool children's task performance and learning. Even when children are given age-appropriate tasks, they have trouble engaging in cooperative problem solving with a same-ability peer. Children's motivation and learning in these joint interactions may be influenced by their cooperative abilities, but also by the experimental settings. That is, preschool children may have trouble completing tasks without asking experimenters for assistance and peer partners do not make problem solving any more motivating or enjoyable in experimental settings. Furthermore, for preschoolers observational learning, imitation or guidance may be important processes for learning from a cooperative interaction, especially when working with a more expert peer. When working with a peer of equal ability, it may be important for children to work closely together and share responsibility on the task, and to find the task mutually engaging and motivating.

1.2.3. Factors That Limit Preschool Children's Cooperative Problem Solving

Research and theory have proposed several social and setting related factors that may limit preschool children’s task performance and learning from cooperative problem solving.

1.2.3.1. Cooperative problem solving abilities

Preschool children’s learning and dyadic task performance may be limited by their cooperative abilities. For example, instead of working together or dividing up labor, children on the conservation of number task either worked independently or acted in parallel to complete the task (Perret-Clermont, 1980). Similarly, young children are fairly unskilled at monitoring their partner's actions and providing explanations for disagreements (Azmitia, 1988; Bearison et al, 1986). They then may have difficulty accurately communicating their views about problems, providing effective instructions, and offering explanations to partners. The empirical work also suggests that preschoolers are not as skilled as older children in assigning roles, acting in complementary ways, or coordinating their actions with peers (Gauvain & Rogoff, 1989). Thus, unlike school-age children, preschool children may not have the necessary cooperative skills for learning about problems and executing problem solving strategies in experimental settings.

As the empirical work suggests, preschool children have difficulty engaging in the type of discussion and conflict that leads to knowledge revision and increased understanding of problems (Azmitia, 1988; Bearison et al., 1986; Tudge, 1992). That is, when peers approach problems from different perspectives, preschoolers may not have the communication skills to benefit from the discussion or end conflict in a way that is useful for problem solving or learning (Azmitia, 1996; Damon, 1984; Gauvain, 2001). Young children have difficulty attending to others' perspectives, evaluating their ideas, and then communicating their ideas to their peers in a discussion (Azmitia & Perlmutter, 1989). Compared to older children, young children also do not engage in advanced forms of negotiation during dyadic interactions. Preschoolers have more trouble coming to a joint decision as well as agreeing upon a solution after a conflict (Azmitia, 1996; Azmitia & Perlmutter, 1989; Cannella, 1993). Thus, preschoolers' communicative skills may not be consolidated or advanced enough for appreciating others' perspectives and communicating their own while engaging in cooperative problem solving.

1.2.3.2. Setting and task factors

In formal settings, the tasks may be difficult for preschool children because most have only one correct solution or best solution (Azmitia, 1988; Bearison et al., 1986 Gauvain &

Rogoff, 1989; Perret-Clermont, 1980). For example, on model building tasks, children are expected to copy exactly the model they are given (Azmitia, 1988). Azmitia (1996) and Garvey (1990) have proposed that preschool children may have trouble focusing their actions and discussion on only one goal or solution.

Setting factors may also influence preschool children's cooperative problem solving. The rules and restrictions of the experimental settings may affect preschool children's motivation and performance. For example, rules about the length of sessions may influence children’s enjoyment of the task. Perlmutter et al. (1989) found that when dyadic sessions were longer, younger preschool dyads enjoyed the interactions as much as did older dyads. When children have time pressures to solve a problem, they may take less time to plan or reflect on their actions (Ellis & Siegler, 1997). The longer sessions may have allowed more relaxed interactions, even though task performance did not improve. Involvement of the experimenters may have also contributed to less effective interactions. Preschoolers enjoyed cooperative interactions more when experimenters only observed children and otherwise let the children complete the tasks on their own (Perlmutter et al., 1989).

It is also possible that an individual pre- and posttest design may not be the most appropriate way to assess the benefits of cooperative interaction. The dyadic interaction and the individual posttest represent two different social contexts and the individual task may not capture the knowledge that children gain from cooperative interactions (Rogoff, Radziszewska, & Masiello, 1995). For example, during a cooperative interaction, children may gain knowledge about how to complete a task jointly or about cooperative strategies to solve a problem. This type of knowledge, however, would not be assessed in an individual posttest.

Thus, together these studies suggest that a range of task, setting, and age-related child factors may limit preschoolers' ability to solve formal tasks cooperatively and/or to profit from cooperative problem solving.

1.3. Social Play: Cooperative Problem Solving in Play

Informal social play contexts provide insight into preschool children's cooperative problem solving behaviors, particularly those that are demonstrated in experimental settings among older children but seem lacking or deficient in younger children. During informal social play, young children often utilize problem solving and planning behaviors that are similar to those behaviors demanded in formal experimental cooperative problem solving situations (Azmitia, 1996; Garvey, 1990). For example, during social play, preschool children define goals, plan, solve problems, and coordinate their behavior to reach the goal (Connolly & Doyle, 1984; Forys & McCune-Nicholich, 1984; Garvey & Berndt, 1977; Goncu, 1987; Howes et al., 1992; Howes & Matheson, 1992; Paley, 1986; Verba, 1993). The informal social play context may be more familiar, flexible, engaging, and motivating than formal experimental settings for preschool children. Play contexts may also permit learning by observation and imitation, and include greater responsibility sharing, which are important underlying learning mechanisms for young children.

Existing work in children's social play has not focused on cooperative problem solving, and no explicit empirical comparison of play versus formal settings has ever been undertaken. As a result, it is difficult to make inferences about the developmental constraints and developmental course of young children's cooperative problem solving, or the benefits of cooperative problem solving for young children's learning and reasoning. Play research offers little experimental, comparative data of children’s individual versus dyadic task performance or of their individual performance on "tasks" following cooperative play. Moreover, the cooperation and problem solving "tasks" in children's play are not as clearly defined as in the formal experimental literature. Unlike the formal contexts that present children with one task or problem to solve, the tasks in children's cooperative play are more variable (Garvey, 1974; Rubin, Fein, & Vanderburg, 1983) and are likely to differ as a function of the toys they play with and the setting in which they play. Although research on social play is more varied and less well-defined, it may nevertheless demonstrate that preschool children have the necessary skills to engage in successful cooperative problem solving that is not captured in the formal experimental literature. The social play research may also provide ways to investigate and promote preschool children’s task performance and knowledge during cooperative interactions. In sum, social play is a context in which natural cooperative problem solving occurs and empirical and theoretical work on social play demonstrates that preschool children engage in the cooperative problem solving skills that seem limited or lacking in experimental settings. Comparing preschoolers’ cooperative problem solving during social play and in formal settings may therefore provide a more complete picture of their abilities, and will lay the groundwork for the current research.

1.3.1. Cooperative problem solving in social play

As previously reviewed, researchers and theorists propose that preschool children's dyadic task performance and individual learning may not improve in cooperative interactions in experimental contexts because their cooperative problem solving skills are still developing and are too fragile for effective cooperation. For example, the empirical work suggests that unlike older children, preschool children have trouble assigning roles, delegating responsibility, prioritizing actions, and cooperating on problems in experimental settings (Azmitia, 1988; Gauvain & Rogoff, 1989; Perlmutter et al., 1989; Perret-Clermont, 1980). During social play, however, preschoolers demonstrate many of these skills. For example, observations of social pretend have shown that when 3-year-olds are playing house together, one child will dictate that she will be the mother and her partner will be the father (Verba, 1993), thereby assigning roles. Studies have also found that when preschool children are playing together they will adopt reciprocal and complementary roles (Field, DeStefano, & Kowler, 1982; Howes et al., 1992; Iwanga, 1973; Verba, 1993). Observations have shown that during a school theme one child pretends to be the bus driver, while the peer pretends to be the student passenger (Iwanga, 1973). Thus, role assignment and delegating responsibility, which appear limited in experimental settings, occur regularly in preschoolers' social play.

As previously discussed, negotiation is crucial for cooperative problem solving in experimental settings. It is also crucial for cooperation in social play. Empirical work in experimental settings has found that preschool children have trouble ending conflicts and taking into account others' perspectives in task solutions (Azmitia, 1988; 1996). Social play, however, is characterized by demands for communicating and negotiating as when children must agree on scripts and rules of play (Bretherton, 1984; Howes et al., 1992). When children play together, they negotiate themes, goals, and roles, as well as understand and accommodate to one another's views (Bonica, 1993; Doyle & Connolly, 1989; Forys & McCune-Nicholich, 1984; Howes et al., 1992; Paley, 1986). For example, observations of preschool children have shown that during pretend play they often disagree about pretend play themes, roles or objects incorporated into the theme (Bonica, 1993; Forys & McCune-Nicholich, 1984; Paley, 1986). But children also attempt to clear up and work through confusion, disagreements, and conflict by establishing exactly what the problem is, discussing it and reaching joint solutions (Garvey, 1990; O'Brien, Roy, Jacobs, Macaluso, & Peyton, 1999; Vespo, Pederson, & Hay, 1995). Thus, during social play, preschool children discuss, negotiate, and communicate ideas to reach a shared understanding of the roles and themes they each will contribute to the joint enterprise (Bonica, 1993; Doyle & Connolly, 1989; Goncu, 1987; 1993; Howes et al., 1992; Paley, 1986).

In sum, during play young children engage in effective cooperative problem solving. Similar to cooperative problem solving in formal settings, preschool children's social play is based on abilities to engage in cooperative behavior and on abilities to solve problems and plan with others. Successful cooperative problem solving in experimental settings and in play requires similar types of cooperative, social-cognitive, and communicative skills. That is, during joint play preschool children must divide labor, assign roles, and coordinate behavior. They must also negotiate conflict, discuss, and reach solutions they both agree upon. Thus, during social play children jointly organize plans and establish, set, and enact goals. These are the very skills required, yet apparently deficient, in formal problem solving settings.

1.3.2. Integrating features of informal play and formal cooperative problem solving

The literature on preschool children's social play demonstrates that young children engage in many of the cooperative problem solving skills that appear limited in experimental settings. Unlike the experimental literature, however, the social play literature provides little information as to whether children's dyadic task performance or knowledge improves when cooperating with a peer in informal play settings. Thus, it is unknown whether cognitive and social benefits arise from cooperative problem solving during play. Integrating features of informal social play with cooperative problem solving in formal experimental settings may provide a more optimal environment for children to solve problems jointly, as well a more accurate picture of young children's cooperation and problem skills. The next section will discuss the features of play and play tasks that may provide a more appropriate and valid context for joint problem solving among young children. More valid estimates of preschoolers' cooperative problem solving abilities will also permit developmental study of the role of social experiences in cognitive change.

Defining features of the play context are that it is familiar, safe, and comfortable (Krasnor & Pepler, 1980; Rubin et al., 1983; Vanderburg, 1980). In this familiar context, play becomes highly engaging, motivating, and enjoyable (Garvey, 1990; Rubin et al., 1983; Sutton-Smith, 2001). Observational work suggests that play interactions are often accompanied by positive emotions and affect (Connolly & Doyle, 1984; Verba, 1993). When children enjoy playing together, they are likely to engage in positive, cooperative behaviors, such as sharing, helping, talking, and negotiating with a peer (Charlesworth & Hartup, 1967; Jeffers & Lore, 1979). During play, children may enjoy interactions even when they are trying to solve difficult problems (Rubin et al., 1983). In contrast, experimental settings do not necessarily motivate preschoolers to work on tasks with a peer and children do not necessarily find working with a peer more enjoyable than working alone (Perlmutter et al., 1989). Thus, play, compared to experimental settings, is motivating and positive for children, which may increase children's desire to work toward a common goal, and to cooperate to solve problems with a partner.

Several other features of the play context may be especially relevant for cooperative problem solving and will be discussed below: 1) the role of adults and freedom from externally imposed rules; 2) flexibility of play; 3) scripts and familiar activities. If these features of play are integrated into formal, experimental settings, this may provide a more supportive context for preschool children’s cooperation and problem solving behavior. The context may also provide ways to understand preschool children’s success in cooperative problem solving, the processes that underlie cooperative interactions, and what they gain from such interactions.

1.3.2.1. Role of adults: Freedom from externally imposed rules

During social play, preschool children have almost complete freedom to determine, maintain, or alter the rules of their interactions and the tasks in which they engage, including their cooperative problem solving attempts. During social play, even in preschool classrooms children usually initiate interactions, and then choose and establish the goal of their activity of interest (Moyles, 1993; Verba, 1993). In contrast, in experimental settings, children are presented by an adult with tasks, goals, and rules of the cooperative interaction. Preschool children may also be more likely to stay engaged with a problem when they have chosen an activity or goal that interests them. Research on individual preschoolers has found that preschool children attend to and are more engaged with toys and play objects that they prefer and had chosen to play with earlier (Renninger, 1990). Thus, preschool children may be more likely to engage in tasks and cooperate with peers when they are able to define and choose their own activities.

Furthermore, preschool children may also be challenged by the extent to which experimenters are involved in their interactions. In experimental settings, adults play a large role in the cooperative interactions by instructing the children to work together on problems and to come to joint decisions (Azmitia, 1988; Gauvain & Rogoff, 1989; Slavin, 1987). As the experimental research has shown, in a formal setting children are likely to ask the adult for help and assistance, instead of working through the problem with a peer (Perret-Clermont, 1980). Young children's social play, however, is usually free from external control, rules, or support, Without an adult’s presence, peers are forced to solve, communicate, and negotiate their own conversations and problems that arise during a cooperative interaction (Moyles, 1992; Rubin et al., 1983). For example, as children transform objects, actions, and roles during cooperative interactions, they must communicate their meaning and actions to their partner (Verba, 1993). If children themselves have established the rules, goals, and problems, they may feel greater ownership and motivation to jointly meet the determined goal and less likely to ask an adult for assistance. For instance, without an adult's request or instructions, preschool children will initiate interactions with peers to seek or give help on problems such as playing games on a new computer (Muller & Perlmutter, 1985). Even observations of preschool play have found that children's conversations change when an adult is involved and children are more likely to talk to the adult than to each other when an adult is present (Garvey, 1990). Thus, preschool children may be more likely to cooperate with peers when they are not told to do so and freedom from imposed rules and little adult involvement may increase their overall motivation and determination to solve problems together.

1.3.2.2. **Flexibility of play**

During play, problems that arise may be solved in numerous ways (Garvey, 1990; Moyles, 1989). Thus, play is extremely flexible in terms of both problem definition and problem solutions. As proposed by Azmitia (1996) and Garvey (1990) and as previously discussed, in experimental settings preschool children may have difficulty successfully completing problems that have only one solution.

The flexibility of play may be important for young children because it provides opportunities to explore, develop, and discover solutions to a problem. Research suggests that during play young children are active in their manipulations and explorations of objects, problems, and possible problem solutions (Garvey, 1974; 1990; Rubin, Watson, & Jambor, 1978). Children can learn how to transform objects, such as putting things together and taking them apart, as well as arranging and rearranging materials (Moyles, 1989; Sylva, Bruner, & Genova, 1976). Even children's pretend play involves active engagement with objects, as well as physically acting out pretend themes (Howes et al., 1992; Verba, 1993). Exploration and play may thus provide children with opportunities to identify and gain understanding of the properties and functions of objects and may suggest novel solutions to problems (Sylva et al., 1976; Pepler & Ross, 1981; Vanderburg, 1980). Research with individual children has shown that after preschoolers played with the materials, they were better able to build novel and unique structures with them than children who simply saw the materials being manipulated (Pepler & Ross, 1981). These playful behaviors may build children's understanding of the problem and suggest solution possibilities (Cheyne & Rubin, 1983).

The flexibility of play may also provide children with opportunities to learn about problems through observational learning, as well as through exploration and play. For example, individual preschool children watched an experimenter demonstrate putting sticks and clamps together to obtain a toy that was out of reach. These children were just as successful at obtaining the toy themselves as children who were given an opportunity to play with the sticks and clamps first (Sylva et al., 1976). This suggests that children learned about the task solution by watching and imitating the experimenter, as well as by exploring the materials. In social play, preschool children may gain greater understanding about problems and problem solving strategies not only from interacting with objects, but also from interacting with and watching others.

1.3.2.3. **Scripts and familiar activities**

Children's play often involves familiar, script-based themes, routines or activities. A study of dyadic play has found that preschoolers are most likely to role play familiar themes, such as kin relationships, like siblings, families, or mothers and fathers (Garvey & Berndt, 1977). For young children, familiar and scripted themes are often well-organized representations of a sequence of actions, props and events (Nelson & Gruendel, 1986). Research on individual children has found that preschoolers create more sophisticated plans for familiar events, such as planning a trip to the beach (Hudson, Shapiro, & Sosa, 1995) than for unfamiliar events. The familiar events and themes may help young children to guide, support and facilitate higher-level cognitive functions, such as those involved in planning and problem solving (Hudson & Fivush, 1991; Nelson & Gruendel, 1986). Thus, familiar themes may support and enhance preschool children's problem solving and planning abilities.

Having a shared understanding of the problem may also allow children to better discuss and negotiate the variables of the problem (Azmitia, 1996), and ultimately promote greater involvement and shared responsibility in completing the task. Research on social play has found that preschool children playing together have an easier time discussing, taking turns, and keeping on the topic when themes are familiar, such as going to the grocery store and eating at McDonalds (Furman & Walden, 1990). Some tasks in experimental settings may not be familiar enough to preschool children to permit effective discussions. On the balance scale task, for example, preschool children are likely to have very little experience with balancing scales that involve variables of weight and distance (Tudge, 1992). But when preschool children are given tasks based on more familiar themes, such as the grocery planning tasks, some children are able to cooperate, discuss, and assist each other on the task (Gauvain & Rogoff, 1989). If peers begin a task with similar knowledge of a familiar, script-based problem, then peers may be able learn about the task and generate effective solutions by discussing the problem, observing one another or sharing task responsibility.

Thus, integrating features of informal social play, such as freedom, flexibility, and familiarity into formal, experimental settings may provide preschool children with a context that promotes, supports and enhances their cooperative problem solving. Preschool children may then experience greater motivation and enjoyment, engage in more discussion and shared task responsibility, as well as utilize more observation and imitation when interacting with peers to solve problems. Research using modified tasks and contexts may provide a better understanding of preschool children's cooperative peer interactions and the potential for cognitive growth from cooperative problem solving.

1.4. Predictions

To summarize, the literature on preschool children's cooperative problem solving in formal and informal play settings provides contrasting conclusions about children's cooperative problem solving abilities. The experimental literature suggests that unlike school-age children, preschoolers' task performance does not necessarily improve nor do they gain greater knowledge about a task or problem when working with a partner. The literature on children's social play demonstrates that young children engage in many of the cooperative problem solving skills that appear limited in experimental settings. Unlike the experimental literature, however, the social play literature provides little information as to whether children's dyadic task performance or knowledge improves when cooperating with a peer in informal play settings. Thus, it is unknown whether cognitive and social benefits arise from cooperative problem solving during play.

The current research capitalized on features of social play to establish an experimental context that was more familiar, flexible, child-driven, and meaningful. The context provided more appropriate procedures for studying developmental and individual differences in early cooperative problem solving, performance on problem solving activities, the potential processes that underlie learning from cooperative interaction, and the knowledge that children carry over into later dyadic problem-solving interactions. The research compared preschool children's cooperative problem-solving strategies, motivation, and performance in an informal, flexible play-like context versus a more formal structured context, similar to formal classrooms and the type of experimental setting in which cooperative problem solving is usually tested. The research investigated whether children's cooperative problem solving strategies and performance on dyadic posttests varied for children who engaged in the play versus structured dyadic sessions. Because individual posttests may not capture the same knowledge as that gained from dyadic interactions, the research utilized dyadic pre- and posttests to identify gains from dyadic interactions.

This research had three aims:

1) To demonstrate that preschool children engage in cooperative and communicative behavior in problem solving settings, and identify the developmental progression of these skills.

2) To investigate whether preschool children in a more informal, play-like setting engage in more cooperative problem solving behavior, are more motivated and share more responsibility, and use more observation and imitation than children interacting in a more structured setting.

3) To investigate whether there are differences in problem solving strategies and performance in an informal versus structured setting.

The following hypotheses were tested. It was expected that there would be:

1) Age Differences

Preschool children's cooperative problem-solving skills and building performance would increase with age. Specifically, older children would share more responsibility and engage in more effective communication with a partner, while engaging in less controlling behavior and attempts to involve the experimenter in the interaction. Older children would also build more elaborate and complete structures and do so more efficiently than younger children.

2) Performance Differences

Preschool children who solved problems in a more play-like setting would demonstrate higher levels of task performance compared to children who solved problems in a more structured setting. The flexibility of the play setting would allow children to develop, explore, and discover ways to build more complete and complex structures, and in more efficient ways.

3) Cooperation and Learning Processes

Preschool children would engage in more cooperative problem solving behavior and communication in a more informal, play-like setting than in a more structured setting. When children have greater control of the goal, their cooperative behavior, such as coordinating their actions with one another, should be greater than if they have less control of the interaction. Furthermore, when the setting and task are more familiar, children would be more likely to ask and respond to each others' questions, direct each other, and be less likely to communicate with the experimenter. The flexibility of the play setting and the familiarity of the activity would allow them to share greater responsibility and to learn about the task from watching and imitating each other. Thus, children who participated in the play setting would also share greater responsibility when completing the task and use more observation and imitation than children in a more structured setting. Preschool children would also find an informal, play-like setting more motivating than a more structured setting; having greater control of the interaction and greater flexibility would increase children's enjoyment and the time they spend on task. Children's task performance would then be mediated by these differences in social and learning processes between the two settings.

Preschool children who interacted in a more play-like setting would also engage in more cooperative behavior and communication in the posttest session. The play-like setting would promote children's cooperative skills and thus positive interactions would carry over into a later dyadic interaction.

4) Individual Differences

It is possible that the differences between the play and structured settings may not influence all preschool children's cooperative problem solving in similar ways. For example, children who are better at cooperating and communicating with their peers may be the most successful on task performance, regardless of the setting of their interaction. These children may be able to cooperate and communicate with a peer to solve problems in settings that are either structured or unstructured. In contrast, children who are poorer at cooperating with a peer may perform more poorly on tasks, regardless of whether they interact with a peer in a structured or unstructured setting. Individual differences in cooperative skills were also explored, and it was expected that individual differences in cooperation and learning processes would be associated with performance differences.

2. METHODS

2.1. Participants

Forty 4-year-old (*M* = 4.5 years, *SD* = .30; 20 girls) and 36 5-year-old (*M* = 5.4 years, *SD* = .23; 18 girls) children from child care centers in the city of Pittsburgh, PA participated in the study. The study was conducted primarily at university-affiliated child care centers, which serve families who are predominantly white and middle to upper-middle class.

2.2. Design

Each child was paired with a familiar peer of the same age and sex. Dyads were seen for two visits on two separate days within approximately one week. All visits were videotaped. Each visit lasted approximately 20 minutes. Two visits were used for two reasons: 1) to minimize the amount of daily time the children were absent from their classrooms, 2) to allow children to establish a stable working style, which can increase the benefits of cooperative interaction (Azmitia, 1988; Forman & Cazden, 1985).

On the first day, all of the children received the same dyadic pretest building task. On the second day, half the dyads were randomly assigned to receive a building task in a setting that mimicked informal play ("play" condition). The other half of the dyads were given a more structured building task in which they were instructed to build a structure that had to include several predetermined characteristics ("structured" condition). All of the dyads also received the same dyadic posttest building task on the second day. An assistant blind to the hypotheses of the study administered half of the experimental and posttest sessions, an equal number of each condition.

Building tasks were chosen for several reasons. First, building is a common task used in prior cooperative problem solving research with preschool children, which allows findings from the current research to be compared to results from previous research (Azmitia, 1988). Second, building with blocks is an informal, play-based activity that can promote learning and cognitive growth, such as the early development of mathematics and problem-solving skills like quantity and managing relationships of various height & weight (NCTM, 2001). Third, being read a story and then engaging in play based on the theme of the story, as well as building with large blocks, are activities recommended for preschool children and are often used in preschool classrooms (Wolfgang, Mackender, & Wolfgang, 1981). Fourth, building activities and tasks promote cooperative interactions (Azmitia, 1988; Morrison & Kuhn, 1983). Finally, listening to a story and building are familiar and enjoyable activities for preschool-age children (Azmitia, 1988).

2.3. Materials

*Building area and block*s. For both of the visits, the children were instructed to play and build their structures on a rug that was approximately 54” x 54”. The carpet defined a standard space large enough for children to build their structures, but small enough to videotape the interaction. For all of the sessions, children used a set of 65 red, yellow, and blue age-appropriate cardboard building blocks of various sizes. The largest blocks were 12” x 6” x 3” and the smallest ones were 3” x 3” x 3” in size. The blocks were placed in a clear plastic box, approximately 33’’x 19” x 13” in size and placed directly next to the carpet before each session.

Stories. At the beginning of the experimental and posttest sessions the dyads were read a story to motivate their play. For the experimental session, children in both conditions were read a short story that established a problem that they were then asked to solve. The story was about two children who needed a place to play together. In the play condition, at the end of the story the children were asked to pretend they were the two children in the story and they should build a fort or a playhouse (See Appendix A for female version). The story included a series of suggestions for five particular characteristics to include in the playhouse, such as high walls and a door. The characteristics were embedded in suggestions for play activities, and the play-like ideas and suggestions were designed to enhance, support, and promote their play behavior while building. For example, they were told that the high walls could be used for playing hide-and-seek.

For the structured condition, children were told they should work together to build a playhouse at the end of the story (See Appendix B for female version of the story). No reference was made to pretending or playing. The children were told directly that they had to include in their structure the same five characteristics that were given as suggestions to the children in the play condition. The characteristics were given in a more directive manner and were not embedded in suggestions for play activities. At the end of the stories, there were a series of questions that the experimenter asked the children to insure that they had understood all of the characteristics described in the stories before they started building. Each story was approximately eight pages long. The stories were age-appropriate and there were gender-specific versions of each.

In the posttest, children in both conditions were read the same story. The story was about a castle and described five characteristics, such as having strong walls and many rooms. At the end of the story the children were asked to build a castle similar to the one described in the story (See Appendix C). The narrative insured that all of the children knew that a castle is a fancy, intricate building to encourage them to build complex structures. The narrative also described characteristics of a castle that the children could include, but no specific instructions about the building of the castle were given. The posttest allowed children to utilize their building experiences from the experimental session and the open-ended instructions in the posttest allowed for measuring differences in cooperative interactions and building skills that carried over from the respective experimental conditions.

2.4. Procedures

2.4.1. General procedures

The children were tested in a room provided by their school or in their classrooms separated by bookshelves and tables from the ongoing activities in the larger room. All of the children's interactions were videotaped. The video camera was placed unobtrusively in a corner approximately 3 feet away from the carpet where the interactions took place, with a full view of the children, the blocks, and the structures. An external microphone (Sony V-F100) was mounted in a block and placed unobtrusively next to the carpet to capture children's verbal communications.

2.4.2. Dyad pairing

Dyads were familiar peers of the same age and gender, excluding peers who were best and worst friends. Prior to the first visit, the experimenters spent time in the classroom establishing rapport with the children. During this time, the experimenters asked the children to name their three best friends or three children they liked to play with the most. The experimenters also asked one of the teachers to name each of the children's three best friends and three children that the child did not get along with. Peers who were not named by the children or by the teacher to be best friends and by the teacher to be worst friends were paired together for the dyadic interaction. The children also had to know each other for at least one month to be paired together.

2.4.3. Pretest and posttest building tasks

A semi-structured cooperative building task that incorporated qualities of both experimental settings was presented for eight minutes to each pair of children on the first visit and again at the end of the second visit.

For the pretest the children were introduced to the carpet and the blocks (See Appendix D for script). The children were asked to build a structure with four standard predetermined characteristics. The children were given a goal, but they were able to complete the goal in multiple ways and the experimenter was only somewhat involved. Specifically, the children were told to: 1) build a house 2) with four walls, 3) a way to get inside the house (like a door), and 4) at least 2 rooms, like a place to eat and a place to sleep. They were told that they should let the experimenter know when they were done building the house, so that the children felt as though they were in control of the session. To prevent them from destroying the house once they had finished, the children were told that the experimenter would take pictures of the house. The experimenter then sat in a corner doing paperwork or tended to the camera and remained uninvolved in the interaction. To help the children manage their time, half-way through the children were told that they had four minutes left. If the dyad had not finished at the end of the eight minutes, the experimenter told the dyad that time was up because they needed to go back to their classrooms. All dyads completed the pretest; however, data are missing for one dyad because their cooperative interaction during the session could not be coded due to experimenter error during videotaping.

After the dyad had finished, the experimenter took four pictures of the house using a digital camera. The experimenter then asked the dyad to describe the house and what they had built, using standard questions and prompts. The experimenter also asked the children about their level of enjoyment during the session using an affect rating scale in which children were shown a series of five faces of varying facial expressions, ranging from a frown to a big smile, adapted from previous research on cooperative problem solving in young children (Perlmutter et al., 1989). (See Appendix D). Each child was asked to place a sticker on the face most like his or hers while building the house and told not to show their partner where they put their sticker so the children did not influence each other's ratings.

For the posttest, children were read a story about a castle, which included an additional two structural characteristics not included in the pretest. The five characteristics embedded into the story were that a castle has: 1) walls all around (i.e., four walls); 2) tall walls; 3) many rooms; 4) a door; and 5) a strong outside. At the end of the story, children were asked to build the castle like the castle in the story, but not explicitly told to include the particular characteristics included in the story as they had been in the pretest. All other procedures were identical to the pretest.

2.4.4. Experimental manipulation

In the second visit, each dyad was randomly assigned to the "play" condition or the "structured" condition. In both conditions children were given 10 minutes to complete the task.

In the "play" condition, children were told a story about two children who cannot find a place to play and the children were asked to pretend that they were the children in the story and to build a playhouse or fort to play in. The children were given non-directive suggestions for the five standard, specific characteristics to include in their playhouse, with no further instructions. These were the same characteristics included in the posttest story. Specifically, the characteristics of the playhouse were: 1) walls all around (i.e., four wall); 2) tall walls; 3) rooms; 4) a door; and 5) a strong outside (i.e., using larger blocks on the outside of the playhouse). The children were able to choose the goal (i.e., what the structure looked like), how they completed the goal and when they were finished completing the goal. Thus, the play condition was child-driven, had more flexible goal structures, and was a more play-like task.

In the "structured" condition dyads were also read a story about the two friends, but were directed to include in their structure the exact characteristics given in the story. These were the same 5 characteristics as in the play condition. They were given specific instructions, including that they must "work together", how the parts of the structures needed to be completed, what the end product should look like, and the amount of time they had to complete the goal. Thus, the structured condition had more experimenter involvement, less flexible goal structures, and was a less play-like task. Otherwise, however, it was identical to the play condition.

At the end of each story, the experimenter read a series of questions about what was to be included in the structure, and asked the children to answer them. If the children could not remember a particular characteristic, i.e. they could not or would not answer a question or they answered it incorrectly, the experimenter gave them the answer and asked the next question. The experimenter then repeated any questions that the children were unable to answer until the children were able to answer them all correctly.

Similar to the pre- and posttests, in both experimental conditions after the dyad had finished the experimenter took at least four pictures of the structures and asked the dyad to describe it. The experimenter then asked the children about their level of enjoyment during the session using the affect rating scale. The experimenter also asked the children about their understanding of the goal of the building session on the Play Rating Scale. For this scale, the children were shown a page with 2 pictures of children playing at one end, 2 pictures of children working at the other end, and a picture of toys and a picture of tools in the middle (see Appendix E). They were then asked to place a sticker on the set of pictures that was most like how they felt the session was to them. The following 3-point rating scale was used: 1 = more like working; 2 = both playing and working; 3 = more like playing. This scale was administered as an experimental manipulation check. The end points of the rating scale were counterbalanced for order. Half of the children, equal numbers across age and condition, were presented the scale with the "more like working" rating first followed by the "more like playing" rating, while the other half was presented the scale in reverse order.

2.5. Coding System

Children's building performance was coded using the pictures taken of the structures immediately after each session. Children's task performance was coded at the dyadic level using a set of rating scales created specifically for the current study, since the tasks were unique. These measures were used to compare children's task performance between conditions (i.e., play versus structured) in the experimental and posttest sessions (details below).

Children's behavior during all three sessions (i.e., pretest, experimental session, and posttest) was coded from the videotapes using the Noldus™ Observer 5.0 computer based observation software. The codes were adapted from empirical work on both cooperative problem solving and social play in young children to capture several aspects of children's cooperative interactions. The coding system thus provided a picture of preschool children's cooperative problem solving, as well as insight into the mechanisms underlying their cooperative learning. Codes were included for positive and negative behavior and communication so that both verbal and nonverbal cooperative problem solving skills were identified. It also included measures of motivation that may have influenced what children gained from cooperative interactions. It also included both modified and new measures of children's performance on the posttest to evaluate what they gained from cooperative problem solving.

2.5.1. Performance outcomes: Building performance and efficiency

Structural Complexity. Pilot testing revealed that structures can be complex on several different levels. For example, one structure may be complex because it is multi-leveled, while another structure may have only one level but has intricate parts, like several rooms. Another structure may be complex because it utilizes the colors and shapes of the blocks, such as using all of the large blocks for the outside of the structure and using all of the smaller ones inside. A different structure may include several intricate bridge type structures to link different rooms together. Thus, structural complexity was based on four criteria and summed into one composite score, which could range from 0 to 24.

Height and length of the structure. The height and length of the structure were determined by counting the number of blocks in the tallest part of the structure (vertically) and by counting the number of blocks in a row in the longest part of the structure (horizontally). The height and length scores were then each applied to the following 6-point rating scale separately: 0 = no intentional structure built; 1 = 1 to 2 blocks used; 2 = 3 to 4 blocks used; 3 = 5 to 6 blocks used; 4 = 7 to 8 blocks used; and 5 = 9 or more blocks used in the tallest or longest part of the structure. The two scores were summed for a total score ranging from 0 to 10. For example, if a structure had 5 blocks in the tallest part of the structure and only 3 blocks in the longest part, it would receive a score of 3 for height and 2 for length for a total of 5 for the height and length of the structure.

Intricacy of the structure. The intricacy of the structure was determined by summing the number of different columns (two or more stacked blocks per column) and the number of different rows (two or more blocks side-by-side per row). The two scores were applied separately to a similar 6-point rating scale and then the two numbers were summed for a total score ranging from 0 to 10. The scale used was: 0 = no intentional levels or rows; 1 = 1 to 2 levels or rows; 2 = 3 to 4 levels or rows; 3 = 5 to 6 levels or rows; 4 = 7 to 8 levels or rows; 5 = 9 or more levels or rows used in the structure. The intricacy score could range from 0 to 10.

Colors and shapes of the blocks. Each structure was given a score for the colors and shapes utilized in the structure based on the following 3-point rating scale: 0 = structure did not utilize the colors and shapes of the blocks; 1 = at least one part of the structure utilized the different colors or sizes of the blocks, for example, if a structure used the large blocks primarily to make up the bottom of the structure, or the small blocks are stacked together to make one wall of the structure, or the yellow blocks were placed in a row; 2 = at least one part of the structure utilized both the different colors and sizes of the blocks. The color and shape score could range from 0 to 2.

Bridges in the structure. Each structure was given a score for whether it contained a bridge formation. For example, when two blocks were placed parallel to one another with a space between them and another block was placed on top over the space. The following 3-point scale was used: 0 = no bridging formations; 1 = at least one bridging formation; 2 = 2 or more bridging formations. Thus, the bridge score could range from 0 to 2.

Structural Completeness. The code for structural completeness was adapted from Azmitia (1988), who created a rating scale for children's performance on a model copying task. The scale was altered to fit the current tasks. A point was given for each of the criteria given by the experimenter that the children included in their structure. The scores for the pretest ranged from 0 to 4 (i.e., one structure, 4 walls, an entrance, and at least 2 rooms). The scores for the experimental and posttest sessions ranged from 0 to 6, which included the two additional characteristics not included in the pretest (i.e., walls at least 2 blocks high and bigger blocks on the outside). Each criterion was considered independent of the other criteria. For example, if the dyad built two structures for the pretest that each had walls, an entrance and multiple rooms, they received a three because they built two structures instead of one.

*Efficiency***.** Children's efficiency in completing the structure was computed by reversing the amount of time a dyad spent on the task and multiplying it by the sum of their score of structural completeness and structural complexity (0-28 or 0-30). Dyads who used the entire session received a 1 for time on task to avoid multiplication by zero, but dyads who had zeros on all components of complexity received a zero for their efficiency score. This score gave a measure of children's efficiency in terms of both time spent to complete the task and the completeness and complexity of their structure. Higher scores indicated greater efficiency. For example, if a dyad was on-task for most of the time, but did not build a very complex structure, they received a low efficiency score. If a dyad was on-task for part of the time but built a very complex structure, they received a higher efficiency score. Efficiency scores could range from 0 to 300, but actually ranged from 0 to 191.

Number of Blocks. The number of blocks that children used in their structures was counted to provide an index of their use of the building resources available to them.

2.5.2. Social and learning process measures

The following measures of social and learning processes were included in the coding system because they reflect the various theoretical emphases on mechanisms of social facilitation and learning processes in the cooperative problem solving literature, especially those relevant to cooperation among preschool age children. Only behavior and communication related to task activities was coded.

Cooperative Behavior. The following codes were adapted from Brownell & Carriger (1990; 1991) and Ashley & Tomasello (2001). These studies investigated young children's interaction with a cooperative problem solving task. The following codes were chosen because they provide insight into young children's nonverbal attempts to coordinate actions with their partner. Frequencies of the following behaviors were coded, unless otherwise indicated.

Demonstrations. Child physically demonstrated for the other child how to do something. A demonstration was coded if it was accompanied by an explanation, suggestion, or directive before, during, or after the demonstration. An example would include a child showing a partner how to put the blocks together in a bridge formation.

Imitation. Child looked at the partner and copied the same action within 10 seconds. These included all task-related behaviors, except simply placing a block on the structure after the partner placed a block.

Controlling. Child physically controlled or blocked a partner's action. Controlling included instrumental acts such as forceful tugs or taking a piece from the partner. Aggressive, destructive, and non-instrumental acts of personal force, such as knocking down the structure and hitting or pushing the partner were not coded.

Durations for the following behaviors were coded.

Coordinated action. The length of time a child attempted to coordinate activity with the partner through physical movements. An example would include the time during which one partner took a block out the box and handed it to the other child to place on the structure. This also included helping behaviors where a child offered and/or provided the partner physical assistance in relation to completing the task, such as helping with balancing a block on top of another block.

Observation. The length of time children spent observing their partners. An observation period had to be at least two seconds in which child observes partner's building without making concurrent placements or removals of blocks.

Communication. The following codes for various aspects of peer communication were adapted from Cooper (1980), Howes (1985), Howes and Unger (1992), Gauvain & Rogoff (1989). These studies investigated the types of verbal communication preschool children use during cooperative interactions and social play. These codes were chosen because they identify children's verbal attempts to coordinate behavior with a peer. Frequencies of the following were coded.

Attention Directing/Directing. Child directed the partner's attention (e.g., "Look," while pointing to a block) or told the partner what to do, either specifically or generally, "Don't do it that way."

Asking Questions. Child asked the partner questions about the task, such as where to put a block or what the partner should do next.

Dividing Labor/ Assigning Roles. Child attempted to divide the work to complete the task or assigned complementary roles in relation to the task. An example would be a child assigning the partner to build a room while the child built the walls.

Explanations. Child explained to the partner about the child's own actions, including what she was doing, what she was going to do, or what she needed to do, such as "I need to build the walls higher to keep out the witch."

Narration. Child made a statement to the partner that described what something was or described what was happening. The statement could have been general or specific and related to the structure or the dyad. Examples include holding a block and describing to peer, “Here’s the door” or announcing to peer, “We are putting some blocks together.”

Negotiation. Child discussed with the partner a problem solving strategy or an aspect of the task and the discussion ended with mutual agreement. For negotiation to be coded the partner had to reciprocate with at least one response and then the child had to make at least one response, to produce a three-turn exchange of statement-response-response. The final response could have been a simple yes/no. Both children were given credit for the negotiation.

Suggestions/Ideas. Child gave a suggestion or an idea for the dyad or for the task, such as a way to complete the task or what could to be done. Suggestions involved the possibility of accomplishing task-related goals or changing (starting/stopping) a state of something. Examples include, “We could make a garage” and “Let’s make the door here.”

Agreement. Child made a statement of acceptance or agreement in response to an action, statement, or question that the partner made. Examples include both simple “yes” responses and agreements with specific content, such as “Yeah, that’s a table,” in response to a peer’s narration statement, “That’s the table.” Only agreements that were not part of a negotiation were coded.

Disagreement. Child made a statement of opposition, protest, or retaliation in response to an action, statement, or question that the partner made. Examples include both simple “no” responses and disagreements with specific content, such as “No, that doesn’t go there,” after the partner placed a block. Only disagreements not part of a negotiation were coded.

Experimenter. Child directed help-seeking statements, questions, or gestures to experimenter. Examples include questions about how to complete the task or where a specific block should go.

Statements and questions regarding the remaining length of time to complete the session were not included, since there was no clock available to the children.

Other task related statements. Child made a non-specific statement about the task. These included statements that are relevant to the task or building, but do not belong in any of the specific categories above, such as "This is fun."

2.5.3. Motivational measures

The following codes for task engagement and enjoyment were adapted from Azmitia (1988) and Perlmutter et al. (1989). Both studies investigated whether working alone versus working with a peer influenced the amount of time children remained engaged with a task. Azmitia found that task engagement mediated children's performance on a posttest following a cooperative interaction. Perlmutter et al. investigated whether children enjoyed working with a peer more than working alone on a problem solving task. They found that how much children enjoyed completing a task influenced their task performance. Task enjoyment was rated by both the children and by the adult coders.

Task engagement. The total time the child was engaged in the task. This included time building, time discussing the task with partner, and time looking at the other child or the task. Off-task behavior included time the child engaged in non-task related discussions and time the child was disengaged from the task, such as sitting down or walking away from the task.

Task enjoyment – Child Affect Rating Scale. After each session, children were shown a series of five simple faces, ranging in expression from a big smile to a big frown. They were each given their own copy of the faces so that the children did not influence each others' responses. They were then asked to place a sticker on the face most like theirs while they were building without showing their partner where they put their sticker. The scale ranged from 1-5 with a higher score indicating greater task enjoyment. The rating scale end points were counterbalanced so half the children, equal numbers across age and condition, were presented the scale with the positive affect faces first followed by the negative affect faces, while the other half was presented the scale in reverse order. One dyad after the pretest and two dyads after the posttest session did not complete the task enjoyment rating because one child in the dyad either refused or became distressed.

Task enjoyment- Adult Affect Rating Scale. The following rating scale was adapted from NICHD Study of Early Child Care (2002) procedures, in which children's positive and negative mood during a dyadic play interaction with a friend was coded. After coding the interaction sessions from videotape, observers rated on a scale from 1-4 the children's enjoyment of the task based on both quality and quantity of behavior. One scale was based on children's positive affect, with a higher score indicating greater smiling, laughter, positive tone of voice and/or enthusiasm expressed. The other scale was based on children's negative affect, with a higher score indicating more expressions of discontent, boredom, anger, and/or hostility. Thus, each child received a rating for positive affect and a rating for negative affect.

2.5.4. Reliability

For task performance outcome measures, interobserver reliability was established between two raters, one of whom was blind to the specific hypotheses of the study. Each observer independently coded the pictures of 21 structures (approximately 20%), equally distributed over age, gender, condition, and cooperative session. The correlation between the raters for structural complexity was r (21) = .98, $p < .001$, and percent agreement within one point was 86%. The correlation between the raters for structural completeness was r (21) = .91, $p < .01$ and percent agreement within one point was 90%. The correlation between the raters for the number of blocks used was *r* (21) = .98, $p < .001$ and percent agreement within one block was 90%.

For cooperative behavior and communication, three independent observers coded the interactions, two of whom were blind to the specific hypotheses of the project. Two of the observers established reliability with a set of tapes coded by the author. Each observer independently coded 17 of the sessions (15%), equally distributed over age, condition, gender, and session. Average percent agreement between the two coders with the master coder ranged from 54% to 97% for each child across all coded behaviors. Percent agreement across children for the individual behaviors is shown in Table 1. The individual behaviors in the coding system were not mutually exclusive, therefore Kappas were not calculated.

Table 1. Percent agreement between coders for individual behaviors

Cooperative Behaviors	**Average % Agree**	**Communication Measures**	**Average % Agree**
Demonstration	54%	Attention Directing/Directing	91%
Imitation	90%	Ask Questions	90%
Controlling	74%	Divide Labor	83%
		Explanations	92%
		Narration	95%
		Negotiation	79%
		Suggestions/Ideas	97%
		Agreements	88%
		Disagreements	86%
		Verbalizations to Experimenter	85%
		Other Task-Related Statements	46%

For the cooperative behaviors, demonstrations occurred relatively infrequently, which accounts for the reduced agreement. For total time coordinating action and observing peer, both coded in seconds, the correlation between the raters was $r = .95$, $p < .001$, and $r = .92$, $p < .001$, respectively. Because the reliability was so low for other task related statements, this code was not used in the analyses. For the motivational measures, the correlation between the raters for total time on task, which was coded in seconds was $r = .96$, $p < .001$; for the adult positive affect rating, the correlation between the raters was $r = .95$, $p < .001$ and percent agreement within one point was 90%; for the adult negative affect rating, the correlation between the raters was $r = .95$, $p < .001$, and percent agreement within one point was 93%. For children's rating scales, the correlation between dyad members' ratings of task enjoyment was $r = .20$, $p = .38$, and percent agreement within one point was 78%; for the play rating scale, the correlation between dyad members was $r = .14$, $p = .40$ and percent agreement within one point was 87%.

2.6. Data Reduction

Means and standard deviations of the performance, process, and motivational measures are presented in Table 2. Because children's behavior within a dyad is not independent; measures were averaged over the two children so the dyad was the unit of analysis. Composite variables were created on both theoretical and empirical grounds. First, preliminary analyses were conducted to create composite variables for the performance outcome measures. Structural complexity and structural completeness were significantly correlated for all three sessions (see Table 3, 4, & 5). Therefore, they were made into a composite of Total Building Performance. Although number of blocks was significantly correlated with structural complexity and structural completeness, it provided a global measure of children's use of building resources, while structural complexity and completeness were more precise measures of children's actual building performance. Therefore, number of blocks was analyzed separately.

Preliminary analyses were also conducted on the social and learning process measures. The correlations among the measures were not consistent across the sessions (see Table 3, 4, 5).

Therefore, composites were created on theoretical grounds (see Table 6). Measures of children's social processes that reflect behavior and communication that are presumed to be productive for cooperative problem solving were summed to create the composite, Cooperative Interaction. Positive communication to the peer that did not necessarily directly influence the partner's actions was summed to create a separate composite of Joint Communication. Various means of coordinating behavior was standardized and summed to create the composite Shared Task Responsibility.

Unproductive or uncooperative behavior and communication were also summed to create the composite, Uncooperative Behavior and Communication. Observation and imitation were standardized and summed into a composite of Observational Learning. Alpha scores were not computed for these measures because they reflected different processes that may not necessarily be observed in the same children. For example, some children may be more likely to talk to an experimenter than control their peers' actions, but both behaviors reflect negative, uncoordinated behavior. Similarly, children who spend time observing their peer's actions may not necessarily imitate them, and vice versa, but both are important components of observational learning. The motivational measures, time on task and adult and child ratings of task enjoyment, were not correlated and therefore were not made into composites.

Table 2. Means and standard deviations as a function of session for the performance, process, and motivation measure

Measures [1]	Pretest	Experimental Session: Play Condition	Experimental Session: Structured Condition	Posttest
Performance Outcomes				
Complexity [2]	15.05(4.02)	16.21 (13.66)	13.79 (5.11)	11.84 (5.49)
Completeness [3]	2.39(1.15)	3.63 (1.64)	3.21 (1.81)	3.00 (1.91)
Efficiency	56.10(30.16)	82.12 (46.27)	67.72 (43.48)	43.83 (31.07)
Number of Blocks	43.53(20.42)	49.16 (21.44)	41.32 (23.00)	35.16 (21.98)
Process Measures				
Demonstrate	0.23 (0.56)	0.26 (0.69)	0.24 (0.75)	0.08 (0.23)
Imitate	0.14 (0.33)	0.13 (0.47)	0.00 (0.00)	0.04 (0.26)
Control	0.03 (0.11)	0.55 (0.88)	0.16 (0.34)	0.21 (0.50)
Coordinated Action [4]	254.27 (167.07)	253.59 (210.90)	330.89 (209.41)	225.63 (171.47)
Observe [4]	3.34 (11.70)	10.45 (16.30)	7.55 (15.15)	12.86 (56.45)
Direct	1.80 (2.12)	2.84 (3.63)	1.89 (1.34)	2.08 (1.73)
Questions	1.18 (1.53)	0.58 (1.0)	0.55 (1.39)	0.87 (1.03)
Divide Labor	0.03 (0.16)	0.24 (0.63)	0.08 (0.19)	0.08 (0.19)
Explain	2.08 (2.09)	2.84 (2.57)	3.26 (3.29)	2.79 (2.14)
Narrate	3.85 (3.20)	5.24 (3.99)	4.84 (4.65)	5.50 (3.85)
Negotiate	0.92 (2.10)	0.95 (1.65)	1.16 (1.92)	0.55 (0.97)
Suggest	2.85 (3.32)	3.84 (3.22)	2.58 (2.23)	2.37 (2.34)
Agree	1.51 (1.71)	1.29 (1.44)	1.16 (2.00)	1.21 (1.98)
Disagree	1.07 (1.11)	2.18 (2.09)	1.76 (2.21)	1.84 (2.48)
To Experimenter	1.89 (2.25)	2.79 (3.24)	2.42 (2.38)	2.84 (2.90)
Motivation Measures				
Task engagement [4]	334.53 (124.90)	386.46 (183.21)	429.09 (144.75)	333.88 (133.72)
Children's affect rating [5]	4.22 (1.06)	3.63 (1.13)	4.32 (0.89)	3.50 (1.06)
Adult pos. affect rating [6]	2.57 (0.58)	2.34 (0.55)	2.45 (0.52)	2.61 (0.70)
Adult neg. affect rating	1.15 (0.31)	1.34 (0.69)	1.42 (0.63)	1.37 (0.60)

1. Measures were averaged over the two children in a dyad
2. Complexity scale ranged from 0-24
3. Completeness scale ranged from 0-4 (pretest) and 0-6 (experimental and posttest sessions)
4. Coded in seconds
5. Child rating scale ranged from 1-5
6. Adult rating scale ranged from 1-4

Table 3. Correlations between performance, process and motivational measures for the pretest session

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Performance Outcomes (n = 38)																							
1. Complexity		.32*	.11	.69**	.15	-.20	-.09	.34*	-.29	.21	.08	.06	.25	.32	.16	.23	.36*	.04	.20	.44*	.07	.30	-.09
2. Complete			.11	.36*	.24	.18	-.08	.45**	-.35*	.02	.00	.12	-.01	.21	.07	.27	.35*	.05	-.11	.22	.12	.12	-.10
3. Efficiency				-.08	-.01	-.11	.06	-.46**	-.16	-.15	-.13	.08	-.10	-.25	-.29	-.10	-.02	-.04	-.32	-.80***	.07	-.13	.03
4. No. of Blocks					-.03	.06	-.02	.25	-.25	-.14	-.03	.20	.19	.16	.18	.13	.24	-.15	.05	.48**	.07	.35*	-.18
Process Measures (n = 37)																							
5. Demonstrate						-.06	-.10	.20	-.06	.11	.11	-.10	-.08	.37*	.15	.28	.27	.24	.13	.09	.05	.21	-.11
6. Imitate							.09	-.13	.42*	-.09	-.02	-.10	-.10	-.23	.00	-.02	.00	-.03	-.04	.03	.16	-.11	.03
7. Control								-.03	.12	-.03	.25	-.06	-.01	.16	-.05	.01	-.07	-.01	-.15	-.09	.23	.00	.40*
8. Coor Action									-.26	.28	-.04	.13	-.04	.37*	.22	.45**	.45**	.12	.15	.68***	.04	.28	-.06
9. Observe										-.03	.07	-.07	.13	-.06	.25	-.01	-.05	.36*	.14	-.11	.22	-.02	.11
10. Direct											.39*	-.12	.15	.46**	.21	.38*	.44**	.43**	.19	.19	.13	.06	.62***
11. Questions												-.07	.29	.47**	.40*	.15	.22	.25	.23	.13	.15	.26	.39*
12. Divide Labor													-.10	-.14	.01	-.11	.10	-.12	-.10	.04	.11	.17	-.15
13. Explain														.40*	.34*	.14	.04	.49**	.29	.13	-.19	.09	.09
14. Narrate															.36*	.57***	.54**	.42**	.31	.35*	-.18	.24	.23
15. Negotiate																.44**	.45**	.41*	.30	.32	.14	.29	.03
16. Suggest																	.72***	.43**	.12	.23	.01	.29	.21
17. Agree																		.33*	.01	.24	.10	.29	.28
18. Disagree																			.15	.00	.00	.25	.23
19. To Exper																				.34*	-.07	.28	-.22
Motivation Measures (n = 37)																							
20. Task engage																					-.01	.30	-.10
21. Children's affect rating																						.17	.13
22. Adult positive affect rating																							-.26
23. Adult negative affect rating																							

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

Table 4. Correlations between performance, process and motivational measures for the experimental session

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Performance Outcomes (n = 38)																							
1. Complexity		.49**	.18	.87***	.25	.03	.16	.14	.22	.08	.17	.37*	.26	.38*	.27	.18	.36*	.27	-.16	.20	-.20	.17	-.12
2. Complete			.24	.42**	.17	.12	-.05	.32	-.22	.06	.25	.14	.05	.28	.09	.36*	.24	.18	-.07	.14	-.21	.27	-.15
3. Efficiency				.03	-.25	-.09	-.32	-.56***	.38*	-.21	-.15	-.05	-.34*	-.14	-.20	-.46**	-.26	-.20	-.27	-.85***	.11	-.06	-.28
4. No. of Blocks					.15	.08	.02	.22	.00	.01	.17	.31	.18	.29	.18	.20	.33*	.12	-.10	.33*	-.11	.12	-.23
Process Measures (n = 38)																							
5. Demonstrate						-.10	.09	.39*	.30	.22	.34*	.10	.21	.21	.23	.45**	.52**	.27	-.23	.32*	.03	.20	.05
6. Imitate							.04	-.28	.10	-.07	-.12	-.08	-.20	-.20	-.12	-.20	-.13	-.11	-.05	.09	.20	-.26	-.03
7. Control								.14	.35*	.68***	.21	.08	.26	.12	-.02	.22	.13	.39*	.24	.29	-.04	.03	.69***
8. Coor Action									.00	.31	.37*	.25	.28	.33*	.36*	.67***	.45**	.17	-.07	.73***	-11	.38*	.11
9. Observe										.17	.05	.09	.37*	.30	.20	.11	.26	.37*	-.04	.34*	-.08	-.04	.27
10. Direct											.48**	-.16	.28	-.02	.03	.32*	.27	.48**	.01	.30	.05	.06	.67***
11. Questions												.30	.45**	.37*	.36	.48**	.72***	.34	.02	.26	-.05	.35*	.31
12. Divide Labor													.30	.25	.46	.38**	.28	.02	.04	.17	-.34*	.42**	-.08
13. Explain														.54***	.38*	.31	.55***	.33*	.19	45**	-.08	.15	.43**
14. Narrate															.45**	.34*	.52**	.35**	.15	.31	-.39*	.21	.21
15. Negotiate																.45**	.61***	.08	.03	.28	-.08	.42**	.15
16. Suggest																	.56***	.32*	.09	.58***	-.18	.48**	.07
17. Agree																		.12	-.08	.40**	-.10	.28	.19
18. Disagree																			.06	.28	-.11	.10	.39*
19. To Experimenter																				.22	.21	.29	.16
Motivation Measures (n = 38)																							
20. Task engage																					.07	.27	.21
21. Children's affect rating																						.07	-.03
22. Adult positive affect rating																							-.09
23. Adult negative affect rating																							

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

Table 5. Correlations between performance, process and motivational measures for the posttest session

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Performance Outcomes (n = 38)																							
1. Complexity		.76***	.26	.87***	.15	.06	-.04	.57***	.16	.28	.15	.01	.25	.46**	.39*	.31	.38*	.18	-.08	.59***	-.15	-.19	-.21
2. Complete			.33*	.66***	.03	-.02	-.08	.48***	.11	.12	.09	-.06	.15	.36*	.22	.35*	.28	.37*	-.28	.39*	.02	-.16	-.18
3. Efficiency				.01	-.04	-.12	-.09	-.27	.00	-.24	-.28	-.14	-.16	-.18	-.11	-.28	-.16	-.05	-.30	-.50***	.06	-.38*	-.05
4. No. of Blocks					.08	-.06	.02	.61***	.22	.33	.20	.06	.36*	.50	.40	.37*	.40*	.18	-.02	.65***	-.22	-.20	-.18
Process Measures (n = 38)																							
5. Demonstrate						-.08	-.16	.24	.25	.14	-.05	.26	-.26	.06	.36*	.14	.18	-.14	-.03	.18	.07	-.12	-.22
6. Imitate							-.09	-.19	-.04	-.13	-.06	-.09	-.07	.02	-.13	-.15	-.06	.03	-.12	.15	.30	.06	-.02
7. Control								-.05	-.08	.33*	.29	.06	.27	-.06	-.19	.03	.02	.25	-.24	.05	-.14	-.25	.85***
8. Coor Action									.10	.47**	.42**	.08	.25	.55***	.49**	.50**	.43**	.24	-.18	.73***	-.37	.19	-.26
9. Observe										.03	.15	.20	.04	.36**	.04	.20	.16	-.10	-.06	.15	-.21	-.45**	-.14
10. Direct											.66***	.36*	.39*	.11	.36*	.30	.17	.25	.01	.34*	-.07	.13	.20
11. Questions												.29	.36*	.12	.13	.32*	.22	.07	.03	.45**	-.24	.20	.09
12. Divide Labor													.17	.06	.55***	.27	.11	-.04	.17	.17	.21	.01	.07
13. Explain														.24	.11	.34	.11	.33*	-.07	.36*	-.31*	-.07	.19
14. Narrate															.32	.62	.56	.22	-.04	.54	-.32	.00	-.12
15. Negotiate																.49	.50	.07	.10	.35	-.02	.33	-.26
16. Suggest																	.75	.36	-.13	.55	-.16	.15	-.10
17. Agree																		.07	-.13	.42	-.27	.18	-.13
18. Disagree																			-.22	.18	.02	-.02	.26
19. To Experimenter																				.06	.10	.25	-.11
Motivation Measures (n = 36)																							
20. Task engage																					-.28	.11	-.19
21. Children's affect rating																						.00	.17
22. Adult positive affect rating																							-.26
23. Adult negative affect rating																							

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

Table 6. Composite measures of performance outcomes, social and learning processes, and motivation measures included in analyses

Dependent Measures	Cronbach's Alpha	Codes
Performance outcomes		
1. Building Performance	X	Structural Complexity + Structural Completeness
2. Efficiency		
3. Number of Blocks		
Process measures		
1. Cooperative Behavior & Communication	.54	Questions + Explanations + Directives + Demonstrations
2. Joint Communication	.73	Suggestions + Narrations + Agreements
4. Sharing Task Responsibility	.52	Coordinated action + Negotiation + Divide Labor
3. Uncoordinated Behavior & Communication	X	Control Peer + Disagreements + Verbalizations to Experimenter
5. Observational Learning	X	Observation + Imitation
Motivation measures		
1. Task engagement		
2. Adult Rated Task Enjoyment - Positive and Negative Affect		
3. Child Rated Task Enjoyment		

3. RESULTS

3.1. Preliminary Analyses

Means and standard deviations of the dependent measures as a function of age and gender averaged across the 3 sessions are presented in Table 7. The adult rating of negative affect was extremely low. Very few children displayed any form of negative affect across the cooperative sessions; consequently the rating was not included in any of the analyses.

Preliminary analyses were conducted to confirm that there were no differences in the performance outcome measures, the social process measures, and the motivation measures among the six different child care centers where the cooperation data was collected. Differences were not expected since all of the child care centers were similar in quality and all served a similar population of families. Repeated measures ANOVAs were conducted with session (pretest; experimental; posttest) as the within-subjects factor, and child care center as the between-subjects factor. The dependent measures were the 3 performance outcome measures, the 5 social process measures, and the 4 measures of motivation, which were each tested individually. As expected, no significant differences in any of the measures due to child care center were found.

Similarly, preliminary analyses were conducted to confirm that there were no experimenter administration effects. Additional repeated measures ANOVAs were conducted with session (pretest; experimental; posttest) as the within-subjects factor, and the experimenter as the between-subjects factor. Again, the dependent measures were the performance outcome measures, the social process measures, and the measures of motivation, which were each individually tested. These analyses confirmed that there were no differences due to experimenter administration; therefore all analyses were conducted on data collapsed over both experimenters. T-tests were also conducted on children's affect rating and play rating manipulation check to determine that there were no differences for the order in which the end points of the scales were presented.

Zero-order correlations were conducted on the process, motivation and outcome measures for each of the three sessions to identify associations among the measures. As presented in Table 8, the three process measures, sharing task responsibility, cooperative interaction, and joint communication were significantly correlated. Multivariate analyses of variance (MANOVAs) were conducted with these variables to control for experimentwise error given that these dependent measures were intercorrelated. The other two process measures, observational learning and uncooperative behavior, were analyzed separately since they were not correlated with any of the other process measures. For the performance outcome measures, only two of the three measures were correlated (see Table 9), and as a result these were analyzed separately in the subsequent analyses. The motivation measures were also not correlated with one another (see Table 10) and were analyzed separately.

Table 7. Means and standard deviations as a function of age and gender for the performance, process, and motivational measures averaged across sessions

Composite Measures [1]	All Dyads	4-year-olds dyads		5-year-olds dyads	
		Boys	Girls	Boys	Girls
Performance outcomes					
Total Building Performance [2]	17.68 (4.30)	14.17 (4.63)	17.27 (3.75)	18.89 (3.10)	20.81 (2.73)
Efficiency	59.66 (28.99)	59.07 (30.14)	51.58 (24.89)	81.29 (28.95)	50.06 (26.04)
Number of Blocks	42.49 (16.36)	29.86 (19.15)	45.90 (13.98)	47.30 (15.82)	47.93 (9.03)
Process measures					
Cooperative Interaction	6.06 (4.15)	5.22 (2.89)	4.90 (3.53)	6.04 (2.99)	8.30 (6.16)
Joint Communication	8.59 (5.98)	8.22 (5.98)	7.33 (5.56)	9.27 (4.39)	9.78 (8.06)
Sharing Task Responsibility [3]	-0.01 (1.82)	-0.75 (1.56)	0.70 (2.53)	-0.26 (1.36)	0.26 (1.39)
Observational Learning [3]	0.67 (10.39)	0.33 (1.24)	-0.06 (0.97)	-0.65 (0.03)	0.32 (1.24)
Uncoordinated Behavior & Communication	3.96 (2.21)	3.88 (2.28)	3.78 (2.05)	4.70 (2.50)	3.57 (2.25)
Motivational measures					
Task engagement [4]	360.38 (115.56)	311.93 (119.50)	394.74 (106.62)	299.64 (110.52)	430.03 (83.62)
Adult Rated Positive Affect [5]	2.49 (0.76)	2.43 (0.37)	2.51 (0.59)	2.47 (0.40)	2.52 (0.69)
Adult Rated Negative Affect	1.31 (0.44)	1.38 (0.44)	1.67 (.18)	1.20 (0.34)	1.50 (0.65)
Child Rated Task Enjoyment [6]	3.97 (.74)	4.14 (0.83)	3.89 (0.89)	3.85 (0.35)	3.98 (0.82)

1. Measures were averaged over the two children in a dyad and over the 3 sessions
2. Building Performance scale ranged from 0-30
3. Measures were standardized and summed to create composite
4. Coded in seconds
5. Adult rating scale ranged from 1-4
6. Child rating scale ranged from 1-5

Table 8. Correlations between the cooperation and learning process measures across the 3 sessions

	Pretest (n = 37)					Experimental (n = 38)					Posttest (n = 38)				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Pretest															
1. Coop Interaction		.56***	.22	-.03	.54**	**.77*****	.44**	.46**	.08	.37*	**.49****	.14	.18	-.15	.34*
2. Joint Communication			.45**	.10	.37*	.54**	**.58*****	.51**	.26	-.07	.20	**.40***	.18	-.11	.19
3. Share Responsibility				-.10	.24	.25	.57***	**.58*****	.00	-.06	.05	.37*	**.31**	.05	.01
4. Observation Learning					.14	.00	-.14	-.15	**.29**	.21	-.15	-.18	-.16	**.07**	.18
5. Uncoop Behavior						.36*	.44**	.45**	-.06	**.20**	.08	.15	.15	.05	**.28**
Experimental Session															
6. Coop Interaction							.58***	.39*	.09	.37*	**.63*****	.34*	.18	-.10	.41*
7. Joint Communication								.68***	.04	.29	.26	**.76**	.42**	.04	.33*
8. Share Responsibility									-.06	.06	.38*	.68	**.72*****	.02	.18
9. Observe Learning										.05	-.15	-.04	.13	**.26**	.11
10. Uncoop Behavior											.08	.14	-.15	-.03	**.31**
Posttest															
11. Coop Interaction												.30	.49**	-.15	.26
12. Joint Communication													.53**	-.04	.10
13. Share Responsibility														-.02	.10
14. Observe Learning															-.17
15. Uncoop Behavior															

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

Table 9. Correlation between the outcome measures across the 3 sessions

	Pretest (n = 38)			Experimental (n = 38)			Posttest (n = 38)		
	1	2	3	4	5	6	7	8	9
Pretest									
1. Building Performance		.70***	.13	**.33***	.32	.06	**.07**	.21	-.37*
2. Number of Blocks			-.08	.44**	**.48****	.01	.02	**.16**	-.33*
3. Efficiency				.05	-.10	**.45****	.17	.10	**.28**
Experimental Session									
4. Building Performance					.84***	.22	**.56*****	.58***	-.26
5. Number of Blocks						.03	.31	**.52****	-.44**
6. Efficiency							.20	.10	**.46****
Posttest									
7. Building Performance								.86***	.30
8. Number of Blocks									.01
9. Efficiency									

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

Table 10. Correlations between motivational measures across the 3 sessions

	Pretest (n = 37)			Experimental (n = 38)			Posttest (n = 36)		
	1	2	3	4	5	6	7	8	9
Pretest									
1. Task engagement		.19	.13	**.58*****	.18	-.01	**.26**	.30	-.14
2. Adult Rated Task Enjoyment			.20	.11	**.60*****	.35*	-.08	**.46****	.19
3. Child Rated Task Enjoyment				.07	.07	**.12**	-.08	.06	**.26**
Experimental Session									
4. Task engagement					.27	.07	**.47****	.20	-.07
5. Adult Rated Task Enjoyment						.07	.00	**.50****	.24
6. Child Rated Task Enjoyment							-.37*	.17	**.43***
Posttest									
7. Task engagement								.11	-.28
8. Adult Rated Task Enjoyment									-.01
9. Child Rated Task Enjoyment									

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

3.2. Substantive Analyses

The substantive analyses are divided into 3 main sections. The first section will report age and gender differences for the performance outcome measures, the social process measures, and the motivational measures. The next section will focus on differences between the play and structured conditions during the experimental session and the posttest. In this section the differences in task performance will first be reported, followed by differences in social processes and motivational measures. Finally, analyses related to individual differences in cooperation on performance differences will be reported.

3.2.1. Age and gender differences

The following analyses were conducted across all three sessions to determine overall age differences. Therefore, these analyses were conducted separately from the analyses investigating the differences between the two experimental conditions which focused only on the experimental and posttest sessions. Although gender differences were not expected, main and interaction effects of gender with age were also tested to determine whether gender should be retained as a factor in the subsequent analyses.

Performance outcome measures. As Table 7 shows, preschool dyads built fairly complex structures (M = 17.68; SD = 5.58). It was hypothesized, however, that older children would produce more complex buildings, use a greater number of blocks in their structures, and build their structures more efficiently than younger children. To test whether there were significant age and/or gender differences in the outcome measures, three separate 3 x 2 x 2 repeated measures ANOVAs were conducted with session (pretest; experimental; posttest) as the within-subjects factor, and age (older, younger) and gender as the between-subjects factors. The dependent measures were the building performance composite, number of blocks in the structures, and efficiency in building. Significant effects emerged for age on children’s building performance, *F* (1, 34) = 12.08, *p* < .01. As predicted, across the three sessions older preschool children built more complex and complete structures (*M* = 19.85) than the younger children (*M* = 15.72). Similarly, older children (*M* = 47.61) used a greater number of blocks in their structures than the younger children (*M* = 37.89), *F* (1, 34) = 3.95, *p* = .05. Although the older preschoolers tended to build their structures more efficiently than the younger children, these differences were not significant. Thus, the 5-year-old children tended to build more complete and complex structures with more blocks than the 4-year-old children, but not necessarily more efficiently.

Although gender differences were not predicted, surprising differences emerged between boys and girls on the building performance measures. Girls (*M* = 19.04) built more complex and complete structures than boys (*M* = 16.53), *F* (1, 34) = 4.46, *p* < .05. Girls (*M* = 46.91) also tended to use more blocks in their structures than boys (*M* = 38.91), although this difference was only marginally significant, *F* (1, 34) = 2.90, *p* = .09. Even though girls built more complex structures than boys, the boys (*M* =70.18) built their structures more efficiently than the girls (*M* = 50.82), *F* (1, 33) = 4.52, *p* < .05. Thus, across the three sessions, girls built more complex structures than boys, but boys built their structures more efficiently than girls.

Cooperation and learning processes. Similar to building performance, it was also hypothesized that across all three sessions the older preschool children would engage in greater amounts of coordinated behavior and communication, share more task responsibility, engage in more joint communication and less negative uncooperative behavior, and would use observation and imitation more often than younger children. As Table 7 shows, older children tended to engage in greater amounts of cooperative interaction, joint communication, shared more task responsibility, as well as engaged in greater amounts of uncooperative behavior than younger children. As in building performance, no gender differences were predicted, although there seemed to be some trends; girls tended to engage in more cooperative behavior, joint communication, and share more task responsibility, as well as engage in less uncooperative behavior than boys. Therefore, both age and gender main and interactions effects were tested.

A 3 x 2 x 2 repeated measures MANOVA was conducted with session (pretest; experimental; posttest) as the within-subjects factor, and age (older, younger) and gender as the between-subjects factors with cooperative behavior and communication, shared task responsibility, and joint communication as the dependent variables. Two additional 3 x 2 x 2 repeated measures ANOVAs were conducted with session (pretest; experimental; posttest) as the within-subjects factor, and age (older, younger) and gender as the between-subjects factors with observational learning and uncooperative behavior as each of the dependent variables. An unexpected age by gender interaction emerged for observational learning, F (1, 33) = 4.09, p = .05. Specifically, post hoc T-test revealed that across the three sessions 4-year-old boys (M = 0.33) and 5-year-old girls (M = .32) utilized observation and imitation more than 5-year-old boys (M = -0.65), t (16) = 2.47, p < .05, t (15) = -2.21, p <.05, respectively. No other significant age or gender effects were found on the process measures. Although there seemed to be trends for older children to engage in greater amounts of cooperative behavior and communication than younger children, these differences were not significant, except for observational learning where older girls and younger boys engaged in more observation and imitation than older boys.

Motivational Measures. As previously reported, older children built more complete and complex structures than younger children. These age differences may then also emerge for children's motivation towards the task. That is, older children may have spent more time on the task and enjoyed the task more than younger children. Similar differences may also emerge for boys and girls, since there were performance differences between genders. To test these possibilities, three separate 3 x 2 x 2 repeated measures ANOVAs were conducted with session (pretest; experimental; posttest) as the within-subjects factor, and age (older, younger) and gender as the between-subjects factors. The dependent measures were the adult and child ratings of task enjoyment, and time engaged with the task. There were no significant age differences, but significant effects did emerge for gender on the amount of time children spend on task. Specifically, girls (M = 412.39) spent more time on engaged with the task than boys (M = 305.79), F (1, 33) = 9.47, $p < .01$, which is consistent with the finding that boys built their structures more efficiently than the girls. Although there were building differences between the older and younger preschool children, there were no differences between the ages on the time they engaged with the task or their enjoyment of the tasks, as rated by adults and the children. Similarly, there were no differences between boys and girls on their own ratings of task enjoyment, even though girls built more complex structures than boys.

In sum, the 5-year-old children built more complete, complex structures using a greater number of blocks than younger children. However, a similar pattern of age differences was not found for cooperation processes or motivational measures. Although there was a trend for older children to engage in greater amounts of cooperative behavior and communication than younger children, the differences were not significant. Both older and younger children seemed to enjoy the task the same, as rated by an adult observer and by the children themselves. Although none were predicted, some effects were found for gender on the outcome, process and motivational measures. Specifically, girls built more complete and complex structures than boys, but less efficiently than boys. Furthermore, older girls and younger boys tended to use observational learning more than older boys. Thus, cooperative problem-solving on building tasks varies by both age and gender during the preschool years.

3.2.2. Pretest differences

The pretest served as a control or baseline measure of children's building abilities and cooperative problem solving skills for the experimental condition. Means and standard deviations for the dependent measures in the pretest session for the two conditions are presented in Table 11. Pretest differences between the play and structured condition were not expected, since children were randomly assigned to the two conditions. To confirm this, a 2 x 2 MANOVA with age and gender was conducted on the three cooperative process measures in the pretest with experimental setting (play versus structured) as the independent variable. Separate 2 x 2 ANOVAs were conducted on the other two process measures, observational learning and uncoordinated behavior, with experimental setting (play versus structured) as the independent variable. Similarly, separate 2 x 2 ANOVAs were conducted on the three motivational measures and the three performance outcome measures. No significant differences between the two settings emerged for any of the above analyses and therefore the pretest measures were not controlled in subsequent analyses.

Table 11. Means and standard deviations for the pretest performance, process, and motivational measures for the two conditions

Composite Measures [1]	Play Condition	Structured Condition
Performance outcomes		
Total Building Performance [2]	16.68 (4.61)	18.21 (4.43)
Efficiency	59.85 (26.77)	52.15 (33.70)
Number of Blocks	42.21 (21.14)	44.21 (20.17)
Process measures		
Cooperative Interaction	5.68 (4.58)	4.86 (3.81)
Joint Communication	7.18 (5.80)	9.31 (7.51)
Sharing Task Responsibility [3]	-0.44 (1.66)	0.47 (2.12)
Observational Learning [3]	0.01 (1.25)	-0.01 (2.09)
Uncoordinated Behavior & Communication	3.16 (2.65)	2.81 (2.69)
Motivational measures		
Task engagement [4]	303.92 (128.87)	366.83 (115.33)
Adult Rated Task Enjoyment [5]	2.47 (0.49)	2.67 (0.66)
Child Rated Task Enjoyment [6]	3.97 (1.10)	4.47 (0.99)

1. Measures were averaged over the two children in a dyad
2. Building Performance scale ranged from 0-28
3. Measures were standardized and summed to create composite
4. Coded in seconds
5. Adult rating scale ranged from 1-4
6. Child rating scale ranged from 1-5

3.2.3. Differences in play and structured conditions

Did the children perceive differences in the play and structured settings? The manipulation check administered at the end of the experimental session revealed that many of the dyads in the play condition felt that the building task was more like playing than like working. Specifically, 10 of the 19 dyads in the play condition rated the task as more like playing, while 10 of the 19 dyads in the structured condition rated that the task was like both working and playing. The following section will report analyses conducted to test where there were differences between the two conditions on: 1) building performance; 2) cooperation and learning processes; and 3) motivational measures during the experimental and posttest session. Means and standard deviations for the dependent measures for the experimental and posttest sessions for each condition are presented in Table 12. The pretest session was not included in the analyses since it served only as a measure of baseline performance, which was equivalent for the two conditions as reported above.

Table 12. Means and standard deviations of the performance, process, and motivational measures for the experimental and posttest session for the play and structured conditions

Dependent Measures [1]	Play Condition		Structured Condition		Significant Differences	
	Experimental Session	Posttest Session	Experimental Session	Posttest Session	Main Effects	Interactions
Performance outcomes						
Building Performance [2]	19.84 (4.79)	19.47 (4.63)	17.00 (6.09)	14.84 (6.95)	Play>Structured	
Efficiency	82.12 (46.27)	52.21 (39.23)	67.72 (43.48)	43.83 (31.07)		
Number of Blocks	49.16 (21.44)	42.26 (19.60)	41.32 (23.05)	45.90 (13.98)		
Process measures						
Cooperative Interaction	7.24 (2.89)	6.11 (5.19)	6.71 (5.49)	5.79 (3.51)		
Joint Communication	10.37 (7.00)	9.52 (7.44)	8.58 (7.26)	7.08 (6.99)		
Sharing Responsibility [3]	-0.05 (2.67)	-0.30 (2.79)	0.05 (1.85)	-0.30 (1.66)		
Observational Learning [3]	0.29 (1.84)	0.42 (1.87)	-0.29 (1.24)	-0.42 (0.26)	Play>Structured	
Uncoordinated Behavior & Communication	5.03 (4.23)	3.66 (2.28)	4.33 (3.12)	4.84 (3.32)		
Motivational measures						
Task engagement [4]	386.46 (183.21)	348.77 (153.43)	429.09 (114.75)	333.88 (133.72)		
Adult Rated Task Enjoyment [5]	2.34 (0.55)	2.36 (0.76)	2.45 (0.52)	2.61 (0.70)		Exp Session: Structured>Play
Child Rated Task Enjoyment [6]	3.63 (1.13)	4.14 (0.83)	4.32 (0.89)	3.50 (1.06)		

1. Measures are averaged over the two children in a dyad
2. Building Performance scale ranged from 0-30
3. Measures were standardized and summed to create composite
4. Coded in seconds
5. Adult rating scale ranged from 1-4
6. Child rating scale ranged from 1-5

Performance outcome measures. It was hypothesized that the play setting would support preschool children's cooperative problem solving and that children who interacted in this condition would build more complex and complete structures, use more blocks, and build more efficiently than children in the structured setting. It was also hypothesized that these differences would carry over into a later dyadic task without explicit instructions or suggestions. To test these hypotheses, three 2 x 2 x 2 x 2 repeated measures ANOVAs were conducted with session (experimental versus posttest) as the within-subjects factor, and experimental setting (play versus structured), age (older, younger), and gender as the between-subjects factors. Age and gender were included as factors since they emerged as significant factors in the first set of analyses. Main effects for setting and session, as well interactions between experimental and posttest performance outcomes and experimental condition were tested.

As hypothesized, significant condition effects emerged for children's total building performance, F (1, 30) = 6.39, $p < .05$ (see Figure 1). Across the experimental and posttest sessions, children in the play condition built more complete and complex structures than children in the structured condition (M = 19.86, M = 16.11, respectively). There were no main or interaction effects for session indicating children in the play condition demonstrated higher building performance across both the experimental and posttest sessions. Although children in the play setting tended to use more blocks in their structures (M = 46.33, M = 38.74, respectively) and to build more efficiently (M = 65.86, M = 57.03, respectively), than children in the structured setting, these differences were not significantly different. Thus, as predicted, children in the play setting built more complete and complex structures than children in the structured condition, although not necessarily more efficiently or using more blocks.

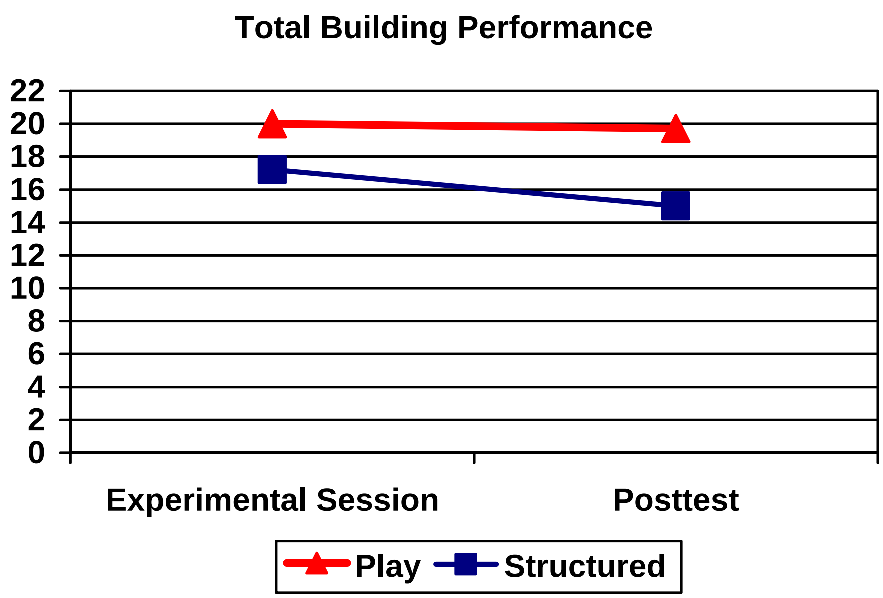


Figure 1. Total building performance between the two conditions in the experimental and posttest sessions

Cooperation and Learning Processes. It was also hypothesized that the children who interacted in the play condition would engage in greater amounts of coordinated behavior, joint communication, share more responsibility, and use more observational learning, while engaging in less uncooperative behavior than children in the structured setting. It was further predicted that these process differences in the experimental session would carry over into the posttest session. To test this hypothesis, a 2 x 2 x 2 x 2 repeated measures MANOVA was conducted with session (experimental versus posttest) as the within-subjects factor, and experimental setting (play versus structured), age (older, younger) and gender as the between-subjects factors with cooperative behavior and communication, shared task responsibility, and joint communication as the dependent variables. Two 2 x 2 x 2 x 2 repeated measures ANOVAs were conducted with the same within-subjects and between-subjects factors to test for effects on observational learning and uncooperative behavior.

Across the two sessions children in the play condition engaged in greater amounts of cooperative behavior and communication (*M* = 6.67, *M* = 6.25, respectively), shared more task responsibility (*M* = .13, *M* = -.13, respectively), engaged in more joint communication (*M* = 9.94, *M* = 7.84, respectively) and less uncooperative behavior (M = 4.34, 4.56, respectively) than children in the structured condition, but these differences were not significant. Significant condition differences did emerge, however, for observational learning, F (1, 30) = 4.97, $p < .05$ (see Figure 2). Across the two sessions, children in the play condition utilized observation and imitation more than children in the structured condition, (*M* = .39, *M* = -.37, respectively). Play seems to particularly support observational learning, in that zero-order correlations revealed that observational learning during the posttest was significantly correlated with children's scores on the Play Rating Scale, r (38) = .33, p <.05. Specifically, across the two conditions, children who felt like the experimental session was more play-like also utilized observation and imitation more than children who felt that the task was more like working.

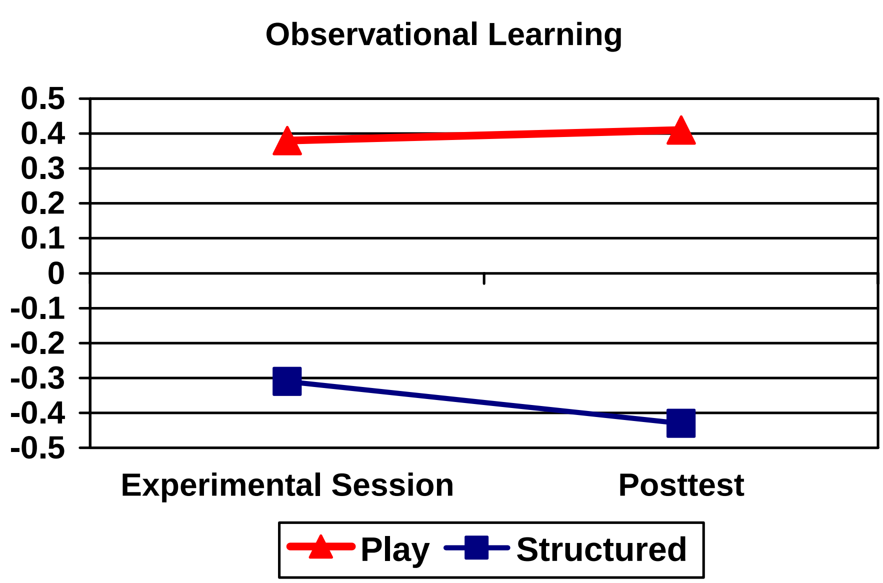


Figure 2. Observational learning between the two conditions in the experimental and posttest sessions

Motivational Measures. It was hypothesized that children in the play condition would enjoy the building task more and would spend more time on task than children in the structured condition. To test this hypothesis, 2 x 2 x 2 x 2 repeated measures ANOVAs were conducted with session (experimental versus posttest) as the within-subjects factor, and experimental setting (play versus structured), age (older, younger) and gender as the between-subjects factors. The dependent variables were adults' rating of positive affect, children's ratings of task enjoyment, and time engaged with the task. A significant interaction emerged for condition and session on children's ratings of task enjoyment, F (1, 28) = 6.16, p < .05. Surprisingly, post hoc T-tests revealed that in the experimental session children in the structured condition rated their enjoyment of the building task higher than children in the play condition, t (36) = -2.08, p <.05, (M = 4.17, M = 3.74, respectively), whereas in the posttest session children in the play condition rated their enjoyment of the task higher than children in the structured condition (M = 3.86, M = 3.50, respectively), although these posttest differences were not significant. There were no differences between the two conditions for adult's rating of task enjoyment or the time children spent engaged with the task.

It was hypothesized that the social and learning process measures would mediate the performance differences between the two settings. None of the process measures, however, could serve as a mediating factor because there were no significant relations between the process measures and experimental condition, except for observational learning, which was not correlated with building performance. As Table 12 shows, total building performance in both the experimental and posttest session was significantly correlated with several of the process measures. Building performance in the posttest session was also significantly correlated with experimental condition performance, r (38) = .33, p < .05. However, the cooperative measures were not significantly related to condition, which is necessary for the process measures to serve as mediators between condition and building performance (Baron & Kenny, 1986). Thus, mediation analyses were not conducted.

In sum, across the experimental and posttest sessions the children in the play condition built more complex and complete structures than children in the structured condition, although they did not use more blocks to do so, nor were they more efficient. These differences emerged even though children in the structured condition rated that they enjoyed the task more than children in the play condition during the experimental session. Children in the play condition also engaged in more observational learning across both sessions than dyads in the structured condition. Because children in the play condition demonstrated greater building performance and observational learning across both sessions, this suggests that the play condition promoted greater building and observational learning in the experimental session, which also carried over into their interactions on a similar cooperative building task in the posttest session.

Table 12. Correlations between process and motivational measures with outcome measures in experimental and posttest session

	Experimental Session Outcomes			Posttest Outcome Measures		
	Building Performance	Number of Blocks	Efficiency	Building Performance	Number of Blocks	Efficiency
Experimental Session Processes						
Process Measures						
Cooperative Interaction	.24	.15	-.34*	.02	.12	-.34*
Joint Communication	.43**	.33*	-.33*	.23	.26	-.30
Share Responsibility	.35*	.42**	-.36*	.05	.18	-.44**
Observation Learning	.11	.06	-.32	.27	.21	-.12
Uncooperative Behavior	.05	.02	-.31	-.20	-.30	-.12
Motivational Measures						
Task engagement	.01	.33*	-.85***	-.06	.08	-.68***
Adult Rated Task Enjoyment	.22	.14	-.06	-.12	-.21	-.18
Child Rated Task Enjoyment	-.23	.03	.11	-.36*	-.39*	.02
Posttest Processes						
Process Measures						
Cooperative Interaction				.28	.40*	-.27
Joint Communication				.46**	.50**	-.23
Share Responsibility				.41*	.47**	-.23
Observation Learning				.14	.12	-.08
Uncooperative Behavior				.04	.12	-.31
Motivational Measures						
Task engagement				.57***	.65***	-.50**
Adult Rated Task Enjoyment				-.20	-.20	-.38*
Child Rated Task Enjoyment				-.13	-.22	.06

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

3.2.4. Individual differences

Do individual differences in cooperation predict children's building performance regardless of their experience in the play or structured setting? This section will focus of individual differences to determine whether children who are better overall at cooperating, communicating, and sharing task responsibility with their peers performed better on the building tasks, and to identify the contributions of cooperation to building performance. Because the three cooperative process measures (i.e., cooperative behavior and communication, joint communication, and sharing task responsibility) were intercorrelated a super composite of cooperative task-related behavior was created by summing these variables and then averaging across the two sessions (Cronbach's alpha = .80). A hierarchical linear regression was then conducted to determine whether cooperative behavior predicts children's building performance averaged across the experimental and posttest sessions. Age was entered first, followed by gender, then cooperative behavior. Consistent with the results reported above, age significantly predicted children's building performance, t (3, 37) = 2.70, $p < .05$; $R^2 = .19$. Additionally, children's cooperative behavior significantly predicted children's building performance, t (7, 37) = 2.56, $p < .05$; $R^2 = .38$; F (3, 37) = 6.97, $p < .001$, above and beyond age. This suggests that older children and children who engaged in greater amounts of cooperation, regardless of experimental condition, built more complex and complete structures than younger children and children who engaged in less cooperation and communication.

In sum, the analyses showed that children's problem solving as measured by their building performance increases with age and varies by gender. Differences in building performance also emerged between the play and structured conditions. Specifically, children in the play condition built more complex structures than children in the structured condition and engaged in more observational learning. Finally, children's cooperation skills predict their building performance regardless of whether they are playing together or working together in a more structured setting.

4. DISCUSSION

The present study examined cooperative play and problem solving in preschool children. Specifically, it investigated whether a cooperative problem solving setting that incorporated features of informal social play promoted cooperation, problem solving, and motivation among preschoolers more than a setting that was more structured, and whether the benefits of interacting in a play-like setting would generalize to a subsequent problem solving task. The study also examined whether 5-year-old children demonstrate greater cooperation and problem solving skills than 4-year-old children, as well as outperform them on the task.

The results suggest that preschool children can work together to solve problems to complete complex building tasks. Consistent with previous research on cooperative problem solving in young children, the preschool children in the current study demonstrated many cooperative skills and abilities, such as coordinating their behavior, explaining their actions, and asking their peer questions (Bearison et al., 1986; Cooper, 1980; Perlmutter et al., 1989). Also consistent with previous research, children's performance on the joint tasks increased with age (Ashley & Tomasello, 1998; Cooper, 1980; Perlmutter et al., 1989). However, unlike other experimental studies on cooperative problem solving in young children, the current results demonstrate that preschool children benefit by working with a peer of equal ability, especially in a setting that is more flexible and child-driven like informal social play. Children who interacted in the play-like condition, even though it varied only slightly varied from the structured condition, built more complex buildings and engaged in more observational learning. Furthermore, regardless of condition, children who engaged in more cooperative interaction with their peer also built more complex structures. This suggests that play-like conditions support children's joint behavior and communication and that it is important to utilize age-appropriate settings to promote cooperation in young children, as well as to accurately assess their interactive skills in and learning from cooperative interactions. Each of these points will be discussed in further detail below. The development of cooperative problem solving skills will first be discussed followed by the role of individual differences in cooperative abilities in young children's joint problem solving. Finally, the importance of play and play-like settings for preschool children's cooperation and joint problem solving will be discussed.

4.1. Development of Cooperative Problem Solving in Preschool Children

As predicted, older preschool children built more elaborate and complete structures, and did so more efficiently than younger children, which suggests that children's cooperative problem solving skills increase during the later preschool years. Several cognitive and social factors are likely to account for these age differences. First, older children were likely to have greater joint problem solving skills than younger children, such as working with a peer in identifying task-related problems, organizing plans, and executing joint solutions. This is consistent with previous literature that has found that cooperative problem solving skills and success on joint problem solving tasks increase with development through the toddler and preschool years (Ashley & Tomasello, 1998; Cooper, 1980; Perlmutter et al., 1989). For example, Perlmutter et al. (1989) found that 5-year-old dyads were more successful and efficient on joint computer problem-solving tasks than 4-year-old dyads.

In general, the current study required little specific knowledge to successfully construct a building; as a result many dyads built relatively complete and complex structures. However, the detailed coding of the buildings revealed that older children were able to better manipulate and position the blocks to create longer, taller, and more complete structures than their younger peers. This suggests that the older children were more skilled at discovering unique ways to combine and orient the blocks, constructing durable buildings, and including the specific aspects of the structures suggested by the experimenter. Thus, problem solving skills continue to develop over the preschool years and the unique tasks and the related coding system used in the current study captured the developmental progression of these skills in young children.

In addition to greater problem-solving skills, older children were also likely to have had more advanced social skills, making them better able to assist their peers, to communicate about the problem, and to coordinate their actions than younger preschool-age children. Although older preschoolers engaged in more cooperative behavior and joint communication, these hypothesized differences were not significant. This is consistent with the studies conducted by Perlmutter et al. (1989), who also found significant differences between 4- and 5-year-old dyads' performance on joint problem-solving task, but did not find significant age differences in their joint communication. Four- and five-year-old children have similar language competencies and may be too close in age for significant age differences in joint communication to be found. Perhaps if studies included samples that span even younger preschool children, then age differences in cooperative behavior and communication would be more evident.

It is also possible that a more detailed coding system of the children's joint communication or additional social cognitive measures are needed to truly capture the age differences in preschool children's cooperation and communication skills. For example, previous research has found that even though both 3- and 4-year-old dyads made comments about a task, the 4-year-old children made more relevant and significant task comments, such as evaluating the results of their own as well as their partner's actions (Cooper, 1980). In the current study, older children may have answered a peer's questions with more substantive responses rather than simple yes or no responses. Older preschool children may have also engaged in more sophisticated argumentation and negotiation, which has been shown to be related to successful cooperative problem solving in school-age children (Kruger & Tomasello, 1986). These differences, however, were not captured through quantitative measures of communication frequencies between partners, but require qualitative assessments of verbalizations.

Older preschool children may also have had more advanced social cognitive skills, such as understanding and interpreting their partner's intentions (Wellman, Cross, & Watson, 2001), which may have assisted them in coordinating with a partner to create more complex structures, regardless of their communicative abilities. Although during the preschool years children develop an understanding that others' desires, intentions, and beliefs can be different from their own (Astington & Gopnik, 1991; Wellman & Woolley, 1990), successful cooperative problem solving really requires the ability to use this understanding of others to reach joint problem solutions (Azmitia & Perlmutter, 1989; Tomasello, Kruger, & Ratner, 1993; Tudge & Rogoff, 1989). The older preschool children may have been better able to understand their partner's reasoning and then coordinate it with their own perspective to reach a solution that was acceptable for both partners, which again would not be captured in the measures used in the current study. Thus, additional social cognitive measures may be needed to further examine age differences in cooperative problem solving through the preschool years.

In addition to age differences, there were gender differences in problem solving performance, observational learning, and time spent engaged with the task. These differences were not expected since the stories used during the experimental session were gender specific, and piloting revealed that all of the tasks were engaging for both boys and girls. It was surprising that girls built more complete and complex structures than boys, since preschool boys are often more interested in building activities during free play (Moyles, 1989), and preschool boys dyads have been shown to be more successful on spatial cooperative problem-solving tasks, such as copying the location of houses in different positions (Cannella, 1992). Boys, however, built more efficiently than the girls in the current study. Given that, during free play girls have been shown to engage in more pretend play than boys (Pellegrini & Perlmutter, 1987), it is possible that in the current study the girls were more engaged in the social aspects of the session, while the boys were more interested in completing the task quickly and were willing to build less complex structures to be finished quicker. For example, a few of the girl dyads created elaborate pretend stories while building the structures. One such dyad even built tables, chairs, and a cooking area to use in the playhouse, and as a result spent the entire time adding more complexity to their structures. Furthermore, although the boys engaged in equal amounts of discussion about the task, they may have spent more time discussing building-related aspects of the task while the girls engaged in pretend-related talk, which may have contributed to the boy's greater building efficiency. As suggested above, a more detailed analysis of the content and quality of the cooperative communications may explain not only age differences but also gender differences in cooperative problem solving.

4.2. The Role of Cooperation in Preschool Children's Dyadic Problem Solving

Individual differences in cooperative abilities played an important role in young children's problem-solving performance in both the play and structured conditions. Children who engaged in greater amounts of cooperative behavior and communication overall across the experimental and posttest sessions built more complete and complex structures. Furthermore, within each session children who engaged in greater cooperative interaction also demonstrated greater task performance. Overall, cooperative interaction seems to be an important contributor to young children's problem solving, regardless of the setting.

The current findings are consistent with previous research on joint problem solving in young children, specifically with studies that have also utilized familiar activities. Gauvain & Rogoff (1989) found that individual differences in dyads' cooperation and joint communication behavior influences preschool children's task performance and learning. Specifically, they found that the subset of 5-year-old dyads in their study that demonstrated more advanced cooperation skills, such as sharing task responsibility, planned more efficient routes on a grocery planning task than others dyads of the same age who did not work as closely with their partners. Furthermore, only children who shared responsibility and cooperated with their partner learned about the task from the dyadic interaction and planned more efficient routes on subsequent planning tasks. Similarly, in 5-year-old dyads of mixed ability, expert partners, who provided more effective communication and greater opportunities for their partners to coordinate their behavior with them on a similar joint planning task, had novice partners who gained more advanced planning skills and generalized them to other planning tasks (Duran & Gauvain, 1998). Studies using model building or model copying tasks have also found that greater cooperative interaction promotes greater task performance in young children. That is, 5-year-old mixed-ability dyads built more accurate models and generalized their building skills to subsequent building tasks more than two novice partners, because the experts explained their actions, provided feedback, and spent time engaged on the building tasks more than novices (Azmitia, 1988; Verba, 1998).

Although the structured condition in the current study was more structured than the play condition, it was also likely to be familiar and play-like to young children because it shared many of the qualities of the play condition. Specifically, both conditions were quite flexible because the children could complete the building tasks in numerous ways, unlike tasks with only one correct or best solution (Bearison et al., 1986; Tudge, 1992). The structured condition was also relatively play-oriented, in that both conditions utilized a block building task, which is a familiar play activity for preschool children (Moyles, 1989). As reviewed above, studies that have used more structured and unfamiliar tasks have found that cooperative interaction and communication does not necessarily lead to greater task performance. For example, on a balance-scale task although 5-year-old dyads engaged in discussions and joint communication about the task, they did not outperform individual children on the task, nor did they perform any better on similar subsequent tasks (Tudge, 1992). Furthermore, even though 5-year-old dyads engaged in many discussions and disagreements about a spatial perspective taking task, it was not related to their task performance or learning from the cooperative interactions (Bearison et al., 1986). In the current study both the play and structured conditions were playful, age-appropriate settings that promoted cooperative behavior and communication in the preschool dyads. Thus, young partners who are better able to cooperate, guide, support, and assist their peers during cooperative interactions also achieve better problem solving outcomes on tasks or within settings that are more familiar and play-like.

The current study is not only consistent with previous experimental research on cooperative problem solving, but also supports and extends prior research on social play in young children. As previously reviewed, during social play preschool-age children engage in many of the same problem-solving behaviors needed for dyadic problem solving in more formal, structured settings, such as negotiating, dividing labor, and coordinating actions to solve problems (Howes et al, 1992; Goncu, 1987). Although theorists have proposed that preschool children learn about problems and problem solving strategies during social play (Garvey, 1990; Moyles, 1989; Rogoff, 1990; 1998; Sutton-Smith, 1979; Wyver & Spence, 1999), tasks in the social play literature are varied and not clearly defined, and the existing research does not allow for task performance and problem solving to be specifically measured. Therefore, it is difficult to draw reliable conclusions about children's cooperation and problem-solving during play or their learning through playful interactions. The current study, however, established play-like contexts that allowed for the examination of the influence of social play on problem solving. The current study found that young children demonstrate many advanced joint problem solving behaviors in play settings, such as spending time engaged with a task, making suggestions to one another, and assisting a partner to complete a problem. This study lays the groundwork for future research in examining how play and task familiarity may promote and support children's problem solving through cooperative interaction. Future research could begin by comparing tasks that are set within a familiar story, play routine, or script against the same structured tasks that are presented without such supports. For example, on the balance-scale task, one group of preschool dyads would make predictions about whether the weights would balance, but the problem would be based upon a story about a group of friends playing on a see-saw, with toys or props to facilitate children's enactment of everyday problem solving activities during play. The other group also would be given a balance-scale task, but without any reference to a story. This line of research would construct structured and play settings more directly than the current study in which play and structured settings are both relatively play-like.

Overall, the current study suggests that cooperation in play-like settings is an effective way to promote problem solving skills in young children. Unlike older school-age children who benefit from more structured, classroom-type activities, younger children may need to interact in settings that are more play-like, child-driven, and familiar. This study suggests there are importance developmental differences that need to be taken into account in designing cooperative activities and settings for young children, and that social play is an important context in which young children can solve problems cooperatively with their peers.

4.3. Differences between Play and Structured Settings

Although the play and structured conditions were similar, the play condition was more flexible and child-driven than the structured condition. In the play condition, children had more freedom to determine or control the interaction and the task goals. In contrast, in the structured condition, the experimenter presented the children the task, goals, and rules of the cooperative interaction. It was expected that the play-like features in the play condition would promote and support children's cooperative behavior and communication, motivation, and problem-solving more than in the structured setting. Specifically, it was hypothesized that children who interacted in the play condition would find the tasks more enjoyable, engage in greater problem solving, as well as greater cooperative behavior and observational learning than children in the structured condition, and this would carry over into a later dyadic problem-solving context. As hypothesized, children who interacted in the play setting built more complete and complex structures and also engaged in more observational learning than children in the structured setting. Furthermore, the advantages of interacting in the play setting also carried over into a similar dyadic problem solving task. That is, children in the play condition also built more complex structures on a subsequent task. Unlike previous experimental research, these results suggest that preschool children's problem solving benefits from cooperative interaction and that working with a peer may be an effective way for young children to gain new knowledge and to generalize it. As argued earlier, previous research may have underestimated cooperative problem solving abilities and their effectiveness in young children because the tasks and settings used in those studies were not age-appropriate and play-like.

The performance differences and differences in observational learning between the two conditions were found even though the play and structured conditions were quite similar, as suggested earlier. As previously discussed, the structured condition was fairly play-like compared to the tasks and settings used in previous experimental research; likewise the play condition was quite structured compared to those studied in the social play literature. For example, both conditions had similar familiar and engaging tasks, where all children listened to an engaging story, played with attractive and familiar toys, and interacted with a familiar classmate. Like play, both of the conditions were also quite flexible because the tasks could be completed in numerous ways. On the other hand, both conditions were also more structured than typical social play interactions, which are usually completely free from adult structuring and involvement (Rubin et al., 1983). That is, both conditions had an experimenter who set some limits to the sessions, established a set a criteria for success, and defined the play space and play themes.

Despite the similarities between the two conditions, children who interacted in the play condition differed in both problem solving and cooperative processes from children in the structured condition, although not all the differences were significant. This suggests that even the small and fairly subtle differences between the settings were sufficient to alter children's behavior. Specifically, the play condition was slightly more flexible and child-driven than the structured condition. For example, in the play condition children were only given suggestions on how to complete the task and not told specifically that they had to work together, what they had to accomplish, or the amount of time they had to complete the task. The children in the structured condition, in contrast, were instructed on what they had to include in the structures, how to complete their task, and when to complete it. Furthermore, the adults did not play as much of a role in creating the rules in the play condition as compared to the structured condition. The play condition also may have been more familiar to the children because they were able to determine exactly the way the task would be completed, much like free play activities in the classroom. Thus, the play condition was less restrictive, more flexible, less adult-driven and possibly more familiar than the structured condition. Yet despite its looser structure, the children outperformed those in the more fully specified structured condition. This is consistent with the argument developed above that play can better support and promote cooperative problem solving skills in younger children that can formal structured settings and tasks.

Why did the play condition produce better performance? The play-like features incorporated into the play condition may have supported or encouraged preschool children's trial-and-error problem solving, their control over the task goals and strategies, and their observational learning. The familiarity in the play condition may have promoted greater pretend play and playful behavior during the sessions. As the play literature suggests, providing children with opportunities to play with object materials allows them to discover properties and functions of objects (Sylva et al., 1976; Vanderburg, 1980). This may have allowed them to explore building with the blocks in ways that the children in the structured condition may not have explored. Furthermore, because the play condition was more child-driven, the children had the freedom to create goals and strategies like they do during informal social play (Moyles, 1989;

Verba, 1993), giving the children greater ownership of the session and the product. All of this may have led to them create more complex and complete structures.

It has been argued that adults should become involved in young children's social play because they can help extend and sustain joint play interactions and even assist children through difficult activities (Kitson, 1996; Simlansky, 1968). As argued earlier, however, adult inventions may actually restrict children's cooperative interactions and prevent them from independently working through problems. Adult involvement may be distracting to young children and can change their interactions and discussions (Garvey, 1990; Moyles, 1989). In both conditions in the current study, however, an adult did play a role in the task by presenting guidelines for the interactions. Therefore, it is difficult to determine exactly how the adult involvement influenced the interaction, and how much a task must be child-driven for it to support children's problem solving. Future research could compare children's cooperation and problem solving on tasks where adults and children are given varied levels of control of the interaction. For example, one group of dyads could be given complete freedom to choose and establish the theme and goal of a task. A second group could then be given some guidance by an experimenter, such as a choice of themes. A third group of dyads would have an experimenter who determined exactly how to complete the task, giving them the theme, the task to complete, how to complete it, and would remain involved in the task by giving directions and keeping the children on task. It could then be established whether there is an appropriate level of control that should be given to children to promote cooperative problem solving.

The flexibility of the play setting may have also promoted greater observational learning between the partners. As demonstrated by previous research, observational learning is an important cooperative learning mechanism for young children (Azmitia, 1988) in contrast to negotiation and co-construction, which are more important for cooperative problem solving among older children (Azmitia, 1996; Tudge & Rogoff, 1989). Play seems to particularly support observational learning because children in the current study who felt as though the task was more play-like also used observation and imitation more often. Although observational learning related to other aspects of cooperative processes and problem solving performance inconsistently, it has been shown in prior research to be a primary learning mechanism in the preschool years. During play, young children engage in imitative behavior with their peers not only to learn from them, but also to initiate and maintain social interactions, (Eckerman & Peterman, 2001). It has been suggested that play gives children opportunities to observe features of their environment that they may neglect to attend to in an environment that is more pressured or goal-oriented (Bruner, 1972). Thus, the play condition may have promoted greater observation and imitation than the structured condition because the setting seemed more relaxed, flexible, and less restrictive, which allowed children to attend more to their partner's actions. For example, children in the structured condition were given an explicit time limit, while the children in play condition were not told what their time limit was. Time constraints may pressure young children and cause them to take less time to plan and reflect on their actions and their partner's actions when completing problem solving tasks (Ellis & Siegler, 1997).

Even though the play condition promoted observational learning, as well as task performance, as hypothesized, this cooperative learning mechanism was not related to joint problem solving in the current study. It is possible that observational learning may not be as important a learning mechanism for young children as proposed. If so, the increase in observational learning in the play setting would not have contributed to children's task performance during the experimental session or performance on subsequent tasks. However, an alternative explanation is that observational learning is indeed an important cooperative learning process for young children, but it was not as relevant for the task used in the current study. Although the tasks were designed to be familiar to young children, it is possible that they may have been too familiar, in that most of the children already had the necessary skills to successfully complete the task. Even though the children observed and imitated one another, they may not have been using this to acquire more advanced structure-building skills if they already possessed sufficient skill to work on the task together and produce a satisfactory outcome. It is possible that observational learning may be more important for more cognitively challenging tasks that require learning of new or more advanced planning, reasoning, and spatial skills or problem-solving strategies.

To determine the role and importance of observation and imitation in preschool children's cooperative problem-solving and learning, it will be important for future research to include tasks that require more advanced problem-solving skills and strategies, such as problems with multiple steps or that require advanced planning, but still within a familiar, play-like framework. For example, dyads could be encouraged to build a bridge over a river to help a lost animal get back home. The children could be given building materials that would need to be constructed in a particular order to successfully complete the bridge, which would demand that they use more advanced spatial reasoning skills, as well as advanced planning skills. Such tasks could help identify how children utilize observational learning to gain new or more sophisticated strategies and skills from observing and imitating their peers, and examine whether observational learning is indeed a useful cooperative learning mechanism for young children.

Previous experimental research on cooperative problem solving has shown that preschool children do not necessarily demonstrate higher individual posttest performance following cooperative interactions (Azmitia, 1988; Perret-Clermont, 1980). The current study, however, utilized a unique design that included a dyadic posttest, which demonstrated that the advantages of interacting in the play condition carried over into a similar problem solving task in a similar interactive setting. Although older school-age children often demonstrate higher performance on individual posttests after cooperative sessions (Azmitia & Montgomery, 1993; Teasley, 1995; Tudge et al., 1996), it is possible that young children are unable to utilize the skills and knowledge they gain from cooperative interactions on individual tasks. The dyadic posttest, however, represents a context to which the learning from the experimental session can be immediately applied, much as in apprenticeship learning (Rogoff et al., 1995). This may have allowed children to more easily transfer new skills gained from the interaction to the similar task. This, then, may be the most age-appropriate way to measure the new knowledge young children may develop through cooperative interactions. Future research should investigate whether the problem solving skills gained from the cooperative interaction also transfer to different cooperative problem solving tasks, such as model- copying tasks, which requires additional building and spatial-reasoning skills, such as mentally breaking down a complex structured into reproducible parts.

Although there was a trend for children in the play condition to engage in greater cooperative behavior and communication, share more task responsibility, and engage in more joint communication during the experimental and posttest sessions, these differences were not significant. It is possible that significant differences between the two conditions would have emerged with a bigger sample, especially since the dyad was the unit of analysis and not individual children. However, even with a small sample, it is possible that if the differences between the two conditions were more distinct, then significant condition differences on the process and motivational measures would have emerged. For example, if the play condition were even more play-like, then children may have engaged in more joint discussion, observational learning, and play-like behavior. Likewise, if the structured condition were even more structured, it may have more strongly influenced the children's communications about the task. Future research should further explore these possible influences of more and less play-like settings on cooperative interactions and motivation on young children, in particular whether preschool children's ability to discuss, solve problems together, and engage in more relevant and useful discussions about the task increases with more play-like conditions and is reduced in more strictly structured conditions.

Several limitations of the current study should be noted. First, the sample used in the study was fairly small and homogenous. All of the children attended child care centers with similar curricula that promoted cooperation, cooperative activities, and social play amongst classmates. Therefore, these children had exposure and experience playing and working cooperatively with peers. It would be interesting and important to investigate children's cooperative learning in child care centers where less emphasis was placed on cooperation and more emphasis on individual activities. Another limitation of the current study is that because the pretest instructions differed from the other two trials, the pretest could only be used as a baseline control measure and did not allow for pretest-posttest comparisons, unlike previous studies on young children's cooperative problem solving. Therefore, it is difficult to assess exactly what and how much knowledge children gained from the cooperative interaction relative to their starting points. A third limitation of the study is that the children interacted with the same partner for all three sessions, and therefore it is also difficult to assess how general the skills were that carried over into the posttest task, i.e., whether they would also generalize to cooperating with a different partner. An additional limitation is that because both conditions in the study were so similar even the structured condition was not as structured as structured tasks used in previous literature. This is likely to have reduced any differences between the play and structured conditions, and it will be important for future research to contrast truly structured conditions with play conditions to better understand the importance of play settings to preschoolers' cooperative problem-solving. Finally, the building tasks in the current study were not especially demanding with respect to spatial reasoning skills, planning skills, or analogical reasoning skills, compared to many of the tasks used in previous studies. Thus, exact comparisons of task performance in the structured condition in the current study with the structured tasks used in prior research cannot be made. Moreover, the role of play in children's cooperative problem-solving may differ depending on how demanding the tasks are.

In sum, the results of the current study extend and strengthen previous experimental research on cooperative problem solving, as well as literature on social play. Unlike previous experimental research on young children, the current study suggests that cooperative interactions with a peer may be an important way for young children to gain knowledge and improve their problem solving skills. Furthermore, unlike much of the social play research, this study demonstrates that social play is a context in which children discover, develop, and practice problem solving skills. Overall, the results suggest that informal play settings both promote and support preschool children's dyadic problem solving, and are an age-appropriate context to investigate cooperative problem solving in young children.

APPENDIX A

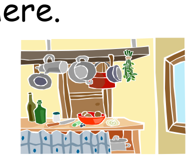
Experimental Session: Play Condtion Story (Female Version)

The Special Playhouse

Once there were two children that spent all of their time together.

Page 1

The two children always had trouble finding places to play. Everywhere they tried to play someone was already busy there.



Page 2

They could not play in the kitchen because their parents were cooking dinner for the families.

Page 3

They could not play in the living room because their grandparents were reading in the living room.

Page 4

And the children could not play in their bedrooms because thier little brothers were playing in there.

Page 5

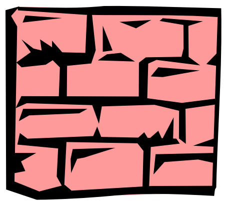
The two kids did not know what to do. They really needed a special place of their own where they could play.

Page 6

Pretend you are the two children. Can you build a playhouse or fort that would be a special place for them to play?

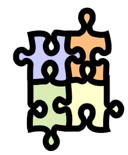
Page 7

The two kids think it would be great to have a playhouse that has really high walls all around them. Then they could play hide-and-seek and no one will be able to see them.



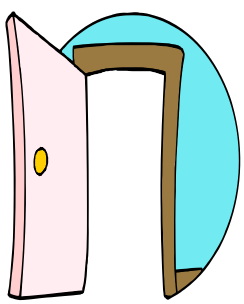
Page 8

They also want their playhouse to have special rooms, one where they can keep their toys, like their dolls, and one where they can play together, like when they are putting puzzles together.



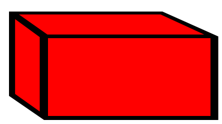
Page 9

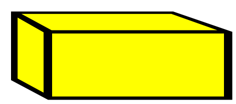
They also think it would be neat for their playhouse to have a door, so they can have a special place of their own to play.



Page 10

The children also think their playhouse should be very strong, so they would only like all the bigger blocks on the outside of the playhouse.





Page 11

APPENDIX B

Experimental Session: Strucutred Condtion Story (Female Version)

The Special Playhouse

Once there were two children that spent all of their time together.

Page 1

The two children always had trouble finding places to play. Everywhere they tried to play someone was already busy there.

Page 2

They could not play in the kitchen because their parents were cooking dinner for the families.

Page 3

They could not play in the living room because their grandparents were reading in the living room.

Page 4

And the children could not play in their bedrooms because thier little brothers were playing in there.

Page 5

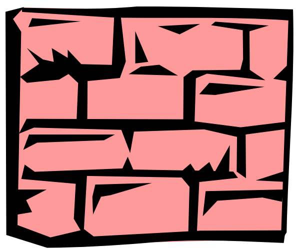
The two kids did not know what to do. They really needed a special place of their own where they could play.

Page 6

I want you to work on a playhouse for the two children. You two have to work together to build a playhouse or fort for the children. You have to work on the playhouse in this space.

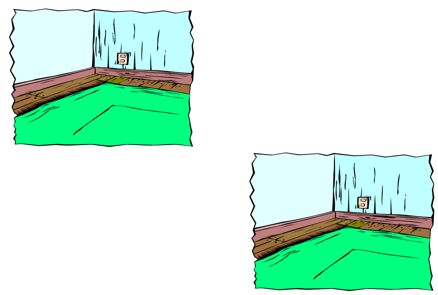
Page 7

The playhouse you work on has to have four walls and they each have to be at least two blocks high.



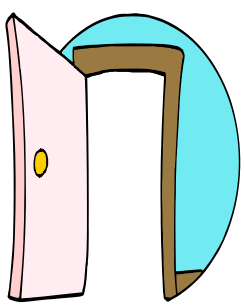
Page 8

The playhouse you work on has to have two rooms.



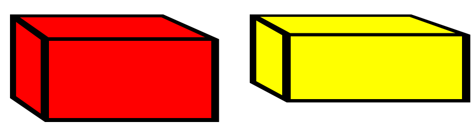
Page 9

The playhouse also has to have a door.



Page 10

When you are working on the playhouse, you have to use the bigger blocks on the outside of the playhouse.

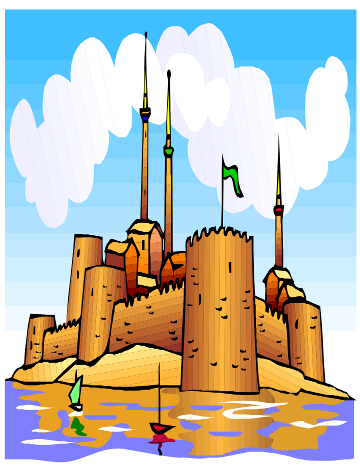


Page 11

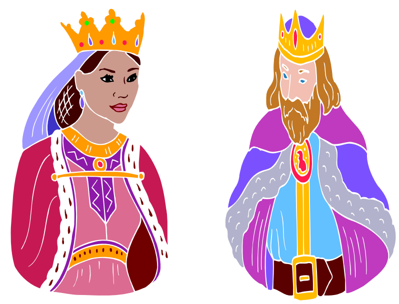
APPENDIX C

Posttest Session Story

The Magic Castle

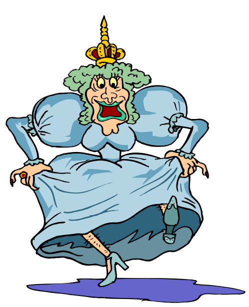


Once upon a time there was a good King and Queen. They were very kind and all of the people in the kingdom loved them.



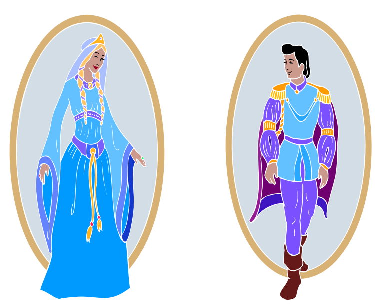
Page 1

Nearby there lived a wicked witch who tried to place an evil spell on the good King and Queen's castle.



Page 2

She was very angry that the King and Queen did not invite her to the wedding of the princess and the young prince.



Page 3

But the spell did not work because the King and Queen lived in a beautiful, magical castle.

Page 4

There were walls around the castle. These walls were so tall that the witch was not able to climb over them.

Page 5

The castle also had so many rooms that the witch would have never been able to find the King and Queen inside.

Page 6

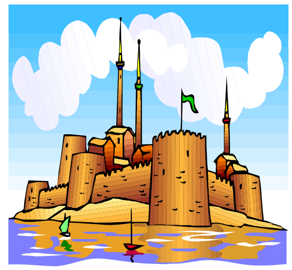
The castle had such big strong doors that the witch was never able to open them.

Page 7

And the outside of the castle was so sturdy and solid that the witch was not able to break through it.

Page 8

Can the two of you build a castle just like the castle the King and Queen live in?



Page 9

APPENDIX D

Pretest Administration Script

"Hello. This is our special carpet (*point to carpet*). All of the activities that we will be doing today will be on this carpet. Can you two please have a seat on the carpet while I tell you what we are going to be doing?

Today you two are going to get to build something with these blocks (*point to the box of blocks*).

I want the two of you to build a house. Your house should have some things that other houses have. It should have 4 walls like other houses. It should also have a way to get into the house, like a door and it should also have at least 2 rooms, like a place to eat and a place to sleep. After that, your house can have other things that houses have, like windows.

You will have about 8 minutes to finish building your house and I will let you know about half-way through how much time you have left. If you finish your house, before I say time is up, please let me know because I would like to take pictures of your house using this camera (*show children the camera*)."

"Do you have any questions?"

If yes, answer the questions and continue as below.

If no,

"Okay. Now remember your house should have 4 walls, a way to get inside and at least two rooms. Your house should be built on this special carpet. If you are finished before the time is up, please tell me you're done and then I will take pictures of it. Do not tear down your house until I have taken pictures of it. You may start."

At 4 minutes:

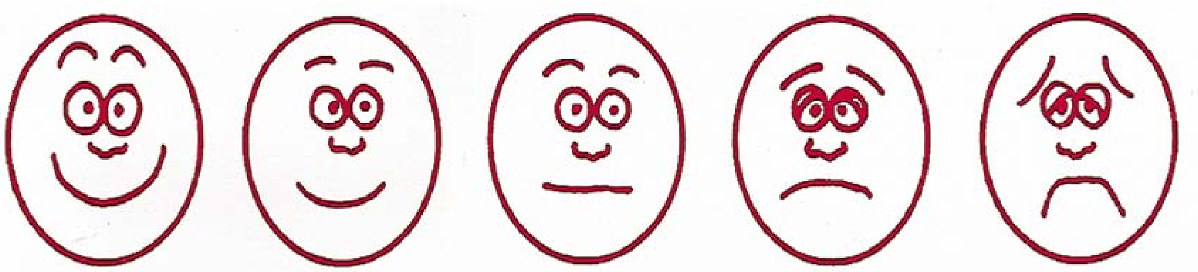
"Your time is half over. You have 4 minutes left to finish."

At 8 minutes:

"Your time is up because you must go back to your classrooms soon."

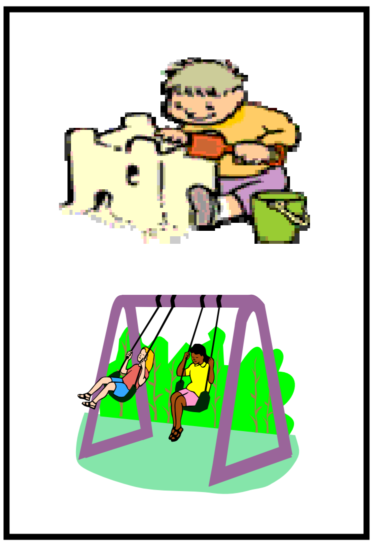
APPENDIX E

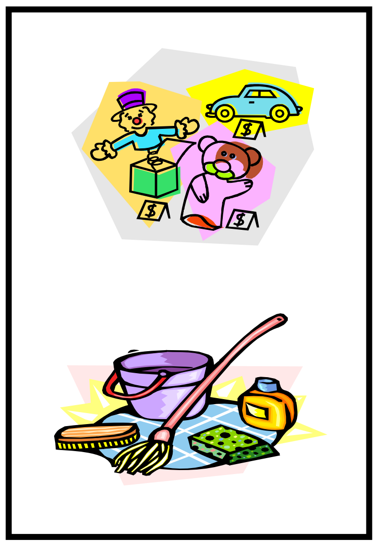
Children's Affect Rating Scale



APPENDIX F

Play Rating Scale





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