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The Development of Early Spatial Thinking

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THE DEVELOPMENT OF EARLY SPATIAL THINKING

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by

Carla Abad

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To: Dean Michael R. Heithaus
College of Arts, Sciences and Education

This dissertation, written by Carla Abad, and entitled The Development of Early Spatial Thinking, having been approved in respect to style and intellectual content, is referred to you for judgment.

We have read this dissertation and recommend that it be approved.

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Date of Defense: March 20, 2018

The dissertation of Carla Abad is approved.

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Florida International University, 2018

DEDICATION

I dedicate my dissertation to my family: my parents (María Rosa and Eduardo Abad), grandparents (María and José Sevilla & Chela and Ernesto Parrella), and soon-to-be husband (Pablo Casco). Everything I accomplish is guided by your love and support.

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ABSTRACT OF THE DISSERTATION

THE DEVELOPMENT OF EARLY SPATIAL THINKING

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The different spatial experiences in the lives of young boys and girls may partly explain sex differences in spatial skills (Baenninger & Newcombe, 1995; Nazareth et al., 2013; Newcombe, Bandura & Taylor, 1983). While several studies have examined the influence of spatial activities on the development of spatial skills (e.g., Nazareth et al., 2013) there currently exists no widely used comprehensive measure to assess children's concurrent participation in spatial activities and engagement with spatial toys. Study 1 of the current dissertation filled this gap in the field of spatial research through the creation of the Spatial Activity Questionnaire, a comprehensive survey designed to assess children's involvement in spatial activities and engagement with spatial toys of diverse gender-typed content. The toys and activities 295 children were reported to have access to and engage with were explored to assess patterns of play with spatial and gender-stereotyped toys and activities. A sample of 76 children between 4 and 6 years of age and their primary caregivers participated in studies 2, 3, and 4 to explore the toys and activities young children have access to and play with (study 2), the link between play and mental rotation (study 3), and the relation between play, gender stereotypes, and mental rotation skills (study 4). Findings reveal great variability in the toys and activities

children have access to and play with, with sex difference suggesting girls play with low-spatial and stereotypically feminine toys and activities more than boys while boys play with highly-spatial and stereotypically masculine toys and activities more than girls. Adding to the exiting literature suggesting the inconsistency of sex differences in early mental rotation skills, our results suggest no sex differences in children's mental rotation ability. Furthermore, no relations were discovered between children's play, gender stereotypes, and mental rotation ability. These findings point to the need to further explore the influence of play on when and how sex differences in mental rotation ability develop in order to promote fun and easy ways to support spatial learning in young boys and girls.

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I. INTRODUCTION

The ability to think about the spatial world (i.e., spatial thinking) is essential in the daily lives of adults and children for achieving numerous goals such as navigating in new environments and locating missing objects. Not only necessary for everyday tasks, spatial skills have also been related to future entry and success in Science, Technology, Engineering, and Mathematics (STEM) fields (Humphreys, Lubinski, & Yao, 1993; Kell, Lubinski, Benbow & Steiger, 2013; Shea, Lubinski, & Benbow, 2001; Uttal & Cohen, 2012; Wai, Lubinski & Benbow, 2009). One specific kind of spatial skill, mental rotation ability, may be of particular importance for success in the STEM fields (Verdine, Golinkoff, Hirsh-Pasek & Newcombe, 2014). Furthermore, the current underrepresentation of women in STEM fields may be partly explained by sex differences consistently found in mental rotation abilities (Linn & Petersen, 1985; Maccoby & Jacklin, 1974; Nazareth, Herrera & Pruden, 2013; Voyer, Voyer, & Bryden, 1995). Some evidence suggests sex differences can be seen early in life, with 4.5 year olds boys outperforming their female peers on a measure of mental rotation and transformation ability (e.g., Levine, Huttenlocher, Taylor, & Langrock, 1999; Levine, Ratliff, Huttenlocher, & Cannon, 2012). Early experiences with spatial activities such as play with blocks and puzzles were found to influence sex differences in mental rotation skills (Caldera, McDonald Culp, O'Brien, Truglio, Alvarez & Huston, 1999; Jirout & Newcombe, 2015; Levine et al., 2012; Verdine, Golinkoff, Hirsh-Pasek, Newcombe, Filipowicz & Chang, 2014). Spatial experiences may be more common in the lives of young boys than young girls (e.g., Cherney & Voyer, 2010) for many possible reasons, including children's emerging gender stereotypes about the kinds of toys and activities

associated with males and females (Serbin, Powlishta, & Gulko, 1993) and caregivers' beliefs about toys and activities appropriate for each gender (Caldera et al., 1989). These early experiential differences may be linked to the development of sex differences in children's spatial abilities. This dissertation aims to explore this possibility by creating a questionnaire to assess young children's engagement with toys and activities of diverse spatial and gendered content and relating these early spatial experiences to performance on a mental rotation task and gender stereotypes.

Given the link between participation in spatial activities and the development of spatial skills, researchers are interested in examining the spatial activities in which boys and girls participate. Some studies focused on assessing the influence of spatial activities on the development of spatial skills via direct observations in school and home settings (e.g., Caldera et al., 1999; Connor & Serbin, 1977; Levine et al., 2012; Serbin & Connor, 1979), while other studies relied on questionnaires completed by parents of young children or by adults recalling their childhood experiences retrospectively (e.g., Cherney & Voyer, 2010; Newcombe, Bandura & Taylor, 1983; Signorella, Krupa, Jamison & Lyons, 1986; Voyer, Nolan & Voyer, 2000). Most of these studies have each created a new system or questionnaire to assess engagement in spatial activities and often measure spatial engagement *retrospectively*. Currently, no measure to examine *concurrent* engagement with spatial activities and spatial toys during childhood exists. To fill the knowledge gap, the current study seeks to develop an empirically-tested and comprehensive questionnaire to assess children's *concurrent* involvement in spatial activities and engagement with spatial toys. Using an iterative method of testing and refining this questionnaire, the final questionnaire will be used to relate children's spatial

and gender-typed play to their spatial ability, their gender stereotypes, and the gender stereotypes of their primary caregivers. Specifically, the proposed dissertation has four aims: (1) the development of a Spatial Activity Questionnaire; (2) exploring children's play with spatial and gender-stereotyped toys and activities; (3) relating play to mental rotation skills in preschool aged children; and (4) exploring the influence of gender stereotypes on young children's play and mental rotation skills.

Study 1: Measure Development

Study 1 consists of the development of a questionnaire designed to assess children's concurrent (rather than retrospective) play with spatial and gender-typed toys and activities. The questionnaire includes a wide variety of toys and activities children between the ages of 4 and 6 years typically play with or participate in. The development of this questionnaire was divided into four iterations: (1) development of a spatial activities questionnaire based on questionnaires created for previous studies and toys, activities, and categories listed on websites of the top-grossing toy retailers and e-retailer in the United States; (2) revisions based on feedback from experts in the field of spatial development; (3) modifications based on undergraduate students' ratings of gendered activities and toys; and (4) revisions based on analyses and feedback from the administration of the questionnaire to 295 primary caregivers of children between 4 and 6 years of age. Furthermore, descriptive statistics of primary caregiver's responses to the Spatial Activity Questionnaire were reported to examine the kinds of activities and toys children play with.

Study 2: Children's Involvement in Spatial Activities

Study 2 explores the responses to the Spatial Activity Questionnaire of 76 primary caregivers to determine the toys and activities children are exposed to and how often children play with them. Children's play with toys and activities of varied spatial and gender-stereotyped content was also examined. Furthermore, study 2 explores sex differences in children's play with all toys and activities on the questionnaire and toys and activities based on spatial and gender-typed content.

Study 3: Spatial Activities & Mental Rotation

Study 3 investigates the relation between play based on responses to the Spatial Activity Questionnaire created in Study 1 and the mental rotation abilities of 76 children between the ages of 4 to 6 years. Children of caregivers who completed the Spatial Activity Questionnaire were assessed on a measure of mental rotation skills, the Children's Mental Transformation Task (CMTT; Levine et al., 1999). Study 3 aims to replicate sex differences in children's mental rotation skills and examine whether play with a greater quantity and variety of toys and activities of diverse spatial and gender-typed content is predictive of children's mental rotation ability.

Study 4: The Influence of Gender Stereotypes

Study 4 examines the influence of children's gender stereotypes and the gender stereotypes of their primary caregivers on children's play and mental rotation abilities. The activity attitude measures from the Preschool Occupations, Activities, and Traits (POAT) and the Occupations, Activities, and Traits (OAT) measures were used to assess children and caregiver gender stereotypes, respectively (Liben & Bigler, 2002). This study explores the relation between the gender stereotypes of primary caregivers and their

children, whether gender stereotypes influence children's mental rotation skills, and the influence of gender stereotypes on children's play.

Together, these studies resulted in the creation of the Spatial Activity Questionnaire to examine children's early spatial experiences. Given that sex differences in mental rotation abilities may be found early in life and might be linked to the underrepresentation of women in the STEM, there is currently a need for a questionnaire that can be used widely and can measure early spatial experiences concurrently during childhood rather than retrospectively in adulthood. Furthermore, exploring the relation between children's play, mental rotation skills, and gender stereotypes results in a greater understanding of the development of spatial thinking. Ultimately, the goal of this dissertation is to better understand the influence of exposure to early spatial toys and activities on the development of spatial skills.

II. LITERATURE REVIEW

Spatial Thinking

Spatial thinking, often referred to as spatial ability or spatial skills, involves a wide range of abilities including the ability to visualize and interpret location, position, distance, direction, relationships, movement, and change over space (Sinton, Bendarz, Gershmehl, Kolvoord & Uttal, 2013). Although there is no one precise definition of spatial ability (Uttal, Meadow, Tipton, Hand, Alden, Warren, & Newcombe, 2013), these are generally divided into three categories proposed by Linn and Petersen (1985): spatial perception, mental rotation, and spatial visualization. Spatial perception requires spatial relations to be determined with respect to the orientation of one's own body while ignoring distracting information. Mental rotation is the ability to mentally rotate a two or three-dimensional figure. Spatial visualization requires the processing of multistep complicated manipulations of spatial information; this task may involve both spatial perception and mental rotation processes but is set apart from them by the possibility of using multiple strategies to find a solution.

Children and adults depend on spatial skills for a variety of everyday situations such as remembering the location of a doll in a game room or a car in the parking lot, fitting toys in a box or suitcases in a trunk, and building a block tower or Ikea furniture. Not only useful for everyday activities, spatial skills provide the foundation for future entry and success in the STEM fields (Humphreys et al., 1993; Kell et al., 2013; Shea et al., 2001; Uttal & Cohen, 2012; Wai et al., 2009). Project Talent, a study that followed 400,000 high school students for 11 years, found that students with strong spatial skills in high school were more likely to major in a STEM field in college and pursue a career in

STEM than students with lower scores on spatial tasks (Humphreys et al., 1993; Wai et al., 2009). Similar results were found in a study by Shea and colleagues (2001) where the spatial skills of high school students in the top 0.5% of general ability were found to be a strong predictor of future entry in the STEM fields. Specifically, students with strong spatial skills were more likely to pursue careers in computer science, engineering, and mathematics, while students with stronger verbal skills were more likely to choose careers in the humanities, social sciences, organic science, medical science, and legal arts (Shea et al., 2001). A decade later, success of these participants in the STEM fields, as measured by evaluating whether they had patents or had published a scholarly article in a peer-reviewed journal, was related to their high school spatial skills (Kell et al., 2013). Spatial ability was found to account for 7.6% of the variance in predicting whether individuals had patents or refereed publications. These studies combined suggest the importance of spatial skills for entry and success in the STEM fields.

One potential reason for the importance of spatial skills for success in the STEM fields is their close relation to mathematical skills. The relation between spatial and mathematical skills has been firmly established for children and continues to grow in strength into adulthood (Verdine, Golinkoff & Hirsh-Pasek & Newcombe, 2014). For instance, a study examining preschoolers' spatial skills found that mathematical performance was significantly predicted by children's spatial skills as measured by a block building task, with spatial skills predicting as much as 15% of the variance in mathematics skills (Verdine, Golinkoff, Hirsh-Pasek, Newcombe, Filipowicz, & Chang, 2014). In a similar study, preschoolers were assessed at two time-points a year apart on their math ability, spatial skills, executive function, and receptive vocabulary (Verdine,

Irwin, Golinkoff, & Hirsh-Pasek, 2014). Together, spatial skills and executive function were predictive of 70% of the variance on math achievement a year later. Controlling for executive function, spatial skills alone were predictive of 27% of variability in math achievement a year later. Examining the influence of spatial skills in slightly older children, Gunderson, Ramirez, Beilock, and Levine (2012) found that spatial skills in 1st and 2nd grade were predictive of improvement on the number line throughout the school year. Additionally, spatial skills of 5-year-olds predicted their performance on an approximate symbolic calculation task at age 8. Later in life, spatial skills, specifically mental rotation and spatial visualization skills, have been repeatedly found to be related to college students' achievement in math (Brunett, Lane & Dratt, 1979; Casey, Nuttall, Pezaris & Benbow, 1995; Casey, Nuttall & Pezaris, 1997). Together, these studies establish the relation between spatial and mathematical skills.

Another possible reason for the link between spatial skills and STEM success is "the reliance of the STEM disciplines on spatial representations such as diagrams, maps, blueprints, and timelines" (Verdine, Golinkoff, Hirsh-Pasek & Newcombe, 2014, p. 8). Thus, the ability to mentally transform and rotate these representations may be particularly important for success in the STEM fields. In order to better understand the link between early spatial skills and future success in the STEM fields, it is necessary to examine the development of mental rotation skills.

Mental Rotation Skills

The current study focuses on mental rotation skills, the ability to mentally rotate two and three dimensional figures, for two reasons. First, given that STEM fields require analyzing and imagining transformations of spatial relations (Uttal, Miller & Newcombe,

2013), it seems of particular importance to explore how mental rotation skills develop in order to gain a greater understanding of the link between spatial skills and STEM fields. Second, while sex differences have been observed in several kinds of spatial tasks, the most consistent sex differences and those with the largest effect sizes have been found in studies of mental rotation (Hyde, 1990). Taking into consideration the existing underrepresentation of women in the STEM fields and the finding that men consistently outperform women in mental rotation tasks, examining how mental rotation skills develop may lead to a greater understanding the underrepresentation of women in the STEM fields.

Sex Differences in Mental Rotation

Over 50 years of research indicate sex differences in spatial ability, with men consistently outperforming women on a wide variety of spatial tasks (see review by Maccoby & Jacklin, 1974). One of the largest meta-analyses conducted on spatial skills analyzed the effect sizes of 172 studies on spatial skills conducted over eight years and found sex differences on a variety of spatial skills. Sex differences on mental rotation tasks showed the larges effect sizes, followed by medium effect sizes for sex differences on spatial perception tasks, and small effect sizes for sex differences on spatial visualization tasks. Similarly, a large meta-analysis conducted by Voyer et al., (1995) analyzed the effect sizes of 282 studies on sex differences in spatial ability and found sex differences in spatial skills, particularly in tasks involving mental rotation. More recent work by Uttal and colleagues (2013) confirmed this male advantage on spatial tasks through a meta-analysis of 217 studies analyzing the magnitude, durability, and

generalizability of training spatial skills. Thus, sex differences in adults' spatial ability, particularly in mental rotation skills, are well established and yield large effect sizes.

Further highlighting the impact of sex differences in spatial skills for STEM outcomes, mental rotation and spatial visualization skills have been found to mediate sex differences found in college students' mathematical ability (Brunett et al., 1979; Casey et al., 1995; 1997), performance on geometric achievement (Battista, 1990; Delgado & Prieto, 2004; Kersh, Casey & Young, 2008) and in middle school students' science performance (Ganley, Vasilyeva & Dulaney, 2014). Therefore, sex differences in adult spatial ability may help explain the underrepresentation of women in the STEM fields; but when and why do these differences emerge?

Research on sex differences in spatial skills in children shows conflicting findings. Some evidence suggests that sex differences in spatial skills can be seen early in life. For instance, Johnson and Meade (1987) examined the spatial skills of 1,875 children between 6 and 18 years of age and found that boys outperformed girls as early as age 10 years. Finding sex differences on an even younger population, Levine and colleagues (1999) developed a measure, the Children's Mental Transformation Task (CMTT), to test mental rotation and transformation skills of 188 children between 4 and almost 7 years of age and found sex differences in children as young as 4.5 years. Replicating this finding, a study examining the influence of early puzzle play on later spatial ability found sex differences on the CMTT at 4.5 years of age (Levine et al., 2012). However, several other studies have found no consistent sex differences in the spatial skills of preschool through primary school children in a variety of spatial tasks, including mental rotation (e.g., Caldwell & Hall, 1970; Estes, 1998; Frick et al., 2009;

Frick et al., 2013; Jahoda, 1979; Jansen & Heil, 2010; Kaess, 1971; Kaplan & Weisberg, 1987; Kruger & Krist, 2009; Kosslyn, Margolis, Barrett, Goldknopf, & Daly, 1990; Lachance & Mazzocco, 2006; Lehmann, Quiaiser-Pohl, & Jansen, 2014; Platt & Cohen, 1981; Verdine et al., 2017). For example, Manger and Eikeland (1998) found no significant sex differences in sixth graders' performance on spatial visualization tasks. Frick and colleagues (2013) found no consistent effects of sex on a mental rotation task for children between the ages of 3 and 5. Recently, Verdine et al., (2017) found no sex differences in a variety of spatial tasks for children between the ages of 3 and 5. Additionally, it is likely that other studies with null findings have remained unpublished due to the file-drawer problem (Rosenthal, 1979).

There is not yet a consensus on when sex differences on spatial ability emerge and why these sex differences develop has proven to be an even more difficult question to answer (Levine, Foley, Lourenco, Ehrlich, & Ratliff, 2016). Researchers argue for biological (e.g., Gaulin & Fitzgerald, 1986; Jones, Braithwaite & Healy, 2003; Maccoby & Jacklin, 1974; McGee, 1979) and environmental influences (e.g., Baenninger & Newcombe, 1995; Eccles & Jacobs, 1986; Lawton, 1994; Levine et al., 2012; Nazareth et al., 2013; Newcombe, Bandura & Taylor, 1983; Parsons, Adler & Kaczala, 1982). While sex differences in spatial skills are likely due to the bidirectional interaction of both biological and environmental factors, the focus of this dissertation is on the influence of environmental factors. Specifically, the overarching goal of this dissertation is to explore the influence of early spatial experiences on both the development of spatial skills and sex differences found in spatial ability.

The Influence of Spatial Activities on Spatial Thinking

Spatial activities are those activities that require spatial thinking (e.g., puzzles, blocks, shape sorters). Children's engagement in a variety of spatial activities, including block building (Brosnan, 1998; Caldera et al., 1999; Ferrara, Hirsh-Pasek, Newcombe, Golinkoff & Lam, 2011; Ginsburg, 2006; Jirout & Newcombe, 2015; Ness & Farenga, 2007; Newman, Hansen & Gutierrez, 2016; Ramani, Zippert, Schweitzer, & Pan, 2014; Verdine, Golinkoff, Hirsh-Pasek & Newcombe, 2014), tangram puzzles and pentominoes (Yang & Chen, 2010), jigsaw puzzles (Levine et al., 2012; Verdine, Troseth, Hodapp & Dykens, 2008; Verdine, Golinkoff, Hirsh-Pasek & Newcombe, 2014), and mazes (Jirout & Newcombe, 2014) has been linked to performance on spatial tasks. To add to the evidence, several intervention studies suggest that experience with spatial toys resulted in improved spatial skills (Casey, Andrews, Schindler, Kersh, Samper & Copley, 2008; Tzuriel & Egozi, 2010) and even correlate with later math achievement (Wolfgang, Stannard, & Jones, 2003). Furthermore, differential experiences with spatial activities for boys and girls is considered a potential factor leading to adult sex differences in spatial ability (e.g., Baenninger & Newcombe, 1995; Nazareth et al., 2013; Newcombe, Bandura & Taylor, 1983). Children have been found to spend a large proportion of time engaging in gendered activities that differ in spatial content with boys participating in significantly more spatial activities than girls (Cherney & Voyer, 2010). Given the importance of participation in spatial activities for the development of spatial skills and sex differences in spatial skills, it is not surprising that many studies have measured the kind and amount of spatial activities boys and girls participate in while closely examining the gendered nature of these activities.

Some studies focused on exploring the influence of toys and activities on the development of spatial skills through direct observations (e.g., Connor & Serbin, 1977; Levine et al., 2012; Caldera et al., 1999; Serbin & Connor, 1979). For instance, Connor and Serbin (1977) observed preschool aged children during play and found that play with masculine toys was positively correlated to scores on two measures of visual-spatial performance, WPPSI Block Design and the Preschool Embedded Figures Test, for boys but not for girls. A subsequent study by the same authors (1979) assessed the boys and girls who played with the most masculine and feminine toys during free play. Results show that the boys and girls who preferred masculine toys performed significantly better on a measure of visual-spatial performance, WPPSI Block Design, than on a measure of receptive vocabulary. Inversely, the boys and girls who preferred feminine toys performed significantly better on receptive vocabulary than visual-spatial measures.

Given the link between play with stereotypically masculine toys and spatial skills, it is important to understand the impact of gender stereotypes on children's toy selection. Gender stereotypes have been repeatedly found to influence children's play (e.g., Liben & Bigler, 2002; Martin & Halverson, 1981; Raag and Rackliff, 1998; O'Brien & Huston; 1985). Specifically, children have been shown to prefer playing with toys and activities considered appropriate for their own sex (e.g., Connor & Serbin, 1977; Liss, 1981; Martin & Ruble, 2004; O'Brien & Huston, 1985). Furthermore, children's play is also influenced by their parents' and peers' perceived or actual stereotyped beliefs. Together, these studies highlight the influence of gender stereotypes on play and suggest that play with toys perceived as masculine is related to the development of spatial skills for both boys and girls. However, the spatial content of masculine and feminine toys was not

examined in these studies; leaving the question of whether play with toys requiring spatial skills is related to children's spatial abilities unanswered.

Most other studies conducting direct observations of spatial experience have focused on engagement in one or few spatial activities thought to be high in spatial content, such as blocks and puzzle play. For instance, puzzle play usually involves mentally and physically transforming pieces to fit into specific locations and provides immediate feedback about whether a piece fits (Levine et al., 2012). Examining the impact of play with puzzles on spatial skills, Levine and colleagues (2012) directly observed 53 children's naturally occurring engagement in puzzle play during six home visits when children were between 26 and 46 months old. Individual variation in the quality and frequency of children's puzzle play was related to performance on a mental transformation task, the CMTT, administered at 54 months. While boys outperformed girls on the spatial transformation task, boys and girls who played with puzzles had higher spatial transformation scores than children who did not play with puzzles even after controlling for parent cumulative language use, income, and education level. These results suggest that puzzle play contributes to the development of spatial skills. Block play has also been frequently associated to the development of spatial skills (Brosnan, 1998; Caldera et al., 1999; Ferrara et al., 2011; Ginsburg, 2006; Jirout & Newcombe, 2015; Ness & Farenga, 2007; Ramani et al., 2014; Verdine, Golinkoff, Hirsh-Pasek, Newcombe, Filipowicz, & Chang, 2014; Verdine, Golinkoff, Hirsh-Pasek, & Newcombe, 2014). Blocks are believed to provide an opportunity for children to play directly with spatial concepts which could facilitate their learning of spatial relationships between objects in the real world (Reifel, 1984). For example, a study examining the play

preferences and skills assembling block structures of preschoolers found that play with blocks was related to spatial visualization skills (Caldera et al., 1999). Block play has also been found to improve spatial visualization in a study comparing kindergartners' spatial visualization performance after a block building intervention, a block building intervention within a story context, and a control group (Casey et al., 2008). Kindergartners improved performance on spatial visualization tasks after both the block building intervention and the intervention within a story context compared to the control group. Additionally, block play has been found to elicit increased use of spatial language with both parents and children producing more spatial language during block play compared to non-spatial tasks (Ferrara et al., 2011), which has been linked to performance on a variety of spatial tasks (Pruden et al., 2011).

Other studies have attempted to examine a wider variety of spatial activities and their impact on spatial skills (e.g., Cherney & London & 2006; Cherney & Voyer, 2010; Jirout & Newcombe, 2015; Newcombe et al., 1983; Signorella et al., 1986; Voyer et al., 2000), given the time-consuming nature of direct observations, most of these studies have created questionnaires to answer specific questions regarding childhood spatial activity engagement.

Survey Measures of Spatial Engagement

Direct measures of children's play are too time-consuming and studies exploring the influence of one or few spatial activities are limited to making inferences only regarding those specific activities. Being able to assess spatial activity experience through a comprehensive questionnaire of spatial activities is a solution to both these problems

and could be greatly beneficial to the study of the influence of spatial activity experiences on the development of spatial abilities.

For that purpose, Newcombe, Bandura, and Taylor (1983) developed a survey to explore the spatial activity experiences of adolescents and adults. The authors first generated a list of 231 activities in which high school and college students engaged; these activities were classified by undergraduate students as requiring spatial ability or not requiring spatial ability and as being either stereotypically masculine or feminine or neutral. Eighty-one activities were judged by 75% or more of the judges as requiring spatial ability and made up the final survey of spatial experiences; of those, 40 were rated as masculine, 21 were rated as feminine, and 20 were considered gender-neutral as there was no agreement among raters. In a second study, 45 undergraduate students were administered the spatial activity experience questionnaire consisting of the 81 spatial activities. Participants were asked to rank the activities according to how often they participated in them based on a 6-point Likert scale ranging from 0 (never participated) to 6 (participate more than once a week). Additionally, participants were tested on a measure of spatial ability, the Differential Aptitudes Test (DAT). A sex difference in spatial ability was found, with males outperforming females on the DAT. When examining males and females together, scores on the DAT were found to be correlated with the spatial activity experience questionnaire. However, when examining the correlation for males and females separately, scores on the DAT were correlated with spatial activity experience for females but not for males. Additionally, males and females did not differ in their overall participation on the 81 spatial activities.

A shortened version of this questionnaire was developed in a study by Signorella, Krupa, Jamison, and Lyons (1986) where 485 undergraduate students completed the 81-item questionnaire indicating how often they participated in the activity using a likert-scale ranging from 1(never participated) to 7 (participated more than once a week). The 10 items from the masculine, feminine, and neutral items with the highest correlations to the total score were chosen to make up the short form of the questionnaire resulting in a short version with only 30 items. Sixty college students completed the short form of the spatial experience questionnaire and were tested on a measure of spatial ability, Piaget's water-level task (WLT) where they saw a sample bottle in an upright position with a water line and were then asked to draw a line where the water would be based on a tipped bottle at different degrees. The shorter version of the spatial activity experience questionnaire was found to replicate the results from the original longer version created by Newcombe and colleagues (1983). That is, masculine-typed spatial activity preference was significantly associated with better performance on the WLT for women but not for men, suggesting that spatial activity experience moderates sex differences in spatial ability, in this case, the water-level task. A more recent study (Nazareth et al., 2013) administered the survey created by Newcombe and colleagues (1983) to undergraduate students along with the Vandenberg and Kuse mental rotation test. Highlighting the importance of early spatial play, the number of masculine spatial activities participants had engaged in during childhood was found to mediate the significant relation between the sex and mental rotation scores.

In another study, Voyer, Nolan, and Voyer (2000) created a new questionnaire in order to examine the influence of childhood experiences with spatial toys and sports on a

mental rotation task and a spatial perception task. Three hundred and forty-four undergraduate students were asked to complete the activity questionnaire developed for the study as well as two measures of spatial ability, the Vandenberg and Kuse Mental Rotations Test (MRT) and the Water Level Task (WLT). The questionnaire consisted of two separate lists of 18 popular toys and 17 sports which participants were asked to rank in order to indicate the 10 toys and sports they spent the most time with as children. Most of the items came from lists utilized for previous studies such as Newcombe et al. (1983) and Serbin and Connor (1979). Participants were also given the option to include toys or sports not included in the questionnaire. Items were classified as spatial or non-spatial according to the classifications used in the previous studies and new items were rated by the authors. Although males and females did not show differences in preference for spatial and non-spatial toys, males were found to outperform females on both spatial tests. Additionally, participants who preferred spatial toys performed better on the spatial tests than those who preferred non-spatial toys. For participants who favored non-spatial toys, males outperformed females on the WLT; however, when they favored spatial toys, there was no difference between males' and females' performance on the WLT, again showing the influence of spatial toy preference on sex differences in a spatial task.

Measuring participation in spatial activities during childhood with a population of children rather than retrospective accounts by adults, a new survey was created for a study by Cherney and London (2006) where they examined how 5- to 13-year-old children's preferences in toys, sports, computers, and television differed with age and gender. One-hundred-and-twenty children completed the survey, sometimes with help of their parents, where they were asked to list their favorite toys, television shows,

computer/video games, and physical activities, regardless of spatial content, and provide an estimate of the daily average number of hours that they typically engaged in watching television, playing computer games, and sports. Categories were provided for toys (i.e., action figures, arts and crafts, dolls, educational games, manipulating/building), television shows (i.e., educational television, adventure, cartoons, drama, sports shows), computer/video games (i.e., action adventure, sports, puzzle/logic, educational, building/construction, fantasy violence), and physical activities (i.e., ball play, individual sport, team sport); each category was followed by three lines for children to write their specific responses. Older students completed the questionnaire at home and returned it to the school while the parents of younger participants completed the survey. Each participant then met individually with an experimenter at the school to review their answers to the questionnaire, responses in the interviews were consistent with those on the surveys approximately 95% of the time. Children generated a total of 319 different activities which adult raters ranked for gender stereotypes based on a 7-point Likert scale ranging from very masculine to very feminine. Girls were found to prefer more feminine toys than boys at all ages, the youngest girls preferred particularly feminine toys. Boys preferred manipulative toys, vehicles, and action figures while girls preferred dolls, stuffed animals, and educational toys. Importantly, the boys' preferred toys have been associated with the development of spatial abilities while feminine toys are associated with nurturing behavior and play complexity.

A study by Jirout and Newcombe (2015) examined data collected by Pearson Education through the Home Environment Questionnaire (HEQ), a 41-item survey about children's behavior, parent-child interaction, and family demographics developed by

Pearson Education for use in the fourth edition of the Wechsler Preschool and Primary Scale of Intelligence (WPPSI-IV) standardization study. The HEQ asked parents of children between 2 and 7 years of age to rate how many times per week their children engaged in play with certain categories of toys (i.e., puzzles, blocks, board games, drawing materials, sound-producing toys, dolls, balls, cars, trucks, bicycles, skateboards, scooters, swing sets) and in play with specific types of parent-child activities (i.e., teaching number skills, teaching shapes, playing math games, playing word and spelling games, telling stories, and talking) on a scale from "never" to "often." Boys were found to engage in spatial play (i.e., play with puzzles, blocks, and board games) significantly more than girls. Additionally, spatial play was related to spatial skill as measured by the Block Design subtest, a task requiring spatial visualization ability in which children recreate patterns with three dimensional colored blocks, while controlling for other aspects of ability.

Taken together, these studies provide useful and different ways to measure participation in spatial activities, yet none of these surveys were created with an empirical method and therefore the different categories of spatial activities are dictated by the authors' or raters' classifications rather than empirical evidence. To fill this gap, Cherney and Voyer (2010) created a spatial activities questionnaire by utilizing exploratory factors analysis to examine how often 496 undergraduate students participated in specific activities during their childhood. One hundred and thirty-eight activities were selected from questionnaires used in other studies (e.g., Bates & Benter, 1973; Newcombe et al., 1983; Signorella et al., 1986; Voyer et al., 2000). Participants were asked to indicate how frequently they engaged in each of the 138 activities between the ages of 3 and 12 years

on a visual analogue scale by placing an "X" at any point along a 100 mm continuous line with "never" and "always" as the extremes. Exploratory factor analysis was conducted to identify clustering of activities in terms of spatial content and gender typing. The 48 activities that produced an arbitrary median score greater than 20 out of 100 were the only ones included in the factor analysis in order to reduce the number of items and include only items with a meaningful level of involvement. The factors with an initial eigenvalue greater than one were considered in the results and single factor activities were removed from the analysis after each iteration to further reduce the number of activities. The factor analysis resulted in 11 factors based on 48 activities. The authors classified the activities as spatial and non-spatial based on the definition of spatial activities provided by Voyer et al. (2000). Activities that were practiced significantly more often by women than by men were considered to be stereotypically feminine, activities that were practiced significantly more often by men were considered stereotypically masculine, and those that showed no sex differences were considered gender neutral. The labels for each of the 11 factors (feminine non-spatial toys, masculine spatial sports, masculine spatial toys, neutral non-spatial sports, feminine spatial games, masculine non-spatial entertainment activities, feminine art non-spatial, neutral balance activities, long range non-spatial individual sports, non-spatial indoor games, long range activities with some spatial aspects) were determined by the authors based on the majority of activities that formed the factor. Sex differences were found on 32 of these activities, with women engaging in play during childhood with baby dolls, Barbie dolls and similar, board games, coloring, crafts, dancing, doll houses, drawing 2D, hopscotch, painting 2D, Play-Doh or molding clay, play kitchen objects, musical instruments,

puppets, puzzles, stuffed animals, swimming, volleyball, and walking significantly more than men. Men participated in air hockey, baseball, basketball, blocks, cars and trucks, construction blocks, dodge ball, football, Frisbee, Lego blocks, ping pong, shooting pool, soccer, video games 2D, video games 3D, and watching television more often than women during childhood. However, this study did not measure the spatial skills of participants, therefore, sex differences in activities could not be related to participants' spatial ability.

To validate the survey developed by Cherney and Voyer (2010) and explore the relation between sex differences in activities and spatial skills, Doyle, Voyer, and Cherney (2012) conducted a study where 403 undergraduates completed a spatial test (Water Level Test and Mental Rotations Test), a verbal test (Letter Identification Task; LIT), and the Childhood Activities Questionnaire. Males were found to score significantly higher than women on the MRT and the WLT while women scored significantly higher than men on the LIT; however, no gender differences were found on grades for English and math courses. Males were found to participate in spatial and masculine activities significantly more than women. Participation in masculine and spatial childhood activities was positively correlated with performance on both tests of spatial ability and math grades. The specific activities that correlated positively with MRT and WLT performance and math grades were mostly masculine spatial activities while the activities that correlated negatively with MRT and WLT performance were generally feminine and non-spatial. However, childhood participation in spatial activities was found to be related with spatial abilities in adulthood for both males and females.

There are many strengths to the survey created by Cherney and Voyer (2010) including the use of exploratory factor analysis to examine how activities group together and the later validation of this survey where it was found to predict spatial abilities in adulthood for both males and females. However, there are also some limitations to this survey including the dependence on adult participants' retrospective memory of their childhood participation in spatial activities and the somewhat arbitrary decision to categorize factors based on whether the majority of activities in the factors were considered to be spatial by the authors. Additionally, the survey can be used to examine the influence of childhood activities on adults' spatial performance, yet given the appearance of sex differences on some spatial tasks in children as young as four and a half years of age, it is important to examine the influence of engagement in spatial activities and toys during childhood on children's development of spatial skills. Therefore, a comprehensive and up-to-date survey that can be used to measure how often young children play with spatial toys and participate in spatial activities could provide a greater understanding of the factors that influence the development of spatial abilities and may help explain the development of sex differences.

Research Aims

The current dissertation seeks to develop a comprehensive questionnaire of children's concurrent play with toys and activities of diverse spatial and gendered content to relate children's play with their spatial ability. Specifically, the current dissertation has four overarching aims: (1) the development of a Spatial Activity Questionnaire; (2) exploring children's play with a wide variety of spatial and gender-typed toys and

activities; (3) relating play to young children's mental rotation skills; and (4) exploring the influence of gender stereotypes on children's play and mental rotation skills.

III. STUDY 1 - MEASURE DEVELOPMENT

Research Question

The goal of study 1 is to develop a quick and simple measure to evaluate children's play with spatial and gender-typed toys and activities. More specifically, this study aims to develop an online questionnaire assessing the spatial and gender-typed toys and activities children between the ages of 4 and 6 are exposed to and the amount of time children spend playing with them. The development of a comprehensive questionnaire of young children's play was completed through four iterations of survey development: (1) the first iteration of the Spatial Activity Questionnaire was based on a previously published spatial activity questionnaire (Cherney & Voyer, 2010), as well as spatial toys, activities, and categories listed on the websites of the three top-grossing toy sellers (i.e., Toys R Us, Walmart, and Target) and the largest e-retailer (i.e., Amazon) in the United States; (2) the second iteration of the Spatial Activity Questionnaire was informed by feedback from experts in the field of spatial development, (3) the third iteration used ratings of gendered activities and toys provided by undergraduate students; and (4) the fourth iteration was built from analysis conducted on the data collected from administration of the questionnaire to the primary caregivers of children between the ages of 4 and 6 and resulted in the finalized version of the Spatial Activity Questionnaire. It was hypothesized that a factor analysis would reveal items clustering together on the basis of spatial content (e.g., spatial, non-spatial) and/or gender stereotypes (e.g., stereotypically feminine, masculine, or gender neutral).

Participants

The Spatial Activity Questionnaire was developed through a four-step iterative process requiring the participation of experts in the field of spatial development, undergraduate students, and primary caregivers of 4 to 6-year-old children.

Experts in the Field of Spatial Development. The Spatial Activity Questionnaire was sent to 20 academic experts in the field of spatial development. Experts were recruited through e-mail, in which the purpose of the study was explained and a link to a Qualtrics survey was provided. Thirteen experts in the field of spatial development (11 female, 2 male) completed the survey by providing feedback on the Spatial Activity Questionnaire and rating toys and activities based on their spatial content. Participants received a $25 Starbucks electronic gift card for their participation.

Undergraduate Raters. A sample of 425 undergraduate students from a large research university in southern Florida was recruited from the SONA system, a university-wide research participant management system, to rate the toys and activities on the questionnaire to determine whether they are gender stereotypical or gender neutral. Participants who failed to pass the two checkpoints created to ensure careful reading of the questionnaire or did not fully complete the questionnaire were excluded from data analyses resulting in a final sample of 298 undergraduate student participants (250 female, 48 male). Participants were compensated by receiving SONA course credit for a psychology course.

Primary Caregivers. A sample of 1,009 primary caregivers of children between the ages of 4 and 6 was recruited through Amazon Mechanical Turk (MTurk; a crowdsourcing internet marketplace where workers can be recruited to complete tasks),

social media (i.e., Facebook and online parenting groups), and flyers located in public spaces in Southern Florida where primary caregivers of young children frequent (e.g., schools, coffee shops, and locations of extracurricular activities). Potential participants were asked to follow the link to an online Qualtrics page where they received additional information about the study and were asked to provide consent to participate. After providing consent, primary caregivers were asked three questions to determine if they met the criteria to participate in the study (i.e., having at least one typically developing child between the ages of 4 and 6 and residing in the United States). Participants who did not meet the study criteria, failed one of the two checkpoints created to ensure careful reading of the questionnaire, did not complete the questionnaire, or reported their children as having access to less than 3 (of 66) toys/activities were excluded from data analyses resulting in a final sample of 295 (197 female, 98 male) primary caregivers of children (126 female, 169 male) between the ages of 4 and 6. Participants received a $6.00 electronic Starbucks gift card (sent to the e-mail address participants provided on the survey) or $6.00 MTurk credit for their participation.

Primary caregivers were mostly white, (N = 250, 84.7%), 19 were Black or African American (6.4%), 3 were American Indian or Alaska Native (1%), 7 were Asian Indian (2.4%), 5 were Chinese (1.7%), 1 was Filipino (0.3%), 2 were Korean (0.7%), 1 was Vietnamese (0.3%), 1 was of another Asian race (0.3%), and 6 were from some other race (2.0%). Only 20 percent of participants were of Hispanic, Latino, or Spanish origin (N = 59), 16 were of Mexican, Mexican American, or Chicano origin (5.4%), 8 were of Puerto Rican origin (2.7%), 20 were of Cuban origin (6.8%), and 15 were of other Hispanic, Latino, or Spanish origin (5.1%).

Families varied in their income and education, two indicators of socioeconomic status (SES). Primary caregivers varied in their highest degree of education completed, with 27 completing a doctorate degree (9.2%), 6 with a professional degree (2%), 61 with a Master's degree (20.7%), 89 with a Bachelor's degree (30.2%), 44 completing an Associate's degree (14.9%), 42 with at least 1 year of college (14.2%), 16 with less than 1 year of college credit (5.4%), 8 with High School degree (2.7%), and 2 completing less than a High School degree (0.7%). Family gross income also varied across participants, with 116 earning $100,000 or more a year (39.3%), 44 earning between $75,000 to $99,999 (14.9%), 56 earning between $50,000 and $74,999 (19%), 27 earning between $35,000 and $49,999 (9.2%), 30 earning between $15,000 and $34,999 (10.2%), and 8 earning less than $15,000 a year (2.7%). Fourteen families did not report their annual gross income (4.7%). Variability in income and highest degree of education allows for a meaningful control of socioeconomic status (SES) in analyses, which has been shown to mediate sex differences found in spatial skills (Levine et al., 2005). Since family gross income and highest degree of education completed were significantly correlated, $r = 0.258$, $p < .001$, and there were no missing data for highest degree of education, we used primary caregiver's highest degree of education completed as a proxy for SES in analyses.

Materials and Procedures

The Spatial Activity Questionnaire was created for the current study with the purpose of assessing children's play with spatial and gender-typed toys/activities in the home setting. The questionnaire was designed and administered through Qualtrics, an online survey creation and data management program. The Spatial Activity Questionnaire

includes a wide variety of spatial toys and activities children between the ages of 4 and 6 typically play with or participate in at home. The questionnaire was created through a four-step iterative process:

Iteration 1. The Spatial Activity Questionnaire was created using a retrospective survey of childhood spatial activities previously developed by Cherney & Voyer (2010) that included items from several questionnaires developed for earlier studies (Bates & Bentler, 1973; Newcombe et al., 1983; Signorella et al., 1986; Voyer et al., 2000). Items from the Cherney and Voyer (2010) spatial activity survey were modified to exclude sports, outdoor play, and age-inappropriate items. The survey asked adults to recall activities they participated in from childhood to adolescence, however, due to our more limited age range, age-inappropriate items (e.g., glass blowing, leatherwork) were excluded. Only indoor toys and activities were included, excluding sports and outdoor play items to limit the length of the questionnaire. Additional toys and activities were added or combined into categories to encompass a greater, but also mutually exclusive, variety of indoor toys and activities. These additional toys and activities followed the categories included in the websites of the three top-grossing toy sellers (i.e., Toys R Us, Walmart, and Target) and the largest e-retailer (i.e., Amazon) in the United States.

Sixty-eight items compose the first iteration of the survey, including 44 toys (e.g., stacking blocks, jigsaw puzzles, board games, phone and tablet games, baby dolls) and 24 activities (e.g., coloring, knitting, playing musical instrument, cooking and baking). Each of the 68 items included item descriptions, written examples, and pictorial examples to help individuals completing the questionnaire visualize each of the items and understand the difference between items (see Figure 1). Although items were not categorized in the

questionnaire, so as to not interfere with analyses, these items can be thought to belong into the following groups: blocks (e.g., stacking blocks, connecting blocks), building sets (e.g., marble runs, magnetic construction), puzzles and brain teasers (e.g., jigsaw puzzles, mazes), games (e.g., board games, dice games), media and electronics (e.g., three-dimensional video and computer games, phone and tablet games), pretend play (e.g., baby dolls, puppets), arts and crafts (e.g., coloring, knitting), and hobbies (e.g., playing a musical instrument, cooking and baking). Items were left grouped together, although not categorized so as not to interfere with analyses, to avoid confusion and ensure that items were treated as mutually exclusive (e.g., floor puzzles were listed right before jigsaw puzzles, otherwise participants might have included floor puzzles under the jigsaw puzzle item despite the clear exclusions described on the items' descriptions). The questionnaire also included 13 basic demographic questions (e.g., parent and child sex, highest level of parent education completed).

Iteration 2. Thirteen experts in the field of spatial development provided feedback on the Spatial Activity Questionnaire and rated items on the survey based on spatial content. Experts were contacted through an e-mail, in which the purpose of the study was explained and a link to a Qualtrics survey including a PDF version of the Spatial Activity Questionnaire created in iteration 1 was provided. Experts were asked to follow the link to review the questionnaire and were provided unlimited space for feedback on five separate aspects of the questionnaire: questionnaire design, scale, questionnaire instructions, items to be added and/or omitted from the survey, and suggestions for other additions to the questionnaire. Additionally, experts were also asked to rate items according to whether or not they believed the toy or activity promoted the

development of spatial thinking. To do so, experts were shown a list of the 68 items and were asked to select one of five choices for each item: “not at all spatial,” “somewhat spatial,” “moderately spatial,” “very spatial,” or “extremely spatial.”

Expert feedback was used to make several changes to the Spatial Activity Questionnaire resulting in the second iteration of the questionnaire; these changes include removing three items (i.e., quilting, carpentry, and using compass), combining items into one item category (i.e., “2D painting” and “3D painting” and “2D drawing” and “3D drawing” were combined into general “painting” and “drawing” items), and adding 3 items (i.e., cube puzzles, tangram puzzles, and making crafts with materials found at home). The changes made using expert feedback were made to ensure the questionnaire includes the most common and age-appropriate toys and activities for children between the ages of 4 and 6, including a range of low spatial and high spatial toys and activities. Given these changes were made after experts in the field of spatial development had provided spatial ratings, 5 items on the finalized version of the questionnaire did not receive a spatial rating by experts; to ensure all items were rated, the principal investigator calculated the average item spatial rating for the new items created by combining 2 items. Additionally, the 3 new items were given the same spatial rating provided for the most similar item on the questionnaire.

The finalized second iteration of the survey included 11 basic demographic questions (e.g., parent and child sex, highest level of parent education complete) and 66 items (46 toys and 20 activities).

Iteration 3. Using the second iteration of the questionnaire, 298 undergraduate students from a large research university in southern Florida rated each item on the

survey according to the gender stereotypes associated with each toy and activity. Undergraduate participants received a Qualtrics survey including five basic demographic questions (e.g., sex, college major), a brief explanation of masculine, feminine, and neutral toys and activities, and a list of 66 items (including descriptions, written examples, and pictorial examples) which they were asked to rate on a 7-point scale according to how masculine or feminine they believe them to be. Participants were asked to rate each item as "extremely masculine," "very masculine," "somewhat masculine," "neutral," "somewhat feminine," "very feminine," or "extremely feminine"; these ratings were used to ensure the questionnaire is representative of activities generally considered to be feminine, masculine, and appropriate for both genders. Based on average stereotype scores provided for each item, participants rated 0 toys and activities as "extremely masculine," 1 as "very masculine," 8 as "somewhat masculine," 38 as "neutral," and 8 as "somewhat feminine," 10 as "very feminine," and 1 as "extremely feminine." Stereotype ratings suggest the items on the questionnaire were representative of stereotypically feminine, masculine, and gender neutral toys and activities; therefore, no changes were made to the questionnaire on the third iteration.

Iteration 4. A brief description of the study and link to the third iteration of the Spatial Activity Questionnaire was distributed through Amazon Mechanical Turk (MTurk), flyers, and social media, including Facebook and parenting groups. A sample of 295 primary caregivers of children between the ages of 4 and 6 successfully completed the Spatial Activity Questionnaire which is divided into four sections: (1) consent; (2) demographics; (3) general access to spatial toys and activities; and (4) detailed ranking of engagement with spatial toys and activities.

Section 1: Consent. The first section of the survey provided participants basic information about the purpose of the study and required a click on one of two options, "agree to participate" or "do not agree to participate," to provide or decline consent for participation.

Section 2: Eligibility and demographics. Participants who provided consent were asked three ambiguous questions to assess whether they met the three criteria for participation of (1) currently living in the United States, and (2) having at least one child between the ages of 4 and 6 (3) who is typically developing. Participants who did not meet the three study requirements were taken to a script that thanked for their participation and explained they were not eligible to complete the study. If the three study requirements were met, participants were taken to a script explaining they would have to pass checks built into the questionnaire to ensure they were carefully reading the questionnaire instructions in order to complete participation in the study and receive payment (see "Questionnaire Checkpoints" under section 4). Participants were then asked basic demographic questions such as the number and sex of their children, the primary caregiver's race/ethnicity, highest level of education, and annual family gross income. The demographic section then asked participants to think about their child (or their youngest child between the ages of 4 and 6 if they have more than one child) when completing the rest of the demographics section (i.e., child's sex, date of birth, ethnicity, and race) and the remaining sections of the questionnaire. Demographic information was used as covariates for statistical analyses.

Section 3: General participation with spatial toys and activities. The third section of the questionnaire included a list of 66 items including toys (e.g., stacking

blocks, jigsaw puzzles, board games, phone and tablet games, baby dolls) and activities (e.g., coloring, knitting, playing musical instrument, cooking and baking). Participants were asked to click on "yes" or "no" to indicate whether their child has access to each of the toys at home or whether their child has engaged in each of the activities at home. Each item (toy or activity) included a brief description of the toy or activity, specific written examples, and a set of three pictorial examples (see Figure 2). Responses from this section were used to limit the number of items administered in the following section of the questionnaire (section 4).

Section 4: Detailed ranking of spatial toys and activities. The fourth and final section of the questionnaire included a list of toys and activities participants previously indicated their children had access to or had participated in through a "yes" response on section 3. After each "yes" response on section three of the questionnaire, participants were asked to rate how often their child has engaged with that specific toy or activity in the past three months in the home setting; to do so, participants were provided with a 6-point Likert scale with the following options: "not in the last 3 months," "less than once a month," "about once a month," "about once a week," "a few times a week," "daily/almost daily" (see Figure 3). The same brief descriptions and written/pictorial examples used in the previous section were provided for all items in this section.

Questionnaire Checkpoints. Section 4 included two checkpoints to ensure participants were reading the questionnaire carefully when completing the study. The checkpoints were formatted like section 4 items of the questionnaire but rather than asking participants to rate how often their child engaged in the activity or played with the toy in the last 3 months in the home setting, the checkpoint asked participants to select a

specific response to the question if they were reading carefully; for example, “If you are reading carefully, please select “daily/almost daily.”

Results

An Exploratory Factor Analysis (EFA) was conducted on Mplus version 7.31 to determine whether toys and activities on the Spatial Activity Questionnaire are grouped by latent factors (i.e., spatial and/or gender-typed content). An EFA was used to detect the underlying factor structure in the Spatial Activity Questionnaire without imposing a preconceived structure. Specifically, factor loadings resulting from the EFA were examined to determine whether the questionnaire measures latent variables based on the items’ spatial and stereotype ratings. R version 3.4.3 was used to conduct a parallel analysis and SPSS version 20 was used to evaluate descriptive statistics.

Preliminary Analyses

Forced responses were part of the questionnaire design, therefore, there was no missing data on primary caregiver responses. Furthermore, given the categorical nature of the data, these were not analyzed for normality or outliers.

Exploratory Factor Analysis

An exploratory factor analysis (EFA) was conducted on the 66 questionnaire items. Given the categorical nature of the data, a weighted least squares means and variance adjusted (WLSMV) estimation was utilized in the EFA (Schmitt, 2011). A parallel analysis, the recommended method to determine the number of factors to retain in a factor analysis (Schmitt, 2011), suggested the retention of 9 factors. Fit indices suggest adequate model fit (e.g., RMSEA = 0.02; CFI = 0.99; SRMR = 0.05). Factor loadings were used to determine which items formed the 9 factors. Then, spatial and

gender stereotype ratings for items on each of the 9 factors were examined to determine whether factors based on these latent constructs emerged from the EFA. Although items seem to be grouped in some way, factor loadings indicate a mix of spatial content and stereotypically feminine and masculine items in each factor, suggesting no logical theoretical basis for interpretation of the factors based on the latent constructs of interest. For instance, examining the spatial content of the 26 items in factor 1 based on expert spatial ratings suggest a mix of items' spatial content; 5 items in factor 1 were rated as extremely spatial, 8 as very spatial, 3 as moderately spatial, 5 as somewhat spatial, and 5 as not at all spatial. Examining the gender-typed content of items in factor 1 indicate a mix of stereotypical and gender neutral items; 2 items were rated as somewhat masculine, 18 as gender neutral, and 6 as somewhat feminine. Given that the factors extracted from the EFAs did not successfully yield factors grouped by items' spatial or stereotype content, descriptive analyses were conducted using the items' spatial and gender stereotype ratings to examine the play behavior of young children (see Table 1 for the distribution across spatial and gender stereotype categories for each item on the questionnaire).

Descriptive Statistics of Children's Play Behavior

Descriptive statistics of children's access and engagement in spatial and gender stereotypical toys and activities were calculated for children's: (1) general access to the 66 toys/activities on the Spatial Activity Questionnaire, (2) general engagement with the 66 toys/activities, (3) access and engagement by categories created using toys' and activities' spatial ratings, and (4) access and engagement by categories created using gender stereotype ratings.

(1) Access. There was great variability in the overall access reported on the Spatial Activity Questionnaire, with some primary caregivers reporting their children had access to only 3 of the toys/activities while others reported their child had access to 57 of the 66 toys/activities included on the questionnaire (M = 26.48, SD = 11.82). The number of children reported to have access to each of the different toys and activities on the Spatial Activity Questionnaire also varied (see Table 2 for access by item). For example, only eight children (2.7%) were reported having access to "knitting" while 223 children (75.6%) were reported to have access to "stuffed animals," "reading or being read books," and "coloring pages." The 10 items the greatest number of children were reported to have access to were: (1) coloring pages, (2) reading or being read books, (3) stuffed animals, (4) drawing, (5) watching television or movies, (6) cars, trucks, or other vehicles, (7) action figures or figurines, (8) jigsaw puzzles, (9) Play-Doh, modeling clay, pottery, or sculpting, and (10) card games. The 10 items the fewest children were reported to have access to were: (1) knitting, (2) embroidering, (3) scrapbooking, (4) sewing, (5) crocheting, (6) DJing, (7) weaving, (8) 3D puzzles, (9) making jewelry, and (10) origami.

(2) Engagement. There was also great variability in how often children were reported to play with the different toys/activities on the questionnaire in the last 3 months (see Table 3 for engagement by item). Differences in engagement were reported even on the most popular items; for instance, out of the 223 children (75.6%) who were reported to have access to "stuffed animals" 6 children (2.69%) were reported to play with stuffed animals "not in the last 3 months," 11 children (4.93%) "less than once a month," 13

children (5.83%) “about once a month,” 29 children (13.01%) “about once a week,” 52 children (23.32%) “a few times a week,” and 112 children (50.22%) “daily/almost daily.”

(3) Access and Engagement by Spatial Categories. Questionnaire items were grouped into categories following spatial ratings provided by 13 experts in the field of spatial development to examine children’s play with toys/activities that promote the development of their spatial abilities. Average item spatial ratings from iteration 2 of questionnaire development were used to create five spatial categories: 11 items had an average rating of 1 and were grouped into the “not at all spatial” category, 12 items with an average rating of 2 formed the “somewhat spatial” category, 17 items with an average rating of 3 formed the “moderately spatial” category, 15 items with an average rating of 4 were grouped into the “very spatial” category, and 11 items with an average rating of 5 formed the “extremely spatial” category.

Spatial category scores. Each child received 5 spatial access scores using reported access to the toys/activities on each of the 5 spatial categories, where they received a score of 1 for each item within the category they were reported to have access to. Additionally, each child received 5 spatial engagement scores using reported play/engagement with the toys/activities on each of the 5 spatial categories. Engagement scores were calculated by adding the scores for how often children were reported to engage with each toy/activity within the category in the last 3 months in the home setting, scores for each item ranged from 0 to 6, where 0 = no access and 6 = daily/almost daily engagement. See Table 4 for descriptive statistics of access and engagement scores for spatial categories and Table 5 for descriptive statistics of average access and engagement scores for spatial categories.

Extremely spatial. Eleven items formed the "extremely spatial" category (i.e., jumbo stacking blocks, stacking blocks, jumbo connecting blocks, connecting blocks, gear sets, marble runs, magnetic construction toys, interlocking stick toys, non-electronic model kits, 3D puzzles, map reading).

There was great variability in children's access to extremely spatial toys and activities; some children (N = 9, 3.1%) had access to none of the extremely spatial toys/activities while others (N = 3, 1%) had access to 9 of the 11 extremely spatial items (M = 3.91, SD = 1.97). There was also variability in children's engagement with toys/activities rated as extremely spatial, engagement scores ranged between 0 and 41 out of a possible score of 66 (M = 14.44, SD = 8.09).

Very spatial. Fifteen items were rated as "very spatial" (i.e., Lincoln logs, train/race care building sets, electronic building toys, floor puzzles, jigsaw puzzles, peg puzzles, cube puzzles, tangram puzzles, brain teasers, mazes, stacking games, drawing, painting, making crafts with materials found at home, Play-Doh/modeling clay/pottery/sculpting).

Children's access to items rated as very spatial varied; some children (N = 12, 4.1%) were reported to have access to none of the very spatial toys/activities while other children (N = 2, 0.7%) had access to 14 of the 15 very spatial items (M = 7.11, SD = 3.27). There was also variability in children's engagement with toys/activities rated as very spatial, engagement scores ranged between 0 and 66 out of a possible score of 90 (M = 24.63, SD = 12.20).

Moderately spatial. Seventeen items were rated as "moderately spatial" (i.e., printing/stamping, scrapbooking, origami, crocheting, embroidering, knitting, weaving,

sewing, making jewelry, fuse beads, science experiments, playing a musical instrument, toys controlled by tablet/computer/smartphone, electronic/remote controlled toys, video/computer games, phone/tablet games).

Variability was found in children's access to items rated as moderately spatial; some children (N = 23, 7.8%) were reported to have access to none of the moderately spatial toys/activities while other children (N = 1, 0.3%) had access to 14 of the 17 moderately spatial items (M = 4.03, SD = 2.60). There was also variability in children's engagement with toys/activities rated as moderately spatial, engagement scores ranged from 0 to 59 out of a possible score of 102 (M = 14.89, SD = 9.52).

Somewhat spatial. Twelve items were rated as "somewhat spatial" (i.e., dice games, tile games, floor games, board games, robots/transformers, kitchens/playfood/housekeeping toys, playhouses/tents/tunnels, cars/trucks/other vehicles, coloring pages, making jewelry with beads, cooking/baking, DJing).

Children's access to items rated as somewhat spatial varied; some children (N = 18, 6.1%) were reported to have access to none of the somewhat spatial toys/activities while others (N = 1, 0.3%) had access to all 12 of the somewhat spatial items (M = 5.31, SD = 2.80). Children's engagement with toys/activities rated as somewhat spatial also varied, engagement scores ranged between 0 and 47 out of a possible score of 72 (M = 20.83, SD = 11.19).

Not at all spatial. Eleven items were rated as "not at all spatial" (i.e., card games, action figures/figurines, baby dolls, Barbie dolls or similar dolls, dolls, costumes/costume accessories, puppets, stuffed animals, reading/being read to, karaoke, watching television/movies).

There was great variability in children's access to toys/activities rated as not at all spatial; some children (N = 17, 5.8%) were reported to have access to none of the not at all spatial toys/activities while other children (N = 9, 3.1%) had access to all 11 of the not at all spatial items (M = 6.12, SD = 3.17). Variability was also found in children's engagement with toys/activities rated as not at all spatial, with engagement scores ranging between 0 and 59 out of a possible score of 66 (M = 27.28, SD = 15.10).

(4) Access and Engagement by Stereotype Categories. Questionnaire items were grouped into categories based on stereotype ratings to better understand children's play with gender stereotypical and gender neutral toys. Average item stereotype ratings provided 298 undergraduate student raters in iteration 3 of survey development were used to create five stereotype categories. Undergraduate raters were asked to rate items on a scale ranging from 1, "extremely masculine" to 7, "extremely feminine"; however, no items were rated as "extremely masculine" and only one item was rated as "extremely feminine." Therefore, rather than forming stereotype categories using the 7-point scale provided to undergraduate raters, items with an average rating of 1 or 2 were grouped into the "masculine" category and items with an average rating of 6 or 7 were grouped into the "feminine" category resulting in 5 stereotype categories: 1 item with an average rating of 1 formed the "masculine" category, 8 items with an average rating of 3 made up the "somewhat masculine" category, 38 items with an average rating of were grouped into the "gender neutral" category, 8 items with an average rating of 5 formed the "somewhat feminine," and 11 items with average ratings of 6 and 7 were grouped into the "feminine" category.

Stereotype category scores. Each child received 5 stereotype access scores on the basis of reported access to the toys/activities on each of the 5 stereotype categories, where they received a score of 1 for each item within the category they were reported to have access to. Additionally, each child received 5 stereotype engagement scores using reported play/engagement with the toys/activities on each of the 5 stereotype categories. Children received a score ranging from 0 to 6 depending on how often they were reported to engage with each toy/activity in the last 3 months in the home setting, where 0 = no access and 6 = daily/almost daily engagement. To calculate engagement scores by stereotype category, item engagement scores were added for all of the items on each of the 5 categories. See Table 6 for descriptives statistics of access and engagement scores for stereotype categories and Table 7 for descriptive statistics of average access and engagement scores for stereotype categories.

Masculine. Only one item was rated as stereotypically "masculine" (i.e., robots/transformers). Children's access to the stereotypically masculine item varied, with slightly more than half of the children (N = 178, 60.3%) having no access and slightly less than half of children (N = 117, 39.7%) having access to robots/transformers (M = 0.40, SD = 0.49). There was also variability in children's engagement with the stereotypically masculine item, engagement scores ranged between 0 and 6 out of a possible score of 6 (M = 1.66, SD = 2.30).

Somewhat masculine. Eight items were rated as "somewhat masculine" (i.e., connecting blocks, gear sets, train/race car building sets, electronic building toys, non-electronic model kits, action figures/figurines, cars/trucks/other vehicles, video/computer games).

There was great variability in children's access to items rated as somewhat masculine, with some children (*N* = 19, 6.4%) having access to none of the somewhat masculine toys/activities and other children (*N* = 2, 0.7%) having access to all 8 of the somewhat masculine items (*M* = 3.67, *SD* = 1.99). Variability was also found in children's engagement with toys/activities rated as somewhat masculine, engagement scores ranged between 0 and 45 out of a possible score of 48 (*M* = 15.72, *SD* = 9.36).

Gender neutral. The " gender neutral" category was comprised of 38 items (i.e., jumbo stacking blocks, jumbo connecting blocks, marble runs, magnetic construction toys, Lincoln logs, interlocking stick toys, floor puzzles, jigsaw puzzles, peg puzzles, cube puzzles, tangram puzzles, 3D puzzles, brain teasers, mazes, card games, dice games, tile games, floor games, stacking games, board games, playhouses/tents/tunnels, puppets, reading/being read to, coloring pages, drawing, painting, origami, making crafts with materials found at home, Play-Doh/modeling clay, pottery/sculpting, science experiments, playing a musical instrument, karaoke, DJing, map reading, watching television/movies, toys controlled by tablet/computer/smartphones, electronic/remote controlled toys, phone/tablet games).

Children's access to items rated as gender neutral varied; some children (*N* = 6, 2%) had access to none of the gender neutral toys/activities while others (*N* = 1, 0.3%) had access to 34 of the 38 gender neutral items (*M* = 16.30, *SD* = 7.43). Children's engagement with toys/activities rated as gender neutral also varied, engagement scores ranged between 3 and 157 out of a possible score of 228 (*M* = 61.10, *SD* = 28.51).

Somewhat feminine. Eight items were rated as "somewhat feminine" (i.e., stacking blocks, kitchens/playfood/housekeeping toys, costumes/costume accessories, stuffed animals, printing/stamping, scrapbooking, fuse beads, cooking/backing).

There was great variability in children's access to items rated as somewhat feminine; some children (N = 22, 7.5%) had access to none of the somewhat feminine toys/activities and other children (N = 3, 1%) had access to all 8 of items in the somewhat feminine category (M = 3.74, SD = 2.14). There was also variability in children's engagement with toys/activities rated as somewhat feminine, engagement scores ranged between 0 and 33 out of a possible score of 48 (M = 14.66, SD = 8.86).

Feminine. Eleven items were rated as "feminine" (i.e., Barbie dolls/similar, baby dolls, dolls, doll houses/doll house accessories, crocheting, embroidering, knitting, weaving, sewing, making jewelry, making jewelry with beads).

Children's access to items rated as stereotypically feminine was found to vary; some children (N = 86, 29.2%) had access to none of the stereotypically feminine toys/activities and other children (N = 1, 0.3%) had access to 10 of the 11 stereotypically feminine items (M = 2.37, SD = 2.17). Variability in children's engagement with toys/activities rated as stereotypically feminine also varied, engagement scores ranged between 0 and 42 out of a possible score of 66 (M = 8.88, SD = 9.12).

Discussion

The goal of the current study was to develop a quick and simple measure to assess children's play with spatial and gender-typed toys and activities. Four iterations of survey development resulted in a finalized comprehensive questionnaire assessing access to and

engagement in 66 spatial and gender-typed toys and activities children between the ages of 4 and 6 typically play with in the home setting.

We hypothesized an exploratory factor analysis would reveal clustering of toys and activities based on spatial content (e.g., spatial, non-spatial) and/or gender stereotypes (e.g., stereotypically feminine, masculine, or gender neutral). However, items clustering together based on the EFA did not share similar spatial or gendered content and therefore could not be used to assess play with spatial and gender-typed toys and activities. Instead, spatial and stereotype categories were created by grouping items based on the spatial ratings provided by experts in the field of spatial development and stereotype ratings provided by undergraduate students. Children's play behavior was explored through descriptive statistics of children's access to and engagement in spatial and gendered toys and activities.

Our findings reveal substantial variability in children's access to the different toys and activities included on the questionnaire. Variability was found in the total number of toys/activities children were reported to have access to, suggesting that some children are exposed to more toys/activities than others. Variability was also found in the number of children who were reported to have access to each of the toys/activities on the questionnaire indicating that, while some toys and activities are more popular among 4 to 6 year olds in our sample, children are exposed to different kinds of toys/activities. Children's engagement in the different toys and activities on the questionnaire also varied, suggesting children not only differ in the kinds of toys/activities they play with or engage in but also in how often they play with them.

Given the goal of this study was to create a survey to examine children's play with toys that help develop spatial skills, children's access to and engagement with toys and activities based on their spatial content was also explored. Variability was found both in children's access and engagement scores for all five spatial categories (i.e., categories encompassing items rated as "not at all spatial," "somewhat spatial," moderately spatial," "very spatial," and "extremely spatial"), suggesting children play with toys and activities with diverse spatial content.

Finally, children's access to and engagement with toys and activities based on their stereotypically gendered content was examined. Variability was found both in children's access and engagement scores for all five stereotype categories (i.e., categories encompassing items rated as "masculine," "somewhat masculine," "gender neutral," "somewhat feminine," and "feminine"), suggesting children play with an assortment of stereotypically gendered and gender neutral toys and activities.

The current findings support previous research (e.g., Cherney & London, 2006; Cherney & Voyer, 2010) showing children engage with a wide variety of toys and activities including toys and activities of diverse spatial and gender stereotypical content. Furthermore, examination of the stereotype and spatial ratings for toys and activities supports previous literature (e.g., Cherney & London, 2006) suggesting highly spatial toys and activities are usually associated with masculine gender stereotypes (e.g, connecting blocks, gear sets) while toys and activities of low spatial content are often associated with feminine gender stereotypes (e.g., Barbie dolls, making jewelry with beads). However, this was not true of all items on the questionnaire, some highly spatial items were rated as stereotypically feminine (e.g. stacking blocks) while some items with

low-spatial content were rated as stereotypically masculine (e.g., action figures or figurines).

Limitations

It is important to note some limitations to this study. There are several limitations that might explain why the exploratory factor analysis did not yield factors interpretable based on the toys' and activities' spatial or gender stereotypical content. Two closely related limitations are sample size and the large number of items on the questionnaire. Although there is no strict rule for the sample size necessary when conducting an EFA, the stronger the factor loadings, the smaller the samples size needed for an accurate EFA (Costello & Osborne, 2005), suggesting our sample of 295 participants may have been too small to detect constructs with weaker factor loadings. Additionally, it is possible that the large number of toys and activities included on the questionnaire might have caused participant fatigue resulting in inaccurate responses to the questionnaire. However, another possibility is that children's play behavior might be too complex to break down into factors solely based on spatial and gender stereotype content.

Conclusion

The current study resulted in the development of the Spatial Activity Questionnaire, a quick and simple assessment of the toys and activities young children have access to and play with in the home setting. Previous research exploring children's play relied on time-consuming direct measures of play (e.g., Caldera et al., 1999; Connor & Serbin, 1977; Levine et al., 2012; Serbin & Connor, 1979), measures created to assess play with one or few toys/activities (Jirout & Newcombe, 2015), retrospective accounts by adults (Voyer et al., 2000; Cherney & Voyer, 2010), or time-consuming and

subjective questionnaires requiring raters to evaluate lists of toys provided by parents or their children (Cherney & London, 2006). The Spatial Activity Questionnaire fills the need in the field of spatial development for an objective, quick, and simple comprehensive measure of young children's concurrent spatial play.

Our findings from questionnaire responses of 295 primary caregivers of children between the ages of 4 and 6 suggest children have access to and play with a diverse variety of toys and activities, including spatial, non-spatial, gender stereotypical, and gender neutral toys. Future research should continue to examine the toys and activities young children play utilizing the Spatial Activity Questionnaire since a larger sample size might yield interpretable EFA findings leading to a greater understanding of the toys children play with. Additionally, continued use of the questionnaire would help assess the reliability of the questionnaire. Finally, given the established link between play and spatial ability (e.g., Casey et al., 2008; Ferrara et al., 2011; Jirout & Newcombe, 2014; 2015; Levine et al., 2012; Verdine, Golinkoff, Hirsh-Pasek, Newcombe, Filipowicz & Chang, 2014; Verdine et al., 2018), studies 2, 3, and 4 of this dissertation explore the relationship between children's play assessed through the Spatial Activity Questionnaire and mental rotation skills.

III. GENERAL METHODOLOGY

Studies 2, 3, and 4 are based on cognitive assessments administered to children between the ages of 4 and 6 and their primary caregivers' responses to the Spatial Activity Questionnaire created in study 1. The general methodology for studies 2, 3, and 4 is described below.

Participants

A sample of 128 primary caregivers of children between the ages of 4 and 6 were recruited from 14 preschools in Miami-Dade County through a letter explaining the study and a consent form sent home from the children's schools. Primary caregivers who returned a signed consent form received a link to the Spatial Activity Questionnaire developed in study 1 through a flyer sent home from the school and an e-mail sent to the e-mail address provided on the consent form. Fifty-two primary caregivers were excluded from the study for failing one of the two built-in checkpoints created to ensure participants were reading the questionnaire carefully ($N = 50$), completing the questionnaire for a child younger than the required age for participation ($N = 1$), or for completing the questionnaire multiple times for siblings in the same participating school ($N = 1$). The final sample consisted of 76 children (38 male, 38 female) between the ages of 4 and 6 ($M = 62.76$ months) and their primary caregivers (13 male, 63 female) recruited from 13 different schools. A $15 Target gift card was provided to primary caregivers as compensation for their participation. A power analysis was conducted utilizing the effect size found in a study by Levine and colleagues (2012) where child sex was found to be significantly related to performance on the mental rotation task used in this study, the Children's Mental Transformation Task. When including 4 covariates, a

sample size of 63 participants was required suggesting the current sample of 76 is adequate.

Primary caregivers were mostly white, (N = 68, 89.5%), 3 were Black or African American (3.9%), 1 was Asian Indian (1.3%), 3 were Chinese (3.9%), and 1 was Filipino (1.3%). Twenty-four primary caregivers were not of Hispanic, Latino, or Spanish origin (31.6%), 3 were of Puerto Rican origin (3.9%), 21 were of Cuban origin (27.6%), and 28 were of other Hispanic, Latino, or Spanish origin (36.8%).

Families varied in their income and education, two indicators of socioeconomic status (SES). Primary caregivers varied in their highest degree of education completed, with 6 completing a doctorate degree (7.9%), 4 with a professional degree (5.3%), 11 with a Master's degree (14.5%), 23 with a Bachelor's degree (30.3%), 13 completing an Associate's degree (17.1%), 10 with at least 1 year of college (13.2%), 5 with less than 1 year of college credit (6.6%), 3 with High School degree (3.9%), and 1 completing less than a High School degree (1.3%). Family gross income also varied across participants, with 19 earning $100,000 or more a year (25%), 12 earning between $75,000 to $99,999 (15.8%), 22 earning between $50,000 and $74,999 (29%), 8 earning between $35,000 and $49,999 (10.5%), 6 earning between $15,000 and $34,999 (7.9%), and 1 earning less than $15,000 a year (1.3%). Eight families did not report their annual gross income (10.5%). Variability in income and highest degree of education allows for a meaningful control of socioeconomic status (SES) in analyses, which has been shown to mediate sex differences found in spatial skills (Levine et al., 2005). Since family gross income and highest degree of education completed were significantly correlated (r = 0.375, $p < .01$)

and there was no missing data for highest degree of education, highest degree of education completed was used as a proxy for SES in analyses.

Child participants were mostly white (N = 66, 86.8%), 4 were Black or African American (5.3%), 1 was Asian Indian (1.3%), 2 were Chinese (2.6%), and 3 were from some other race (3.9%). Twenty-two children were not of Hispanic, Latino, or Spanish origin (28.9%), 1 was of Mexican, Mexican American, or Chicano origin (1.3%), 2 were of Puerto Rican origin (2.6%), 18 were of Cuban origin (23.7%), and 33 were of other Hispanic, Latino, or Spanish origin (43.4%). Children ranged in age from 48.13 to 80.29 months (M = 62.76).

Materials & Procedures

The study was discussed with the school directors, providing them all the necessary information about the study as well as director consent forms. After consent was provided by the school director, recruitment letters including study information and a primary caregiver consent form were sent from the schools to the families of all children enrolled in pre-kindergarten through first grade classes. Once primary caregiver consent was signed and returned to the child's school, a link to the online Spatial Activity Questionnaire was sent to the e-mail provided on the consent form and through flyers sent home from the school. Participating primary caregivers were asked to complete the Spatial Activity Questionnaire and a measure of parent gender stereotypes (activity attitude measure on the Occupations, Activities, and Traits measure; OAT-AM) online at their earliest convenience before the end of the school year.

The first question on the questionnaire asked potential participants to indicate whether they had received, signed, and returned a consent form provided by their child's

school by selecting one of two choices, “yes” or “no”; all potential participants responded “yes.” Next, participants were shown a script explaining they would have to pass checks built into the questionnaire to ensure careful reading of the questionnaire in order to complete participation in the study and receive payment. Participants were asked to complete a demographics section (e.g., parent sex, race, ethnicity, highest level of education) including the name and school of the child participating in the study to later link questionnaire responses to the children’s assessment scores. Participants were then taken to a script reminding them to think of their child who is participating in the study at their school when asked to complete demographic information about their child (e.g., child sex, date of birth, race, ethnicity) and the remainder of the questionnaire developed in study 1. Children of primary caregivers who completed the online questionnaire were assessed, in fixed order, on their ability to mentally rotate and transform objects (Children’s Mental Transformation Task; CMTT), English receptive vocabulary (Peabody Picture Vocabulary Test; PPVT), and gender stereotypes (activity attitude measure on the Preschool Occupations, Activities, and Traits measure; POAT-AM). Children were assessed by a graduate student or research assistant during the school day in a separate room in the school or in a separate area in the classroom. Together, the three child assessments took approximately 35 to 40 minutes to administer. At the end of the testing session, children received a sticker of their choice as a reward.

Spatial Activity Questionnaire. Children’s play was assessed through the Spatial Activity Questionnaire created in study 1. The online questionnaire was divided into 4 sections: (1) consent; (2) demographics; (3) general access to 66 toys and activities; and (4) detailed raking of engagement with different toys and activities. The questionnaire

was designed to assess children's access to and engagement with typical indoor toys and activities for 4 to 6 year olds, with a focus on engagement in spatial and gender stereotypical play. Scores to the questionnaire were calculated based on (1) children's general access to the 66 toys/activities on the Spatial Activity Questionnaire, (2) general engagement with the toys/activities, (3) access and engagement by categories created based on toys' and activities' spatial content, and (4) access and engagement by categories created based on gender stereotype ratings (see "Spatial category scores" and "Stereotype category scores" sections in study 1 for a detailed description of questionnaire scoring).

Parent Gender Stereotype Measure. The activity attitude measure from the Occupations, Activities, and Traits measure (OAT-AM; Liben & Bigler, 2002) was included immediately after the Spatial Activity Questionnaire. Caregivers were asked to indicate whether a series of 25 activities should be performed by "only men," "only women," or "both men and women." Items appeared in a fixed order. This measure took approximately 5 minutes to complete. Proportion scores were calculated by adding the number of stereotypically feminine items assigned to "only women" and the number of stereotypically masculine items assigned to "only men" and then dividing that number by the total number of stereotypical items on the scale; leading to a possible score range between 0 and 1, with higher scores indicating greater gender stereotyping. Scores on the OAT-AM were treated as trial scores, where proportion scores where multiplied by 100 and rounded in order to get a trial score to facilitate interpretation (e.g., a proportion of 0.25 was converted into 25 suggesting 25 successes over 100 trials).

Children's Mental Transformation Task. The Children's Mental Transformation Task (CMTT; Levine et al., 1999) was used to evaluate children's ability to mentally rotate and translate two shapes to make a whole object. On each of 32 items, children were shown two pieces of shapes and four target shapes and were asked to point to the shape that the two pieces make when put together. Each item required one of four kinds of 2D mental transformations: horizontal translation, diagonal translation, horizontal rotation, and diagonal rotation. This assessment took approximately 10 to 15 minutes to administer. Children were administered all 32 items in a fixed order; every correct response received 1 point leading to a possible score range of 0 to 32 points.

Receptive Vocabulary. Children were administered the fourth edition of the Peabody Picture Vocabulary Test (PPVT; Dunn & Dunn, 1997), a measure of English receptive vocabulary. This measure was used as a control for children's verbal intelligence in statistical analyses (see studies 3 and 4). For each test item, the child was asked to point to a picture from a set of four pictures; for example, "point to feather." This assessment took approximately 15 minutes to administer. Scores for each child on the PPVT are age-based standardized scores based on a mean score of 100 with a standard deviation of 15.

Child Gender Stereotype Measure. The attitude measure (AM) from the Preschool Occupations, Activities, and Traits measure (POAT-AM; Liben & Bigler, 2002) were administered to examine children's beliefs regarding whether men or women should engage in certain activities. Children were shown 14 different activities and were asked to point to one of three cards showing "only boys," "only girls," or "both boys and girls" to indicate who they believe should play with each activity. For example, children

were asked "who do you think should play with dishes; only boys, only girls, or both boys and girls?" Children were administered all 14 items in a fixed order, following the guidelines for administration. This assessment took approximately 5 minutes to administer. The proportion of feminine items assigned to "only girls" and the proportion of masculine items assigned to "only boys" on the POAT-AM were added to calculate a stereotyping proportion score, leading to a possible score range of 0 to 1, with a higher score indicating greater stereotyping. Scores on the POAT-AM were treated as trial scores, where proportion scores where multiplied by 100 and rounded in order to get a trial score to facilitate interpretation (e.g., a proportion of 0.25 was converted into 25 suggesting 25 successes over 100 trials).

Preliminary Analyses

Prior to analyses, variables were examined for missing data and univariate and multivariate outliers. Continuous variables (i.e., child age, and scores on the CMTT, PPVT, POAT-AM, and OAT-AM) were examined for univariate outliers and multivariate outliers. Examination of histograms (Tabachnick & Fidell, 2013) suggests no univariate outliers on any of the variables tested. No multivariate outliers were identified by using Mahalanobis distance with $p < .001$ (Yuan & Hayashi, 2010).

Data were missing on four variables: child age ($N = 1$, 1.3% variable missing data), CMTT score ($N = 1$, 1.3% variable missing data), PPVT score ($N = 1$, 1.3% variable missing data), POAT-AM ($N = 3$, 3.9% variable missing data). Little's Missing Completely At Random (MCAR) test was conducted to assess whether data were missing at random. Little's MCAR test was not significant ($X^2 = 200.11$, $df = 235$, $p = 0.95$) suggesting data were missing at random (Tabachnick & Fidell, 2013). Multiple

imputations were conducted to address missing data using five imputations (Schafer & Graham, 2002). Unless otherwise stated, reported results are from analyses conducted utilizing pooled data from the five imputations.

Descriptive Statistics

Descriptive statistics for children's performance on the CMTT, PPVT, and POAT-AM scores show considerable variability. Average assessment scores (see Tables 8 and 9) suggest no floor or ceiling effects for any of the assessments given and ranges suggest variability in and boys' and girls' performance on mental rotation, receptive vocabulary, and gender stereotype measure. However, primary caregiver's scores cluster on the lower end, suggesting primary caregivers have mostly low gender stereotypes.

IV. STUDY 2 - EXPLORING CHILDREN'S PLAY

The purpose of this study is to explore the kinds of toys and activities young children have access to and engage in most often in the home setting. Specifically, the current study utilized responses of 76 primary caregivers to the Spatial Activity Questionnaire created in study 1 to accomplish two aims: (aim 1) examine the toys and activities young children have access to and how often they play with them in the home setting, and (aim 2) assess whether there are sex differences in the kinds of toys and activities young children have access to and how often they play with them in the home setting. We hypothesize that engagement with spatial activities and toys will show great variability. We also hypothesize that we will find sex differences, with girls engaging in activities and toys of low spatial content rated as stereotypically feminine significantly more than boys. We do not expect to find sex differences in engagement with activities and toys rated as highly spatial, stereotypically masculine, or gender neutral.

Results

Main Analyses

Descriptive statistics, *t*-tests, and linear regressions were run on SPSS version 20 to explore children's play. Descriptive statistics were examined to better understand the toys and activities young children have access to and how often they play with them in the home setting (aim 1). Additionally, *t*-tests and linear regressions were run to determine whether there are sex differences in the toys and activities young boys and girls have access and in how often they play with them (aim 2).

Aim 1: Exploring Access and Engagement in Toys and Activities

Descriptive statistics were examined for children's access to and engagement in the 66 toys/activities on the Spatial Activity Questionnaire. Additionally, descriptive statistics were analyzed for access and engagement to toys/activities grouped into categories based on the items' spatial and gendered content (see study 1 section "Access and Engagement by Spatial Categories" and "Access and Engagement by Stereotype Categories" for a detailed description of category creation and scoring).

Access. The total number of toys and activities children were reported to have access to varied; children's exposure to the toys and activities included on the Spatial Activity Questionnaire ranged from access to 8 to 48 of the 66 toys/activities (M = 30.01, SD = 7.92). Additionally, there was great variability in the number of children reported to have access to the different toys and activities on the questionnaire (see Table 10 for access by item). For example, only one child (1.3%) was reported having access to "weaving," "knitting," and "embroidering" while all 76 children (100%) were reported to have access to "watching television or movies." The 10 items the greatest number of children were reported to have access to were: (1) watching television or movies, (2) coloring pages, (3) stuffed animals, (4) reading or being read books, (5) Play-Doh, modeling clay, pottery, or sculpting, (6) cars, trucks, or other vehicles, (7) drawing, (8) action figures or figurines, (9) costumes or costume accessories, and (10) jigsaw puzzles. The 10 items the fewest children were reported to have access to were: (1) weaving, (2) knitting, (3) embroidering, (4) crocheting, (5) 3D puzzles, (6) sewing, (7) DJing, (8) scrapbooking, (9) electronic building toys, and (10) interlocking stick toys.

Engagement. There was also great variability in how often children were reported to play with the different toys/activities on the questionnaire in the last 3 months (see Table 11 for engagement by item). Differences in engagement were reported even on the most popular items; for instance, while all children were reported to have access to "watching television or movies," 6 children (7.9%) were reported to engage in "watching television or movies" about once a week, 21 children (27.6%) a few times a week, and 49 children (64.5%) daily/ almost daily.

Access and Engagement by Spatial Categories. Questionnaire items were grouped into 5 distinct categories based on spatial ratings provided by 13 experts in the field of spatial development: "not at all spatial," "somewhat spatial," "moderately spatial," "very spatial," and "extremely spatial," Participants received access and engagement scores for each of the spatial categories (see section "Access and Engagement by Spatial Categories" in study 1 for a detailed explanation of how spatial categories were created and scored). Descriptive statistics for spatial categories' access and engagement scores were examined to better understand children's spatial play (see Table 12 for access and engagement scores by spatial category and Table 13 for average access and engagement spatial scores).

Extremely spatial. There was variability in children's access to items rated as extremely spatial; some children (N = 3, 3.9%) had access to none of the extremely spatial toys/activities while other children (N = 1, 1.3%) had access to 8 of the 11 extremely spatial items (M = 3.34, SD = 1.72). There was also variability in children's engagement with toys/activities rated as extremely spatial; engagement scores ranged between 0 and 34 out of a possible score of 66 (M = 11.30, SD = 6.69).

Very spatial. Children's access to items rated as very spatial varied; some children (*N* = 4, 5.3%) were reported to have access to 3 of the very spatial toys/activities while others (*N* = 4, 5.3%) had access to 12 of the 15 very spatial items (*M* = 7.86, *SD* = 2.29). There was also variability in children's engagement with toys/activities rated as very spatial; engagement scores ranged between 7 and 51 out of a possible score of 90 (*M* = 27.71, *SD* = 9.87).

Moderately spatial. There was variability in children's access to items rated as moderately spatial; some children (*N* = 1, 1.3%) were reported to have access to none of the moderately spatial toys/activities while other children (*N* = 1, 1.3%) had access to 13 of the 17 moderately spatial items (*M* = 4.70, *SD* = 2.26). Children's engagement with toys/activities rated as moderately spatial also varied; engagement scores ranged from 0 to 38 out of a possible score of 102 (*M* = 17.38, *SD* = 8.08).

Somewhat spatial. There was variability in children's access to items rated as somewhat spatial; some children (*N* = 2, 2.6%) were reported to have access to only 1 of the somewhat spatial toys/activities while other children (*N* = 4, 5.3%) had access to 10 of the somewhat spatial items (*M* = 6.21, *SD* = 2.21). Children's engagement with toys/activities rated as somewhat spatial also varied; engagement scores ranged between 4 and 42 out of a possible score of 72 (*M* = 24.01, *SD* = 8.70).

Not at all spatial. Children's access to toys/activities rated as not at all spatial varied, some children (*N* = 2, 2.6%) were reported to have access to 3 of the not at all spatial toys/activities while others (*N* = 5, 6.6%) had access to all 11 of the not at all spatial items (*M* = 7.91, *SD* = 2.07). There was also variability in children's engagement

with toys/activities rated as not at all spatial, with engagement scores ranging between 9 and 55 out of a possible score of 66 (M = 34.64, SD = 9.54).

Access and Engagement by Stereotype Categories. Questionnaire items were grouped into 5 distinct categories based on stereotype ratings provided by 298 undergraduate student raters: "masculine," "somewhat masculine," "gender neutral," "somewhat feminine," and "feminine." Participants received access and engagement scores for each of the stereotype categories (see section "Access and Engagement by Stereotype Categories" in study 1 for a detailed explanation of how spatial categories were created and scored). Descriptive statistics for stereotype categories' access and engagement scores were examined to better understand children's play with gender-typed and gender neutral toys and activities (see Table 14 for access and engagement scores by stereotype category and Table 15 for average access and engagement stereotype scores).

Masculine. Children's access to the only item rated as stereotypically "masculine" was varied, with slightly more than half of the children (N = 42, 55.3%) not having access and slightly less than half of children (N = 34, 44.7%) having access to the stereotypically masculine item (M = 0.45, SD = 0.50). There was also variability in children's engagement with the stereotypically masculine toy; engagement scores ranged between 0 and 6 out of a possible score of 6 (M = 2.07, SD = 2.47).

Somewhat masculine. There was great variability in children's access to items rated as somewhat masculine; some children (N = 3, 3.9%) had access to none of the somewhat masculine toys/activities and other children (N = 1, 1.3%) had access to all 8 of the somewhat masculine items (M = 4.12, SD = 1.58). There was also variability in

children's engagement with toys/activities rated as somewhat masculine; engagement scores ranged between 0 and 44 out of a possible score of 48 (M = 17.43, SD = 7.77).

Gender neutral. Children's access to items rated as gender neutral varied, some children (N = 2, 2.6%) had access to 5 of the gender neutral toys/activities while others (N = 1, 1.3%) had access to 28 of the 38 gender neutral items (M = 18.26, SD = 4.87). Children's engagement with toys/activities rated as gender neutral also varied; engagement scores ranged between 18 and 106 out of a possible score of 228 (M = 68.42, SD = 19.00).

Somewhat feminine. There was great variability in children's access to items rated as somewhat feminine, some children (N = 1, 1.3%) had access to none of the somewhat feminine toys/activities while other children (N = 2, 2.6%) had access to all 8 of the gender neutral items (M = 4.54, SD = 1.64). Children's engagement with toys/activities rated as somewhat feminine also varied; engagement scores ranged between 0 and 39 out of a possible score of 48 (M = 17.13, SD = 7.59).

Feminine. Children's access to items rated as stereotypically feminine varied, some children (N = 24, 31.6%) had access to none of the stereotypically feminine toys/activities while other children (N = 1, 1.3%) had access to 9 of the 11 stereotypically feminine items (M = 2.65, SD = 2.30). There was also variability in children's engagement with toys/activities rated as stereotypically feminine; engagement scores ranged between 0 and 29 out of a possible score of 66 (M = 10.00, SD = 9.62).

Aim 2: Exploring Sex Differences in Play

The second aim of this study was to explore sex differences in young children's play. Sixty-six t-tests were run to examine sex differences in young children's access to

and engagement with the toys/activities on the Spatial Activity Questionnaire. Additionally, multiple regressions were conducted to determine whether child sex is predictive of engagement scores across the different spatial and gender stereotype categories of toys and activities.

Results from *t*-tests suggest sex differences in engagement on 22 items (see Table 16 for *t*-test results). These results should be taken with caution given the increased likelihood of finding significant results at random when conducting multiple analyses (i.e., familywise error rate). Nevertheless, 66 *t*-tests with an alpha set at 0.05 would result in a true type 1 error rate of 0.96 suggesting 10% or 7 significant findings by chance (Keppel & Wickens, 2004), a much smaller number than the 22 sex differences found, suggesting the majority of our significant results are not a result of familywise error rate. Boys had significantly greater engagement than girls with connecting blocks ($t(74) = 2.07$, $p = 0.04$), gear sets ($t(42.56) = 2.12$, $p = 0.04$), train or race car building sets ($t(74) = 4.99$, $p < .001$), action figures or figurines ($t(66.45) = 2.76$, $p = .007$), robots or transformers ($t(48.07) = 9.64$, $p < .001$), and cars, trucks and other vehicles ($t(51.70)=7.53$, $p < .001$. Girls had significantly greater engagement than boys in floor puzzles ($t(72.21) = -2.92$, $p = .005$), tangram puzzles ($t(55.95) = -2.24$, $p = .03$), baby dolls ($t(74) = -7.44$, $p < .001$), Barbie dolls or similar ($t(74) = -11.90$, $p < .001$), dolls ($t(40.03) = -6.98$, $p < .001$), doll houses or dollhouse accessories ($t(59.88) = -8.20$, $p < .001$), kitchens playfood or housekeeping toys ($t(69.18) = -4.87$, $p < .001$), stuffed animals ($t(66.50) = -2.04$, $p = .046$), drawing ($t(58.59) = -3.29$, $p = .002$), painting ($t(74) = -3.52$, $p = .001$), printing or stamping ($t(74) = -3.29$, $p = .002$), origami ($t(42.25) = -2.04$, $p = .048$), making crafts with materials found at home ($t(74) = -4.46$, $p < .001$),

making jewelry ($t(37) = -3.93$, $p < .001$), making jewelry with beads ($t(52.06) = -3.41$, $p = .001$), and cooking or baking ($t(74) = -4.23$, $p < .001$).

To further explore sex differences in engagement, multiple linear regressions were run on the engagement scores for 5 spatial and 5 gender stereotype categories to assess whether sex is predictive of children's engagement with the toys and activities in each category while controlling for child age, SES as measured by primary caregiver's highest level of education, PPVT scores as a proxy for general IQ, and general access score to control for children who have access to dissimilar amounts of toys and activities.

Sex Differences in Spatial Categories. Regressions revealed significant sex differences in access to toys and activities in the "not at all spatial" and "extremely spatial" categories, with girls having significantly more access to toys in the "not at all spatial" ($b = 1.60$, $p < 0.000$) category and significantly less access to the "extremely spatial" ($b = -0.75$, $p = 0.029$) category when compared to boys. Additionally, significant sex differences were found in engagement with toys and activities for the "not at all spatial" ($b = 8.82$, $p < .000$), "somewhat spatial" ($b = -3.36$, $p = 0.024$), and "extremely spatial" ($b = -3.35$, $p = 0.022$) categories; girls engaged with toys and activities in the "not at all spatial" category significantly more than boys while boys engaged with toys and activities in the "somewhat spatial" and "extremely spatial" categories significantly more than girls (see Table 17).

Sex Differences in Stereotype Categories. Regressions revealed sex differences in children's access to toys and activities in all five of the stereotype categories: "masculine," "somewhat masculine," "gender neutral," "somewhat feminine," and "feminine" categories. Boys were found to have significantly more access than girls to

"masculine" (b = -0.75, $p < .000$), "somewhat masculine" (b = -2.03, $p < .000$), and "gender neutral" (b = -0.99, $p = 0.029$) toys and activities. Girls were found to have significantly more access than boys to "somewhat feminine" (b = 1.06, $p < .000$) and "feminine" (b = 2.72, $p < .000$) toys and activities. Additionally, significant sex differences were found in engagement with toys and activities for the "somewhat masculine," "somewhat feminine," and "feminine" categories. Boys were shown to play significantly more often than girls with "somewhat masculine" (b = -11.10, $p < .000$) toys and activities. Girls were found to play significantly more than boys with "somewhat feminine" (b = 5.81, $p < .000$) and "feminine" (b = 14.02, $p < .000$) toys and activities (see Table 18).

Discussion

The goal of the current study was to explore the toys and activities young children play with in the home setting. Specifically, the responses of 76 primary caregivers to the Spatial Activity Questionnaire created in study 1 were examined to (aim 1) better understand the toys and activities young children have access to and how often they play with them in the home setting and (aim 2) assess whether there are sex differences in the kinds of toys and activities young children have access to and how often they play with them.

Aim 1: Variability in Children's Play

The first aim of this study was to better understand the toys and activities young children have access to and how often they play with them in the home setting. As hypothesized, descriptive statistics show great variability in children's access to and engagement with the different toys and activities included on the questionnaire.

Variability was found in the total number of toys/activities children were reported to have access to, suggesting that some children are exposed to a greater quantity of toys/activities than others. Variability was also found in the number of children who were reported to have access to each of the toys/activities on the questionnaire indicating that, while some toys and activities are more popular among 4 to 6 year olds in our sample, children are exposed to different kinds of toys/activities. Children's engagement in the different toys and activities on the questionnaire also varied, suggesting children not only differ in the kinds of toys/activities they play with or engage in but also in how often they play with them.

Children's access to and engagement with toys and activities based on their spatial content was also explored. Variability was found both in children's access to and engagement with toys and activities in all five spatial categories (i.e., categories encompassing items rated as "not at all spatial," "somewhat spatial," moderately spatial," "very spatial," and "extremely spatial"), suggesting children play with toys and activities of diverse spatial content.

Finally, children's access to and engagement with toys and activities based on their gendered content was examined. Variability was found both in children's access to and engagement in all five stereotype categories (i.e., categories encompassing items rated as "masculine," "somewhat masculine," "gender neutral," "somewhat feminine," and "feminine"), suggesting children play with an assortment of stereotypically gendered and gender neutral toys and activities. Together, descriptive statistics show great variability in 4 to 6-year old's access to and engagement in different toys and activities, regardless of spatial and gender-typed content.

Aim 2: Sex Differences in Children's Play

The second aim of this study was to assess whether sex differences exist in the kinds of toys and activities young children have access to and how often they play with them in the home setting. Our findings revealed significant sex differences in children's play. Sixty-six *t*-tests examining sex differences in access and engagement scores for each of the toys and activities on the Spatial Activity Questionnaire suggest boys played with some of the stereotypically masculine and mostly spatial toys/activities (e.g., gear sets) significantly more often than girls. In contrast, girls were found to play with some of the stereotypically feminine toys with low spatial content (e.g., Barbie dolls) and gender neutral items ranging in spatial content (e.g., tangram puzzles) significantly more often than boys.

Sex Differences in Spatial Toys and Activities. Regressions conducted on the 5 spatial categories point to sex differences in children's spatial play. As hypothesized, girls were found to have significantly greater access to non-spatial toys and activities and significantly less access to extremely spatial toys and activities compared to boys. Also consistent with our hypothesis, girls were found to play significantly more with non-spatial toys and activities when examining sex difference in engagement. In contrast, boys engaged in play with somewhat and extremely spatial toys and activities significantly more than girls.

Sex Differences in Gendered Toys and Activities. Sex differences in access to gendered toys and activities suggest girls have significantly greater exposure than boys to toys and activities rated as somewhat feminine and stereotypically feminine. Meanwhile, boys had greater access than girls to stereotypically masculine, somewhat stereotypically

masculine, and gender neutral toys and activities. Results also revealed sex differences in engagement with gendered toys/activities. As hypothesized, girls were found to engage with toys and activities rated as somewhat feminine and stereotypically feminine significantly more than boys. On the other hand, boys engaged in play with toys and activities rated as somewhat masculine more than girls.

It is important to note that sex differences in children's access and engagement to spatial and gendered toys were found even when controlling for highest caregiver education level, children's receptive vocabulary scores, children's age, and general access to toys and activities. Therefore, our findings suggest sex differences in play are found in children from diverse socioeconomic status regardless of children's general intelligence, age, or the number of toys and activities a child has access to.

The current findings, along with results from study 1, support previous research (e.g., Cherney & London, 2006; Cherney & Voyer, 2010) showing children play with a great variety of toys and activities including toys and activities of diverse spatial and gender-typed content. Our findings also support previous findings showing boys and girls play with toys typically associated with their gender (e.g., Cherney & London, 2006). Additionally, given that highly spatial toys are commonly considered stereotypically masculine while toys with low spatial content are often considered stereotypically feminine, it is not surprising that girls played with non-spatial toys and activities more often than boys while boys played with somewhat and extremely spatial toys and activities more often than girls. However, previous research on sex differences in spatial play show contradictory results, some previous research suggests no differences in boys' and girls' preference for spatial and non-spatial toys (Voyer, Nolan, & Voyer, 2000)

while other studies found boys had a stronger preference for spatial toys than girls (Cherney & London, 2006; Cherney & Voyer, 2010). Our findings support Cherney et al. (2006; 2010) suggesting differences in boys' and girls' play based on toys' spatial content with girls playing with non-spatial toys/activities more often than boys while boys play with spatial toys/activities more often than girls.

Furthermore, comparing descriptive statistics of study 1 and study 2 suggest similar patterns of children's play. For instance, the 9 of the 10 most popular toys and activities were the same in both studies (i.e., watching television or movies, coloring pages, stuffed animals, reading or being read books, Play-Doh/modeling clay/pottery/sculpting, cars/trucks/other vehicles, drawing, action figures or figurines, jigsaw puzzles). Furthermore, 8 of the 10 least popular toys and activities were the same in both studies (i.e., 3D puzzles, weaving, DJing, crocheting, scrapbooking, sewing, embroidering, knitting). These similarities are important given that similar findings with two distinct populations suggest reliability of the Spatial Activity Questionnaire.

Limitations

It is important to note some limitations to this study. First, although comparing findings from study 1 and study 2 suggests reliability of the Spatial Activity Questionnaire, the measure has not yet been validated and therefore may not be an accurate way of assessing children's play. Additionally, the questionnaire relies on parent report of their children's access to different toys and activities in the home setting and engagement in the last 3 months. It may be difficult for caregivers to recall all the toys and activities their children play with or how often they play with them, potentially resulting in participant fatigue and inaccurate survey completion. Importantly,

interpretations of this data based on descriptive statistics and *t*-tests should be taken with caution. Descriptive statistics and *t*-tests were used as a way to summarize the data, however, given family-wise error rate, more rigorous statistical tests are necessary to better understand the data. Nevertheless, results from *t*-tests and analysis of descriptive statistics were supported by regression analyses and by previous literature suggesting our conclusions are valid.

Conclusion

The current study explored the toys and activities young children have access to and play with in the home setting. Our findings from questionnaire responses by the primary caregivers of 76 children between the ages of 4 and 6 suggest children have access to and play with a diverse variety of toys and activities, including spatial, non-spatial, gender stereotypical, and gender neutral toys. Additionally, significant sex differences were found in children's access to and engagement with spatial and gendered toys and activities with girls playing with stereotypically feminine and non-spatial toys/activities more often than boys while boys play with stereotypically masculine and spatial toys/activities more often than girls.

Future research should continue to examine the toys and activities young children play with through a larger sample to better understand children's play and assess the reliability and validity of the Spatial Activity Questionnaire. Furthermore, given the variability found in children's play and the link between play with spatial toys and spatial ability established in the literature (e.g., Casey et al., 2008; Ferrara et al., 2011; Jirout & Newcombe, 2014; 2015; Levine et al., 2012; Verdine, Golinkoff, Hirsh-Pasek, Newcombe, Filipowicz & Chang, 2014; 2018), the Spatial Activity Questionnaire will be

used in study 3 to explore how differences in play influence the development of spatial skills.

V. STUDY 3 - SPATIAL ACTIVITIES & MENTAL ROTATION

The goal of this study is to explore the relation between children's play and mental rotation ability. Specifically, the current study examines the relation between 4 to 6-year olds' access and engagement to toys and activities in the home setting, as measured by the Spatial Activity Questionnaire developed in study 1, and their mental rotation skills, as measured by the Children's Mental Transformation Task (CMTT: Levine et al., 1999). The current study has 4 aims: (aim 1) replicate sex differences in children's mental rotation skills; (aim 2) examine whether access to a greater number of toys and activities is predictive of children's mental rotation ability; (aim 3) investigate whether play with spatial activities and toys is predictive of mental rotation skills; and (aim 4) explore whether play with stereotypically gendered toys and activities is predictive of mental rotation skills. We hypothesize that boys will perform significantly better than girls on the mental rotation task (aim 1); the number of toys and activities children have access to will not predict their mental rotation skills (aim 2); children who play with highly spatial toys and activities often will have higher scores on the mental rotation task (aim 3); and that play with stereotypically masculine toys and activities will be positively predictive of mental rotation scores (aim 4).

Results

Multiple linear regressions were run on SPSS version 20 to explore the relation between children's play and mental rotation skills.

Aim 1: Sex Differences in Mental Rotation and Transformation Skills

The first aim of study 3 was to replicate sex differences in the mental rotation skills of 4 to 6-year-old children. A power analysis utilizing the effect size found in

Levine et al.'s study (2012) where child sex was found to be significantly related to performance on the CMTT suggests a sample size of 63 is necessary when including 4 covariates, indicating a sample of 76 is adequate. A multiple regression was conducted to determine whether child sex is predictive of performance on the CMTT while controlling for the influence of SES, age, and receptive vocabulary scores. While no sex differences were identified, age was found to significantly predict CMTT scores, b = .406, $p < .001$ (see Table 19). Given these findings and previous research suggesting sex differences in mental rotation skills might develop at this age (Abad, Odean, & Pruden, in preparation), we explored sex differences in the mental rotation skills of the oldest children in our sample. A multiple regression was conducted to determine whether child sex is predictive of performance on the CMTT for children of 5 years of age or older while controlling for the influence of SES, age, and receptive vocabulary. However, sex was not a significant predictor of mental rotation skills even when examining the mental rotation skills of only the oldest children in our sample (see Table 20).

Aim 2: **General Access to Toys/Activities and Mental Rotation Skills**

The second aim of study 3 was to examine whether access to a greater number of toys and activities is predictive of children's mental rotation abilities. The total number of toys and activities children were reported having access to on the Spatial Activity Questionnaire was added to determine a general access score, regardless of spatial and gendered content (see Table 10 for a summary of the number of toys/activities children were reported to have access to). A multiple regression was run to determine whether general access score is predictive of performance on the CMTT while controlling for the influence of SES, child's sex, age, and PPVT scores. As hypothesized, general access

scores were not predictive of CMTT scores, b = -0.032, $p = 0.723$; only age was a significant predictor of CMTT scores, b = 0.405, $p < .001$ (see Table 21).

Aim 3: Spatial Play and Mental Rotation Skills

The third aim of study 3 was to investigate whether play with toys and activities of diverse spatial content is predictive of children's mental rotation ability. Multiple regressions were conducted to determine whether access and engagement scores for toys and activities grouped together based on spatial content (see study 1 section "Access and Engagement by Spatial Categories" for a detailed description of category creation and scoring) are predictive of scores on the CMTT. Regressions controlled for the influence of SES, child sex, age, and PPVT scores.

Access to Spatial Toys/Activities. Five multiple regressions were run to determine whether access to toys and activities in the 5 spatial categories (i.e., not at all spatial, somewhat spatial, moderately spatial, very spatial, and extremely spatial) is predictive of scores on the CMTT. Results suggest access to toys and activities rated as not at all spatial, somewhat spatial, moderately spatial, very spatial, and extremely spatial was not predictive of children's scores on the CMTT. Age was the only variable consistently predictive of children's CMTT scores (see Table 22). Figure 4 depicts the relation between spatial access scores by spatial category and CMTT scores.

Engagement in Spatial Toys/Activities. Five multiple regressions were run to determine whether children's play with toys and activities in the 5 spatial categories was predictive of children's mental rotation skills. CMTT scores were regressed on the engagement scores on each of the 5 spatial categories. Results suggest play with toys and activities rated as not at all spatial, somewhat spatial, moderately spatial, very spatial, and

extremely spatial was not predictive of children's scores on the CMTT. Age was the only variable consistently predictive of children's CMTT scores (see Table 22). Figure 5 depicts the relation between spatial engagement scores by spatial category and CMTT scores.

Aim 4: **Gendered Play and Mental Rotation and Transformation Skills**

The fourth aim of study 3 was to examine whether play with toys and activities of diverse gender-typed content is predictive of children's mental rotation ability. Multiple regressions were conducted to determine whether access and engagement scores for toys and activities grouped together based on stereotypically gendered content (see study 1 section "Access and Engagement by Stereotype Categories" for a detailed description of category creation and scoring) are predictive of scores on the CMTT. Regressions controlled for the influence of child sex, SES, children's age, and PPVT scores.

Access to Gender Stereotypical Toys/Activities. Five multiple regressions were run to determine whether access and engagement scores on the 5 stereotype categories (i.e., masculine, somewhat masculine, gender neutral, somewhat feminine, and feminine" are predictive of CMTT scores. Results suggest access to toys/activities rated as masculine, somewhat masculine, gender neutral, somewhat feminine, or feminine was not predictive of children's scores on the CMTT. Age was the only variable consistently predictive of children's CMTT scores (see Table 23). Figure 6 depicts the relation between stereotype access scores by spatial category and CMTT scores.

Engagement in Gender Stereotypical Toys/Activities. Five multiple regressions were run to determine whether children's play with toys and activities in the 5 stereotype categories (i.e., masculine, somewhat masculine, gender neutral, somewhat feminine, and

feminine" was predictive of children's mental rotation skills. Engagement scores on each of the 5 spatial categories were regressed on the CMTT scores. Results suggest play with toys and activities rated as masculine, somewhat masculine, gender neutral, somewhat feminine, or feminine was not predictive of children's scores on the CMTT. Age was the only variable consistently predictive of children's CMTT scores (see Table 23). Figure 7 depicts the relation between stereotype engagement scores by spatial category and CMTT scores.

Discussion

The goal of the current study was to explore the relation between children's play and their mental rotation skills. Particularly, the current study examined the relation between 4 to 6-year-old children's access and engagement to toys and activities in the home setting, as measured by the Spatial Activity Questionnaire developed in study 1, and their mental rotation skills, as measured by the Children's Mental Transformation Task (CMTT: Levine et al., 1999). The current study had 4 aims: (aim 1) replicate sex differences in children's mental rotation skills; (aim 2) examine whether access to a greater variety of toys and activities is predictive of children's mental rotation abilities; (aim 3) investigate whether spatial play is predictive of mental rotation skills; and (aim 4) explore whether play with gender-typed and gender-neutral toys and activities is predictive of mental rotation skills.

Aim 1: Sex Differences in Mental Rotation Skills

The first aim of this study was to replicate sex differences in children's mental rotation skills. Given the task utilized in this study to assess children's mental rotation skills has been used in previous studies where sex differences have been found (i.e.

Levine et al., 1999; 2012), we expected to find a male advantage. However, our findings suggest no sex differences in mental rotation skills as measured by the CMTT. In fact, SES, and receptive vocabulary were also not significant predictors of children's scores on the CMTT. Only, child's age was found to significantly predict mental rotation skills, with older children outperforming their younger peers. Given the current sample included children slightly younger than the studies conducted by Levine and colleagues where sex differences on the CMTT were established, we also tested for sex differences in the CMTT scores of children who were five-years-old or older. Once again, child's age was the only significant predictor of the mental rotation skills; however, one possibility is that the sample size was too small to detect sex differences.

Our findings, along numerous studies where no sex differences in children's spatial skills were found (e.g., Caldwell & Hall, 1970; Estes, 1998; Frick et al., 2009; 2013; Jahoda, 1979; Jansen & Heil, 2010; Kaess, 1971; Kaplan & Weisberg, 1987; Kruger & Krist, 2009; Kosslyn et al., 1990; Lachance & Mazzocco, 2006; Lehmann, et a., 2014; Platt & Cohen, 1981; Verdine et al., 2017), suggest the male advantage in mental rotation skills is not consistent in childhood. These results highlight the complexity of the development of spatial ability and emphasize the need to continue examining the factors that influence the development of spatial skills, including when and how sex differences in spatial thinking develop. The remainder of this study sought to examine the effect of one of these factors, play, on children's mental rotation skills.

Aim 2: General Access to Toys/Activities and Mental Rotation Skills

The second aim of study 3 was to assess whether general access to toys/activities is predictive of children's mental rotation skills. As hypothesized, the total number of

toys and activities children were reported to have access to on the Spatial Activity Questionnaire was not predictive of children's mental rotation skills. Furthermore, socioeconomic status and receptive vocabulary were also not predictive of children's scores on the CMTT. Only child age was found to predict children's scores on the CMTT, with older children outperforming their younger peers. These findings are not surprising, we hypothesized children's mental rotation skills would be influenced by play with highly spatial and stereotypically masculine toys and activities rather than the overall quantity of toys and activities children have access to. Aims 3 and 4 tested the relation between children's play with toys and activities of diverse spatial and gendered content on their mental rotation skills.

Aim 3: Spatial Play and Mental Rotation Skills

The third aim of study 3 was to explore the relation between spatial play and children's mental rotation skills. First, we assessed whether access to a greater quantity of toys and activities of diverse spatial content is predictive of children's mental rotation skills. Once again, child's age was the only significant predictor of children's scores on the CMTT. Access to toys and activities rated as "not at all spatial," "somewhat spatial," "moderately spatial," "very spatial," and "extremely spatial" was not predictive of children's CMTT scores. These findings suggest the number of toys children have access to, regardless of the toys' spatial content, is not related to children's mental rotation and skills.

It is possible that simply having access to spatial toys and activities is not enough to impact children's mental rotation skills. Therefore, we examined whether play with toys and activities of diverse spatial content would predict children's mental rotation and

skills. However, our findings suggest child's age was the only significant predictor of children's scores on the CMTT. Engagement with to toys and activities rated as "not at all spatial," "somewhat spatial," "moderately spatial," "very spatial," and "extremely spatial" was not predictive of children's CMTT scores.

Aim 4: Gendered Play and Mental Rotation Skills

The fourth and final aim of study 3 was to assess the relation between gendered play and children's mental rotation skills. First, we examined whether access to a greater quantity of toys and activities of diverse gender-typed content is predictive of children's mental rotation ability. Once again, child's age was the only significant predictor of children's scores on the CMTT. Access to toys and activities rated as "stereotypically masculine," "somewhat masculine," "gender neutral," "somewhat feminine," or "stereotypically feminine" was not predictive of children's CMTT scores. These findings suggest the number of toys children have access to, regardless of the toys' gendered content, is not related to children's mental rotation skills.

We then assessed whether play with toys and activities of diverse gendered content, rather than access, would predict children's mental rotation ability. Our findings suggest child's age was the only significant predictor of children's scores on the CMTT. Engagement with toys and activities rated as "stereotypically masculine," "somewhat masculine," "gender neutral," "somewhat feminine," or "stereotypically feminine" was not predictive of children's CMTT scores. These findings suggest children's play with toys and activities, regardless of their gendered content, is not related to children's mental rotation skills.

Our findings contradict previous research linking children's play, particularly play with stereotypically masculine and highly spatial toys and activities, to their spatial abilities (e.g., Cherney & London, 2006; Connor & Serbin, 1977; Doyle et al., 2012; Ferrara et al., 2011; Jirout & Newcombe, 2014; 2015; Levine et al., 2012; Ness & Farenga, 2007; Newcombe et al., 1983; Ramani et al., 2014; Signorella et al., 1986; Verdine, Golinkoff, Hirsh-Pasek, Newcombe, Filipowicz & Chang, 2014; Verdine et al., 2008; Yang & Chen, 2010). Children's play with spatial and stereotypically masculine toys and activities has even explained some sex differences found on spatial tasks (e.g., Levine et al., 2012; Newcombe et al., 1983; Voyer et al, 2000). Furthermore, utilizing the same measure of mental rotation ability as the current study, a study by Levine and colleagues (2012) exploring the relation between puzzle play and the CMTT scores of 53 children found children who played with puzzles had higher mental rotation scores. Given that studies have found spatial play is a strong predictor of children's performance on a variety of spatial tasks, across different ages, and for both sexes, it is possible that the measure utilized to assess children's engagement in spatial and gendered toys and activities (the Spatial Activity Questionnaire created in study 1) does not adequately measure the subtle differences in children's spatial and gendered play that may be predictive of mental rotation ability.

Limitations

There are several limitations to this study. One potential limitation is that the Spatial Activity Questionnaire is not an adequate measure of children's play with spatial and gendered toys; this could be due to several reasons. First, the questionnaire relies on parent report of their children's access to different toys and activities in the home setting

and engagement in the last 3 months. It may be difficult for caregivers to recall all the toys and activities their children play with or how often they play with them. Second, the questionnaire requires primary caregivers to report children's play on 66 different toys and activities which may potentially result in participant fatigue and inaccurate survey completion. Third, ratings provided by experts in the field of spatial development and undergraduate students may not accurately represent the toys and activities spatial and gendered content resulting in survey scores that may not accurately reflect children's spatial and gendered play.

Another limitation of this study is the sample size, while a power analysis based on previous studies where sex difference were found on the CMTT suggest our sample was sufficient, if sex differences in the mental rotation skills of our sample were weaker than those of previous studies due to publication bias (Begg, 1994), it is possible that they may not have been detected with our sample. Additionally, although sex differences utilizing the CMTT have been found, it is possible that the required ability to translate items on this task may be obscuring sex differences found in mental rotation skills. Furthermore, these findings would have been more convincing if multiple assessments of mental rotation ability had been used.

Conclusion

The current study explored the relation between play with spatial and gendered toys and activities and children's mental rotation skills. To assess the link between play and mental rotation skills, we examined the questionnaire responses by primary caregivers of 76 children between the ages of 4 and 6 and children's performance on the CMTT. Findings suggest children's sex, access, and engagement to spatial or gendered

toys and activities, are not predictive of mental rotation skills. Only child's age was found to be predictive of children's mental rotation skills, with older children outperforming their younger peers.

Future research should continue to explore the complex factors influencing the emergence of sex differences in young children's mental rotation skills and the relation between play and mental rotation ability. Additionally, future research should further examine the influence of children's play, as measured by the Spatial Activity Questionnaire, on different measures of children's spatial abilities to better understand the relation between play and spatial skills while assessing whether the questionnaire can predict other aspects of children's spatial ability. Given the established link in the literature between stereotypically masculine spatial play and spatial skills, future research should explore the role of children's gender stereotypes on spatial skills and their play behavior. Study 4 was conducted to examine the relation between gender stereotypes, spatial skills, and play behavior.

VI. STUDY 4 - THE INFLUENCE OF GENDER STEREOTYPES

The goal of this study is to examine the relation between children's play, mental rotation ability, and the gender stereotypes of children and their primary caregivers. Specifically, the current study examined the relation between 4 to 6-year olds' access and engagement to spatial and gendered toys and activities in the home setting (as measured by the Spatial Activity Questionnaire developed in study 1), their mental rotation and skills (as measured by the Children's Mental Transformation Task; Levine et al., 1999), their gender stereotypes (as measured by the POAT-AM scale; Liben & Bigler, 2002), and the gender serotypes of their primary caregivers (as measured by the OAT-AM scale; Liben & Bigler, 2002). The current study has 4 aims: (aim 1) examine the relation between child and parent gender stereotypes; (aim 2) determine whether children's gender stereotypes are predictive of their mental rotation and ability; (aim 3) assess whether children's gender stereotypes are predictive of children's engagement with toys and activities of diverse spatial content; and (aim 4) explore whether children's gender stereotypes are predictive of children's engagement with gender stereotypical and gender neutral toys and activities. We hypothesize that primary caregivers with greater gender stereotypes will have children with the strongest gender stereotypes (aim 1); that boys, but not girls, with greater gender stereotypes will outperform boys with lower gender stereotypes and girls on the CMTT (aim 2); and that children's gender stereotypes will be predictive of their engagement with spatial (aim 3) and gendered (aim 4) toys and activities, with greater stereotypes resulting in play with more spatial and stereotypically masculine toys/activities for boys and play with less spatial and more stereotypically feminine toys/activities for girls.

Results

A bivariate correlation, multiple linear regressions, and mixed models were run in SPSS version 20 to explore the relation between children's play and mental rotation skills.

Aim 1: Exploring the Relation Between Parent and Child Gender Stereotypes

The first aim of study 4 was to examine the relation between the gender stereotypes of children and the gender stereotypes of their primary caregivers. A bivariate correlation was conducted to determine whether primary caregiver's OAT-AM scores and their children's POAT-AM scores are related. Results suggest OAT-AM and POAT-AM scores were not significantly related, $r(76) = -0.171$, $p = .142$.

Aim 2: Gender Stereotypes and Mental Rotation Skills

The second aim of study 4 was to investigate whether children's gender stereotypes are predictive of their mental rotation skills. A multiple regression was conducted to determine whether children's scores on the POAT activities-AM are predictive of their CMTT scores. Regressions controlled for the influence of SES, child sex, age, and receptive vocabulary. POAT-AM scores were not predictive of CMTT scores, b = 0.521, $p = 0.842$, and only age was predictive of CMTT scores, b = 0.401, $p < .001$ (see Table 24).

Furthermore, a multiple regression including the interaction between child sex and scores on the POAT-AM as predictors of mental rotation scores were conducted to investigate whether the mental rotation skills of boys and girls are differently influenced by their gender stereotypes. The regression controlled for the influence of child sex, mean centered POAT-AM scores, the interaction between child sex and POAT-AM scores, and

children's age. Child's sex (b = -6.207, p = 0.052), POAT-AM scores (-0.039, p = 0.294), and the interaction between them (b = 0.087, p = 0.095) were not predictive of scores on the CMTT. Child's age (b = 0.405, p < 0.001) was the only significant predictor of scores on the mental rotation task (see Table 25).

Aim 3: **Gender Stereotypes and Spatial Play**

The third aim of study 4 was to explore whether children's gender stereotypes are predictive of their engagement in spatial toys and activities (see Figure 8 for a depiction of the relation between play by spatial category and POAT-AM scores). A mixed model where POAT-AM scores predict engagement scores on the 5 spatial categories was conducted with fixed effects on the POAT-AM scores and a random intercept using listwise deletion. Results suggest POAT-AM scores are not predictive of spatial engagement (POAT-AM = -0.001, p = 0.988); the negative, although non-significant, relation between POAT-AM scores and spatial engagement suggest children with higher gender stereotypes have lower engagement scores even when controlling for the differences among spatial categories (i.e., not at all spatial, somewhat spatial, moderately spatial, very spatial, extremely spatial). Furthermore, results reveal no significant differences in children's mean spatial engagement scores (intercept = 9.52, p = 0.440) suggesting children have similar spatial engagement scores.

To further investigate the influence of gender stereotypes on spatial play, five multiple regressions were conducted to determine whether boys' and girls' scores on the POAT-AM are predictive of their engagement scores on each of the 5 spatial categories while controlling for the influence of SES, child sex, SES, age, and receptive vocabulary. POAT-AM scores were not predictive of children's engagement with toys and activities

in any of the five spatial categories: "not at all spatial," b = 1.970, p = 0.609; "somewhat spatial," b = -3.656, p = 0.390; "moderately spatial," b = 2.176, p = 0.611; "very spatial," b = 2.379, p = 0.629; and "extremely spatial," b = 3.253, p = 0.341 (see Table 26). Child's sex was found to predict play in some of the spatial categories, with girls having greater engagement with toys and activities in the "very spatial" (b = 5.375, p = 0.023), "moderately spatial" (b = 3.797, p = 0.047), and "not at all spatial" (b = 11.670, $p <$ 0.001) categories when controlling for gender stereotype scores. Additionally, age was found to predict play with items in the "not at all spatial" category, with younger children playing more with the "not at all spatial" toys and activities than their older peers.

Aim 4: Gender Stereotypes and Gendered Play

The fourth aim of study 4 was to explore whether the children's gender stereotypes are predictive of their engagement in gendered and gender-neutral toys and activities (see Figure 9 for a depiction of the relation between play by stereotype category and POAT-AM scores). A mixed model where POAT-AM scores predict engagement scores on the 5 stereotype categories was conducted with fixed effects on the POAT-AM scores and a random intercept using listwise deletion. Results suggest POAT-AM scores are not predictive of stereotype engagement (POAT-AM = 0.044, p = 0.391); the positive, although not significant, relation between POAT-AM scores and spatial engagement suggest children with higher gender stereotypes have higher engagement scores even when controlling for the differences among stereotype categories (i.e., masculine, somewhat masculine, gender neutral, somewhat feminine, feminine). Furthermore, results reveal no significant differences in children's mean stereotype

engagement scores (intercept = 7.47, $p = 0.729$) suggesting children have similar engagement scores.

To further investigate the influence of gender stereotypes on gendered play, five multiple regressions were conducted to determine whether boys' and girls' scores on the POAT -AM are predictive of their engagement scores on the 5 stereotype categories. Regressions controlled for the influence of SES, child sex, age, and receptive vocabulary. POAT-AM scores were not predictive of children's engagement with toys and activities in any of the five spatial categories: "stereotypically masculine," b = 1.072, $p = 0.387$; "somewhat masculine," b = 3.098, $p = 0.351$; "gender neutral," b = -1.621, $p = 0.868$; "somewhat feminine," b = 1.358, $p = 0.668$; and "stereotypically feminine," b = 3.473, $p = 0.234$ (see Table 27). Child's sex was found to predict play in some of the gendered categories, with boys playing with toys and activities in the "somewhat masculine" (b = -8.979, $p < 0.001$) category more than girls and girls playing with toys and activities in the "somewhat feminine" (b = 8.404, $p < 0.001$) and "stereotypically feminine" (b = 15.749, $p < 0.001$) categories more than boys. Additionally, age was found to predict play with items in the "somewhat feminine" and "stereotypically feminine" categories, with younger children playing more with the toys and activities in these categories.

Discussion

The goal of study 4 was to examine the relation between children's play, mental rotation ability, and the gender stereotypes of children and their primary caregivers. Specifically, this study aimed to determine whether: (aim 1) primary caregivers' gender stereotypes are related to the gender stereotypes of their children; (aim 2) children's gender stereotypes predict their mental rotation abilities; (aim 3) children's engagement

with toys and activities of diverse spatial content are predicted by their gender stereotypes; and (aim 4) children's gender stereotypes are predictive of children's engagement with a variety of gender-typed and gender neutral toys and activities.

Aim 1: Exploring the Relation Between Parent and Child Gender Stereotypes

The first aim of study 4 was to examine the relation between gender stereotypes of primary caregivers and those of their children. Our findings suggest parents' gender stereotypes are not related to the gender stereotypes of their children. One potential explanation for these null findings is that the measure used to assess primary caregivers' gender stereotypes may not accurately reflect adults' stereotyped beliefs. The OAT-AM scale asks participants to select who *should* engage in certain activities, giving them the opportunity to select "both males and females." Given the small variability in primary caregiver's scores on the OAT-AM, with over 80 percent of participants selecting "both males and females" for all activities on the questionnaire, it is possible that asking individuals who they believe should perform an activity is not representative their gender stereotypes.

Aim 2: Gender Stereotypes and Mental Rotation Skills

The second aim of study 4 was to explore the relation between children's gender stereotypes and mental rotation skills. First, we investigated whether children's gender stereotypes are predictive of mental rotation skills. Our findings suggest children's gender stereotype scores are not predictive of their mental rotation ability. Second, we examined whether the interaction between children's sex and their gender stereotypes would be predictive of mental rotation scores. We hypothesized boys with greater gender stereotypes and girls with lower gender stereotypes would have higher mental rotation

scores. However, our findings suggest the interaction between children's sex and their gender stereotypes is not a significant predictor of mental rotation scores. Together, these findings suggest the gender stereotypes of 4 to 6 year olds are not predictive of their mental rotation ability.

We expected children's gender stereotypes would be related to their mental rotation skills given the established links between (1) children's spatial play and spatial skills (e.g., Ferrara et al., 2011; Jirout & Newcombe, 2014; 2015; Verdine, Golikoff, Hirsh-Pasek, Newcombe, Filipowicz & Chang, 2014; Levine et al., 2012; Verdine et al., 2008) and (2) gender stereotypes and play (Liben & Bigler, 2002; Martin & Halverson, 1981; Raag and Rackliff, 1998; O'Brien & Huston; 1985). However, finding no effect of gender stereotypes on mental rotation skills is not surprising given the lack of sex differences in children's mental rotation skills. Some possible accounts for our null findings may be that the link between children's sex, gender stereotypes and mental rotation skills is too weak at this age to be detected with our sample size or influenced by many confounding factors not taken into consideration in this study.

Aim 3: Gender Stereotypes and Spatial Play

The third aim of study 4 was to explore the relation between children's gendered beliefs and their engagement with spatial toys and activities. We assessed whether children's gender stereotype scores were predictive of engagement scores on the five categories of spatial toys and activities. Results from mixed models indicate gender stereotypes are not predictive of spatial play. Furthermore, regression results suggest engagement with toys and activities on each of the five spatial categories (i.e., "not at all spatial," "somewhat spatial," "moderately spatial," "very spatial," and "extremely

spatial") were not predicted by children's gender stereotypes. These findings suggest children's gender stereotypes do not predict play with toys and activities of diverse spatial content. Highly spatial toys and activities are often perceived as stereotypically masculine (Cherney & London, 2006) and literature suggests children prefer play with toys and activities associated with their sex (e.g., Connor & Serbin, 1977; Liss, 1981; Martin & Ruble, 2004; O'Brien & Huston, 1985), therefore our findings that gender stereotypes are not predictive of spatial play are unexpected. See the discussion of the fourth aim of this study, where the relation between gender stereotypes and gendered play is examined, which points to potential reasons for these null findings.

Aim 4: Gender Stereotypes and Gendered Play

The fourth and final aim of study 4 was to assess the relation between children's gender stereotypes and gendered play. We assessed whether children's gender stereotype scores were predictive of engagement scores on the five categories of gender-typed toys and activities. Results from mixed models indicate gender stereotypes are not predictive of gendered play. Furthermore, regression results suggest children's gender stereotypes were not predictive of engagement with toys and activities in any of the gendered (i.e., masculine, somewhat masculine, gender neutral, somewhat feminine, feminine) categories, suggesting children's gender stereotypes do not predict play with toys and activities of varied gender-typed content.

It is important to note that although a link between gender stereotypes and play was not found, child sex and age were found to predict children's engagement with toys and activities of diverse spatial *and* gender-typed content. When controlling for gender stereotype scores, girls were found to engage with toys and activities in the "very

spatial," "moderately spatial," and "not at all spatial," "somewhat feminine," and "feminine" categories significantly more than boys. Moreover, boys were found to play with toys and activities in the "somewhat masculine" category significantly more than girls when controlling for the influence of gender stereotypes. These findings, when compared with results from study 2 where sex differences in play with toys and activities in the different spatial and gender-typed was explored, suggest children's play with toys and activities associated with their sex regardless of the strength of their gender stereotypes. Interestingly, although masculine items are often linked with highly spatial tasks, girls were shown to play with "very spatial" and "moderately spatial" toys and activities more often than boys only when controlling for gender stereotypes, that is, in study 4 but not in study 2. These findings indicate there might be an effect of children's gender stereotypes related to spatial play that may be too weak to be directly detected through regression analyses. Additionally, younger children played with the "not at all spatial," "somewhat feminine," and "feminine" toys and activities more often than their older peers; toys and activities in these categories are often of low spatial content suggesting older children may play with more highly spatial toys and activities than their younger peers. Differences in spatial play between children of different ages may be a factor explaining why spatial skills improve with age. Furthermore, if younger engage in less spatial play than older children, it is possible that the impact of spatial play on mental rotation skills will not be seen for years. Thus, these findings may help explain why play with highly spatial toys and activities was not predictive of mental rotation skills and why sex differences in children's mental rotation skills were not found in our sample and are inconsistent in the literature.

The link between spatial skills and highly spatial toys, often considered to be stereotypically masculine, has been established in the literature (e.g., Cherney & London, 2006; Connor & Serbin, 1977; Doyle et al., 2012; Ferrara et al., 2011; Jirout & Newcombe, 2014; 2015; Levine et al., 2012; Ness & Farenga, 2007; Newcombe et al., 1983; Ramani et al., 2014; Signorella et al., 1986; Verdine, Golinkoff, Hirsh-Pasek, Newcombe, Filipowicz & Chang, 2014; Verdine et al., 2008; Yang & Chen, 2010). This study hoped to better understand how play is related to children's spatial ability by examining the influence of gender stereotypes on children's play with toys and activities of diverse gender-typed and spatial content. However, our results suggest children's gender stereotypes are not predictive of mental rotation skills or play with spatial and gender stereotypical toys and activities. These findings contradict research linking gender stereotypes to play behavior (e.g., Raag & Rackliff, 1998). Previous research has demonstrated repeatedly that children have a preference for toys associated with their gender (e.g. Connor & Serbin, 1977; Liss, 1981; Martin & Ruble, 2004; O'Brien & Huston, 1985). Furthermore, the features of stereotypically masculine toys and the ways masculine toys are played with have been linked to the development of spatial skills (e.g., Cherney & London, 2006).

Previous research suggests a link between toys' spatial and gender-typed features; highly spatial toys are often considered stereotypically masculine while highly feminine toys are usually associated with low spatial content (Cherney & London, 2006). Notably, play with mostly masculine spatial activities is linked to strong performance on spatial tasks while play with highly feminine non-spatial activities is associated with poor spatial performance (Doyle et al., 2012). While several studies suggest play with masculine toys

is linked to improved spatial performance, other studies examining spatial and gendered play have found masculine-typed spatial activities to be related stronger performance on spatial tasks for women but not men (Newcombe et al., 1983), suggesting the complex relation between sex, play, and spatial ability. Given this complexity, one potential explanation for our null findings is that confounding factors not measured in this study may have weakened the relationship between sex, play, and spatial skills. It is important to examine this study's limitations to assess potential explanations for our findings contradicting the literature.

Limitations

There are several limitations to this study. One potential limitation is that the Spatial Activity Questionnaire is not an adequate measure of children's play with spatial and gendered toys; this could be due to several reasons. First, the questionnaire relies on parent report of their children's access to different toys and activities in the home setting and engagement in the last 3 months. It may be difficult for caregivers to recall all the toys and activities their children play with or how often they play with them. Second, the questionnaire requires primary caregivers to report children's play on 66 different toys and activities which may potentially result in participant fatigue and inaccurate survey completion. Third, ratings provided by experts in the field of spatial development and undergraduate students may not accurately represent the toys and activities spatial and gendered content resulting in survey scores that may not accurately reflect children's spatial and gendered play.

Another limitation of this study is that children's gender stereotypes were measured only through the short version of the activity subscale of the POAT-AM scale.

Although this scale has been shown to be reliable, utilizing the longer version of the scale or multiple scales may have resulted in a more complete assessment of children's gender stereotypes. A third limitation is the lack of variability in primary caregivers' gender stereotype scores. Given the small variability in primary caregiver's gender stereotype scores, it is possible that the measure utilized may not accurately assess the gender stereotypes of adults in our sample. A fourth limitation is the age range of children participating in this study, children of this age may be too young to develop sex differences in mental rotation skills strong enough to be detected with this sample size or through these measures. Relatedly, another possibility is that the current sample size was too small to detect existing relations between play, gender stereotypes, and mental rotation skills.

Conclusion

The current study explored the relation between children's gender stereotypes, mental rotation skills, play with spatial and gender-typed toys and activities, and the gender stereotypes of their primary caregivers. To assess the link between gender stereotypes, mental rotation skills, and play, we examined the questionnaire responses by primary caregivers of 76 children between the ages of 4 and 6, children's performance on the CMTT, and gender stereotypes of children and their primary caregivers as measured by the POAT-AM and OAT-AM scales. Results suggest the gender stereotypes of primary caregivers are not related to the gender stereotypes of their children. Furthermore, our findings suggest children's gender stereotypes are not related to their mental rotation skills or their play with gendered and spatial toys and activities. Only child's age and sex were found to be predictive of children's play with toys and activities

within some spatial and gendered categories when controlling for the influence of gender stereotypes.

Future research should aim to explore the complex relationship between spatial ability and play. Given the established influence of gender stereotype on children's preference and play with toys (Liben & Bigler, 2002; Martin & Halverson, 1981; Raag and Rackliff, 1998; O'Brien & Huston; 1985), it is important to explore the link between children's evolving gender stereotypes and the development of spatial skills. While many factors may shape children's play, children's gender stereotypes and the influence of their parents and peers have been show to influence the toys and activities children choose to play with (e.g., Fagot & Leinbach, 1989; Leaper, Leve, Strasser, & Schwartz, 1995; Serbin, Conner, Burkhardt, & Citron, 1979). Therefore, it is important to understand whether masculine qualities of spatial toys are pushing girls away from spatial play; companies like Lego and GoldieBlox have already been designing highly spatial toys with stereotypically feminine qualities based on this possibility. Understanding the complex relationship between gender stereotypes, play, and spatial skills is necessary to continue promoting the development of spatial skills in both young boys and girls.

VII. GENERAL DISCUSSION

Summary

The overarching goal guiding this dissertation was to better understand the relation between children's play, gender stereotypes, and mental rotation skills through the development of questionnaire designed to assess young children's concurrent play with toys and activities of diverse spatial and gender-typed content.

Research has demonstrated a link between performance on spatial tasks and childhood play with highly spatial, typically masculine, toys and activities (e.g., Cherney & London, 2006; Connor & Serbin, 1977; Doyle et al., 2012; Ferrara et al., 2011; Jirout & Newcombe, 2014; 2015; Levine et al., 2012; Ness & Farenga, 2007; Nazareth et al., 2013; Newcombe et al., 1983; Ramani et al., 2014; Signorella et al., 1986; ; Verdine, Golinkoff, Hirsh-Pasek, Newcombe, Filipowicz & Chang, 2014; Verdine et al., 2008; Yang & Chen, 2010). Some studies have assessed the influence of spatial activities on spatial skills via direct observations in school and home settings (e.g., Caldera et al., 1999; Connor & Serbin, 1977; Levine et al., 2012; Serbin & Connor, 1979), while other studies relied on questionnaires completed by parents of young children or by adults thinking of their childhood experiences retrospectively (e.g., Cherney & Voyer, 2010; Newcombe et al., 1983; Signorella et al., 1986; Voyer, Nolan & Voyer, 2000). Most of these studies have each created a new system or questionnaire to assess engagement in spatial activities and often measure spatial engagement *retrospectively*. There currently exists no widely-used or comprehensive measure to examine *concurrent* engagement with spatial toys and activities during childhood.

The current dissertation sought to fill this gap, through the development of the Spatial Activity Questionnaire, a comprehensive questionnaire designed to assess children's *concurrent* play with toys and activities of diverse spatial and gender-typed content. Each of the four studies comprising this dissertation aimed to utilize the Spatial Activity Questionnaire to evaluate a different aspect of the relation between children's play, mental rotation skills, and gender stereotypes:

Study 1: The development of the Spatial Activity Questionnaire. The goal of study 1 was to develop the Spatial Activity Questionnaire and utilize it to explore the play patterns of children. A four-step iterative method of testing and refining the questionnaire resulted in the final version of the Spatial Activity Questionnaire including 66 toys and activities of diverse spatial and gendered content. Although items clustering together based on an exploratory factor analysis showed no similar patterns of spatial or gender-typed content, spatial and gender stereotype categories were created from item ratings provided by experts in the field of spatial development and undergraduate raters in order to assess children's spatial and gender-typed play. Descriptive statistics of questionnaire responses from 295 primary caregivers revealed great variability in children's play.

Findings revealed variability in children's access to and engagement in the different toys and activities on the questionnaire. These findings suggest that while some toys and activities are more popular than others, children are exposed to different toys and activities and vary in how often they play with them. Variability was also found in children's access to and engagement in toys and activities in all spatial and stereotype categories. These findings support previous research (e.g., Cherney & London, 2006;

Cherney & Voyer, 2010) showing children engage with a wide variety of toys and activities including toys and activities of diverse spatial and gender-typed content.

Study 2: Exploring children's play. Study 2 aimed to better understand children's play by examining the toys and activities 76 children between the ages of 4 and 6 have access to and play with as reported by their primary caregivers on the Spatial Activity Questionnaire. Variability was found in access and engagement to toys and activities in all spatial and stereotype categories indicating children differ in the number of toys and activities they have access to, the kinds of toys/activities they play with, and in how often they play with them regardless of spatial or gender-typed content. Some significant sex differences were found. For instance, sex differences in children's engagement with spatial toys and activities show boys play with stereotypically masculine and highly spatial toys and activities significantly more often than girls. Meanwhile, girls played with non-spatial, and stereotypically feminine toys and activities significantly more often than boys.

Our findings support previous research (e.g., Cherney & London, 2006; Cherney & Voyer, 2010) showing children engage with a wide variety of toys and activities including toys and activities of diverse spatial and gender stereotypical content. Our findings also support previous work showing girls engage with stereotypically feminine toys and activities of low spatial content more often than boys while boys engage in play with stereotypically masculine and highly spatial toys and activities (e.g., Cherney & London, 2006).

Study 3: Play and metal rotation skills. The goal of study 3 was to relate children's play to their mental rotation skills. The mental rotation skills of 76 children

between the ages of 4 and 6 were assessed in the school setting through the Children's Mental Tranformation Task (CMTT). The toys and activities children have access to and play with was reported by their primary caregivers on the Spatial Activity Questionnaire. Findings suggest children's sex, access, and engagement to spatial and gendered toys and activities are not predictive of mental rotation skills. Child's age was the only consistent significant predictor of their mental rotation skills, with older children outperforming their younger peers. These findings support previous research suggesting spatial skills improve over time (e.g., Levine et al., 2016; Voyer et al., 1995) while highlighting the complexity of sex differences in spatial skills by adding to the literature suggesting sex differences in childhood are inconsistent. However, our results also contradict previous research linking children's play, particularly play with stereotypically masculine and highly spatial toys and activities, to their spatial abilities (e.g., Cherney & London, 2006; Connor & Serbin, 1977; Doyle et al., 2012; Ferrara et al., 2011; Jirout & Newcombe, 2014; 2015; Levine et al., 2012; Ness & Farenga, 2007; Newcombe et al., 1983; Ramani et al., 2014; Signorella et al., 1986; Verdine et al., 2008; Verdine, Golinkoff, Hirsh-Pasek, Newcombe, Filipowicz & Chang, 2014; Yang & Chen, 2010).

Study 4: Play, gender stereotypes and mental rotation ability. The fourth and final study of this dissertation explored the influence of gender stereotypes on involvement in spatial activities and mental rotation skills of preschool children. We examined the questionnaire responses by primary caregivers of 76 children between the ages of 4 and 6, children's performance on the CMTT, and gender stereotypes of children and their primary caregivers as measured by the POAT-AM and OAT-AM scales. Findings from study 4 suggest the gender stereotypes of primary caregivers are not

related to the gender stereotypes of their children. Furthermore, results indicate children's gender stereotypes are not related to their mental rotation skills or their play with gendered and spatial toys and activities. Only child's age and sex were found to be predictive of children's play with toys and activities within some spatial and gendered categories when controlling for children's gender stereotypes. Specifically, comparing results from studies 2 and 4 shows girls engaged in more toys and activities in the "very spatial" and "moderately spatial" categories only when controlling for the influence of gender stereotypes. Thus, although gender stereotypes were not directly predictive of spatial or gender-typed play, these findings suggest a link between children's sex, gender stereotypes, and play.

Limitations

Sample size. While there is no strict rule for the sample size necessary when conducting an exploratory factor analysis (EFA), as is true for all analyses, the stronger the data the smaller the samples size needed for valid results (Costello & Osborne, 2005), suggesting our sample of 295 participants may have been too small to detect constructs with weaker factor loadings. A larger sample size might have detected constructs based on the items' spatial and gender-typed content. Additionally, while a power analysis based on previous studies where sex difference were found on the CMTT suggest our sample was sufficient, a larger sample might have detected the relation between mental rotation skills, play, and gender stereotypes even if these relationships were weaker than expected.

Spatial Activity Questionnaire. Although comparing findings from study 1 and study 2 suggests reliability of the Spatial Activity Questionnaire, the measure has not yet

been validated and therefore may not be an accurate way of assessing children's play. In order to create a relatively quick measure of spatial play, only indoor toys and activities were included in the survey. The exclusion of sports and outdoor play may provide an incomplete or inaccurate assessment of children's play potentially resulting in weaker relations between play, spatial skills, and gender stereotypes. Additionally, the questionnaire relies on parent report of their children's access to and engagement in 66 different toys and activities in the home setting. It may be difficult for caregivers to recall all the toys and activities their children play with or how often they play with them, potentially resulting in participant fatigue and inaccurate survey completion. Another limitation of the Spatial Activity Questionnaire is that spatial and gender stereotype categories used to assess spatial and gendered play were created based on ratings provided by experts in the field of spatial development and undergraduate students rather than discovered through exploratory factor analysis.

Stereotype measures. Children's gender stereotypes were measured only through the short version of the activity subscale of the POAT-AM scale. Although this scale has been shown to be reliable, utilizing the longer version of the scale or multiple scales may have resulted in a more complete assessment of children's gender stereotypes. Additionally, the lack of variability in primary caregivers' gender stereotype scores suggests the measure utilized may not accurately assess the gender stereotypes of adults in our sample.

Children's age. Children's age range for this dissertation was selected based on previous research finding sex differences in children as young as 4-and-a-half years of age (Levine et al., 1999; 2012). However, given sex differences in spatial skills may be

developing at this age (Abad, Odean, & Pruden, in preparation) and that sex differences in mental rotation are larger in older children and adults (Levine et al., 2016; Voyer et al., 1995), it is possible the complex relationships between spatial reasoning, sex, play, and gender stereotypes are too weak to be easily and consistently detected at this age. A wider age range including children older than 6-years-old could have provided a more complete understanding of the relation between play, gender stereotypes, and mental rotation ability.

Implications and Future Directions

It is critical to understand the factors influencing the development of spatial skills given the importance of these skills for day-to-day activities (i.e., finding your car in a parking lot or fitting toys in a closet) and the link between spatial ability and achievement in math and STEM fields. Furthermore, understanding how play can impact spatial development could lead to the implementation of a fun and simple way to expand the spatial skills of young boys and girls and prepare them for the challenges of their future academic and professional careers. However, assessing children's play through direct observations can be incredibly time-consuming and there is currently no widely-used comprehensive survey to measure children's concurrent spatial and gender-typed play. This dissertation addressed the need in the field of spatial research for a quick and simple measure of spatial play through creation of the Spatial Activity Questionnaire. While not without limitations, the Spatial Activity Questionnaire has many strengths setting it apart from other existing surveys of spatial play. The Spatial Activity Questionnaire includes a wide range of toys and activities common in the lives of young children with written and pictorial examples as well as descriptions for each of the 66 toys and activities in order to

facilitate the distinction between similar items for survey-takers. The toys and activities included on the questionnaire were carefully selected from previous surveys of play and the largest toy retailers in the United States to include a multitude of age-appropriate toys and activities used in the current day and age, omitting age-inappropriate and outdated items. Finally, the questionnaire is administered online, facilitating the data collection process.

This dissertation shed light into the play patterns of young children, highlighting the diversity in children's play with toys of varied spatial and gender-typed content as well as the sex differences in children's play. Although our findings did not reveal a relation between children's play assessed through the Spatial Activity Questionnaire and children's mental rotation skills and gender stereotypes, it is important for future research to continue utilizing this questionnaire to explore the impact of play on distinct aspects of children's cognitive and social development. Gathering a larger sample of questionnaire responses may allow a greater understanding of children's play through exploratory and confirmatory factor analysis, potentially resulting in a shortened and improved version of the questionnaire. Additionally, continued use of the Spatial Activity Questionnaire would allow to test for its validity and reliability in order to implement it in future studies of children's play.

Future research should continue exploring the relation between play, spatial thinking, and gender stereotypes through the Spatial Activity Questionnaire and through various measures of spatial ability and gender stereotypes. Moreover, our findings point to the need to further explore the development of sex differences in mental rotation skills from a longitudinal framework. While sex differences in mental rotation skills are well-

established in adults (Maccoby & Jacklin, 1974; Uttal et al., 2013; Voyer et al., 1995), our results add to the research suggesting no consistent sex differences in mental rotation skills in childhood (Levine et al., 2016). Given the importance of spatial thinking, understanding the complex factors that influence the gender gap in spatial performance and identifying when these sex differences develop is essential for closing the gender gap in spatial achievement and improving the spatial skills of both boys and girls.

In conclusion, this line of research aims to better understand the impact of play on cognitive development in hopes of helping parents and educators make a conscious effort to provide a fun and simple way for children to attain higher levels of spatial thinking, preparing them to master every-day tasks such as navigating a city and the challenges of their future academic and professional careers.

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Table 1

Study 1: Item Spatial and Stereotype Ratings

	Masculine	Somewhat Masculine	Gender Neutral	Somewhat Feminine	Feminine
Extremely Spatial		• Connecting Blocks • Gear Sets • Non-Electronic Model Kits	• Jumbo Stacking Blocks • Jumbo Connecting Blocks • Marble Runs • Magnetic Construction Blocks • Interlocking Stick Toys • 3D Puzzles • Map Reading	• Stacking Blocks	
Very Spatial		• Train or Race Car Building Sets • Electronic Building Toys	• Lincoln Logs • Floor Puzzles • Jigsaw Puzzles • Peg Puzzles • Cube Puzzles • Tangram Puzzles • Brain Teasers • Mazes • Stacking Games • Drawing • Painting • Making Crafts with		

			Materials Found at Home • Play-Doh, Modeling Clay, Pottery, or Sculpting		
Moderately Spatial		• Video or Computer Games	• Origami • Science Experiments • Playing a Musical Instrument • Toys Controlled by Tablet, Computer, or Smartphones • Electronic or Remote Controlled Toys • Phone or Tablet Games	• Printing or Stamping • Scrapbooking • Fuse Beads	• Doll Houses or Doll House Accessories • Crocheting • Embroidering • Knitting • Weaving • Sewing • Making Jewelry
Somewhat Spatial	• Robots or Transformers	• Cars, Trucks, or Other Vehicles	• Dice Games • Tile Games • Floor Games • Board Games • Playhouses, Tents, or Tunnels • Coloring Pages • DJing	• Kitchens, Playfood, or Housekeeping Toys • Cooking or Baking	• Making Jewelry with Beads
Not at All Spatial		• Action Figure or Figurines	• Card Games • Puppets • Reading or Being	• Costumes or Costume Accessories	• Baby Dolls • Barbie Dolls or Similar

	Read Books • Karaoke • Watching Television or Movies	• Stuffed Animals	• Dolls

Table 2

Study 1: Number and Percentage of Children with Access to Toys/Activities by Child Sex

Item	# of Children with Access	% of Children with Access	# of Boys with Access	% of Boys with Access	# of Girls with Access	% of Girls with Access
Jumbo Stacking Blocks	62	21	41	24.26	21	16.67
Stacking Blocks	195	66.1	112	66.27	83	65.87
Jumbo Connecting Blocks	196	66.4	112	66.27	84	66.67
Connecting Blocks	177	60	105	62.13	72	57.14
Gear Sets	60	20.3	34	20.12	26	20.63
Marble Runs	84	28.5	48	28.40	36	28.57
Magnetic Construction Blocks	122	41.4	75	44.38	47	37.30
Lincoln Logs	80	27.1	47	27.81	33	26.19
Interlocking Stick Toys	71	24.1	39	23.08	32	25.40
Train or Race Car Building Sets	172	58.3	115	68.05	57	45.24
Electronic Building Toys (excluding train & race car sets)	68	23.1	40	23.67	28	22.22

Non-electronic model kits (excluding train sets, race car sets, & interlocking blocks such as Legos)	75	25.4	48	28.40	27	21.43
Floor Puzzles	173	58.6	91	53.85	82	65.08
Jigsaw Puzzles (excluding jigsaw oversized floor puzzles)	207	70.2	111	65.68	96	76.19
Peg Puzzles	170	57.6	96	56.80	74	58.73
Cube Puzzles	65	22	32	18.93	33	26.19
Tangram Puzzles	78	26.4	40	23.67	38	30.16
3D Puzzles	31	10.5	20	11.83	11	8.73
Brain Teasers	69	23.4	43	25.44	26	20.63
Mazes	117	39.7	67	39.64	50	39.68
Card Games	200	67.8	107	63.31	93	73.81
Dice Games	85	28.8	43	25.44	42	33.33
Tile Games	90	30.5	46	27.22	44	34.92
Floor Games (excluding floor puzzles)	92	31.2	43	25.44	49	38.89
Stacking Games	126	42.7	73	43.20	53	42.06
Board Games	189	64.1	98	57.99	91	72.22
Action Figures or Figurines	207	70.2	125	73.96	82	65.08
Robots or Transformers	117	39.7	90	53.25	27	21.43
Baby Dolls (excluding Barbie-like dolls & dolls that resemble older children)	52	51.5	52	30.77	100	79.37
Barbie Dolls or Similar	121	41	31	18.34	90	71.43
Dolls (excluding baby dolls and Barbie like dolls)	97	32.9	28	16.57	69	54.76

Doll Houses or Doll House Accessories	122	41.4	42	24.85	80	63.49
Kitchens, Playfood, or Housekeeping Toys	167	56.6	80	47.34	87	69.05
Playhouses, Tents, or Tunnels	146	49.5	82	48.52	64	50.79
Costumes or Costume Accessories	186	63.1	93	55.03	93	73.81
Puppets	113	38.3	61	36.09	52	41.27
Stuffed Animals	223	75.6	119	70.41	104	82.54
Cars, Trucks, or Other Vehicles	207	70.2	126	74.56	81	64.29
Reading or Being Read Books	223	75.6	120	71.01	103	81.75
Coloring Pages	223	75.6	121	71.60	102	80.95
Drawing	222	75.3	122	72.19	100	79.37
Painting	172	58.3	90	53.25	82	65.08
Printing or Stamping	110	37.3	54	31.95	56	44.44
Scrapbooking	19	6.4	7	4.14	12	9.52
Origami	47	15.9	29	17.16	18	14.29
Making Crafts with Materials found at Home	173	58.6	88	52.07	85	67.46
Crocheting	20	6.8	11	6.51	9	7.14
Embroidering	11	3.7	6	3.55	5	3.97
Knitting	8	2.7	3	1.78	5	3.97
Weaving	27	9.2	9	5.33	18	14.29
Sewing	19	6.4	6	3.55	13	10.32
Making Jewelry	42	14.2	11	6.51	31	24.60

Fuse Beads	54	18.3	23	13.61	31	24.60
Making Jewelry with beads	79	26.8	19	11.24	60	47.62
Play-Doh, Modeling Clay, Pottery, or Sculpting	205	69.5	109	64.50	96	76.19
Cooking or Baking	150	50.8	65	38.46	85	67.46
Science Experiments	111	37.6	59	34.91	52	41.27
Playing a Musical Instrument	154	52.2	93	55.03	61	48.41
Karaoke	71	24.1	31	18.34	40	31.75
DJing	22	7.5	14	8.28	8	6.35
Map Reading	80	27.1	48	28.40	32	25.40
Watching Television or Movies	212	71.9	116	68.64	96	76.19
Toys Controlled by Tablet, Computer, or Smartphones	54	18.3	26	15.38	28	22.22
Electronic or Remote Controlled Toys (excluding toys controlled by tablets, computers, or smartphones)	137	46.4	83	49.11	54	42.86
Video or Computer Games	117	39.7	69	40.83	48	38.10
Phone or Tablet Games	137	46.4	73	43.20	64	50.79

Table 3

Study 1: Number and Percentage of Children with Access/Engagement to Toys/Activities by Child Sex

Item	Spatial Rating	Stereo -type Rating	Child Sex	No access	Not in the last 3 months	Less than once a month	About once a month	About once a week	A few times a week	Daily Almost Daily

Jumbo Stacking Blocks	5	4	Both	233 (78.98%)	3 (1.02%)	5 (1.69%)	11 (3.73%)	22 (7.46%)	17 (5.76%)	4 (1.36%)
			M	128 (75.74%)	1 (0.59%)	4 (2.37%)	3 (1.78%)	16 (9.47%)	14 (8.28%)	3 (1.78%)
			F	105 (83.33%)	2 (1.59%)	1 (0.79%)	8 (6.35%)	6 (4.76%)	3 (2.38%)	1 (0.79%)
Stacking Blocks	5	5	Both	100 (33.90%)	18 (6.10%)	30 (10.17%)	45 (15.25%)	55 (18.64%)	41 (13.90%)	6 (2.03%)
			M	57 (33.73%)	6 (3.55%)	20 (11.83%)	28 (16.57%)	29 (17.16%)	24 (14.20%)	5 (2.96%)
			F	43 (34.13%)	12 (9.52%)	10 (7.94%)	17 (13.49%)	26 (20.63%)	17 (13.49%)	1 (0.79%)
Jumbo Connecting Blocks	5	4	Both	99 (33.56%)	20 (6.78%)	14 (4.75%)	29 (9.83%)	53 (17.97%)	61 (20.68%)	19 (6.44%)
			M	57 (33.73%)	6 (3.55%)	9 (5.33%)	18 (10.65%)	32 (18.93%)	33 (19.53%)	14 (8.28%)
			F	42 (33.33%)	14 (11.11%)	5 (3.97%)	11 (8.73%)	21 (16.67%)	28 (22.22%)	5 (3.97%)
Connecting Blocks	5	3	Both	118 (40.00%)	2 (0.68%)	7 (2.37%)	29 (9.83%)	47 (15.93%)	55 (18.64%)	37 (12.54%)
			M	64 (37.87%)	0 (0.00%)	2 (1.18%)	15 (8.88%)	28 (16.57%)	31 (18.34%)	29 (17.16%)
			F	54 (42.86%)	2 (1.59%)	5 (3.97%)	14 (11.11%)	19 (15.08%)	24 (19.05%)	8 (6.35%)
Gear Sets	5	3	Both	235 (79.66%)	7 (2.37%)	10 (3.39%)	19 (6.44%)	11 (3.73%)	10 (3.39%)	3 (1.02%)
			M	135 (79.88%)	2 (1.18%)	4 (2.37%)	13 (7.69%)	8 (4.73%)	4 (2.37%)	3 (1.78%)
			F	100 (79.37%)	5 (3.97%)	6 (4.76%)	6 (4.76%)	3 (2.38%)	6 (4.76%)	0 (0.00%)
Marble	5	4	Both	211	9	17	31	17	9	1

Runs				(71.53%)	(3.05%)	(5.76%)	(10.51%)	(5.76%)	(3.05%)	(0.34%)
			M	121	4	9	18	12	4	1
				(71.60%)	(2.37%)	(5.33%)	(10.65%)	(7.10%)	(2.37%)	(0.59%)
			F	90	5	8	13	5	5	0
				(71.43%)	(3.97%)	(6.35%)	(10.32%)	(3.97%)	(3.97%)	(0.00%)
Magnetic	5	4	Both	173	7	11	23	38	26	17
Constructio				(58.64%)	(2.37%)	(3.73%)	(7.80%)	(12.88%)	(8.81%)	(5.76%)
n Blocks			M	94	6	8	16	21	15	9
				(55.62%)	(3.55%)	(4.73%)	(9.47%)	(12.43%)	(8.88%)	(5.33%)
			F	79	1	3	7	17	11	8
				(62.70%)	(0.79%)	(2.38%)	(5.56%)	(13.49%)	(8.73%)	(6.35%)
Lincoln	4	4	Both	215	10	20	14	23	12	1
Logs				(72.88%)	(3.39%)	(6.78%)	(4.75%)	(7.80%)	(4.07%)	(0.34%)
			M	122	4	12	10	16	5	0
				(72.19%)	(2.37%)	(7.10%)	(5.92%)	(9.47%)	(2.96%)	(0.00%)
			F	93	6	8	4	7	7	1
				(73.81%)	(4.76%)	(6.35%)	(3.17%)	(5.56%)	(5.56%)	(0.79%)
Interlockin	5	4	Both	224	5	10	20	22	13	1
g Stick				(75.93%)	(1.69%)	(3.39%)	(6.78%)	(7.46%)	(4.41%)	(0.34%)
Toys			M	130	3	5	10	13	7	1
				(76.92%)	(1.78%)	(2.96%)	(5.92%)	(7.69%)	(4.14%)	(0.59%)
			F	94	2	5	10	9	6	0
				(74.60%)	(1.59%)	(3.97%)	(7.94%)	(7.14%)	(4.76%)	(0.00%)
Train or	4	3	Both	123	16	19	35	40	36	26
Race Car				(41.69%)	(5.42%)	(6.44%)	(11.86%)	(13.56%)	(12.20%)	(8.81%)
Building			M	54	8	9	25	23	28	22
Sets				(31.95%)	(4.73%)	(5.33%)	(14.79%)	(13.61%)	(16.57%)	(13.02%)
			F	69	8	10	10	17	8	4
				(54.76%)	(6.35%)	(7.94%)	(7.94%)	(13.49%)	(6.35%)	(3.17%)
Electronic	4	3	Both	227	9	6	18	17	16	2
Building				(76.95%)	(3.05%)	(2.03%)	(6.10%)	(5.76%)	(5.42%)	(0.68%)

Toys			M	129 (76.33%)	5 (2.96%)	1 (0.59%)	8 (4.73%)	13 (7.69%)	12 (7.10%)	1 (0.59%)
			F	98 (77.78%)	4 (3.17%)	5 (3.97%)	10 (7.94%)	4 (3.17%)	4 (3.17%)	1 (0.79%)
Non-electronic model kits	5	3	Both	220 (74.58%)	9 (3.05%)	16 (5.42%)	17 (5.76%)	13 (4.41%)	14 (4.75%)	6 (2.03%)
			M	121 (71.60%)	2 (1.18%)	12 (7.10%)	8 (4.73%)	10 (5.92%)	11 (6.51%)	5 (2.96%)
			F	99 (78.57%)	7 (5.56%)	4 (3.17%)	9 (7.14%)	3 (2.38%)	3 (2.38%)	1 (0.79%)
Floor Puzzles	4	4	Both	122 (41.36%)	22 (7.46%)	27 (9.15%)	50 (16.95%)	39 (13.22%)	29 (9.83%)	6 (2.03%)
			M	78 (46.15%)	10 (5.92%)	17 (10.06%)	25 (14.79%)	24 (14.20%)	12 (7.10%)	3 (1.78%)
			F	44 (34.92%)	12 (9.52%)	10 (7.94%)	25 (19.84%)	15 (11.90%)	17 (13.49%)	3 (2.38%)
Jigsaw Puzzles	4	4	Both	88 (29.83%)	16 (5.42%)	31 (10.51%)	59 (20.00%)	55 (18.64%)	42 (14.24%)	4 (1.36%)
			M	58 (34.32%)	9 (5.33%)	21 (12.43%)	32 (18.93%)	27 (15.98%)	20 (11.83%)	2 (1.18%)
			F	30 (23.81%)	7 (5.56%)	10 (7.94%)	27 (21.43%)	28 (22.22%)	22 (17.46%)	2 (1.59%)
Peg Puzzles	4	4	Both	125 (42.37%)	59 (20.00%)	25 (8.47%)	33 (11.19%)	31 (10.51%)	17 (5.76%)	5 (1.69%)
			M	73 (43.20%)	33 (19.53%)	14 (8.28%)	21 (12.43%)	17 (10.06%)	9 (5.33%)	2 (1.18%)
			F	52 (41.27%)	26 (20.63%)	11 (8.73%)	12 (9.52%)	14 (11.11%)	8 (6.35%)	3 (2.38%)
Cube Puzzles	4	4	Both	230 (77.97%)	19 (6.44%)	13 (4.41%)	14 (4.75%)	10 (3.39%)	7 (2.37%)	2 (0.68%)
			M	137	9	6	5	6	4	2

				(81.07%)	(5.33%)	(3.55%)	(2.96%)	(3.55%)	(2.37%)	(1.18%)
			F	93	10	7	9	4	3	0
				(73.81%)	(7.94%)	(5.56%)	(7.14%)	(3.17%)	(2.38%)	(0.00%)
Tangram Puzzles	4	4	Both	217	19	16	17	16	9	1
				(73.56%)	(6.44%)	(5.42%)	(5.76%)	(5.42%)	(3.05%)	(0.34%)
			M	129	10	8	9	8	4	1
				(76.33%)	(5.92%)	(4.73%)	(5.33%)	(4.73%)	(2.37%)	(0.59%)
			F	88	9	8	8	8	5	0
				(69.84%)	(7.14%)	(6.35%)	(6.35%)	(6.35%)	(3.97%)	(0.00%)
3D Puzzles	5	4	Both	264	7	6	10	4	3	1
				(89.49%)	(2.37%)	(2.03%)	(3.39%)	(1.36%)	(1.02%)	(0.34%)
			M	149	4	4	7	1	3	1
				(88.17%)	(2.37%)	(2.37%)	(4.14%)	(0.59%)	(1.78%)	(0.59%)
			F	115	3	2	3	3	0	0
				(91.27%)	(2.38%)	(1.59%)	(2.38%)	(2.38%)	(0.00%)	(0.00%)
Brain Teasers	4	4	Both	226	12	19	16	15	5	2
				(76.61%)	(4.07%)	(6.44%)	(5.42%)	(5.08%)	(1.69%)	(0.68%)
			M	126	8	13	11	8	2	1
				(74.56%)	(4.73%)	(7.69%)	(6.51%)	(4.73%)	(1.18%)	(0.59%)
			F	100	4	6	5	7	3	1
				(79.37%)	(3.17%)	(4.76%)	(3.97%)	(5.56%)	(2.38%)	(0.79%)
Mazes	4	4	Both	178	12	26	43	21	13	2
				(60.34%)	(4.07%)	(8.81%)	(14.58%)	(7.12%)	(4.41%)	(0.68%)
			M	102	8	17	25	11	5	1
				(60.36%)	(4.73%)	(10.06%)	(14.79%)	(6.51%)	(2.96%)	(0.59%)
			F	76	4	9	18	10	8	1
				(60.32%)	(3.17%)	(7.14%)	(14.29%)	(7.94%)	(6.35%)	(0.79%)
Card Games	1	4	Both	95	17	24	57	57	36	9
				(32.20%)	(5.76%)	(8.14%)	(19.32%)	(19.32%)	(12.20%)	(3.05%)
			M	62	10	18	29	27	19	4
				(36.69%)	(5.92%)	(10.65%)	(17.16%)	(15.98%)	(11.24%)	(2.37%)

			F	33 (26.19%)	7 (5.56%)	6 (4.76%)	28 (22.22%)	30 (23.81%)	17 (13.49%)	5 (3.97%)
Dice Games	2	4	Both	210 (71.19%)	16 (5.42%)	15 (5.08%)	25 (8.47%)	16 (5.42%)	11 (3.73%)	2 (0.68%)
			M	126 (74.56%)	8 (4.73%)	9 (5.33%)	12 (7.10%)	10 (5.92%)	4 (2.37%)	0 (0.00%)
			F	84 (66.67%)	8 (6.35%)	6 (4.76%)	13 (10.32%)	6 (4.76%)	7 (5.56%)	2 (1.59%)
Tile Games	2	4	Both	205 (69.49%)	19 (6.44%)	22 (7.46%)	19 (6.44%)	26 (8.81%)	3 (1.02%)	1 (0.34%)
			M	123 (72.78%)	8 (4.73%)	14 (8.28%)	11 (6.51%)	13 (7.69%)	0 (0.00%)	0 (0.00%)
			F	82 (65.08%)	11 (8.73%)	8 (6.35%)	8 (6.35%)	13 (10.32%)	3 (2.38%)	1 (0.79%)
Floor Games	2	4	Both	203 (68.81%)	7 (2.37%)	26 (8.81%)	21 (7.12%)	24 (8.14%)	12 (4.07%)	2 (0.68%)
			M	126 (74.56%)	2 (1.18%)	12 (7.10%)	10 (5.92%)	14 (8.28%)	5 (2.96%)	0 (0.00%)
			F	77 (61.11%)	5 (3.97%)	14 (11.11%)	11 (8.73%)	10 (7.94%)	7 (5.56%)	2 (1.59%)
Stacking Games	4	4	Both	169 (57.29%)	14 (4.75%)	24 (8.14%)	41 (13.90%)	36 (12.20%)	8 (2.71%)	3 (1.02%)
			M	96 (56.80%)	5 (2.96%)	13 (7.69%)	24 (14.20%)	21 (12.43%)	8 (4.73%)	2 (1.18%)
			F	73 (57.94%)	9 (7.14%)	11 (8.73%)	17 (13.49%)	15 (11.90%)	0 (0.00%)	1 (0.79%)
Board Games	2	4	Both	106 (35.93%)	8 (2.71%)	19 (6.44%)	50 (16.95%)	64 (21.69%)	41 (13.90%)	7 (2.37%)
			M	71 (42.01%)	6 (3.55%)	8 (4.73%)	30 (17.75%)	33 (19.53%)	18 (10.65%)	3 (1.78%)
			F	35	2	11	20	31	23	4

				(27.78%)	(1.59%)	(8.73%)	(15.87%)	(24.60%)	(18.25%)	(3.17%)
Action Figures or Figurines	1	3	Both	88 (29.83%)	3 (1.02%)	14 (4.75%)	16 (5.42%)	41 (13.90%)	51 (17.29%)	82 (27.80%)
			M	44 (26.04%)	3 (1.78%)	5 (2.96%)	9 (5.33%)	23 (13.61%)	31 (18.34%)	54 (31.95%)
			F	44 (34.92%)	0 (0.00%)	9 (7.14%)	7 (5.56%)	18 (14.29%)	20 (15.87%)	28 (22.22%)
Robots or Transformers	2	2	Both	178 (60.34%)	6 (2.03%)	10 (3.39%)	17 (5.76%)	25 (8.47%)	26 (8.81%)	33 (11.19%)
			M	79 (46.75%)	3 (1.78%)	3 (1.78%)	13 (7.69%)	18 (10.65%)	22 (13.02%)	31 (18.34%)
			F	99 (78.57%)	3 (2.38%)	7 (5.56%)	4 (3.17%)	7 (5.56%)	4 (3.17%)	2 (1.59%)
Baby Dolls	1	6	Both	143 (48.47%)	20 (6.78%)	19 (6.44%)	17 (5.76%)	26 (8.81%)	20 (6.78%)	50 (16.95%)
			M	117 (69.23%)	17 (10.06%)	13 (7.69%)	6 (3.55%)	8 (4.73%)	2 (1.18%)	6 (3.55%)
			F	26 (20.63%)	3 (2.38%)	6 (4.76%)	11 (8.73%)	18 (14.29%)	18 (14.29%)	44 (34.92%)
Barbie Dolls or Similar	1	7	Both	174 (58.98%)	10 (3.39%)	13 (4.41%)	10 (3.39%)	22 (7.46%)	30 (10.17%)	36 (12.20%)
			M	138 (81.66%)	9 (5.33%)	7 (4.14%)	4 (2.37%)	7 (4.14%)	3 (1.78%)	1 (0.59%)
			F	36 (28.57%)	1 (0.79%)	6 (4.76%)	6 (4.76%)	15 (11.90%)	27 (21.43%)	35 (27.78%)
Dolls	1	6	Both	198 (67.12%)	14 (4.75%)	10 (3.39%)	10 (3.39%)	19 (6.44%)	19 (6.44%)	25 (8.47%)
			M	141 (83.43%)	9 (5.33%)	6 (3.55%)	4 (2.37%)	4 (2.37%)	2 (1.18%)	3 (1.78%)
			F	57 (45.24%)	5 (3.97%)	4 (3.17%)	6 (4.76%)	15 (11.90%)	17 (13.49%)	22 (17.46%)

Doll Houses or Doll House Accessories	3	6	Both	173 (58.64%)	8 (2.71%)	14 (4.75%)	19 (6.44%)	26 (8.81%)	33 (11.19%)	22 (7.46%)
			M	127 (75.15%)	5 (2.96%)	8 (4.73%)	8 (4.73%)	11 (6.51%)	9 (5.33%)	1 (0.59%)
			F	46 (36.51%)	3 (2.38%)	6 (4.76%)	11 (8.73%)	15 (11.90%)	24 (19.05%)	21 (16.67%)
Kitchens, Playfood, or Housekeeping Toys	2	5	Both	128 (43.39%)	11 (3.73%)	19 (6.44%)	26 (8.81%)	40 (13.56%)	42 (14.24%)	29 (9.83%)
			M	89 (52.66%)	6 (3.55%)	15 (8.88%)	16 (9.47%)	18 (10.65%)	17 (10.06%)	8 (4.73%)
			F	39 (30.95%)	5 (3.97%)	4 (3.17%)	10 (7.94%)	22 (17.46%)	25 (19.84%)	21 (16.67%)
Playhouses, Tents, or Tunnels	2	4	Both	149 (50.51%)	13 (4.41%)	20 (6.78%)	35 (11.86%)	38 (12.88%)	21 (7.12%)	19 (6.44%)
			M	87 (51.48%)	4 (2.37%)	16 (9.47%)	19 (11.24%)	23 (13.61%)	10 (5.92%)	10 (5.92%)
			F	62 (49.21%)	9 (7.14%)	4 (3.17%)	16 (12.70%)	15 (11.90%)	11 (8.73%)	9 (7.14%)
Costumes or Costume Accessories	1	5	Both	109 (36.95%)	10 (3.39%)	28 (9.49%)	28 (9.49%)	40 (13.56%)	54 (18.31%)	26 (8.81%)
			M	76 (44.97%)	7 (4.14%)	19 (11.24%)	14 (8.28%)	20 (11.83%)	21 (12.43%)	12 (7.10%)
			F	33 (26.19%)	3 (2.38%)	9 (7.14%)	14 (11.11%)	20 (15.87%)	33 (26.19%)	14 (11.11%)
Puppets	1	4	Both	182 (61.69%)	23 (7.80%)	29 (9.83%)	36 (12.20%)	20 (6.78%)	4 (1.36%)	1 (0.34%)
			M	108 (63.91%)	13 (7.69%)	20 (11.83%)	17 (10.06%)	9 (5.33%)	1 (0.59%)	1 (0.59%)
			F	74 (58.73%)	10 (7.94%)	9 (7.14%)	19 (15.08%)	11 (8.73%)	3 (2.38%)	0 (0.00%)
Stuffed	1	5	Both	72	6	11	13	29	52	112

Animals				(24.41%)	(2.03%)	(3.73%)	(4.41%)	(9.83%)	(17.63%)	(37.97%)
			M	50	4	8	7	17	31	52
				(29.59%)	(2.37%)	(4.73%)	(4.14%)	(10.06%)	(18.34%)	(30.77%)
			F	22	2	3	6	12	21	60
				(17.46%)	(1.59%)	(2.38%)	(4.76%)	(9.52%)	(16.67%)	(47.62%)
Cars, Trucks, or Other Vehicles	2	3	Both	88	2	8	15	42	70	70
				(29.83%)	(0.68%)	(2.71%)	(5.08%)	(14.24%)	(23.73%)	(23.73%)
			M	43	1	0	7	11	43	64
				(25.44%)	(0.59%)	(0.00%)	(4.14%)	(6.51%)	(25.44%)	(37.87%)
			F	45	1	8	8	31	27	6
				(35.71%)	(0.79%)	(6.35%)	(6.35%)	(24.60%)	(21.43%)	(4.76%)
Reading or Being Read Books	1	4	Both	72	0	2	6	10	43	162
				(24.41%)	(0.00%)	(0.68%)	(2.03%)	(3.39%)	(14.58%)	(54.92%)
			M	49	0	1	4	5	25	85
				(28.99%)	(0.00%)	(0.59%)	(2.37%)	(2.96%)	(14.79%)	(50.30%)
			F	23	0	1	2	5	18	77
				(18.25%)	(0.00%)	(0.79%)	(1.59%)	(3.97%)	(14.29%)	(61.11%)
Coloring Pages	2	4	Both	72	1	6	24	47	74	71
				(24.41%)	(0.34%)	(2.03%)	(8.14%)	(15.93%)	(25.08%)	(24.07%)
			M	48	1	4	18	28	41	29
				(28.40%)	(0.59%)	(2.37%)	(10.65%)	(16.57%)	(24.26%)	(17.16%)
			F	24	0	2	6	19	33	42
				(19.05%)	(0.00%)	(1.59%)	(4.76%)	(15.08%)	(26.19%)	(33.33%)
Drawing	4	4	Both	73	1	4	18	53	66	80
				(24.75%)	(0.34%)	(1.36%)	(6.10%)	(17.97%)	(22.37%)	(27.12%)
			M	47	1	4	12	38	36	31
				(27.81%)	(0.59%)	(2.37%)	(7.10%)	(22.49%)	(21.30%)	(18.34%)
			F	26	0	0	6	15	30	49
				(20.63%)	(0.00%)	(0.00%)	(4.76%)	(11.90%)	(23.81%)	(38.89%)
Painting	4	4	Both	123	5	27	57	47	28	8
				(41.69%)	(1.69%)	(9.15%)	(19.32%)	(15.93%)	(9.49%)	(2.71%)

			M	79 (46.75%)	3 (1.78%)	19 (11.24%)	28 (16.57%)	26 (15.38%)	12 (7.10%)	2 (1.18%)
			F	44 (34.92%)	2 (1.59%)	8 (6.35%)	29 (23.02%)	21 (16.67%)	16 (12.70%)	6 (4.76%)
Printing or Stamping	3	5	Both	185 (62.71%)	4 (1.36%)	25 (8.47%)	36 (12.20%)	34 (11.53%)	10 (3.39%)	1 (0.34%)
			M	115 (68.05%)	2 (1.18%)	13 (7.69%)	22 (13.02%)	13 (7.69%)	4 (2.37%)	0 (0.00%)
			F	70 (55.56%)	2 (1.59%)	12 (9.52%)	14 (11.11%)	21 (16.67%)	6 (4.76%)	1 (0.79%)
Scrapbooking	3	5	Both	276 (93.56%)	1 (0.34%)	7 (2.37%)	2 (0.68%)	7 (2.37%)	2 (0.68%)	0 (0.00%)
			M	162 (95.86%)	1 (0.59%)	3 (1.78%)	0 (0.00%)	2 (1.18%)	1 (0.59%)	0 (0.00%)
			F	114 (90.48%)	0 (0.00%)	4 (3.17%)	2 (1.59%)	5 (3.97%)	1 (0.79%)	0 (0.00%)
Origami	3	4	Both	248 (84.07%)	7 (2.37%)	12 (4.07%)	13 (4.41%)	10 (3.39%)	4 (1.36%)	1 (0.34%)
			M	140 (82.84%)	5 (2.96%)	6 (3.55%)	10 (5.92%)	6 (3.55%)	2 (1.18%)	0 (0.00%)
			F	108 (85.71%)	2 (1.59%)	6 (4.76%)	3 (2.38%)	4 (3.17%)	2 (1.59%)	1 (0.79%)
Making Crafts with Materials found at Home	4	4	Both	122 (41.36%)	5 (1.69%)	16 (5.42%)	56 (18.98%)	45 (15.25%)	38 (12.88%)	13 (4.41%)
			M	81 (47.93%)	4 (2.37%)	13 (7.69%)	27 (15.98%)	23 (13.61%)	16 (9.47%)	5 (2.96%)
			F	41 (32.54%)	1 (0.79%)	3 (2.38%)	29 (23.02%)	22 (17.46%)	22 (17.46%)	8 (6.35%)
Crocheting	3	6	Both	275 (93.22%)	1 (0.34%)	3 (1.02%)	9 (3.05%)	5 (1.69%)	2 (0.68%)	0 (0.00%)
			M	158	0	2	6	1	2	0

				(93.49%)	(0.00%)	(1.18%)	(3.55%)	(0.59%)	(1.18%)	(0.00%)
			F	117	1	1	3	4	0	0
				(92.86%)	(0.79%)	(0.79%)	(2.38%)	(3.17%)	(0.00%)	(0.00%)
Embroidering	3	6	Both	284	1	2	3	2	3	0
				(96.27%)	(0.34%)	(0.68%)	(1.02%)	(0.68%)	(1.02%)	(0.00%)
			M	163	1	0	1	1	3	0
				(96.45%)	(0.59%)	(0.00%)	(0.59%)	(0.59%)	(1.78%)	(0.00%)
			F	121	0	2	2	1	0	0
				(96.03%)	(0.00%)	(1.59%)	(1.59%)	(0.79%)	(0.00%)	(0.00%)
Knitting	3	6	Both	287	1	1	3	1	2	0
				(97.29%)	(0.34%)	(0.34%)	(1.02%)	(0.34%)	(0.68%)	(0.00%)
			M	166	0	1	1	0	1	0
				(98.22%)	(0.00%)	(0.59%)	(0.59%)	(0.00%)	(0.59%)	(0.00%)
			F	121	1	0	2	1	1	0
				(96.03%)	(0.79%)	(0.00%)	(1.59%)	(0.79%)	(0.79%)	(0.00%)
Weaving	3	6	Both	268	7	4	6	10	0	0
				(90.85%)	(2.37%)	(1.36%)	(2.03%)	(3.39%)	(0.00%)	(0.00%)
			M	160	1	0	2	6	0	0
				(94.67%)	(0.59%)	(0.00%)	(1.18%)	(3.55%)	(0.00%)	(0.00%)
			F	108	6	4	4	4	0	0
				(85.71%)	(4.76%)	(3.17%)	(3.17%)	(3.17%)	(0.00%)	(0.00%)
Sewing	3	6	Both	276	1	4	3	8	3	0
				(93.56%)	(0.34%)	(1.36%)	(1.02%)	(2.71%)	(1.02%)	(0.00%)
			M	163	0	0	0	4	2	0
				(96.45%)	(0.00%)	(0.00%)	(0.00%)	(2.37%)	(1.18%)	(0.00%)
			F	113	1	4	3	4	1	0
				(89.68%)	(0.79%)	(3.17%)	(2.38%)	(3.17%)	(0.79%)	(0.00%)
Making Jewelry	3	6	Both	253	5	13	7	12	5	0
				(85.76%)	(1.69%)	(4.41%)	(2.37%)	(4.07%)	(1.69%)	(0.00%)
			M	158	3	2	1	4	1	0
				(93.49%)	(1.78%)	(1.18%)	(0.59%)	(2.37%)	(0.59%)	(0.00%)

			F	95 (75.40%)	2 (1.59%)	11 (8.73%)	6 (4.76%)	8 (6.35%)	4 (3.17%)	0 (0.00%)
Fuse Beads	3	5	Both	241 (81.69%)	13 (4.41%)	18 (6.10%)	16 (5.42%)	6 (2.03%)	1 (0.34%)	0 (0.00%)
			M	146 (86.39%)	7 (4.14%)	7 (4.14%)	6 (3.55%)	3 (1.78%)	0 (0.00%)	0 (0.00%)
			F	95 (75.40%)	6 (4.76%)	11 (8.73%)	10 (7.94%)	3 (2.38%)	1 (0.79%)	0 (0.00%)
Making Jewelry	2	6	Both	216 (73.22%)	10 (3.39%)	25 (8.47%)	22 (7.46%)	19 (6.44%)	3 (1.02%)	0 (0.00%)
with beads			M	150 (88.76%)	4 (2.37%)	9 (5.33%)	3 (1.78%)	3 (1.78%)	0 (0.00%)	0 (0.00%)
			F	66 (52.38%)	6 (4.76%)	16 (12.70%)	19 (15.08%)	16 (12.70%)	3 (2.38%)	0 (0.00%)
Play-Doh, Modeling	4	4	Both	90 (30.51%)	11 (3.73%)	20 (6.78%)	67 (22.71%)	64 (21.69%)	31 (10.51%)	12 (4.07%)
Clay, Pottery, or			M	60 (35.50%)	5 (2.96%)	12 (7.10%)	41 (24.26%)	35 (20.71%)	13 (7.69%)	3 (1.78%)
Sculpting			F	30 (23.81%)	6 (4.76%)	8 (6.35%)	26 (20.63%)	29 (23.02%)	18 (14.29%)	9 (7.14%)
Cooking or	2	5	Both	145 (49.15%)	2 (0.68%)	12 (4.07%)	35 (11.86%)	55 (18.64%)	37 (12.54%)	9 (3.05%)
Baking			M	104 (61.54%)	1 (0.59%)	7 (4.14%)	13 (7.69%)	26 (15.38%)	13 (7.69%)	5 (2.96%)
			F	41 (32.54%)	1 (0.79%)	5 (3.97%)	22 (17.46%)	29 (23.02%)	24 (19.05%)	4 (3.17%)
Science	3	4	Both	184 (62.37%)	5 (1.69%)	24 (8.14%)	50 (16.95%)	24 (8.14%)	7 (2.37%)	1 (0.34%)
Experiments			M	110 (65.09%)	3 (1.78%)	13 (7.69%)	24 (14.20%)	13 (7.69%)	6 (3.55%)	0 (0.00%)
			F	74	2	11	26	11	1	1

				(58.73%)	(1.59%)	(8.73%)	(20.63%)	(8.73%)	(0.79%)	(0.79%)
Playing a	3	4	Both	141	4	13	26	58	31	22
Musical				(47.80%)	(1.36%)	(4.41%)	(8.81%)	(19.66%)	(10.51%)	(7.46%)
Instrument			M	76	3	7	13	37	21	12
				(44.97%)	(1.78%)	(4.14%)	(7.69%)	(21.89%)	(12.43%)	(7.10%)
			F	65	1	6	13	21	10	10
				(51.59%)	(0.79%)	(4.76%)	(10.32%)	(16.67%)	(7.94%)	(7.94%)
Karaoke	1	4	Both	224	5	11	16	15	18	6
				(75.93%)	(1.69%)	(3.73%)	(5.42%)	(5.08%)	(6.10%)	(2.03%)
			M	138	2	7	8	5	5	4
				(81.66%)	(1.18%)	(4.14%)	(4.73%)	(2.96%)	(2.96%)	(2.37%)
			F	86	3	4	8	10	13	2
				(68.25%)	(2.38%)	(3.17%)	(6.35%)	(7.94%)	(10.32%)	(1.59%)
DJing	2	4	Both	273	0	4	6	8	4	0
				(92.54%)	(0.00%)	(1.36%)	(2.03%)	(2.71%)	(1.36%)	(0.00%)
			M	155	0	1	4	5	4	0
				(91.72%)	(0.00%)	(0.59%)	(2.37%)	(2.96%)	(2.37%)	(0.00%)
			F	118	0	3	2	3	0	0
				(93.65%)	(0.00%)	(2.38%)	(1.59%)	(2.38%)	(0.00%)	(0.00%)
Map	5	4	Both	215	3	12	29	21	11	4
Reading				(72.88%)	(1.02%)	(4.07%)	(9.83%)	(7.12%)	(3.73%)	(1.36%)
			M	121	2	6	15	12	9	4
				(71.60%)	(1.18%)	(3.55%)	(8.88%)	(7.10%)	(5.33%)	(2.37%)
			F	94	1	6	14	9	2	0
				(74.60%)	(0.79%)	(4.76%)	(11.11%)	(7.14%)	(1.59%)	(0.00%)
Watching	1	4	Both	83	0	1	4	12	48	147
Television				(28.14%)	(0.00%)	(0.34%)	(1.36%)	(4.07%)	(16.27%)	(49.83%)
or Movies			M	53	0	1	3	4	30	78
				(31.36%)	(0.00%)	(0.59%)	(1.78%)	(2.37%)	(17.75%)	(46.15%)
			F	30	0	0	1	8	18	69
				(23.81%)	(0.00%)	(0.00%)	(0.79%)	(6.35%)	(14.29%)	(54.76%)

Toys Controlled by Tablet, Computer, or Smartphones	3	4	Both	241 (81.69%)	3 (1.02%)	3 (1.02%)	10 (3.39%)	15 (5.08%)	14 (4.75%)	9 (3.05%)
			M	143 (84.62%)	1 (0.59%)	1 (0.59%)	3 (1.78%)	10 (5.92%)	7 (4.14%)	4 (2.37%)
			F	98 (77.78%)	2 (1.59%)	2 (1.59%)	7 (5.56%)	5 (3.97%)	7 (5.56%)	5 (3.97%)
Electronic or Remote Controlled Toys	3	4	Both	158 (53.56%)	9 (3.05%)	27 (9.15%)	37 (12.54%)	30 (10.17%)	29 (9.83%)	5 (1.69%)
			M	86 (50.89%)	5 (2.96%)	13 (7.69%)	17 (10.06%)	23 (13.61%)	21 (12.43%)	4 (2.37%)
			F	72 (57.14%)	4 (3.17%)	14 (11.11%)	20 (15.87%)	7 (5.56%)	8 (6.35%)	1 (0.79%)
Video or Computer Games	3	3	Both	178 (60.34%)	3 (1.02%)	9 (3.05%)	13 (4.41%)	24 (8.14%)	43 (14.58%)	25 (8.47%)
			M	100 (59.17%)	1 (0.59%)	5 (2.96%)	7 (4.14%)	12 (7.10%)	26 (15.38%)	18 (10.65%)
			F	78 (61.90%)	2 (1.59%)	4 (3.17%)	6 (4.76%)	12 (9.52%)	17 (13.49%)	7 (5.56%)
Phone or Tablet Games	3	4	Both	159 (53.90%)	3 (1.02%)	10 (3.39%)	4 (1.36%)	25 (8.47%)	47 (15.93%)	47 (15.93%)
			M	97 (57.40%)	3 (1.78%)	6 (3.55%)	3 (1.78%)	14 (8.28%)	23 (13.61%)	23 (13.61%)
			F	62 (49.21%)	0 (0.00%)	4 (3.17%)	1 (0.79%)	11 (8.73%)	24 (19.05%)	24 (19.05%)

Table 4

Study 1: Descriptive Access and Engagement Scores by Spatial Category

Score Type	Spatial Rating Category	Possible Score Range	Child Sex	Mean Score	SD	Min Score	Max Score
Access	Not at all Spatial	0 - 11	Both	6.12	3.18	0	11
			Males	5.22	2.92	0	11
			Females	7.32	3.11	0	11
	Somewhat Spatial	0 - 12	Both	5.31	2.80	0	12
			Males	4.89	2.72	0	10
			Females	5.87	2.82	0	12
	Moderately Spatial	0 - 17	Both	4.03	2.60	0	14
			Males	3.57	2.40	0	11
			Females	4.64	2.74	0	14
	Very Spatial	0 - 15	Both	7.11	3.28	0	14
			Males	6.89	3.37	0	14
			Females	7.41	3.13	0	14
	Extremely Spatial	0 - 11	Both	3.91	1.97	0	9
			Males	4.04	1.93	0	9
			Females	3.74	2.01	0	9
Engagement	Not at all Spatial	0 - 66	Both	27.28	15.10	0	59
			Males	22.28	12.64	0	59
			Females	33.98	15.57	0	57
	Somewhat Spatial	0 - 72	Both	20.83	11.19	0	47
			Males	19.53	11.10	0	45
			Females	22.58	11.13	0	47
	Moderately Spatial	0 - 102	Both	14.89	9.52	0	59
			Males	13.28	9.03	0	50
			Females	17.04	9.78	0	59
	Very Spatial	0 - 90	Both	24.63	12.20	0	66
			Males	23.50	11.92	0	49
			Females	26.14	12.45	0	66
	Extremely	0 - 66	Both	14.44	8.09	0	41

	Spatial	Males	15.43	7.93	0	39
		Females	13.12	8.14	0	41

Table 5

Study 1: Descriptive Average Access and Engagement Scores by Spatial Category

Score Type	Spatial Rating Category	Child Sex	Mean Score	SD	Min Score	Max Score
Access	Not at all Spatial	Both	55.62	28.86	0	100
		Males	47.50	26.61	0	100
		Females	66.52	28.25	0	100
	Somewhat Spatial	Both	44.27	23.33	0	100
		Males	40.78	22.64	0	83.33
		Females	48.94	23.50	0	100
	Moderately Spatial	Both	23.71	15.28	0	82.35
		Males	21.02	14.10	0	64.71
		Females	27.31	16.11	0	82.35
	Very Spatial	Both	47.39	21.83	0	93.33
		Males	45.92	22.46	0	93.33
		Females	49.37	20.88	0	93.33
	Extremely Spatial	Both	35.53	17.87	0	81.82
		Males	36.69	17.57	0	81.82
		Females	33.98	18.23	0	81.82
Engagement	Not at all Spatial	Both	41.33	22.87	0	89.39
		Males	33.76	19.15	0	89.39
		Females	51.48	23.59	0	86.36
	Somewhat Spatial	Both	28.94	15.55	0	65.28
		Males	27.13	15.41	0	62.50
		Females	31.36	15.46	0	65.28

Moderately Spatial	Both	14.59	9.34	0	57.84
	Males	13.02	8.85	0	49.02
	Females	16.71	9.58	0	57.84
Very Spatial	Both	27.36	13.56	0	73.33
	Males	26.11	13.24	0	54.44
	Females	29.05	13.84	0	73.33
Extremely Spatial	Both	21.89	12.25	0	62.12
	Males	23.38	12.01	0	59.09
	Females	19.88	12.33	0	62.12

Table 6

Study 1: Descriptive Access and Engagement Scores by Gender Stereotype Category

Score Type	Spatial Rating Category	Possible Score Range	Child Sex	Mean Score	SD	Min Score	Max Score
Access	Stereotypically Masculine	0 - 1	Both	0.40	0.49	0	1
			Males	0.53	0.50	0	1
			Females	0.21	0.41	0	1
	Somewhat Masculine	0 - 8	Both	3.67	1.99	0	8
			Males	3.92	2.05	0	8
			Females	3.34	1.87	0	7
	Gender Neutral	0 - 38	Both	16.30	7.43	1	34
			Males	15.60	7.55	1	31
			Females	17.24	7.19	1	34
	Somewhat Feminine	0 - 8	Both	3.74	2.12	0	8
			Males	3.27	2.05	0	7
			Females	4.37	2.11	0	8
	Stereotypically	0 - 11	Both	2.37	2.17	0	10

	Feminine		Males	1.29	1.64	0	7
			Females	3.81	1.95	0	10
Engagement	Stereotypically Masculine	0 - 6	Both	1.66	2.30	0	6
			Males	1.47	2.25	0	6
			Females	1.91	2.34	0	6
	Somewhat Masculine	0 - 48	Both	9.36	15.72	0	45
			Males	17.70	10.12	0	45
			Females	13.05	7.47	0	30
	Gender Neutral	0 - 228	Both	61.10	28.51	3	157
			Males	57.67	28.25	3	118
			Females	65.70	28.33	3	157
	Somewhat Feminine	0 - 48	Both	14.66	8.86	0	33
			Males	12.40	8.11	0	31
			Females	17.70	8.94	0	33
	Stereotypically Feminine	0 - 66	Both	8.88	9.12	0	42
			Males	3.79	5.58	0	36
			Females	15.71	8.47	0	42

Table 7

Study 1: Descriptive Average Access and Engagement Scores by Gender Stereotype Category

Score Type	Spatial Rating Category	Child Sex	Mean Score	SD	Min Score	Max Score
Access	Stereotypically Masculine	Both	39.66	49.00	0	100
		Males	53.25	50.04	0	100
		Females	21.43	41.20	0	100
	Somewhat Masculine	Both	45.89	24.91	0	100
		Males	48.97	25.64	0	100
		Females	41.77	23.35	0	87.50

	Gender Neutral	Both	42.90	19.55	2.63	89.47
		Males	41.06	19.86	2.63	81.58
		Females	45.36	18.92	2.63	89.47
	Somewhat Feminine	Both	46.78	26.77	0	100
		Males	40.90	25.62	0	87.50
		Females	54.66	26.35	0	100
	Stereotypically Feminine	Both	21.51	19.73	0	90.91
		Males	11.73	14.93	0	63.64
		Females	34.63	17.69	0	90.91
Engagement	Stereotypically Masculine	Both	27.69	38.25	0	100
		Males	24.56	37.49	0	100
		Females	31.88	38.99	0	100
	Somewhat Masculine	Both	32.74	19.49	0	93.75
		Males	36.88	21.07	0	93.75
		Females	27.18	15.56	0	62.50
	Gender Neutral	Both	26.80	12.51	1.32	68.86
		Males	25.29	12.39	1.32	51.75
		Females	28.82	12.42	1.32	68.86
	Somewhat Feminine	Both	30.54	18.46	0	68.75
		Males	25.83	16.90	0	64.58
		Females	36.87	18.63	0	68.75
	Stereotypically Feminine	Both	13.45	13.82	0	63.64
		Males	5.74	8.45	0	54.55
		Females	23.80	12.84	0	63.64

Table 8

General Methodology: Descriptive Statistics for Raw Assessment Scores

	M	SD	Min	Max
CMTT	13.55	6.01	0	26
PPVT	99.16	15.93	43	139
POAT-AM	0.56	0.25	0	1
OAT-AM	0.03	0.08	0	0.45

Note. Scores in this table were not imputed.

Table 9

General Methodology: Descriptive Statistics for Raw Assessment Scores by Participant Sex

	Males				Females			
	M	SD	Min	Max	*M*	SD	Min	Max
CMTT	13.30	5.29	2	23	13.69	6.80	0	26
PPVT	97.95	12.19	70	119	100.51	19.7	43	139
POAT-AM	0.53	0.25	0	1	.57	.25	0	1
OAT-AM	0.07	0.13	0	0.45	0.02	0.07	0	0.40

Note. Scores in this table were not imputed. OAT-AM scores are presented by parent sex, not child sex.

Table 10

Study 2: Number and Percentage of Children with Access to Toys/Activities by Child Sex Ordered by Access

Item	# of Children with Access	% of Children with Access	# of Boys with Access	% of boys with Access	# of Girls with Access	% of Girls with Access
Watching Television or Movies	76	100	38	100.00	38	100.00
Coloring Pages	74	97.4	37	97.37	37	97.37
Stuffed Animals	73	96.1	35	92.11	38	100.00
Reading or Being Read Books	72	94.7	36	94.74	36	94.74
Play-Doh, Modeling Clay, Pottery, or Sculpting	71	93.4	34	89.47	37	97.37
Cars, Trucks, or Other Vehicles	69	90.8	38	100.00	31	81.58
Drawing	69	90.8	32	84.21	37	97.37
Action Figures or Figurines	68	89.5	36	94.74	32	84.21
Costumes or Costume Accessories	67	88.2	31	81.58	36	94.74
Jigsaw Puzzles (excluding jigsaw oversized floor puzzles)	62	81.6	31	81.58	31	81.58
Phone or Tablet Games	62	81.6	31	81.58	31	81.58
Kitchens, Playfood, or Housekeeping Toys	60	78.9	24	63.16	36	94.74
Jumbo Connecting Blocks	59	77.6	27	71.05	32	84.21
Painting	58	76.3	26	68.42	32	84.21
Floor Puzzles	54	71.1	22	57.89	32	84.21
Train or Race Car Building Sets	52	68.4	34	89.47	18	47.37
Making Crafts with Materials found at Home	52	68.4	19	50.00	33	86.84
Board Games	51	67.1	27	71.05	24	63.16
Cooking or Baking	51	67.1	19	50.00	32	84.21
Card Games	50	65.8	24	63.16	26	68.42
Electronic or Remote Controlled Toys (excluding toys	50	65.8	29	76.32	21	55.26

controlled by tablets, computers, or smartphones)						
Connecting Blocks	48	63.2	28	73.68	20	52.63
Baby Dolls (excluding Barbie-like dolls & dolls that resemble older children)	48	63.2	15	39.47	33	86.84
Peg Puzzles	47	61.8	23	60.53	24	63.16
Playhouses, Tents, or Tunnels	47	61.8	22	57.89	25	65.79
Barbie Dolls or Similar	45	59.2	8	21.05	37	97.37
Playing a Musical Instrument	44	57.9	23	60.53	21	55.26
Stacking Blocks	41	53.9	17	44.74	24	63.16
Karaoke	40	52.6	14	36.84	26	68.42
Mazes	38	50	17	44.74	21	55.26
Doll Houses or Doll House Accessories	37	48.7	6	15.79	31	81.58
Printing or Stamping	36	47.4	11	28.95	25	65.79
Video or Computer Games	36	47.4	21	55.26	15	39.47
Robots or Transformers	34	44.7	31	81.58	3	7.89
Dolls (excluding baby dolls and Barbie like dolls)	32	42.1	6	15.79	26	68.42
Puppets	30	39.5	14	36.84	16	42.11
Stacking Games	28	36.8	17	44.74	11	28.95
Toys Controlled by Tablet, Computer, or Smartphones	27	35.5	17	44.74	10	26.32
Non-electronic model kits (excluding train sets, race car sets, & interlocking blocks such as Legos)	26	34.2	14	36.84	12	31.58
Map Reading	26	34.2	13	34.21	13	34.21
Floor Games (excluding floor puzzles)	24	31.6	11	28.95	13	34.21
Dice Games	22	28.9	7	18.42	15	39.47
Cube Puzzles	20	26.3	10	26.32	10	26.32
Magnetic Construction Blocks	18	23.7	7	18.42	11	28.95
Tangram Puzzles	18	23.7	6	15.79	12	31.58
Science Experiments	18	23.7	10	26.32	8	21.05
Tile Games	17	22.4	9	23.68	8	21.05
Making Jewelry with beads	17	22.4	2	5.26	15	39.47

Brain Teasers	14	18.4	8	21.05	6	15.79
Making Jewelry	13	17.1	0	0.00	13	34.21
Jumbo Stacking Blocks	11	14.5	6	15.79	5	13.16
Fuse Beads	11	14.5	4	10.53	7	18.42
Marble Runs	9	11.8	5	13.16	4	10.53
Origami	8	10.5	2	5.26	6	15.79
Gear Sets	7	9.2	6	15.79	1	2.63
Lincoln Logs	7	9.2	4	10.53	3	7.89
Interlocking Stick Toys	7	9.2	3	7.89	4	10.53
Electronic Building Toys (excluding train & race car sets)	7	9.2	5	13.16	2	5.26
Scrapbooking	6	7.9	1	2.63	5	13.16
DJing	6	7.9	4	10.53	2	5.26
Sewing	4	5.3	1	2.63	3	7.89
3D Puzzles	2	2.6	2	5.26	0	0.00
Crocheting	2	2.6	0	0.00	2	5.26
Embroidering	1	1.3	0	0.00	1	2.63
Knitting	1	1.3	0	0.00	1	2.63
Weaving	1	1.3	0	0.00	1	2.63

Table 11

Study 2: Number and Percentage of Children Describing Access/Engagement to Toys/Activities by Child Sex

Item	Spatial Rating	Stereo -type Rating	Child Sex	No access	Not in the last 3 months	Less than once a month	About once a month	About once a week	A few times a week	Daily/ Almost Daily
Jumbo Stacking	5	4	Both	65 (85.53%)	3 (3.95%)	2 (2.63%)	2 (2.63%)	1 (1.32%)	3 (3.95%)	0 (0.00%)

Blocks			Male	32 (84.21%)	1 (2.63%)	2 (5.26%)	0 (0.00%)	1 (2.63%)	2 (5.26%)	0 (0.00%)
			Female	33 (86.84%)	2 (5.26%)	0 (0.00%)	2 (5.26%)	0 (0.00%)	1 (2.63%)	0 (0.00%)
Stacking Blocks	5	5	Both	35 (46.05%)	11 (14.47%)	4 (5.26%)	9 (11.84%)	10 (13.16%)	6 (7.89%)	1 (1.32%)
			Male	21 (55.26%)	4 (10.53%)	2 (5.26%)	5 (13.16%)	4 (10.53%)	2 (5.26%)	0 (0.00%)
			Female	14 (36.84%)	7 (18.42%)	2 (5.26%)	4 (10.53%)	6 (15.79%)	4 (10.53%)	1 (2.63%)
Jumbo Connecting Blocks	5	4	Both	17 (22.37%)	8 (10.53%)	5 (6.58%)	15 (19.74%)	15 (19.74%)	12 (15.79%)	4 (5.26%)
			Male	11 (28.95%)	3 (7.89%)	2 (5.26%)	5 (13.16%)	6 (15.79%)	8 (21.05%)	3 (7.89%)
			Female	6 (15.79%)	5 (13.16%)	3 (7.89%)	10 (26.32%)	9 (23.68%)	4 (10.53%)	1 (2.63%)
Connecting Blocks	5	3	Both	28 (36.84%)	1 (1.32%)	5 (6.58%)	7 (9.21%)	16 (21.05%)	7 (9.21%)	12 (15.79%)
			Male	10 (26.32%)	1 (2.63%)	3 (7.89%)	2 (5.26%)	9 (23.68%)	5 (13.16%)	8 (21.05%)
			Female	18 (47.37%)	0 (0.00%)	2 (5.26%)	5 (13.16%)	7 (18.42%)	2 (5.26%)	4 (10.53%)
Gear Sets	5	3	Both	69 (90.79%)	1 (1.32%)	1 (1.32%)	3 (3.95%)	2 (2.63%)	0 (0.00%)	0 (0.00%)
			Male	32 (84.21%)	1 (2.63%)	0 (0.00%)	3 (7.89%)	2 (5.26%)	0 (0.00%)	0 (0.00%)
			Female	37 (97.37%)	0 (0.00%)	1 (2.63%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Marble Runs	5	4	Both	67 (88.16%)	2 (2.63%)	3 (3.95%)	2 (2.63%)	0 (0.00%)	2 (2.63%)	0 (0.00%)
			Male	33	1	1	1	0	2	0

				(86.84%)	(2.63%)	(2.63%)	(2.63%)	(0.00%)	(5.26%)	(0.00%)
			Female	34	1	2	1	0	0	0
				(89.47%)	(2.63%)	(5.26%)	(2.63%)	(0.00%)	(0.00%)	(0.00%)
Magnetic	5	4	Both	58	3	2	6	2	2	3
Construct				(76.32%)	(3.95%)	(2.63%)	(7.89%)	(2.63%)	(2.63%)	(3.95%)
ion			Male	31	0	1	4	0	2	0
Blocks				(81.58%)	(0.00%)	(2.63%)	(10.53%)	(0.00%)	(5.26%)	(0.00%)
			Female	27	3	1	2	2	0	3
				(71.05%)	(7.89%)	(2.63%)	(5.26%)	(5.26%)	(0.00%)	(7.89%)
Lincoln	4	4	Both	69	1	2	0	4	0	0
Logs				(90.79%)	(1.32%)	(2.63%)	(0.00%)	(5.26%)	(0.00%)	(0.00%)
			Male	34	1	0	1	2	0	0
				(89.47%)	(2.63%)	(0.00%)	(2.63%)	(5.26%)	(0.00%)	(0.00%)
			Female	35	0	0	1	2	0	0
				(92.11%)	(0.00%)	(0.00%)	(2.63%)	(5.26%)	(0.00%)	(0.00%)
Interlocki	5	4	Both	69	1	4	0	2	0	0
ng Stick				(90.79%)	(1.32%)	(5.26%)	(0.00%)	(2.63%)	(0.00%)	(0.00%)
Toys			Male	35	1	1	0	1	0	0
				(92.11%)	(2.63%)	(2.63%)	(0.00%)	(2.63%)	(0.00%)	(0.00%)
			Female	34	0	3	0	1	0	0
				(89.47%)	(0.00%)	(7.89%)	(0.00%)	(2.63%)	(0.00%)	(0.00%)
Train or	4	3	Both	24	9	6	12	12	8	5
Race Car				(31.58%)	(11.84%)	(7.89%)	(15.79%)	(15.79%)	(10.53%)	(6.58%)
Building			Male	4	3	4	8	9	5	5
Sets				(10.53%)	(7.89%)	(10.53%)	(21.05%)	(23.68%)	(13.16%)	(13.16%)
			Female	20	6	2	4	3	3	0
				(52.63%)	(15.79%)	(5.26%)	(10.53%)	(7.89%)	(7.89%)	(0.00%)
Electroni	4	3	Both	69	0	2	1	2	0	2
c				(90.79%)	(0.00%)	(2.63%)	(1.32%)	(2.63%)	(0.00%)	(2.63%)
Building			Male	33	0	1	1	1	0	2
Toys				(86.84%)	(0.00%)	(2.63%)	(2.63%)	(2.63%)	(0.00%)	(5.26%)

			Female	36 (94.74%)	0 (0.00%)	1 (2.63%)	0 (0.00%)	1 (2.63%)	0 (0.00%)	0 (0.00%)
Non-electronic model kits	5	3	Both	50 (65.79%)	2 (2.63%)	4 (5.26%)	9 (11.84%)	4 (5.26%)	5 (6.58%)	2 (2.63%)
			Male	24 (63.16%)	2 (5.26%)	3 (7.89%)	3 (7.89%)	1 (2.63%)	3 (7.89%)	2 (5.26%)
			Female	26 (68.42%)	0 (0.00%)	1 (2.63%)	6 (15.79%)	3 (7.89%)	2 (5.26%)	0 (0.00%)
Floor Puzzles	4	4	Both	22 (28.95%)	4 (5.26%)	5 (6.58%)	16 (21.05%)	19 (25.00%)	8 (10.53%)	2 (2.63%)
			Male	16 (42.11%)	3 (7.89%)	3 (7.89%)	6 (15.79%)	6 (15.79%)	3 (7.89%)	1 (2.63%)
			Female	6 (15.79%)	1 (2.63%)	2 (5.26%)	10 (26.32%)	13 (34.21%)	5 (13.16%)	1 (2.63%)
Jigsaw Puzzles	4	4	Both	14 (18.42%)	4 (5.26%)	11 (14.47%)	18 (23.68%)	22 (28.95%)	7 (9.21%)	0 (0.00%)
			Male	7 (18.42%)	1 (2.63%)	8 (21.05%)	11 (28.95%)	9 (23.68%)	2 (5.26%)	0 (0.00%)
			Female	7 (18.42%)	3 (7.89%)	3 (7.89%)	7 (18.42%)	13 (34.21%)	5 (13.16%)	0 (0.00%)
Peg Puzzles	4	4	Both	29 (38.16%)	14 (18.42%)	10 (13.16%)	14 (18.42%)	5 (6.58%)	3 (3.95%)	1 (1.32%)
			Male	15 (39.47%)	7 (18.42%)	8 (21.05%)	3 (7.89%)	2 (5.26%)	2 (5.26%)	1 (2.63%)
			Female	14 (36.84%)	7 (18.42%)	2 (5.26%)	11 (28.95%)	3 (7.89%)	1 (2.63%)	0 (0.00%)
Cube Puzzles	4	4	Both	56 (73.68%)	8 (10.53%)	4 (5.26%)	5 (6.58%)	1 (1.32%)	2 (2.63%)	0 (0.00%)
			Male	28 (73.68%)	3 (7.89%)	2 (5.26%)	2 (5.26%)	1 (2.63%)	2 (5.26%)	0 (0.00%)
			Female	28	5	2	3	0	0	0

				(73.68%)	(13.16%)	(5.26%)	(7.89%)	(0.00%)	(0.00%)	(0.00%)
Tangram Puzzles	4	4	Both	58 (76.32%)	4 (5.26%)	2 (2.63%)	9 (11.84%)	2 (2.63%)	1 (1.32%)	0 (0.00%)
			Male	32 (84.21%)	2 (5.26%)	2 (5.26%)	2 (5.26%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
			Female	26 (68.42%)	2 (5.26%)	0 (0.00%)	7 (18.42%)	2 (5.26%)	1 (2.63%)	0 (0.00%)
3D Puzzles	5	4	Both	74 (97.37%)	1 (1.32%)	1 (1.32%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
			Male	36 (94.74%)	1 (2.63%)	1 (2.63%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
			Female	38 (100.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Brain Teasers	4	4	Both	62 (81.58%)	4 (5.26%)	4 (5.26%)	4 (5.26%)	2 (2.63%)	0 (0.00%)	0 (0.00%)
			Male	30 (78.95%)	1 (2.63%)	4 (10.53%)	3 (7.89%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
			Female	32 (84.21%)	3 (7.89%)	0 (0.00%)	1 (2.63%)	2 (5.26%)	0 (0.00%)	0 (0.00%)
Mazes	4	4	Both	38 (50.00%)	2 (2.63%)	8 (10.53%)	17 (22.37%)	7 (9.21%)	2 (2.63%)	2 (2.63%)
			Male	21 (55.26%)	0 (0.00%)	4 (10.53%)	7 (18.42%)	5 (13.16%)	0 (0.00%)	1 (2.63%)
			Female	17 (44.74%)	2 (5.26%)	4 (10.53%)	10 (26.32%)	2 (5.26%)	2 (5.26%)	1 (2.63%)
Card Games	1	4	Both	26 (34.21%)	6 (7.89%)	8 (10.53%)	14 (18.42%)	15 (19.74%)	4 (5.26%)	3 (3.95%)
			Male	14 (36.84%)	5 (13.16%)	3 (7.89%)	3 (7.89%)	7 (18.42%)	3 (7.89%)	3 (7.89%)
			Female	12 (31.58%)	1 (2.63%)	5 (13.16%)	11 (28.95%)	8 (21.05%)	1 (2.63%)	0 (0.00%)

Dice Games	2	4	Both	54 (71.05%)	5 (6.58%)	5 (6.58%)	7 (9.21%)	3 (3.95%)	2 (2.63%)	0 (0.00%)
			Male	31 (81.58%)	1 (2.63%)	2 (5.26%)	3 (7.89%)	1 (2.63%)	0 (0.00%)	0 (0.00%)
			Female	23 (60.53%)	4 (10.53%)	3 (7.89%)	4 (10.53%)	2 (5.26%)	2 (5.26%)	0 (0.00%)
Tile Games	2	4	Both	59 (77.63%)	4 (5.26%)	2 (2.63%)	8 (10.53%)	3 (3.95%)	0 (0.00%)	0 (0.00%)
			Male	29 (76.32%)	2 (5.26%)	1 (2.63%)	4 (10.53%)	2 (5.26%)	0 (0.00%)	0 (0.00%)
			Female	30 (78.95%)	2 (5.26%)	1 (2.63%)	4 (10.53%)	1 (2.63%)	0 (0.00%)	0 (0.00%)
Floor Games	2	4	Both	52 (68.42%)	4 (5.26%)	4 (5.26%)	6 (7.89%)	8 (10.53%)	2 (2.63%)	0 (0.00%)
			Male	27 (71.05%)	4 (10.53%)	2 (5.26%)	3 (7.89%)	1 (2.63%)	1 (2.63%)	0 (0.00%)
			Female	25 (65.79%)	0 (0.00%)	2 (5.26%)	3 (7.89%)	7 (18.42%)	1 (2.63%)	0 (0.00%)
Stacking Games	4	4	Both	48 (63.16%)	3 (3.95%)	2 (2.63%)	14 (18.42%)	6 (7.89%)	2 (2.63%)	1 (1.32%)
			Male	21 (55.26%)	2 (5.26%)	1 (2.63%)	10 (26.32%)	2 (5.26%)	1 (2.63%)	1 (2.63%)
			Female	27 (71.05%)	1 (2.63%)	1 (2.63%)	4 (10.53%)	4 (10.53%)	1 (2.63%)	0 (0.00%)
Board Games	2	4	Both	25 (32.89%)	6 (7.89%)	10 (13.16%)	11 (14.47%)	14 (18.42%)	9 (11.84%)	1 (1.32%)
			Male	11 (28.95%)	4 (10.53%)	5 (13.16%)	7 (18.42%)	6 (15.79%)	4 (10.53%)	1 (2.63%)
			Female	14 (36.84%)	2 (5.26%)	5 (13.16%)	4 (10.53%)	8 (21.05%)	5 (13.16%)	0 (0.00%)
Action	1	3	Both	8	1	1	2	12	22	30

Figures				(10.53%)	(1.32%)	(1.32%)	(2.63%)	(15.79%)	(28.95%)	(39.47%)
or			Male	2	0	0	1	4	10	21
Figurines				(5.26%)	(0.00%)	(0.00%)	(2.63%)	(10.53%)	(26.32%)	(55.26%)
			Female	6	1	1	1	8	12	9
				(15.79%)	(2.63%)	(2.63%)	(2.63%)	(21.05%)	(31.58%)	(23.68%)
Robots or	2	2	Both	42	1	1	5	6	11	10
Transfor				(55.26%)	(1.32%)	(1.32%)	(6.58%)	(7.89%)	(14.47%)	(13.16%)
mers			Male	7	1	0	4	5	11	10
				(18.42%)	(2.63%)	(0.00%)	(10.53%)	(13.16%)	(28.95%)	(26.32%)
			Female	35	0	1	1	1	0	0
				(92.11%)	(0.00%)	(2.63%)	(2.63%)	(2.63%)	(0.00%)	(0.00%)
Baby	1	6	Both	28	7	4	6	8	12	11
Dolls				(36.84%)	(9.21%)	(5.26%)	(7.89%)	(10.53%)	(15.79%)	(14.47%)
			Male	23	6	2	4	1	1	1
				(60.53%)	(15.79%)	(5.26%)	(10.53%)	(2.63%)	(2.63%)	(2.63%)
			Female	5	1	2	2	7	11	10
				(13.16%)	(2.63%)	(5.26%)	(5.26%)	(18.42%)	(28.95%)	(26.32%)
Barbie	1	7	Both	31	4	2	8	5	13	13
Dolls or				(40.79%)	(5.26%)	(2.63%)	(10.53%)	(6.58%)	(17.11%)	(17.11%)
Similar			Male	30	4	0	1	1	1	1
				(78.95%)	(10.53%)	(0.00%)	(2.63%)	(2.63%)	(2.63%)	(2.63%)
			Female	1	0	2	7	4	12	12
				(2.63%)	(0.00%)	(5.26%)	(18.42%)	(10.53%)	(31.58%)	(31.58%)
Dolls	1	6	Both	44	8	1	4	7	9	3
				(57.89%)	(10.53%)	(1.32%)	(5.26%)	(9.21%)	(11.84%)	(3.95%)
			Male	32	5	1	0	0	0	0
				(84.21%)	(13.16%)	(2.63%)	(0.00%)	(0.00%)	(0.00%)	(0.00%)
			Female	12	3	0	4	7	9	3
				(31.58%)	(7.89%)	(0.00%)	(10.53%)	(18.42%)	(23.68%)	(7.89%)
Doll	3	6	Both	39	2	2	5	9	13	6
Houses				(51.32%)	(2.63%)	(2.63%)	(6.58%)	(11.84%)	(17.11%)	(7.89%)

or Doll House			Male	32 (84.21%)	1 (2.63%)	1 (2.63%)	2 (5.26%)	1 (2.63%)	1 (2.63%)	0 (0.00%)
Accessories			Female	7 (18.42%)	1 (2.63%)	1 (2.63%)	3 (7.89%)	8 (21.05%)	12 (31.58%)	6 (15.79%)
Kitchens, Playfood, or Housekeeping Toys	2	5	Both	16 (21.05%)	5 (6.58%)	3 (3.95%)	16 (21.05%)	17 (22.37%)	10 (13.16%)	9 (11.84%)
			Male	14 (36.84%)	4 (10.53%)	2 (5.26%)	9 (23.68%)	5 (13.16%)	1 (2.63%)	3 (7.89%)
			Female	2 (5.26%)	1 (2.63%)	1 (2.63%)	7 (18.42%)	12 (31.58%)	9 (23.68%)	6 (15.79%)
Playhouses, Tents, or Tunnels	2	4	Both	29 (38.16%)	8 (10.53%)	8 (10.53%)	14 (18.42%)	11 (14.47%)	4 (5.26%)	2 (2.63%)
			Male	16 (42.11%)	3 (7.89%)	3 (7.89%)	10 (26.32%)	4 (10.53%)	0 (0.00%)	2 (5.26%)
			Female	13 (34.21%)	5 (13.16%)	5 (13.16%)	4 (10.53%)	7 (18.42%)	4 (10.53%)	0 (0.00%)
Costumes or Costume Accessories	1	5	Both	9 (11.84%)	3 (3.95%)	7 (9.21%)	19 (25.00%)	16 (21.05%)	14 (18.42%)	8 (10.53%)
			Male	7 (18.42%)	3 (7.89%)	2 (5.26%)	9 (23.68%)	8 (21.05%)	6 (15.79%)	3 (7.89%)
			Female	2 (5.26%)	0 (0.00%)	5 (13.16%)	10 (26.32%)	8 (21.05%)	8 (21.05%)	5 (13.16%)
Puppets	1	4	Both	46 (60.53%)	14 (18.42%)	6 (7.89%)	5 (6.58%)	3 (3.95%)	1 (1.32%)	1 (1.32%)
			Male	24 (63.16%)	8 (21.05%)	2 (5.26%)	1 (2.63%)	1 (2.63%)	1 (2.63%)	1 (2.63%)
			Female	22 (57.89%)	6 (15.79%)	4 (10.53%)	4 (10.53%)	2 (5.26%)	0 (0.00%)	0 (0.00%)
Stuffed Animals	1	5	Both	3 (3.95%)	4 (5.26%)	7 (9.21%)	6 (7.89%)	8 (10.53%)	19 (25.00%)	29 (38.16%)
			Male	3	3	4	3	4	9	12

				(7.89%)	(7.89%)	(10.53%)	(7.89%)	(10.53%)	(23.68%)	(31.58%)
			Female	0	1	3	3	4	10	17
				(0.00%)	(2.63%)	(7.89%)	(7.89%)	(10.53%)	(26.32%)	(44.74%)
Cars,	2	3	Both	7	1	4	8	18	10	28
Trucks,				(9.21%)	(1.32%)	(5.26%)	(10.53%)	(23.68%)	(13.16%)	(36.84%)
or Other			Male	0	0	0	1	5	7	25
Vehicles				(0.00%)	(0.00%)	(0.00%)	(2.63%)	(13.16%)	(18.42%)	(65.79%)
			Female	7	1	4	7	13	3	3
				(18.42%)	(2.63%)	(10.53%)	(18.42%)	(34.21%)	(7.89%)	(7.89%)
Reading	1	4	Both	4	0	0	1	11	22	38
or Being				(5.26%)	(0.00%)	(0.00%)	(1.32%)	(14.47%)	(28.95%)	(50.00%)
Read			Male	2	0	0	0	4	11	21
Books				(5.26%)	(0.00%)	(0.00%)	(0.00%)	(10.53%)	(28.95%)	(55.26%)
			Female	2	0	0	1	7	11	17
				(5.26%)	(0.00%)	(0.00%)	(2.63%)	(18.42%)	(28.95%)	(44.74%)
Coloring	2	4	Both	2	0	2	4	14	29	25
Pages				(2.63%)	(0.00%)	(2.63%)	(5.26%)	(18.42%)	(38.16%)	(32.89%)
			Male	1	0	1	3	10	16	7
				(2.63%)	(0.00%)	(2.63%)	(7.89%)	(26.32%)	(42.11%)	(18.42%)
			Female	1	0	1	1	4	13	18
				(2.63%)	(0.00%)	(2.63%)	(2.63%)	(10.53%)	(34.21%)	(47.37%)
Drawing	4	4	Both	7	0	0	1	12	25	31
				(9.21%)	(0.00%)	(0.00%)	(1.32%)	(15.79%)	(32.89%)	(40.79%)
			Male	6	0	0	1	8	15	8
				(15.79%)	(0.00%)	(0.00%)	(2.63%)	(21.05%)	(39.47%)	(21.05%)
			Female	1	0	0	0	4	10	23
				(2.63%)	(0.00%)	(0.00%)	(0.00%)	(10.53%)	(26.32%)	(60.53%)
Painting	4	4	Both	18	2	6	17	15	13	5
				(23.68%)	(2.63%)	(7.89%)	(22.37%)	(19.74%)	(17.11%)	(6.58%)
			Male	12	2	4	12	4	4	0
				(31.58%)	(5.26%)	(10.53%)	(31.58%)	(10.53%)	(10.53%)	(0.00%)

			Female	6 (15.79%)	0 (0.00%)	2 (5.26%)	5 (13.16%)	11 (28.95%)	9 (23.68%)	5 (13.16%)
Printing or Stamping	3	5	Both	40 (52.63%)	1 (1.32%)	3 (3.95%)	15 (19.74%)	10 (13.16%)	6 (7.89%)	1 (1.32%)
			Male	27 (71.05%)	1 (2.63%)	1 (2.63%)	4 (10.53%)	2 (5.26%)	3 (7.89%)	0 (0.00%)
			Female	13 (34.21%)	0 (0.00%)	2 (5.26%)	11 (28.95%)	8 (21.05%)	3 (7.89%)	1 (2.63%)
Scrapbooking	3	5	Both	70 (92.11%)	2 (2.63%)	2 (2.63%)	0 (0.00%)	2 (2.63%)	0 (0.00%)	0 (0.00%)
			Male	37 (97.37%)	0 (0.00%)	1 (2.63%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
			Female	33 (86.84%)	2 (5.26%)	1 (2.63%)	0 (0.00%)	2 (5.26%)	0 (0.00%)	0 (0.00%)
Origami	3	4	Both	68 (89.47%)	3 (3.95%)	3 (3.95%)	2 (2.63%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
			Male	36 (94.74%)	2 (5.26%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
			Female	32 (84.21%)	1 (2.63%)	3 (7.89%)	2 (5.26%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Making Crafts with Materials found at Home	4	4	Both	24 (31.58%)	2 (2.63%)	6 (7.89%)	18 (23.68%)	12 (15.79%)	12 (15.79%)	2 (2.63%)
			Male	19 (50.00%)	2 (5.26%)	2 (5.26%)	8 (21.05%)	5 (13.16%)	2 (5.26%)	0 (0.00%)
			Female	5 (13.16%)	0 (0.00%)	4 (10.53%)	10 (26.32%)	7 (18.42%)	10 (26.32%)	2 (5.26%)
Crocheting	3	6	Both	74 (97.37%)	1 (1.32%)	0 (0.00%)	1 (1.32%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
			Male	38 (100.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
			Female	36	1	0	1	0	0	0

				(94.74%)	(2.63%)	(0.00%)	(2.63%)	(0.00%)	(0.00%)	(0.00%)
Embroidering	3	6	Both	75	1	0	0	0	0	0
				(98.68%)	(1.32%)	(0.00%)	(0.00%)	(0.00%)	(0.00%)	(0.00%)
			Male	38	0	0	0	0	0	0
				(100.00%)	(0.00%)	(0.00%)	(0.00%)	(0.00%)	(0.00%)	(0.00%)
			Female	37	1	0	0	0	0	0
				(97.37%)	(2.63%)	(0.00%)	(0.00%)	(0.00%)	(0.00%)	(0.00%)
Knitting	3	6	Both	75	1	0	0	0	0	0
				(98.68%)	(1.32%)	(0.00%)	(0.00%)	(0.00%)	(0.00%)	(0.00%)
			Male	38	0	0	0	0	0	0
				(100.00%)	(0.00%)	(0.00%)	(0.00%)	(0.00%)	(0.00%)	(0.00%)
			Female	37	1	0	0	0	0	0
				(97.37%)	(2.63%)	(0.00%)	(0.00%)	(0.00%)	(0.00%)	(0.00%)
Weaving	3	6	Both	75	0	1	0	0	0	0
				(98.68%)	(0.00%)	(1.32%)	(0.00%)	(0.00%)	(0.00%)	(0.00%)
			Male	38	0	0	0	0	0	0
				(100.00%)	(0.00%)	(0.00%)	(0.00%)	(0.00%)	(0.00%)	(0.00%)
			Female	37	0	1	0	0	0	0
				(97.37%)	(0.00%)	(2.63%)	(0.00%)	(0.00%)	(0.00%)	(0.00%)
Sewing	3	6	Both	72	0	1	3	0	0	0
				(94.74%)	(0.00%)	(1.32%)	(3.95%)	(0.00%)	(0.00%)	(0.00%)
			Male	37	0	0	1	0	0	0
				(97.37%)	(0.00%)	(0.00%)	(2.63%)	(0.00%)	(0.00%)	(0.00%)
			Female	35	0	1	2	0	0	0
				(92.11%)	(0.00%)	(2.63%)	(5.26%)	(0.00%)	(0.00%)	(0.00%)
Making Jewelry	3	6	Both	63	3	0	8	1	1	0
				(82.89%)	(3.95%)	(0.00%)	(10.53%)	(1.32%)	(1.32%)	(0.00%)
			Male	38	0	0	0	0	0	0
				(100.00%)	(0.00%)	(0.00%)	(0.00%)	(0.00%)	(0.00%)	(0.00%)
			Female	25	3	0	8	1	1	0
				(65.79%)	(7.89%)	(0.00%)	(21.05%)	(2.63%)	(2.63%)	(0.00%)

Fuse Beads	3	5	Both	65 (85.53%)	6 (7.89%)	3 (3.95%)	1 (1.32%)	1 (1.32%)	0 (0.00%)	0 (0.00%)
			Male	34 (89.47%)	2 (5.26%)	2 (5.26%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
			Female	31 (81.58%)	4 (10.53%)	1 (2.63%)	1 (2.63%)	0 (0.00%)	1 (2.63%)	0 (0.00%)
Making Jewelry with beads	2	6	Both	59 (77.63%)	1 (1.32%)	7 (9.21%)	5 (6.58%)	2 (2.63%)	2 (2.63%)	0 (0.00%)
			Male	36 (94.74%)	0 (0.00%)	1 (2.63%)	0 (0.00%)	1 (2.63%)	0 (0.00%)	0 (0.00%)
			Female	23 (60.53%)	1 (2.63%)	6 (15.79%)	5 (13.16%)	1 (2.63%)	2 (5.26%)	0 (0.00%)
Play-Doh, Modeling Clay, Pottery, or Sculpting	4	4	Both	5 (6.58%)	4 (5.26%)	4 (5.26%)	19 (25.00%)	25 (32.89%)	15 (19.74%)	4 (5.26%)
			Male	4 (10.53%)	2 (5.26%)	1 (2.63%)	12 (31.58%)	14 (36.84%)	4 (10.53%)	1 (2.63%)
			Female	1 (2.63%)	2 (5.26%)	3 (7.89%)	7 (18.42%)	11 (28.95%)	11 (28.95%)	3 (7.89%)
Cooking or Baking	2	5	Both	25 (32.89%)	1 (1.32%)	7 (9.21%)	11 (14.47%)	17 (22.37%)	12 (15.79%)	3 (3.95%)
			Male	19 (50.00%)	1 (2.63%)	4 (10.53%)	5 (13.16%)	6 (15.79%)	3 (7.89%)	0 (0.00%)
			Female	6 (15.79%)	0 (0.00%)	3 (7.89%)	6 (15.79%)	11 (28.95%)	9 (23.68%)	3 (7.89%)
Science Experiments	3	4	Both	58 (76.32%)	1 (1.32%)	3 (3.95%)	11 (14.47%)	3 (3.95%)	0 (0.00%)	0 (0.00%)
			Male	28 (73.68%)	1 (2.63%)	1 (2.63%)	7 (18.42%)	1 (2.63%)	0 (0.00%)	0 (0.00%)
			Female	30 (78.95%)	0 (0.00%)	2 (5.26%)	4 (10.53%)	2 (5.26%)	0 (0.00%)	0 (0.00%)

Playing a Musical Instrument	3	4	Both	32 (42.11%)	1 (1.32%)	4 (5.26%)	8 (10.53%)	19 (25.00%)	9 (11.84%)	3 (3.95%)
			Male	15 (39.47%)	1 (2.63%)	2 (5.26%)	5 (13.16%)	8 (21.05%)	5 (13.16%)	2 (5.26%)
			Female	17 (44.74%)	0 (0.00%)	2 (5.26%)	3 (7.89%)	11 (28.95%)	4 (10.53%)	1 (2.63%)
Karaoke	1	4	Both	36 (47.37%)	0 (0.00%)	5 (6.58%)	9 (11.84%)	13 (17.11%)	7 (9.21%)	6 (7.89%)
			Male	24 (63.16%)	0 (0.00%)	0 (0.00%)	2 (5.26%)	6 (15.79%)	2 (5.26%)	4 (10.53%)
			Female	12 (31.58%)	0 (0.00%)	5 (13.16%)	7 (18.42%)	7 (18.42%)	5 (13.16%)	2 (5.26%)
DJing	2	4	Both	70 (92.11%)	0 (0.00%)	0 (0.00%)	2 (2.63%)	3 (3.95%)	1 (1.32%)	0 (0.00%)
			Male	34 (89.47%)	0 (0.00%)	0 (0.00%)	1 (2.63%)	2 (5.26%)	1 (2.63%)	0 (0.00%)
			Female	36 (94.74%)	0 (0.00%)	0 (0.00%)	1 (2.63%)	1 (2.63%)	0 (0.00%)	0 (0.00%)
Map Reading	5	4	Both	50 (65.79%)	2 (2.63%)	4 (5.26%)	13 (17.11%)	4 (5.26%)	3 (3.95%)	0 (0.00%)
			Male	25 (65.79%)	0 (0.00%)	4 (10.53%)	7 (18.42%)	1 (2.63%)	1 (2.63%)	0 (0.00%)
			Female	25 (65.79%)	2 (5.26%)	0 (0.00%)	6 (15.79%)	3 (7.89%)	2 (5.26%)	0 (0.00%)
Watching Television or Movies	1	4	Both	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	6 (7.89%)	21 (27.63%)	49 (64.47%)
			Male	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	2 (5.26%)	12 (31.58%)	24 (63.16%)
			Female	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	4 (10.53%)	9 (23.68%)	25 (65.79%)
Toys	3	4	Both	49	3	0	2	6	8	8

Controlled by Tablet, Computer, or Smartphones				(64.47%)	(3.95%)	(0.00%)	(2.63%)	(7.89%)	(10.53%)	(10.53%)
			Male	21 (55.26%)	1 (2.63%)	0 (0.00%)	2 (5.26%)	3 (7.89%)	5 (13.16%)	6 (15.79%)
			Female	28 (73.68%)	2 (5.26%)	0 (0.00%)	0 (0.00%)	3 (7.89%)	3 (7.89%)	2 (5.26%)
Electronic or Remote Controlled Toys	3	4	Both	26 (34.21%)	3 (3.95%)	7 (9.21%)	19 (25.00%)	11 (14.47%)	6 (7.89%)	4 (5.26%)
			Male	9 (23.68%)	3 (7.89%)	4 (10.53%)	10 (26.32%)	5 (13.16%)	4 (10.53%)	3 (7.89%)
			Female	17 (44.74%)	0 (0.00%)	3 (7.89%)	9 (23.68%)	6 (15.79%)	2 (5.26%)	1 (2.63%)
Video or Computer Games	3	3	Both	40 (52.63%)	5 (6.58%)	2 (2.63%)	5 (6.58%)	10 (13.16%)	8 (10.53%)	6 (7.89%)
			Male	17 (44.74%)	3 (7.89%)	0 (0.00%)	1 (2.63%)	8 (21.05%)	5 (13.16%)	4 (10.53%)
			Female	23 (60.53%)	2 (5.26%)	2 (5.26%)	4 (10.53%)	2 (5.26%)	3 (7.89%)	2 (5.26%)
Phone or Tablet Games	3	4	Both	14 (18.42%)	2 (2.63%)	7 (9.21%)	3 (3.95%)	14 (18.42%)	23 (30.26%)	13 (17.11%)
			Male	7 (18.42%)	0 (0.00%)	3 (7.89%)	2 (5.26%)	5 (13.16%)	12 (31.58%)	9 (23.68%)
			Female	7 (18.42%)	2 (5.26%)	4 (10.53%)	1 (2.63%)	9 (23.68%)	11 (28.95%)	4 (10.53%)

Table 12

Study 2: Descriptive Access and Engagement Scores by Spatial Category

Score Type	Spatial Rating Category	Possible Score Range	Child Sex	Mean Score	SD	Min Score	Max Score
Access	Not at all Spatial	0 - 11	Both	7.91	2.07	3	11
			Males	6.76	1.98	3	11
			Females	9.05	1.43	5	11
	Somewhat Spatial	0 - 12	Both	6.21	2.21	1	10
			Males	6.08	2.15	1	10
			Females	6.34	2.28	1	10
	Moderately Spatial	0 - 17	Both	4.70	2.26	0	13
			Males	4.11	1.75	1	9
			Females	5.29	2.57	0	13
	Very Spatial	0 - 15	Both	7.86	2.29	3	12
			Males	7.58	2.25	3	12
			Females	8.13	2.33	3	12
	Extremely Spatial	0 - 11	Both	3.34	1.72	0	8
			Males	3.37	1.73	0	8
			Females	3.32	1.73	0	7
Engagement	Not at all Spatial	0 - 66	Both	34.65	9.54	9	55
			Males	29.26	8.24	9	51
			Females	40.03	7.56	23	55
	Somewhat Spatial	0 - 72	Both	24.01	8.70	4	42
			Males	24.00	8.71	6	42
			Females	24.03	8.81	4	38
	Moderately Spatial	0 - 102	Both	17.38	8.08	0	38
			Males	15.74	7.02	4	38
			Females	19.03	8.80	0	38
	Very Spatial	0 - 90	Both	27.71	9.87	7	51
			Males	25.53	9.60	7	48
			Females	29.90	9.78	10	51
	Extremely	0 - 66	Both	11.30	6.69	0	34

	Spatial	Males	11.79	6.35	0	34
		Females	10.82	7.07	0	26

Table 13

Study 2: Descriptive Average Access and Engagement Scores by Spatial Category

Score Type	Spatial Rating Category	Child Sex	Mean Score	SD	Min Score	Max Score
Access	Not at all Spatial	Both	71.89	18.79	27.27	100
		Males	61.48	17.99	27.27	100
		Females	82.30	13.02	45.45	100
	Somewhat Spatial	Both	51.75	18.38	8.33	83.33
		Males	50.66	17.90	8.33	83.33
		Females	52.85	19.01	8.33	83.33
	Moderately Spatial	Both	27.63	13.31	0	76.47
		Males	24.15	10.31	5.88	52.94
		Females	31.15	15.10	0	76.47
	Very Spatial	Both	52.49	15.27	20	80
		Males	50.53	15.00	20	80
		Females	54.21	15.51	20	80
	Extremely Spatial	Both	30.38	15.61	0	72.73
		Males	30.62	15.74	0	72.73
		Females	30.14	15.69	0	63.64
Engagement	Not at all Spatial	Both	52.49	14.45	13.64	83.33
		Males	44.34	12.48	13.64	77.27
		Females	60.65	11.45	34.85	83.33
	Somewhat Spatial	Both	33.35	12.09	5.56	58.33
		Males	33.33	12.10	8.33	58.33
		Females	33.37	12.23	5.56	52.78

Moderately Spatial	Both	17.04	7.92	0	37.25
	Males	15.43	6.89	3.92	37.25
	Females	18.65	8.62	0	37.25
Very Spatial	Both	30.79	10.97	7.78	56.67
	Males	28.36	10.67	7.78	53.33
	Females	33.22	10.87	11.11	56.67
Extremely Spatial	Both	17.13	10.14	0	51.52
	Males	17.86	9.62	0	51.52
	Females	16.39	10.72	0	39.39

Table 14

Study 2: Descriptive Access and Engagement Scores by Gender Stereotype Category

Score Type	Spatial Rating Category	Possible Score Range	Child Sex	Mean Score	SD	Min Score	Max Score
Access	Stereotypically Masculine	0 - 1	Both	0.45	0.50	0	1
			Males	0.82	0.39	0	1
			Females	0.08	0.27	0	1
	Somewhat Masculine	0 - 8	Both	4.12	1.58	0	8
			Males	4.79	1.17	3	8
			Females	3.45	1.66	0	7
	Gender Neutral	0 - 38	Both	18.26	4.87	5	28
			Males	17.55	4.75	5	28
			Females	18.97	4.95	5	27
	Somewhat Feminine	0 - 8	Both	4.54	1.64	0	8
			Males	3.74	1.50	0	6
			Females	5.34	1.36	3	8
	Stereotypically Feminine	0 - 11	Both	2.65	2.30	0	9
			Males	1.00	1.54	0	6

			Females	4.28	1.68	0	9
Engagement	Stereotypically Masculine	0 - 1	Both	2.07	2.47	0	6
			Males	2.24	2.52	0	6
			Females	1.90	2.44	0	6
	Somewhat Masculine	0 - 8	Both	17.43	7.77	0	44
			Males	21.71	5.68	13	44
			Females	13.16	7.25	0	31
	Gender Neutral	0 - 38	Both	68.42	19.00	18	106
			Males	65.03	18.52	22	106
			Females	71.82	19.16	18	101
	Somewhat Feminine	0 - 8	Both	17.13	7.59	0	39
			Males	13.24	6.66	0	28
			Females	21.03	6.42	9	39
	Stereotypically Feminine	0 - 11	Both	10.00	9.62	0	29
			Males	2.45	4.72	0	19
			Females	17.55	6.94	0	29

Table 15

Study 2: Descriptive Average Access and Engagement Scores by Gender Stereotype Category

Score Type	Spatial Rating Category	Child Sex	Mean Score	SD	Min Score	Max Score
Access	Stereotypically Masculine	Both	44.74	50.05	0	100
		Males	81.58	39.29	0	100
		Females	7.90	27.33	0	100
	Somewhat Masculine	Both	51.48	19.68	0	100
		Males	59.87	14.58	37.50	100
		Females	43.09	20.69	0	87.50
	Gender Neutral	Both	48.06	12.81	13.16	73.68

		Males	46.19	12.49	13.16	73.68
		Females	49.93	13.02	13.16	71.05
	Somewhat Feminine	Both	56.74	20.46	0	100
		Males	46.71	18.76	0	75
		Females	66.78	17.02	37.50	100
	Stereotypically Feminine	Both	24.04	20.93	0	81.82
		Males	9.09	14.02	0	54.55
		Females	39	15.23	0	81.82
Engagement	Stereotypically Masculine	Both	34.43	41.13	0	100
		Males	37.28	41.99	0	100
		Females	31.58	40.60	0	100
	Somewhat Masculine	Both	36.32	16.19	0	91.67
		Males	45.23	11.83	27.08	91.67
		Females	27.41	15.11	0	64.58
	Gender Neutral	Both	30.01	8.33	7.89	46.49
		Males	28.52	8.12	9.65	46.49
		Females	31.50	8.38	7.89	44.30
	Somewhat Feminine	Both	35.69	15.81	0	81.25
		Males	27.58	13.87	0	58.33
		Females	43.81	13.38	18.75	81.25
	Stereotypically Feminine	Both	15.15	14.58	0	43.94
		Males	3.71	7.16	0	28.79
		Females	26.60	10.51	0	43.94

Table 16

Study 2: Results for t-tests Exploring Sex Differences in Children's Engagement by Toys/Activities

Item	Child Sex	Mean	SD	t	df	*p*
Jumbo Stacking Blocks	Males	0.50	1.33	0.58	74	0.67

	Females	0.34	1.05			
Stacking Blocks	Males	1.29	1.71	-1.50	74	0.14
	Females	1.92	1.96			
Jumbo Connecting Blocks	Males	2.74	2.18	0.06	70.02	0.95
	Females	2.71	1.71			
Connecting Blocks	Males	3.21	2.30	2.07	74	0.04*
	Females	2.13	2.24			
Gear Sets	Males	0.47	1.18	2.12	42.56	0.04*
	Females	0.05	0.32			
Marble Runs	Males	0.42	1.24	0.92	74	0.36
	Females	0.21	0.66			
Magnetic Construction	Males	0.63	1.42	-0.90	74	0.37
Blocks	Females	0.97	1.87			
Lincoln Logs	Males	0.32	1.02	0.11	74	0.91
	Females	0.29	1.01			
Interlocking Stick Toys	Males	0.18	0.73	-0.44	74	0.66
	Females	0.26	0.83			
Train or Race Car Building	Males	3.32	1.82	4.99	74	0.000***
Sets	Females	1.29	1.72			
Electronic Building Toys	Males	0.55	1.55	1.42	52.09	0.39
	Females	0.16	0.72			
Non-electronic model kits	Males	1.26	1.97	0.37	74	0.71
	Females	1.11	1.72			
Floor Puzzles	Males	1.90	1.94	-2/92	72.21	0.005**
	Females	3.11	1.66			
Jigsaw Puzzles	Males	2.53	1.50	-0.78	74	0.44
	Females	2.82	1.72			
Peg Puzzles	Males	1.47	1.66	-0.36	74	0.72
	Females	1.61	1.55			
Cube Puzzles	Males	0.71	1.43	0.86	74	0.39
	Females	0.47	0.92			

Tangram Puzzles	Males	0.32	0.81	-2.24	55.95	0.03*
	Females	0.95	1.54			
3D Puzzles	Males	0.08	0.36	1.36	37	0.18
	Females	0	0			
Brain Teasers	Males	0.47	0.98	0.46	74	0.65
	Females	0.37	1.02			
Mazes	Males	1.45	1.77	-0.58	74	0.56
	Females	1.68	1.79			
Card Games	Males	2.13	2.12	0.00	69.7	1.00
	Females	2.13	1.65			
Dice Games	Males	0.47	1.08	-1.87	65.61	0.07
	Females	1.05	1.58			
Tile Games	Males	0.63	1.26	0.38	74	0.70
	Females	0.53	1.13			
Floor Games	Males	0.68	1.30	-1.48	67.78	0.14
	Females	1.21	1.77			
Stacking Games	Males	1.40	1.76	1.16	74	0.25
	Females	0.95	1.61			
Board Games	Males	2.24	1.87	0.24	74	0.81
	Females	2.13	1.93			
Action Figures or Figurines	Males	5.13	1.46	2.76	66.45	0.007*
	Females	4.00	2.07			
Robots or Transformers	Males	3.90	2.18	9.64	48.07	0.000***
	Females	0.24	0.85			
Baby Dolls	Males	0.97	1.57	-7.44	74	0.000***
	Females	4.05	2.01			
Barbie Dolls or Similar	Males	0.58	1.45	-	74	0.000***
	Females	4.55	1.47	11.90		
Dolls	Males	0.18	0.46	-6.98	40.03	0.000***
	Females	2.79	2.26			
Doll Houses or Doll House	Males	0.47	1.22	-8.20	59.88	0.000***

Accessories	Females	3.68	2.08			
Kitchens, Playfood, or	Males	2.05	1.99	-4.87	69.18	0.000***
Housekeeping Toys	Females	4.03	1.52			
Playhouses, Tents, or	Males	1.76	1.82	-0.50	74	0.62
Tunnels	Females	1.97	1.84			
Costumes or Costume	Males	3.00	1.92	-1.85	74	0.07
Accessories	Females	3.74	1.54			
Puppets	Males	0.79	1.46	-0.34	74	0.74
	Females	0.90	1.27			
Stuffed Animals	Males	4.03	2.02	-2.04	66.50	0.046*
	Females	4.84	1.42			
Cars, Trucks, or Other	Males	5.47	0.83	7.53	51.70	0.000***
Vehicles	Females	3.03	1.82			
Reading or Being Read	Males	5.18	1.41	0.72	74	0.47
Books	Females	4.45	1.45			
Coloring Pages	Males	4.55	1.22	-1.93	74	0.06
	Females	5.11	1.27			
Drawing	Males	4.16	1.97	-3.29	58.89	0.002**
	Females	5.37	1.13			
Painting	Males	2.16	1.75	-3.52	74	0.001**
	Females	3.63	1.90			
Printing or Stamping	Males	1.00	1.72	-3.29	74	0.002**
	Females	2.37	1.90			
Scrapbooking	Males	0.05	0.32	-1.60	45.32	0.12
	Females	0.32	0.96			
Origami	Males	0.05	0.23	-2.04	42.25	0.048*
	Females	0.34	0.85			
Making Crafts with	Males	1.58	1.78	-4.46	74	0.000***
Materials found at Home	Females	3.36	1.72			
Crocheting	Males	0	0	-1.28	37.00	0.21
	Females	0.11	0.51			

Embroidering	Males	0	0	-1.00	37.00	0.32
	Females	0.03	0.16			
Knitting	Males	0	0	-1	37.00	0.32
	Females	0.03	0.16			
Weaving	Males	0	0	-1.00	37	0.32
	Females	0.05	0.32			
Sewing	Males	0.08	0.49	-0.92	74	0.36
	Females	0.21	0.74			
Making Jewelry	Males	0	0	-3.93	37	0.000***
	Females	0.95	1.49			
Fuse Beads	Males	0.16	0.50	-1.17	54.15	0.25
	Females	0.37	1.00			
Making Jewelry with beads	Males	0.16	0.72	-3.41	52.06	0.001**
	Females	1.11	1.56			
Play-Doh, Modeling Clay,	Males	3.21	1.49	-1.89	74	0.06
Pottery, or Sculpting	Females	3.84	1.42			
Cooking or Baking	Males	1.66	1.86	-4.23	74	0.000***
	Females	3.45	1.83			
Science Experiments	Males	0.74	1.31	0.35	74	0.72
	Females	0.63	1.28			
Playing a Musical	Males	2.34	2.15	0.32	74	0.75
Instrument	Females	2.18	2.12			
Karaoke	Males	1.68	2.33	-1.69	74	0.10
	Females	2.53	2.01			
DJing	Males	0.42	1.27	0.98	62.52	0.33
	Females	0.18	0.80			
Map Reading	Males	1.00	1.49	-0.29	74	0.78
	Females	1.11	1.71			
Watching Television or	Males	5.58	0.60	0.18	74	0.86
Movies	Females	5.55	0.69			
Toys Controlled by Tablet,	Males	2.11	2.55	1.94	70.55	0.06

Computer, or Smartphones	Females	1.08	2.03			
Electronic or Remote	Males	2.61	1.94	1.55	74	0.13
Controlled Toys	Females	1.92	1.91			
Video or Computer Games	Males	2.29	2.38	1.77	72.09	0.08
	Females	1.40	2.02			
Phone or Tablet Games	Males	3.84	2.16	0.98	74	0.33
	Females	3.37	2.07			

Notes. * p < .05, ** p < .01, *** p < .001. DF values less than 74 are for *t*-tests where equal variances are not assumed given Levene's Test of Equal Variances.

Table 17

Study 2: Regression Analyses Predicting Access/Engagement Scores by Spatial Category

		Access Category Scores			Engagement Category Scores		
Category	Variable	B	SE (B)	*p*	B	SE (B)	*p*
Extremely	Constant	-2.85	1.88	0.129	-7.16	7.94	0.367
Spatial	Child's Sex	-0.75	0.35	0.029*	-3.35	1.46	0.022*
	SES	0.06	0.09	0.474	0.30	0.37	0.413
	Age	0.02	0.02	0.454	0.06	0.10	0.585
	PPVT	0.01	0.01	0.310	0.01	0.04	0.782
	General Access	0.14	0.02	0.000***	0.46	0.09	0.000***
Very Spatial	Constant	1.69	2.01	0.399	19.53	10.77	0.070
	Child's Sex	-0.47	0.37	0.203	1.79	1.95	0.356
	SES	0.03	0.09	0.741	-0.70	0.50	0.161
	Age	0.00	0.03	0.896	-0.05	0.14	0.713
	PPVT	-0.01	0.01	0.328	-0.10	0.06	0.108
	General Access	0.24	0.02	0.000***	0.81	0.12	0.000***

Moderately Spatial	Constant	-1.15	1.98	0.562	8.02	8.42	0.341
	Child's Sex	0.20	0.36	0.587	0.57	1.49	0.703
	SES	-0.02	0.09	0.860	-0.41	0.39	0.292
	Age	0.02	0.03	0.458	0.05	0.10	0.652
	PPVT	-0.02	0.01	0.038*	-0.13	0.05	0.014*
	General Access	0.23	0.02	0.000***	0.72	0.09	0.000***
Somewhat Spatial	Constant	0.31	1.67	0.855	-3.37	8.08	0.677
	Child's Sex	-0.58	0.31	0.059	-3.36	1.49	0.024*
	SES	-0.08	0.08	0.284	-0.55	0.38	0.146
	Age	-0.03	0.02	0.142	0.02	0.10	0.869
	PPVT	0.02	0.01	0.072	0.05	0.04	0.227
	General Access	0.23	0.02	0.000***	0.87	0.09	0.000***
Not At All Spatial	Constant	2.00	1.59	0.209	22.87	8.54	0.007**
	Child's Sex	1.60	0.29	0.000***	8.82	1.57	0.000***
	SES	0.01	0.07	0.931	-0.42	0.40	0.295
	Age	-0.01	0.02	0.666	-0.14	0.11	0.212
	PPVT	0.01	0.01	0.454	-0.01	0.05	0.800
	General Access	0.17	0.02	0.000***	0.65	0.10	0.000***

Note. R^2 = 0.306; 0.435; 0.509; 0.573; 0.603. * p < .05, ** p < .01, *** p < .001.

Table 18

Study 2: Regression Analyses Predicting Access/Engagement Scores by Stereotype Category

		Access Category Scores			Engagement Category Scores		
Category	Variable	B	SE (B)	*p*	B	SE (B)	*p*
Masculine	Constant	0.65	0.45	0.146	2.49	3.48	0.474

	Child's Sex	-0.75	0.08	0.000***	-0.21	0.64	0.742
	SES	-0.06	0.02	0.009**	-0.05	0.16	0.765
	Age	0.00	0.01	0.605	0.02	0.04	0.731
	PPVT	0.00	0.00	0.889	0.00	0.02	0.992
	General Access	0.01	0.01	0.037*	-0.03	0.04	0.399
Somewhat Masculine	Constant	-0.62	1.58	0.692	2.030	7.74	0.793
	Child's Sex	-2.03	0.29	0.000***	-11.10	1.43	0.000***
	SES	0.08	0.07	0.307	0.07	0.36	0.844
	Age	0.04	0.02	0.039	0.16	0.10	0.107
	PPVT	-0.01	0.01	0.371	-0.04	0.04	0.377
	General Access	0.12	0.02	0.000***	0.47	0.09	0.000***
Gender Neutral	Constant	1.42	2.47	0.565	29.39	16.73	0.079
	Child's Sex	-0.99	0.46	0.029*	-0.51	3.02	0.865
	SES	-0.09	0.17	0.418	-1.20	0.78	0.121
	Age	-0.01	0.03	0.825	-0.00	0.21	0.985
	PPVT	0.01	0.01	0.641	-0.14	0.10	0.166
	General Access	0.59	0.03	0.000***	1.99	0.19	0.000***
Somewhat Feminine	Constant	1.01	1.16	0.382	4.48	6.52	0.492
	Child's Sex	1.06	0.21	0.000***	5.81	1.20	0.000***
	SES	0.02	0.05	0.779	-0.24	0.31	0.443
	Age	-0.02	0.02	0.110	-0.10	0.08	0.230
	PPVT	0.000009.191	0.01	0.999	-0.00	0.03	0.904
	General Access	0.15	0.01	0.000***	-0.59	0.08	0.000***
Feminine	Constant	-2.46	1.66	0.138	0.41	7.12	0.954
	Child's Sex	2.72	0.30	0.000***	14.02	1.30	0.000***
	SES	0.06	0.08	0.451	-0.15	0.33	0.660

Age	-0.01	0.02	0.515	-0.12	0.09	0.170
PPVT	0.00	0.01	0.817	-0.01	0.04	0.909
General Access	0.14	0.02	0.000***	0.39	0.08	0.000***

Note. R^2 = 0.023; 0.510; 0.633; 0.635; 0.735. * p < .05, ** p < .01, *** p < .001.

Table 19

Study 3: *Regression Analysis Predicting CMTT Scores*

Variable	B	SE (B)	t	*p*
Constant	-18.968	6.796	-2.791	0.005**
Child's Sex	-1.837	1.285	-1.429	0.153
SES	0.615	0.337	1.826	0.068
PPVT	0.046	0.040	1.142	0.253
Age	0.406	0.091	4.479	0.000***

Note. R^2 = 0.261; * p < .05, ** p < .01, *** p < .001.

Table 20

Study 3: Regression Analysis Predicting CMTT Scores of Children Over 60 Months

Variable	B	SE (B)	t	*p*
Constant	-18.588	10.236	-1.816	0.069
Child's Sex	-0.389	1.594	-0.244	0.807
SES	0.802	0.412	1.947	0.052
PPVT	0.073	0.046	1.581	0.114
Age	0.334	0.146	2.281	0.023*

Note. $R^2 = 0.261$; *$p < .05$.

Table 21

Study 3: Regression Analysis with General Access to Toys/Activities Predicting CMTT Scores

Variable	B	SE (B)	t	*p*
Constant	-18.245	8.032	-2.272	0.024*
General Access Score	-0.032	0.089	-0.354	0.723

Child's Sex	-1.813	1.417	-1.280	0.201
SES	0.626	0.365	1.713	0.087
PPVT	0.047	0.048	0.989	0.329
Age	0.405	0.096	4.239	0.000***

Note. $R^2 = 0.262$; * p < .05, ** p < .01, *** p < .001.

Table 22

Study 3: Regression Analyses – Access/Engagement with Toys/Activities by Spatial Category Predicting CMTT Scores

	Access Scores				Engagement Scores			
Variable	B	SE (B)	t	*p*	B	SE (B)	t	*p*
Constant	-15.880	7.825	-2.029	0.043*	-20.769	8.239	-2.521	0.012*
Not At All Spatial Score	-0.460	0.381	-1.209	0.226	0.034	0.083	0.413	0.679
Child's Sex	-0.879	1.613	-0.545	0.048*	-2.352	1.670	-1.409	0.159
Age	0.392	0.094	4.156	0.012*	0.422	0.096	4.385	0.000***
SES	0.662	0.357	1.853	0.078	0.601	0.356	1.689	0.092

PPVT	0.052	0.048	1.089	0.385	0.045	0.048	0.930	0.359
Constant	-17.896	7.772	-2.302	0.022*	-20.367	7.608	-2.677	0.008**
Somewhat Spatial Score	-0.174	0.308	-0.565	0.572	0.045	0.076	0.591	0.555
Child's Sex	-1.874	1.352	-1.387	0.166	-1.973	1.341	-1.472	0.141
Age	0.398	0.097	4.105	0.000***	0.420	0.094	4.460	0.000***
SES	0.618	0.357	1.730	0.084	0.599	0.355	1.685	0.092
PPVT	0.050	0.048	1.040	0.305	0.041	0.048	0.858	0.396
Constant	-19.296	7.634	-2.528	0.012*	-20.698	8.152	-2.539	0.012*
Moderately Spatial Score	0.003	0.298	0.011	0.992	0.045	0.090	0.496	0.621
Child's Sex	-1.957	1.403	-1.395	0.163	-2.120	1.407	-1.507	0.132
Age	0.413	0.094	4.392	0.000***	0.417	0.094	4.452	0.000***
SES	0.602	0.361	1.667	0.096	0.596	0.356	1.673	0.095
PPVT	0.045	0048	0.941	0.354	0.050	0.051	0.990	0.331
Constant	-22.094	8.003	-2.761	0.006**	-24.384	8.198	-2.974	0.004**

Very Spatial Score	0.303	0.298	1.015	0.311	0.112	0.070	1.593	0.113
Child's Sex	-2.126	1.352	-1.572	0.116	-2.550	1.392	-1.832	0.067
Age	0.427	0.094	4.551	0.000***	0.438	0.093	4.714	0.000***
SES	0.540	0.363	1.487	0.138	0.614	0.349	1.759	0.079
PPVT	0.045	0.048	0.939	0.355	0.052	0.049	1.058	0.300
Constant	-18.603	7.288	-2.553	0.011*	-18.723	7.362	-2.543	0.012*
Extremely Spatial Score	-0.428	0.379	-1.130	0.259	-0.071	0.099	-0.717	0.473
Child's Sex	-2.018	1.332	-1.515	0.130	-2.046	1.339	-1.529	0.126
Age	0.407	0.093	4.391	0.000***	0.409	0.093	4.388	0.000***
SES	0.673	0.360	1.869	0.062	0.648	0.364	1.782	0.075
PPVT	0.053	0.048	1.097	0.280	0.048	0.047	1.011	0.319

Note. R^2 for access scores = 0.273; 0.263; 0.260; 0.272; 0.273. R^2 for engagement scores = 0.262; 0.264; 0.265; 0.291; 0.266. *p < .05; **p < .01; ***p < .001.

Table 23

Study 3: Regression Analyses – Access/Engagement with Toys/Activities by Stereotype Category Predicting CMTT Scores

	Access Scores				Engagement Scores			
Variable	B	SE(B)	t	*p*	B	SE (B)	t	*p*
Constant	-17.679	7.521	-2.350	0.019*	-19.690	7.261	-2.712	0.007**
Masculine Score	-1.594	1.923	-0.829	0.407	0.298	0.257	1.159	0.246
Child's Sex	-3.076	1.901	-1.618	0.106	-1.846	1.330	-1.388	0.165
Age	0.413	0.093	4.446	0.000***	0.406	0.093	4.379	0.000***
SES	0.528	0.365	1.445	0.149	0.624	0.353	1.770	0.077
PPVT	0.046	0.048	0.956	0.388	0.046	0.048	0.956	0.346
Constant	-17.912	7.366	-2.432	0.015*	-18.160	7.537	-2.410	0.017*
Somewhat Masculine Score	-0.430	0.449	-0.958	0.338	-0.065	0.098	-0.658	0.511
Child's Sex	-2.604	1.504	-1.731	0.084	-2.537	1.587	-1.599	0.110

Age	0.419	0.093	4.502	0.000***	0.416	0.093	4.461	0.000***
SES	0.672	0.360	1.866	0.062	0.630	0.359	1.756	0.080
PPVT	0.045	0.048	0.934	0.357	0.045	0.048	0.934	0.357
Constant	-19.323	8.019	-2.410	0.017*	-22.556	8.353	-2.700	0.008**
Gender Neutral Score	0.003	0.140	0.019	0.985	0.035	0.036	0.961	0.338
Child's Sex	-1.957	1.372	-1.427	0.154	-2.241	1.386	-1.617	0.106
Age	0.413	0.096	4.318	0.000***	0.428	0.094	4.544	0.000***
SES	0.602	0.362	1.663	0.097	0.593	0.354	1.673	0.095
PPVT	0.045	0.048	0.950	0.348	0.047	0.048	0.966	0.342
Constant	-21.621	7.904	-2.735	0.007**	-23.072	7.669	-3.008	0.003**
Somewhat Feminine Score	0.410	0.478	0.858	0.391	0.162	0.100	1.612	0.107
Child's Sex	-2.650	1.591	-1.666	0.096	-3.311	1.591	-2.082	0.038*
Age	0.435	0.097	4.493	0.000***	0.450	0.095	4.749	0.000***
SES	0.552	0.362	1.526	0.127	0.570	0.351	1.623	0.105

PPVT	0.042	0.048	0.885	0.382	0.041	0.047	0.865	0.394
Constant	-18.066	7.316	-2.469	0.014*	-19.427	7.593	-2.559	0.011*
Feminine Score	-0.624	0.427	-1.459	0.145	0.012	0.118	0.103	0.918
Child's Sex	0.117	2.001	0.058	0.954	-2.143	2.358	-0.909	0.365
Age	0.385	0.094	4.091	0.000***	0.415	0.097	4.283	0.000***
SES	0.701	0.362	1.938	0.053	0.601	0.357	1.681	0.093
PPVT	0.051	0.047	1.097	0.280	0.045	0.048	0.953	0.347

Note. R^2 for access scores = 0.266; 0.269; 0.260; 0.268; 0.285. R^2 for engagement scores = 0.274; 0.265; 0.272; 0.287; 0.285. *p < .05; **p < .01; ***p < .001.

Table 24

Study 4: Regression Analysis with POAT-AM Scores Predicting CMTT Scores

Variable	B	SE (B)	t	*p*
Constant	-18.958	6.841	-2.771	0.006**
POAT-AM	0.005	0.026	0.190	0.850
Child's Sex	-1.883	1.292	-1.457	0.145

SES	0.597	0.341	1.751	0.080
PPVT	0.047	0.040	1.161	0.245
Age	0.401	0.097	4.147	0.000***

Note. R^2 = 0.260; *p < .05; **p < .01; ***p < .001.

Table 25

Study 4: Regression Analysis with the Interaction between Sex and POAT-AM Scores Predicting CMTT Scores

Variable	B	SE (B)	t	*p*
Constant	-9.097	5.716	-1.591	0.112
Child's Sex	-6.207	3.190	-1.946	0.052
POAT-AM	-0.039	0.037	-1.050	0.294
Interaction	0.087	0.052	1.672	0.095
Age	0.405	0.097	4.171	0.000***

Note. R^2 = 0.232; *p < .05; **p < .01; ***p < .001.

Table 26

Study 4: Regression Analyses – Engagement with Toys/Activities by Spatial Category Predicting Spatial Play

	Engagement Scores

Variable	B	SE (B)	t	*p*
		Extremely Spatial		
Constant	8.505	8.612	0.988	0.323
POAT-AM	3.253	3.413	0.953	0.341
Child's Sex	-1.303	1.623	-0.803	0.422
SES	0.601	0.429	1.403	0.161
PPVT	0.036	0.051	0.710	0.478
Age	-0.085	0.122	-0.694	0.488
		Very Spatial		
Constant	47.469	12.536	3.787	0.000***
POAT-AM	2.379	4.928	0.483	0.629
Child's Sex	5.375	2.360	2.278	0.023*
SES	-0.095	0.623	-0.152	0.879
PPVT	-0.075	0.074	-1.014	0.311
Age	-0.252	0.177	-1.420	0.156

	Moderately Spatial			
Constant	33.397	10.169	3.284	0.001***
POAT-AM	2.176	4.270	0.510	0.611
Child's Sex	3.797	1.914	1.984	0.047*
SES	0.148	0.506	0.293	0.770
PPVT	-0.116	0.060	-1.926	0.054
Age	-0.135	0.145	-0.932	0.351
	Somewhat Spatial			
Constant	24.481	11.287	2.169	0.030*
POAT-AM	-3.656	4.252	-0.860	0.390
Child's Sex	0.311	2.122	0.147	0.883
SES	0.142	0.560	0.254	0.800
PPVT	0.087	0.067	1.303	0.192
Age	-0.127	0.159	-0.798	0.425

		Not At All Spatial		
Constant	44.088	10.110	4.361	0.000***
POAT-AM	1.970	3.855	0.511	0.609
Child's Sex	11.670	1.908	6.116	0.000***
SES	0.027	0.504	0.054	0.957
PPVT	0.024	0.060	0.407	0.684
Age	-0.302	0.143	-2.113	0.035*

Note. R^2 for engagement scores = 0.068, 0.095, 0.111, 0.058, 0.365. *p < .05; **p < .01; ***p < .001.

Table 27

Study 4: Regression Analyses – POAT-AM Scores Predicting Gendered Play

		Engagement Scores		
Variable	B	SE (B)	t	*p*
		Stereotypically Masculine		
Constant	1.679	3.244	0.518	0.605

POAT-AM	1.072	1.240	0.865	0.387
Child's Sex	-0.344	0.612	-0.562	0.574
SES	-0.086	0.162	-0.533	0.594
PPVT	-0.002	0.019	-0.104	0.917
Age	0.010	0.046	0.221	0.825
	Somewhat Masculine			
Constant	17.958	8.479	2.118	0.034*
POAT-AM	3.098	3.318	0.934	0.351
Child's Sex	-8.979	1.601	-5.609	0.000***
SES	0.382	0.423	0.904	0.366
PPVT	-0.010	0.050	-0.209	0.835
Age	0.018	0.120	0.150	0.881
	Gender Neutral			
Constant	96.328	24.595	3.917	0.000***
POAT-AM	-1.621	9.742	-0.166	0.868

Child's Sex	8.134	4.622	1.760	0.078
SES	0.370	1.222	0.303	0.762
PPVT	-0.073	0.145	-0.500	0.617
Age	-0.413	0.348	-1.188	0.235
	Somewhat Feminine			
Constant	24.011	8.348	2.876	0.004**
POAT-AM	1.358	3.171	0.428	0.668
Child's Sex	8.404	1.574	5.340	0.000***
SES	0.185	0.416	0.445	0.656
PPVT	0.025	0.049	0.515	0.607
Age	-0.245	0.118	-2.081	0.037*
	Stereotypically Feminine			
Constant	13.986	7.542	1.855	0.064
POAT-AM	3.473	2.916	1.191	0.234

Child's Sex	15.749	1.419	11.100	0.000***
SES	0.102	0.375	0.272	0.785
PPVT	0.013	0.045	0.284	0.776
Age	-0.249	0.107	-2.337	0.019*

Note. R^2 for engagement scores = 0.025; 0.328; 0.064; 0.318; 0.656 *$p < .05$; **$p < .01$; ***$p < .001$.

FIGURES

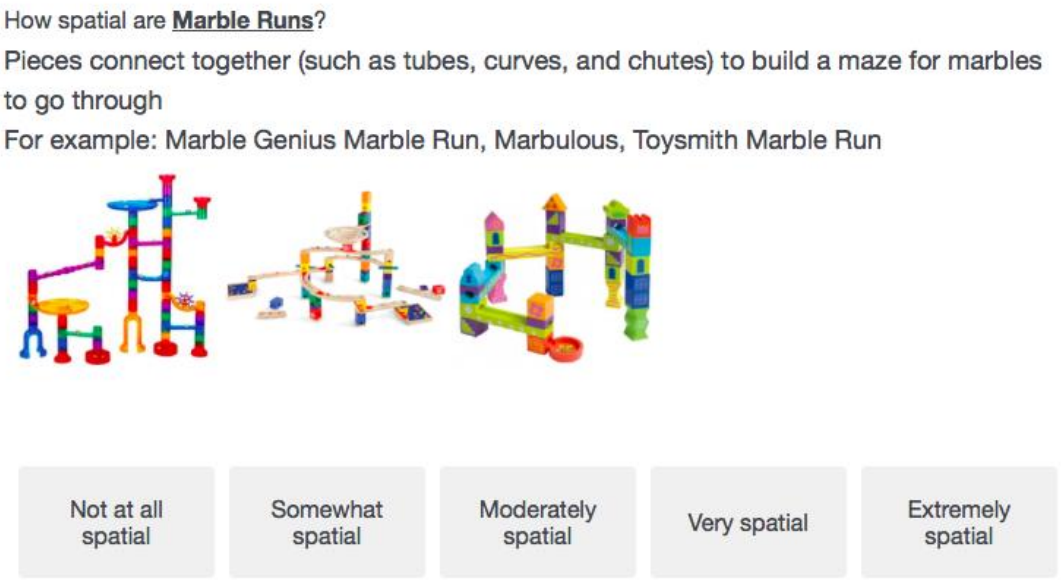

Figure 1. *Sample Item from Iteration 1 of the Spatial Activity Questionnaire*

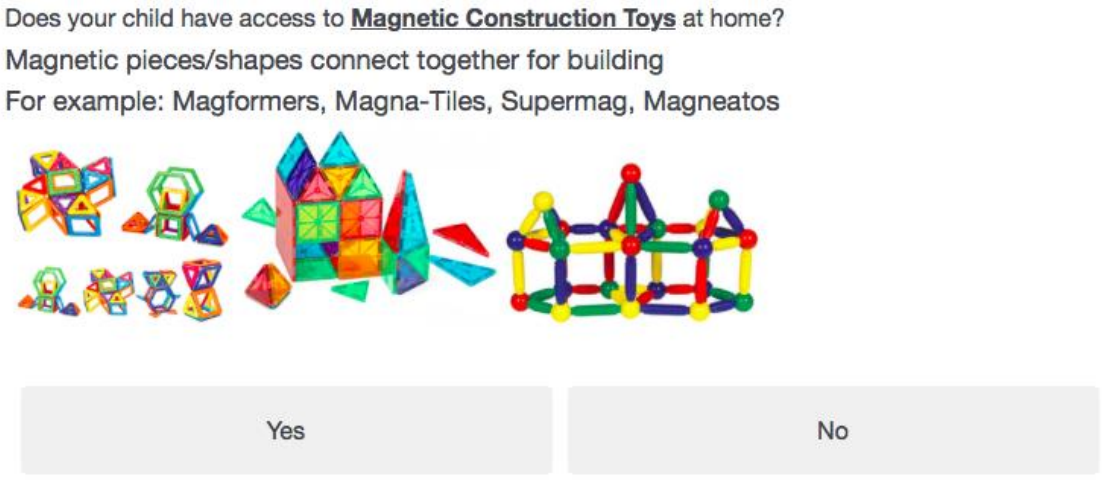

Figure 2. *Sample Access Item from Final Version of the Spatial Activity Questionnaire*

Figure 3. *Sample Engagement Item Final Version of the Spatial Activity Questionnaire*

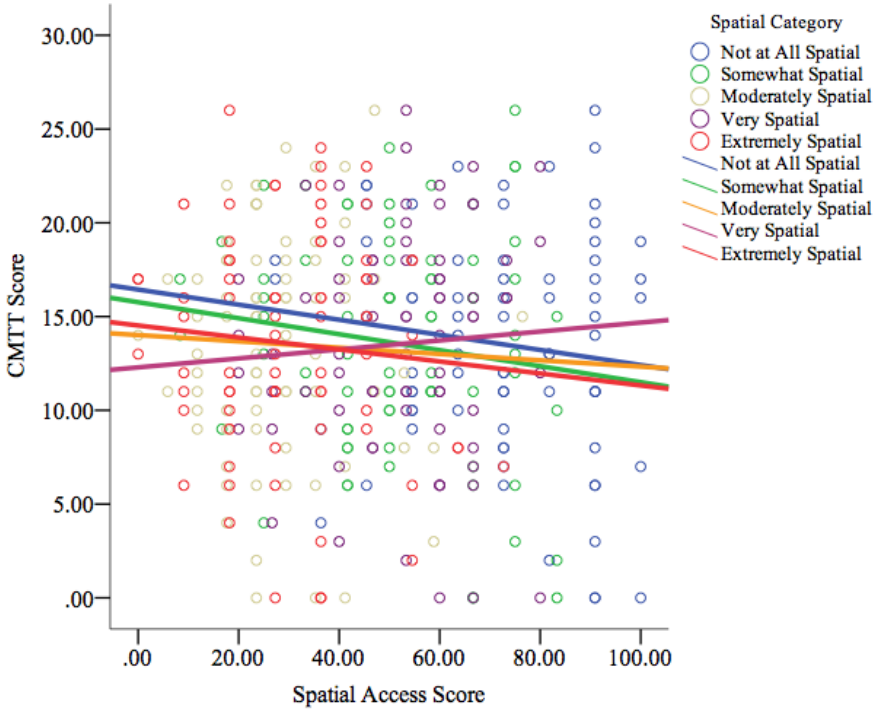

Figure 4. *CMTT Score by Spatial Category for Average Spatial Access Scores*

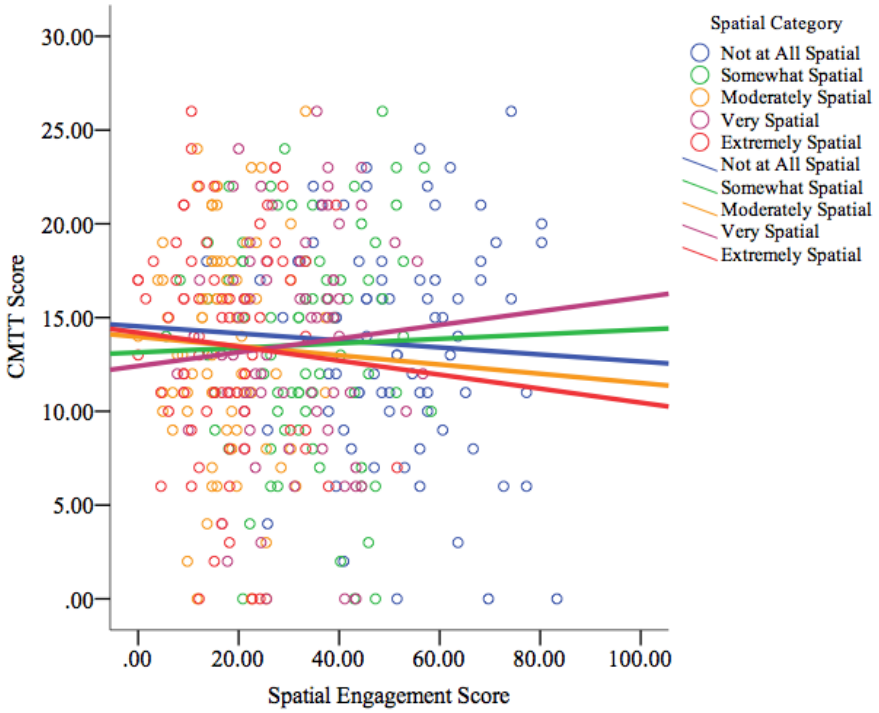

Figure 5. *CMTT Score by Spatial Category for Average Spatial Engagement Scores*

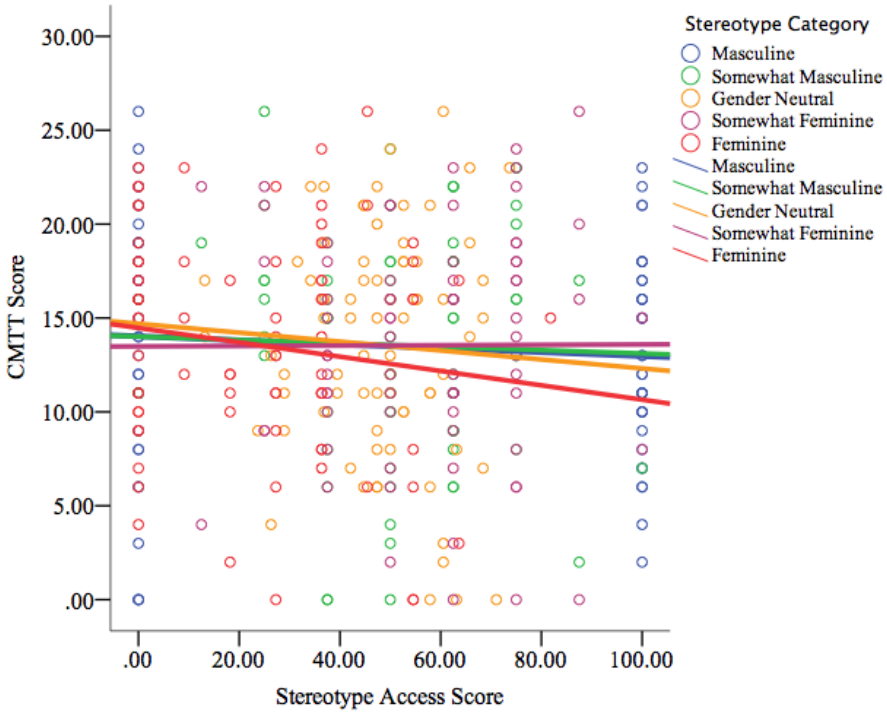

Figure 6. *CMTT Score by Stereotype Category for Average Stereotype Access Scores*

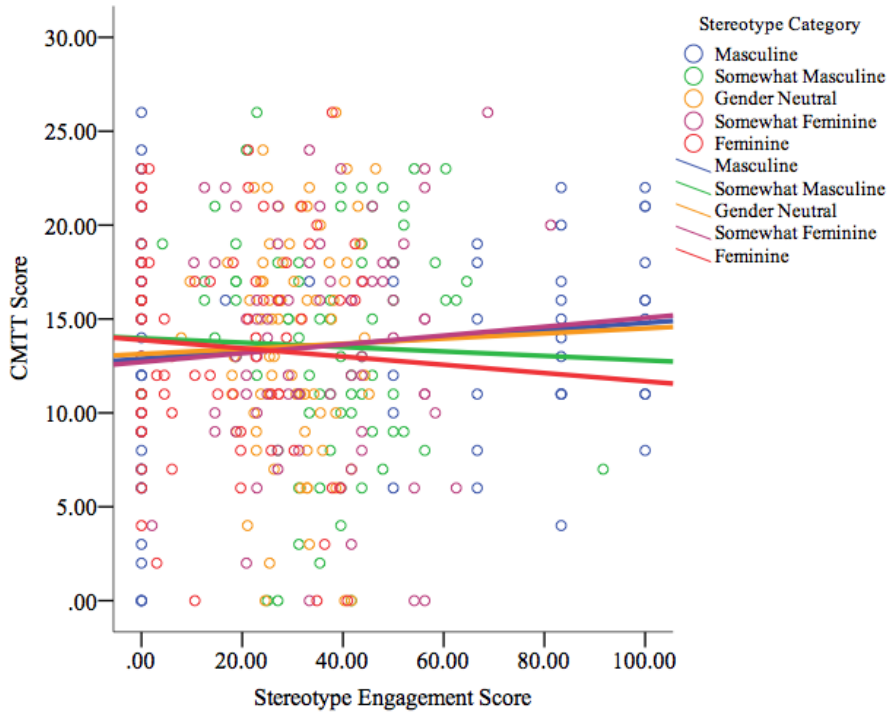

Figure 7. *CMTT Score by Stereotype Category for Average Stereotype Engagement Scores*

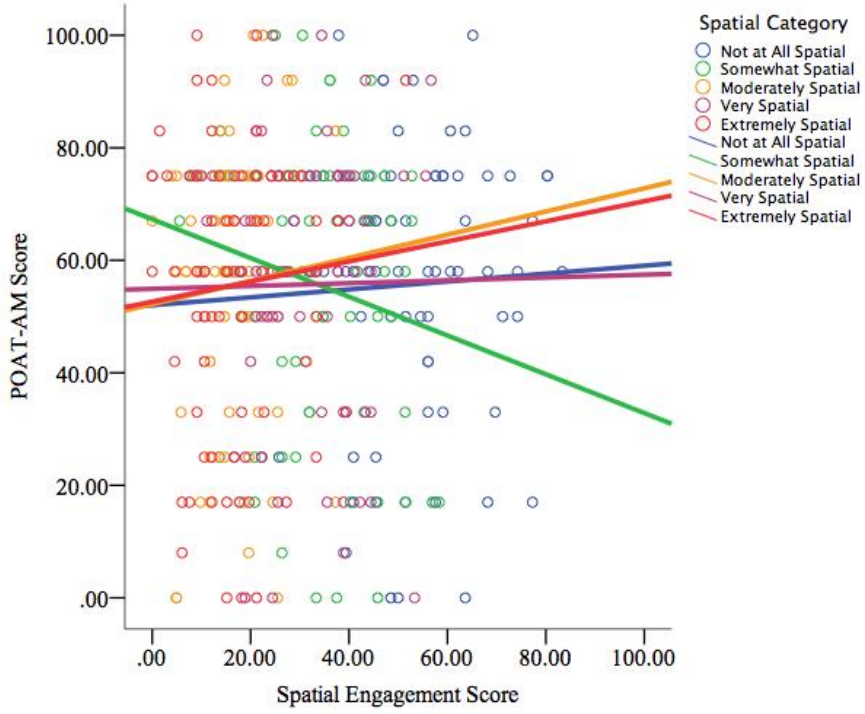

Figure 8. *POAT-AM Score by Spatial Category for Average Spatial Engagement Scores*

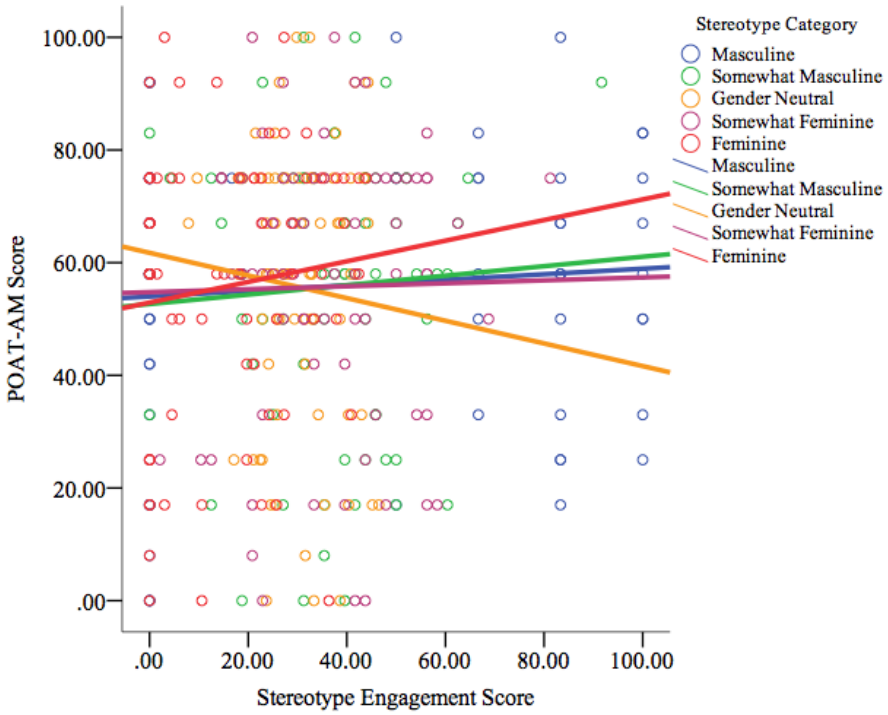

Figure 9. *POAT-AM Score by Stereotype Category for Average Stereotype Engagement Scores*

VITA

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2007-2009	A.A., Psychology The Honors College at Miami Dade College, Miami, FL
2009-2011	B.A., Psychology New College of Florida, Sarasota, FL
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PUBLICATIONS AND PRESENTATIONS

Abad, C. (2014, September) *National Science Foundation Fellows presentation*. Talk presented at the Board of Trustees Academic Policy and Student Affairs Committee Meeting, Miami, FL.

Abad, C. & Odean, R. (2017) April. *Kahoot: A free tool to increase classroom engagement*. Talk presented at the Developmental Science Teaching Institute pre-conference at the biennial meeting of the Society for Research in Childhood Development, Austin, TX.

Abad, C. & Pruden, S.M. (2017, March). *Are parent and child mental rotation skills related?* Talk presented at the Graduate Student Appreciation Week Scholarly Forum, Miami, FL.

Abad, C., & Pruden, S.M. (2013). Do storybooks really break children's gender stereotypes? *Frontiers in Psychology, 4*.

Abad, C., & Pruden, S.M., (2017, October). *Parent mental rotation skills predict the mental rotation skills of their children*. Presented at the biennial meeting of the Cognitive Development Society, Portland, OR.

Abad, C., Alvarez, D., Gonzalez, A., Alayeto, A., & Pruden, S.M. (2017, April). *Exploring the relationship between parent and child mental rotation skills.* Submitted to the Society for Research in Child Development, Austin, TX.

Abad, C., Lopez, M., Perez, V., Odean, R., Pruden, S.M. (2015, April). *The role of language in early spatial development.* Talk presented at the Graduate Student

Appreciation Week Scholarly Forum, Miami, FL.

Abad, C., Odean, R., & Pruden, S. M. (in preparation). Sex differences in gains among Hispanic pre-kindergartners' spatial thinking.

Abad, C., Odean, R., & Pruden, S.M. (2015, October). *Exploring sex differences in Hispanic pre-kindergartners spatial skills*. Presented at the biennial meeting of the Society for the Study of Human Development, Austin, TX.

Abad, C., Odean, R., & Pruden, S.M. (2016, August). Sex differences in spatial skill gains throughout pre-kindergarten. Presented at Spatial Cognition, Philadelphia, PA.

Abad, C., Odean, R., Barriga, T., Pruden, S.M. (2015, May). *The development of spatial skills in pre-kindergarten classrooms.* Talk presented at the South Florida Child Psychology Research Conference, Miami, FL.

Abad, C., Odean, R., Costales, A. Barriga, T., & Pruden, S.M. (2013, June). *Same classroom, different experience: Sex differences in preschoolers' spatial reasoning.* Poster presented at 2013 Workshop on Infant Language Development, San Sebastián, Spain.

Abad, C., Odean, R., Costales, A., & Pruden, S.M. (2013, April). *Pre-kindergarten educators' spatial language use in the classroom: Using LENA to examine sources of sex differences.* Poster presented at 2013 LENA International Conference, Denver, CO.

Abad, C., Odean, R., Costales, A., Ferret, S., & Pruden, S.M. (2013, June). *Influence of teachers' numeracy language on pre-kindergarteners' spatial reasoning.* Poster presented at 2013 Workshop on Infant Language Development, San Sebastián, Spain.

Abad, C., Odean, R., Lopez, M., Salazar, D., & Pruden, S.M. (2014, May). *The role of educators' language on pre-kindergarteners' numeracy and spatial skills.* Poster presented at the Association for Psychological Science, San Francisco, CA.

Abad, C., Odean, R., Pruden, S.M. (2015, October). *Sex differences in gains on spatial ability throughout pre-kindergarten*. Presented at the biennial meeting of the Cognitive Development Society, Columbus, OH.

Abad, C., Odean, R., Pruden, S.M. (2016, April). *Pre-kindergartners' gain in spatial skills.* Talk presented at the Graduate Student Appreciation Week Scholarly Forum, Miami, FL.