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ORIGINAL ARTICLE

Building a Pink Dinosaur: the Effects of Gendered Construction Toys on Girls' and Boys' Play

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Abstract Play with building toys such as LEGO® sets promotes spatial learning in children. The present study examined the effects of the color of the bricks (either pink or blue) and the femininity/masculinity of the object built on boys' and girls' play with LEGO® sets. Children (n = 116, M_{age} = 7.27 range = 5–10) were given the opportunity to build with LEGO® brick sets, both instructed and free play tasks. For the instructed task, the type of object (feminine: cat; masculine: dinosaur) and color of the bricks (pink, blue) were counterbalanced across participants. Their play was coded for accuracy of following the instructions and time to complete the task. In the free play task, brick color (pink, blue) was counterbalanced across participants, and structures were coded for femininity/masculinity and the number of bricks used. Overall, children took longer to build a feminine object with blue bricks than with pink bricks. In the free-play task, boys built more masculine objects than girls did, regardless of the color of bricks they were given. Results showed that boys completed the LEGO® tasks faster than did girls, controlling for interest in and experience with LEGO® play. These findings suggest that toy color and type can impact how children interact and play with toys.

Keywords Construction play · Gender-typing · Spatial ability

Children build important cognitive skills when playing with construction toys like LEGO® sets (Brosnan 1998; Caldera et al. 1999; Casey et al. 2008). In particular, experience with building toys is associated with improved spatial skills, including better mental rotation and geometric thinking (Jirout and Newcombe 2015; Serbin et al. 1990). Feeling efficacy in these domains may increase interest in STEM activities (Science. Technology, Engineering, and Mathematics) as well as occupational aspirations in STEM fields (Uttal and Cohen 2012; Wai et al. 2009). Stereotypes surrounding STEM domains suggest that men are more capable of such skills than are women (McGlone and Aronson 2006). These stereotypes, in turn, affect children's access to such toys (via targeted gender advertising and parental toy selection; Schwartz and Markham 1985) and interest in them (Weisgram 2016).

Combating such stereotypes and encouraging girls' interest in STEM building toys often begins with the marketing of the toys. That is, whether the toys are geared toward boys or girls in their advertising and the types of gender cues present in the toys' appearance (e.g., the color of the toys) affects girls' and boys' interest in them (Weisgram et al. 2014). It is possible that toy manufacturers may feminize building or science toys in an attempt to increase girls' interest in such toys. LEGO® recently introduced its *Friends* line of building sets in order to appeal to girls and their parents (LEGO Friends 2017). Although the purported goal of creating this line of girl-marketed LEGO® sets was to increase the number of girls interested in LEGO® play, it is possible that the gender coding present in the *Friends* line leads children to play differently than they would with more traditional LEGO® sets. A primary aim of the present study was to investigate whether gendered cues in LEGO® sets (brick color and object type)

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impact children's performance and style of play with both instructed and free play building tasks.

Although always popular, LEGO® sales have increased dramatically with a trend toward parents' increased interest in promoting children's STEM activities (Kell 2016). Since their first production in the 1960s, LEGO® sets have become more thematic in nature (i.e., sets are packaged with instructions to build a specific item, like a pirate ship, rather than just an assortment of bricks), and these themes have been rooted in traditionally masculine domains (Black et al. 2016). In response to criticisms that the masculine themes of the majority of LEGO® sets have had the effect of excluding girls, LEGO® released the *Friends* line of products. Aside from the more traditionally feminine brick colors and themes, the *Friends* line differs from traditional sets (like the LEGO® *City* line) in the number of girl mini-figures included with the sets and in a focus on friendships and relationships rather than building structures and vehicles (Black et al. 2016). Thus, the result of creating the new line of LEGO® *Friends* has been that LEGO® sets are now firmly gender-segregated.

Although the addition of the new LEGO® *Friends* sets has increased girls' interest (and thus access to) building play, it is unknown what effects, either positive or negative, the feminization of the LEGO® sets might have on children's broader beliefs about who should and can build with LEGO® toys. Will the new girl-oriented LEGO® sets work to increase girls' interest in spatial play and thus give them more opportunities to build spatial skills? Conversely, is it possible that the color of LEGO® bricks and the masculinity/femininity of the objects being built impact girls' performance, perhaps by activating stereotypes?

Play and Spatial Ability

Historically, men and boys have outperformed girls and women on tests of spatial skills (Miller and Halpern 2014; Voyer et al. 1995). There is evidence for an environmental source for such differences. Play with LEGO® bricks and other construction toys is associated with spatial ability (Brosnan 1998; Ness and Farenga 2007). Indeed, some evidence has shown that practice with spatial tasks improves girls' performance and reduces the gender gap in such tasks (Feng et al. 2007; Moe 2016). Thus, encouraging girls to play more with such toys appears to be beneficial for boosting their spatial skills.

Hyde's (2014) review of the available meta-analyses points out that the size of the reported gender difference in spatial ability varies from study to study and can change drastically due to the type of task, the time allotted for the task, and the age of the participants. Indeed, one recent study of elementary school-aged children showed no gender differences across these years in children's performance on a spatial reasoning task after both girls and boys received training in 3D modeling (Safhalter et al. 2016). However, the perception of the existence of a large and inflexible gender gap in spatial reasoning persists and may influence children's interest in and persistence with tasks that draw on spatial skills. It may be that the preponderance of LEGO® sets available to boys lead girls to believe that LEGO® play is not for them and thus hinders their performance on such tasks. Children may hold entity theories about building tasks, which suggest that ability is a result of natural or inborn talent and not the result of hard work (Dweck and Leggett 1988). The marketing of segregated toys may sustain such theories, implying that boys and girls are so different in interest and ability that they need different toys (and even different toy aisles in stores). Attempting to tailor learning opportunities and environments to fit the perceived preferences and abilities of boys and girls as homogenous groups ignores variation within the genders (Bigler et al. 2015; Hyde 2005).

Stereotype Threat and Spatial Performance

There is evidence that, even for children in elementary school, activating social identity can have a measurable effect on academic tasks (Cimpian et al. 2012). Depending on the identity that is being activated, increasing the salience of one's group membership can boost (e.g., Asian identity) or depress (e.g., gender identity) girls' performance on math tests (Ambady et al. 2001) via the awareness that one's performance is being judged based on stereotypes about their social group (stereotype threat; Spencer et al. 1999). In college-aged students, priming gender before a mental rotation task has been shown to enhance men's and depress women's scores on the task, whereas priming participants' identity as students at a selective school increased both men's and women's scores (McGlone and Aronson 2006). When children believe that their ability on a task relies at least in part on membership in a social category, they are less likely to persist and may show impaired performance when asked to complete a task that they believe is better suited for the other gender (Cimpian et al. 2012).

Even by fourth grade, these kinds of gender priming statements have measurable effects on mental rotation scores; when girls hear either the phrase "Girls are better" or, interestingly, that "there are no gender differences" on the task, their scores on the task increase (Neuburger et al. 2012). However, some experimental work has shown a more negative effect of gender-labeling of tasks across genders: that is, when children (both boys and girls) are told that performance on a novel shape-drawing task is linked to category membership (e.g., "Boys/girls are usually good at this game"), their performance on that task decreases, regardless of whether they are in the social group associated with the task (Cimpian et al. 2012).This

finding may indicate that trying to garner girls' interest in STEM by feminizing toys may backfire, sending the message that "there is a different kind of science for you" instead of "there is no gender difference." Indeed, when gender is activated, girls perform less well on LEGO® building tasks (Shenouda and Danovitch 2014).

Toys "for" Boys and Girls

When a child is building with LEGO® bricks, regardless of whether they are using specific instructions or their own imaginations, there are two phases to their play. First, they build an object (by following instructions or creating an original object), and second, they play with their constructed object. According to sociocultural theory (Vygotsky 1978), children's toys and the play that toys provoke are symbolic artifacts that carry not just a physical function but also a cultural meaning. Research has shown that, when a person is rating either the sturdiness of a LEGO® object or how well it represents some cultural concept, different parts of the brain are activated, suggesting that LEGO® toys have more than one function (and more than one set of learning opportunities): cognitive and cultural (Tylen et al. 2016).

When deciding which toys with which to engage in their environments, children look for information about whether a toy is "for me" or "not for me." They are less likely to approach and engage with a toy that they believe is for the other gender (Li and Wong 2016; Liben and Bigler 2002; Martin and Halverson 1981; Weisgram 2016). One such cultural marker of whether a toy is "for" girls or boys is the color of the toy; specifically, pink is often associated with girls and girls' things, whereas blue and other primary colors are associated with boys and boys' things (Weisgram et al. 2014). As of late, more toys are being marketed to a specific gender using these color cues (Sweet 2013). Parents respond to these marketing tactics and chose things for their children, from toys to room décor, based on these color and marketing cues (Sutfin et al. 2008). By early preschool age, children understand that color may serve as a marker of gender-appropriateness; girls begin to prefer pink whereas boys begin actively to avoid pink things (Jadva et al. 2010; LoBue and DeLoache 2011; Wong and Hines 2015).

This gendered color preference phenomena appears to be culturally constructed, perhaps in part driven by gender-segregated marketing, because these color preferences are not apparent across cultures (Taylor et al. 2013). Thus, toys that are marketed to or oriented toward one gender over the other using color cues may be unavailable to the other gender as learning or social tools. Wong and Hines (2015) found that, when toy colors of typically gendered toys are changed, children's play with gender-atypical toys increased. Similarly, it seems that girls are more likely to engage with masculine-typed toys (such as a truck) if they are pink (Weisgram et al. 2014). Thus, coloring a building toy pink has complicated implications: It may increase girls' interest in and access to the toy, but it may also result in different types of play. The color pink may also serve to make gender more salient to children as they work on a building task. If girls are thinking about gender while building, their performance may be inhibited.

If LEGO® sets are segregated by gender using similar types of color and thematic cues, then children have access to gender-segregated and specialized versions of these cultural tools (Vygotsky 1978), branching into different experiences with the toys and possibly different lessons learned. Studies have identified that boys' and girls' toys have defining characteristics: Boys' toys are rated as more violent and competitive than neutral or than girls' toys (Blakemore and Centers 2005). Boys' toys are also rated more exciting, dangerous, and needing of more adult supervision than are girls' toys (Blakemore and Centers 2005). Boys' toys are rated as more realistic, including more information and details, whereas girls' toys are reported to be more fantastical and simple.

These differences emerge in LEGO® sets as well. The gender-segregated and specifically marketed "girl" and "boy" LEGO® sets create what are, in a sense, separate cultural tools with which boys and girls engage and learn. Boys' LEGO® sets present roles that emphasize action and agency. Conversely, LEGO® Friends sets present roles that emphasize relationships and passivity (Black et al. 2016). LEGO® sets that include the construction of gendered objects may serve to activate cultural play scripts and to remind girls that LEGOs® may be more difficult for them. The current study will investigate how object type may impact children's performance on LEGO® building tasks.

Instructed versus Free Play with LEGO® Bricks

Across types of LEGO® sets, it is clear that children can build with LEGO® bricks in two ways: by completing the instructions given to build an object designed by LEGO® or by using the bricks to create an object of their own. Although both types of play build spatial relations skills, free play with LEGO® bricks has been shown to be especially beneficial to fostering creativity and confidence in solving ill-structured problems (i.e., those without an algorithm or pre-determined solution; Moreau and Engeset 2016). Moreau and Engeset (2016) found that college students who participated in a LEGO® free play session scored higher on a subsequent measure of creativity than did college students who had been assigned to complete an instructed LEGO® task instead. These findings may have implications for the impact that these types of LEGO® play have on children's problem solving skills, and they indicate that children as well as adults may be building different types of

skills and efficacies depending on how they play with LEGO® bricks (Moreau and Engeset 2016). The popularity of LEGO® sets with step-by-step instructions may also be inhibiting children's practice of solving ill-structured problems and creativity. There is little research on how children approach free play with LEGO® bricks and if gender differences occur. However, the preponderance of masculine LEGO® theme sets may be making all LEGO® play appear masculine and so girls may have less opportunity to build these creativity and problem-solving skills.

Because of the freedom they afford to create different types of structures, LEGO® bricks can be used easily to create masculine or feminine objects during free play. These objects become toys that children will play with similarly to other gendered toys. Thus, the masculinity or femininity of the objects that children build with the LEGO® bricks may activate typically gendered play scripts. Such play scripts are developed through life-long play experiences which differ for boys and girls. Girls and boys are provided with and spend time with different types of toys. Typical "boys'" toys, such as cars and trains, are more likely to involve and reward action and movement, whereas girls' toys do not (Pennell 1994). Whereas girls frequently incorporate female human forms (e.g., baby or adult dolls), boys' toys are more likely to involve male human forms (e.g., adult action figures; Nelson 2005). Interestingly, both boys and girls show more complex play while playing with dolls than when they are engaged with masculine or neutral toys (Cherney et al. 2003).

Thus, even free play with LEGO® bricks may become gendered if children draw on gendered scripts as a template for object creation. It may be that without instruction children do not feel more free to build but instead build the gendered objects that are familiar. Toy selection and play in childhood are linked to children's formations of their future selves, and they shape children's ideas about the kinds of occupations they may want to have when they grow up (Fulcher and Coyle 2017). The toys with which children play reinforce their visions of their future selves. Children may constrain the type of objects they build according the color of the bricks available to them. An aim of our research is to examine if children create gendered objects during free play and whether brick color has an impact on object creation. In particular, we were interested in whether boys would be more likely to build vehicles or moving toys (with wheels) and girls more likely to build humans or animals (with eyes).

The Current Study

It may be that the color of LEGO® bricks impacts girls' and boys' play in both instructed tasks and in free play. In our study, we looked at play in elementary school-aged children for whom most LEGO® products are designed. This is also a developmental period characterized by more gender flexibility (Katz and Ksansnak 1994), but also by more gender-segregated play (Maccoby 1998). Middle childhood is also a critical time in the formation of math and science interest (Simpkins et al. 2006). We predicted that, for instructed LEGO® tasks, pink bricks would activate girls' stereotypes about spatial relations, thus impairing their performance on such tasks (Hypothesis 1). Specifically, we expected that girls with feminine-colored bricks would take longer to complete an instructed task (Hypothesis 1a) and make the object less accurately (Hypothesis 1b) than would girls with masculine-colored bricks. We further hypothesized that girls who were assigned a feminine object to build would take longer (Hypothesis 1c) and build it less accurately (Hypothesis 1d) than would girls assigned to build a masculine object. Because there is no cultural stereotype or expectation that would threaten boys' performance on LEGO® tasks, we predicted that object type and brick color would have no impact on boys' performance (Prediction 1).

While engaging with free play with LEGO® bricks, we predicted that the color (Hypothesis 2) and type (i.e., eyes and wheels; Hypothesis 3) of bricks would impact play as well—for both girls and boys. We hypothesized that the availability of only feminine-color bricks may prompt girls to build more feminine objects (e.g., animals, houses) and thus create more feminine cultural tools even within a genre of toys that is stereotypically "for" boys (Hypothesis 2a). We also expected boys, compared to girls, to build more masculine objects regardless of the color of the bricks available to them (Hypothesis 2b). As for specific types of bricks, we expected girls to incorporate eyes into their free play object more than boys would (Hypothesis 3a) and that objects that included eyes would be rated as less masculine (Hypothesis 3b). In contrast, we hypothesized that boys compared to girls would be more likely to include wheels into their free play object (Hypothesis 3c) and that these objects would be regarded as more masculine (Hypothesis 3d).

Method

Participants

Participants included 116 children (48, 41% girls) ranging in age from 5 to 10 years of age (M_{age} = 7.27, SD = 1.07). The sample of children was 80.2% (n = 93) European American, 6% (n = 7) African-American, 3.4% (n = 4) Asian American, 5.2% (n = 6) Latino, and 4.3% (n = 5) other races. One parent did not report the race of their child. Children were recruited from local schools, afterschool programs and camps, and local notices in two locations in the southern Unites States. Fully 30% (n = 35) of children had a parent with a STEM

occupation. There were no significant age differences between boys and girls or between the experimental or geographical groups.

Materials and Measures

Interest in STEM and LEGO® Play

Parents reported children's interest in STEM activities as well as their interest in LEGO® play on a 5-point scale from 1 (*not at all interested*) to 5 (*very interested*). Parents also reported how often their child plays with LEGOs® on a 5-point scale: 1 (*never*), 2 (*A few times a year*), 3 (*once a month*), 4 (*once a week*), 5 (*every day*).

Instructed Objects

In order to remain close to what children would experience if given instructions from a commercially available LEGO® set, we selected objects and instructions from LEGO.com from their supplement collections. We chose the masculine items from the instructions for the LEGO® Classic Creative Supplement. This set of LEGO® bricks includes black, white, gray, yellow orange, red, blue, green, and brown, and it was designed for children ages four years and older. The suggested objects to build with the set were a rocket, numbers, a submarine, a pirate ship, a jet, a shark, a dinosaur, and a robot. LEGO® reports the difficulty of instructed objects using a brick rating (i.e., a larger number of bricks next to the object indicates a more difficult structure). We chose the rocket (1 brick difficulty rating) as the masculine practice task and the dinosaur (3 brick difficulty rating) as the masculine instructed task. The rocket included 12 pieces (6 unique pieces) and the dinosaur (see online supplement, Fig. 1) included 42 pieces (12 unique pieces).

The instructions for the feminine objects were selected from the LEGO® Classic Creative Supplement: Bright. The Bright version of the supplemental set includes grey, white, red, orange, yellow, green, light blue, purple, and pink bricks, and it was designed for children ages four years and older. The suggested objects to build with this set are a flower, a butterfly, a guitar, a bunny, a birdhouse, a birthday cake, and letters. We initially chose the birthday cake (1 brick difficulty rating) and the bunny (3 bricks difficulty rating). The birthday cake included 9 pieces (4 unique pieces). However, participants' feedback during pilot testing revealed that the bunny figure was not easily discernable as a bunny. Thus, we made slight changes to the suggested build, modifying the bunny head to be a more recognizable cat while maintaining a similar level of difficulty. The cat (see online supplement, Fig. 2) included 32 pieces (10 unique).

A group of 39 (21 female) undergraduate students rated images of the LEGO® Classic Creative Supplement boxes on a 5-point Likert scale from 1 (*very masculine/marketed to boys*) to 5 (*very feminine/marketed to girls*). The Classic Creative Supplement was rated as more masculine (M = 2.21, SD = .47) than was the Creative Bright Supplement (M = 4.10, SD = .64), t (38) = −13.43, $p < .001$. Student ratings of both packages also differed significantly from the neutral rating of 3 ("marketed equally to boys and girls"); the Classic Creative Supplement was rated significantly more masculine than neutral, t (38) = −10.58, $p < .001$, and the Bright Supplement was rated significantly more feminine than neutral, t(38) = 10.75, $p < .001$. Inter-rater reliability was high for these ratings, ICC (2, 39) = .99.

Instructed Task

Children were given black-and-white pictorial instructions to construct two objects using a set of LEGO® bricks. Participants were randomly assigned to build either two feminine (cake and cat) or two masculine (rocket and dinosaur) objects. Additionally, participants were randomly assigned to complete the feminine or masculine objects and to use either pink/purple or blue/green bricks. Children were told to follow the instructions and build objects as best as they could. In order to correctly complete the construction task, a child had to use every LEGO® brick contained in the set they were given.

Performance on the instructed task was measured by children's accuracy in building the object and the time participants took to complete each object. Following the completion of each instructed building, a research assistant who was familiar with the objects and aware of how they should look when correctly assembled took a picture of the object and recorded several measures of performance. The picture of the object was framed on a paper mat that included the time the participant took to complete the build (in minutes and seconds), whether the object was built correctly (yes or no), and the number of bricks leftover. The number of unused bricks was included as a measure of accuracy because several children reported that they were finished with the task (and thus stopped building) without using all the bricks (thus, higher numbers of unused bricks indicated a less accurate performance).

Free Play Task

After a short distraction coloring task (designed to distract children from the color of bricks and the type of objects they build during the instructed phase), children received a set of 42 LEGO® bricks. Each child was randomly assigned to receive either primarily feminine (pinks and white) or primarily masculine (blues and grays) color bricks in their free play set. Sets were identical in brick shape and type, differing only in brick color. Each set included a pair of eyes and four wheels. Children were asked to create whatever they wanted, and they

were told that they did not have to use all the bricks in the set (see online supplement, Fig. 3, for examples of structures). When children indicated that they were finished building, the researcher asked, "What did you make?" Free play performance was measured by the time spent constructing the object, the number of bricks used in constructing the object, and the masculinity/femininity of the object constructed. Fifteen undergraduate students (13 female) rated the masculinity/femininity of the object constructed using the children's labels of their object. Undergraduate raters were given the list of all the children's descriptions of what they made and rated each description on a 5-point scale from 1 (*feminine*) to 5 (*masculine*). Participants' gender and to the color of the bricks used were masked to raters. Raters showed high inter-rater reliability, ICC (2, 15) = .94.

Procedure

The LEGO® play sessions were conducted in either a quiet classroom or laboratory settings. Following a brief parental consent process, children were asked whether they wanted to work on a few LEGO® projects and were given the opportunity to indicate their assent verbally. Children were randomly assigned to one of four instructed task groups: traditional masculine (green dinosaur), non-traditional masculine (pink dinosaur), traditional feminine (pink cat) or non-traditional feminine (blue cat). Children first engaged in an easy building task to practice using the instructions to build with the LEGO® bricks. Importantly, the object they built during this practice trial was matched in traditionality and color to their experimental group (blue or pink birthday cake or blue or pink rocket). Following the completion of the practice task, children were given the instructions for the more difficult target, instructed task. Only performance on the second, more difficult instructed task (cat or dinosaur) was used in analyses.

Following the completion of the instructed task, children were given a distractor coloring task. For the free play task, children received a set of either blue and gray or pink and white bricks. The color of the set of free-play bricks was counterbalanced across participants separately from the color of instructed bricks that the children were given. Children were told they could build whatever they wanted with the bricks. When the children indicated that they were finished building, they were asked to verbally indicate what they had built. Children were then thanked for their help and given a small bag of multi-colored LEGO® bricks as a thank you gift.

Results

Preliminary Analyses

A one-way MANOVA was conducted to test whether children's gender was associated with parent-reported children's interest in STEM, interest in LEGOs®, or frequency of play with LEGOs® (see Table 1). Boys were reported by their

Table 1 Descriptive statistics and correlations among study variables

Variables	Boys	Girls	Correlations							
	M (*SD*)	*M* (*SD*)	1	2	3	4	5	6	7	8
1. Interest in STEM[a]	4.30 $_a$ (.70)	3.91 $_b$ (.70)	--	.21	.00	−.13	.00	−.08	−.10	.06
2. Interest in LEGO® play[b]	4.63 $_a$ (.62)	3.72 $_b$ (1.08)	.33**	--	.72**	−.27	−.03	−.09	−.13	.28
3. Frequency of LEGO® play[c]	4.46 $_a$ (.72)	3.36 $_b$ (1.00)	.35**	.39**	--	−.11	.08	.10	−.05	−22
4. Time spent in instructed task	571.41 $_a$ (227.95)	770.57 $_b$ (222.80)	−.24	−.35**	−.37	--	−.21	−.18	−.10	.16
5. Instructed task #bricks not used	4.03 $_a$ (8.35)	6.29 $_b$ (7.83)	−.23	−.25*	−.17	.34**	--	−.21	−.14	.07
6. Time spent in free play	280.25 $_a$ (130.96)	338.59 $_b$ (138.45)	.13	−.02	.32*	−.29*	−.20	--	.39**	.03
7. Number of bricks not used in free play	18.77 $_a$ (8.63)	22.98 $_b$ (11.44)	.16	−.14	.07	.19	.02	.39**	--	−.09
8. Masculinity/Femininity of free play object	3.58 $_a$ (.56)	3.28 $_b$ (.69)	−.08	−.30*	−.06	.22	.13	−.06	.08	--

*p < .05, ** p < .01

Boys (n = 68); girls (n = 48). Means with different subscripts in a row report a significant gender difference (p < .05). Correlations for girls are represented above the diagonal; for boys, below

[a] Interest in STEM responses ranged from 1 (*not at all interested*) to 5 (*very interested*)

[b] Interest in LEGO® play responses ranged from 1 (*not at all interested*) to 5 (*very interested*)

[c] Frequency of LEGO® play responses ranged from 1 (*never*) to 5 (*every day*)

parents to be more interested in STEM than were girls, $F(1, 112) = 10.17, p = .002, \eta_p^2 = .08$. Additionally, boys were reported to be more interested in LEGO® play than were girls, $F(1112) = 31.15$, $p < .001$, $\eta_p^2 = .22$. Finally, boys were reported by parents to play with LEGO® bricks more frequently than were girls, $F(1112) = 50.03$, $p < .001$, $\eta_p^2 = .31$. Because these variables differed significantly by gender, we next checked to see whether they were also associated with the outcome variables. Indeed, the higher children's LEGO® interest and the more frequently they played with LEGO® bricks, the more quickly they completed the instructed task than did children who were less interested, $r(95) = -.28, p = .01$, or who had less experience with LEGO® play, $r(95) = -25, p = .01$. Interest and frequency of play with LEGO® sets were also correlated with one another, $r(95) = .59$, $p < .001$. Thus, for analyses that included the speed of completing an instructed task, interest in LEGO® play, and experience with LEGO® play, the relevant variables were statistically controlled. (See Table 1 for the correlation matrix for children's pre-measures and dependent measures by gender.)

There was not a significant difference in age between genders or experimental groups. Age was not associated with other demographic variables. It was associated with several outcome variables, however. Older children took less time to complete the instructed task, $r(105) = -.39$, $p < .001$, had fewer leftover bricks, $r(109) = -.33, p = .001$, and took longer to build their free play object, $r(104) = .21, p = .03$. Age did not differ between experimental groups, and thus it was not used as a covariate.

Hypothesis 1: Instructed Task Performance

A 2 (gender) × 2 (masculine/feminine object) × 2 (LEGO® color) MANCOVA was conducted to test the effects of these variables, controlling for interest in and frequency of LEGO® play, on speed of task completion and number of LEGO® bricks remaining. There was a main effect of gender, such that boys ($M = 574.35$, $SD = 229.83$) completed the LEGO® task faster than did girls ($M = 770.57$, $SD = 222.80$), $F(1106) = 6.24, p = .014, \eta_p^2 = .06$, even controlling for interest in and frequency of LEGO® play. There was also a main effect of object type, such that children completed the feminine object ($M = 567.65$, $SD = 234.63$) more quickly than they completed the masculine object ($M = 679.21$, $SD = 214.29$), $F(1, 106) = 14.96$, $p < .001$, $\eta_p^2 = .14$. No two way or three-way interactions emerged, and there were no significant effects of these variables on the number of bricks children failed to use in the task.

A series of chi-square tests was performed to assess the effects of the independent variables (child gender, object type, and brick color) on whether children built the object correctly. These tests showed no effects of either child gender or brick color on object correctness. There was, however, a significant effect of object type: Children were more likely to correctly construct the feminine (28, 47%) than the masculine (15, 27%) object, $\chi^2(1) = 4.94$, $p = .026$, Cramer's $V = .21$.

Hypothesis 1 was not supported. Brick color did not impact how long it took girls to complete the construction (Hypothesis 1a) nor the accuracy of their construction (Hypotheses 1b). Object type did impact children's time spent in construction as well as their accuracy on the instructed tasks. Contrary to Hypothesis 1c and 1d, both boys and girls were able to more quickly and accurately build the feminine item than the masculine item. Prediction 1 was partially supported. The object's gender-typing, but not its brick color, impacted both girls' and boys' performance.

Hypothesis 2: Free Play Creations

A 2 (gender) × 2 (brick color) MANOVA was conducted to test their effects on free play time, number of bricks used in free play, and the masculinity or femininity of the object created. Main effects for gender emerged for each dependent variable (see Table 2). Boys spent less time creating their free play object, $F(1, 103) = 5.97$, $p = .016$, $\eta_p^2 = .06$, used more bricks in their object than did girls, $F(1, 103) = 5.11$, $p = .026$, $\eta_p^2 = .05$, and created more masculine objects than did girls,

Table 2 Gender differences in free play building by brick color set

Dependent Variables	Boys		Girls	
	Pink Set *M* (*SD*) or *n* (%)	Blue Set *M* (*SD*) or *n* (%)	Pink Set *M* (*SD*) or *n* (%)	Blue Set *M* (*SD*) or *n* (%)
Time in seconds	295.50 (133.88)	252.14 (121.14)	347.73 (160.42)	329.45 (115.51)
Number of bricks used	25.30 (12.34)	20.66 (10.80)	18.45 (9.89)	18.14 (6.79)
Masculinity/ femininity rating of object	3.67 (.56)	3.51 (.57)	3.04_{a} (.69)	3.51_{b} (.63)
Percent using wheels	30 (88.2%)	30 (90.9%)	15 (62.5%)	17 (70.8%)
Percent using eyes	11 (32.4%)	13 (39.4%)	9 (37.5%)	15 (62.5%)

Means with different subscripts in a row report a significant gender difference ($p < .05$)

$F(1103) = 7.07, p = .009, \eta_p^2 = .07$. There was no main effect of brick color, although a gender by brick color interaction did emerge, $F(1, 103) = 6.48, p = .012, \eta_p^2 = .06$. Specifically, girls with pink bricks created more feminine objects than did girls with blue bricks, t (45) = −2.17, p = .036, Cohen's d = .40. Bricks color did not have an effect on the masculinity/femininity of boys' free play structures (see Fig. 1). Thus Hypothesis 2 was supported. Girls built more feminine objects when given the feminine-colored bricks than when they were given masculine-colored bricks (Hypothesis 2a). Boys built more masculine objects than did girls, regardless of brick color (Hypothesis 2b).

Hypothesis 3: Eyes and Wheels in Free Play

Only 42% (n = 48) of children incorporated eyes into their free play objects. Conversely, 79% (n = 92) of participants used the wheels in their free play object. Additionally, boys were more likely to use wheels than were girls, χ^2 = 7.20, p = .007, Cramer's V = .25. No such difference emerged for the use of eyes or by the color of the bricks. Objects with eyes (M = 3.42, SD = .64) were not rated as less masculine than were objects without eyes (M = 3.47, SD = .64), t(108) = −.44, p = .66. However, objects that included wheels (M = 3.55, SD = .56) were rated as more masculine than were objects without wheels (M = 3.00, SD =. 79), t (107) = 3.68, p < .001, Cohen's d = .80.

Hypothesis 3 was thus partially supported. Girls were not more likely than were boys to use eyes in their free play objects (Hypothesis 3a), and objects with eyes were not rated as less masculine as those without eyes (Hypothesis 3b). However, boys were more likely to use wheels in their free play object than were girls (Hypothesis 3c), and objects with wheels were rated as more masculine than were objects without wheels (Hypothesis 3d).

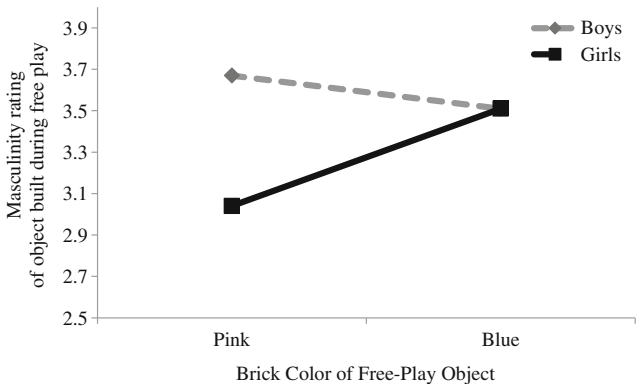

Fig. 1 Gender differences in masculinity of free-play object by brick color. The objects that girls built with blue bricks were significantly more masculine than were the objects girls built with pink bricks. The color of the brick had no impact on the masculinity of the object boys built

Discussion

In the present study, we investigated the multiple intersections of children's gender and the manner that they engage with building toys such as LEGO® bricks. First, we examined parents' reports of their daughters' and sons' prior experiences with and interest in LEGO® play. As expected, boys had more interest in and experience playing with LEGO® toys than did girls, according to their parents. Although this gender difference in experience is not surprising, it may reflect a rather recent cultural phenomenon. Earlier studies of LEGO® use found that girls reported more play with LEGO® bricks than did boys (Brosnan 1998), and LEGO® had an emphasis on gender-neutral marketing in the 70s and 80s (Black et al. 2016). This historical shift in the frequency of girls' LEGO® play could be a result of the growth of toy gender segregation in general (Sweet 2013), in addition to the LEGO® company's move toward more instructed sets, particularly those with masculine themes (e.g., Star Wars, Super Heroes; Black et al. 2016). This finding is especially noteworthy given the recent marketing push to create LEGO® themes and sets that appeal to girls; at least in our sample of children, girls remain less interested in and less familiar with this type of play when compared to their male peers.

We hypothesized that girls' (but not boys') performances on the instructed task would be impacted by gender cues, such that girls would take longer and be less accurate when constructing a feminine object or when using pink bricks. We hypothesized that these gender cues would activate gender stereotypes in girls, impacting their performance. However, even when controlling for boys' higher level of interest in LEGO® play, boys still completed the instructed tasks more quickly than did girls. It may be that boys have more experience and interest in other building or construction toys, in addition to LEGO® toys, that may help them build efficacy for spatial relations tasks. There is evidence that boys play more video games that also involve spatial relation skills than do girls (Cotton et al. 2014; Kaiser Family Foundation 2010). Interestingly, even short (one hour) interventions for women that include video game play can boost spatial skills (Cherney et al. 2014). Future studies should look at building and construction play interventions on girls' spatial relations skills.

Both boys and girls were able to complete the feminine object (cat) faster than the masculine object (dinosaur), irrespective of the brick color. It may be that children perceive a feminine object to be less complicated or technical than a masculine object and thus approached the cat with more confidence. However, it is also likely that the cat figure was, in fact, easier to build and thus took less time to complete. Although both objects were given the same suggested ability level on the LEGO® website, the cat did have fewer pieces overall and fewer unique pieces than the dinosaur did. In fact,

it was difficult to identify a pattern for a feminine object on the LEGO® website that required advanced skill.

It is important to note here that, although the child's gender and the type of object did predict the *speed* of completion on the instructed task, there were no effects of either variable on the *accuracy* of children's completed task. This finding is consistent with previous research that found that the time taken to complete a spatial task is not associated with accuracy on the task (Titze et al. 2010). In our sample, children who correctly assembled the object were faster than those who did not. But, even among those who did not correctly build the object, boys were finished more quickly than were girls. There is evidence that men may approach spatial tasks with a different response style. For men, part of this style is moving quickly to complete more items than do women whose response style seems to be to persist longer on individual items (Goldstein et al. 1990). When spatial task scores are computed by total correct items, men score higher; however, when scores are computed by a ratio of correct items over tried items, the gender difference in scores disappears (Goldstein et al. 1990). Although the task in our study had only one item, boys moved through it quickly with no difference in accuracy from girls. It is also likely that practice using the LEGO® bricks, and experience with using instructions to build with the LEGOs®, explains the discrepancy between girls' and boys' completion times. This is consistent with our finding that parents reported that their daughters in our sample spent less time playing with LEGO® sets.

We also hypothesized that girls,' but not boys,' free play would be impacted by the color of the bricks such that girls would build more feminine items with pink bricks and more masculine items with blue bricks. When given an opportunity to create objects of their own, boys created more masculine objects than did girls and were more likely to incorporate wheels into their creations than were girls. Interestingly, when girls played with blue bricks during the free play task, the objects that they built were rated to be as masculine as the objects built by boys. This was not the case when girls were given pink bricks; girls' objects built with the pink bricks were rated as significantly more feminine than when they were built by boys in either condition.

There are a few possible explanations for the effects that brick color had on girls' free play. First, for girls especially, playing with toys like the pink bricks may activate gendered play scripts (Weisgram et al. 2014). It is possible that feminizing a masculine toy may simply offer girls another toy that promotes feminized play (Coyle and Liben 2016). In this way, girls whose parents provide pink bricks to encourage spatial play may also be providing girls with yet another opportunity for scripted feminine play of relationship maintenance and appearance play. However, girls' structures that they built with the blue bricks were just as likely to be rated as masculine as boys' structures were. This could either mean that the blue bricks activated masculine play scripts for girls, or simply that the girls thought that they were expected to build a more stereotypically masculine structure (like a car) when they were given "boy color" bricks. Although our results indicated a clear switch in the type of play in which girls engaged with the different color blocks, girls' motivations for building the different kinds of structures remain unclear, and it is a question that can be answered using additional self-report measures in future studies. However, there was no difference in the masculinity of the objects boys built as a function of brick color. It may be that boys feel limited to masculine scripts in play regardless of the materials presented whereas girls have more flexibility which is prompted by brick color. It would be useful to include an additional control free-build condition in which children are given multi-colored bricks (a combination of masculine and feminine bricks) to examine whether similar gender-typed styles of play emerge.

Finally, we hypothesized that girls would be more likely to use eyes in their creations and boys would be more likely to use wheels. Regardless of the color of bricks offered to them, boys created masculine objects, often with wheels. Boys' scripts, regardless of toys available, are culturally constricted to masculine themes. It is interesting that so many participants chose to use the wheels in their free play objects and that these objects were rated as more masculine. Boys overwhelmingly used the wheels when building their objects, even in instances for which their self-reported labels for their creations were not vehicles (e.g., water monster, machine gun). Although in practice boys are not more likely to choose to play with wheeled toys when offered a variety of toys, girls did report that boys would like toys with wheels more (Dinella et al. 2016). Wheels may serve as a cultural marker to indicate that a toy is for boys, in much the same way that pink indicates that a toy is for girls. Boys may be accustomed to playing with wheeled toys and thus fall back on familiar scripts when creating their objects. Although toys with wheels are abundantly available and familiar to boys, when given a wide variety of toys, boys are not more likely to choose to play with wheeled toys than other types of toys (Dinella et al. 2016). This suggests that increasing the shapes and colors available will release boys from only creating and playing with vehicles.

It would be interesting to find a component, in contrast to the wheels, that would provoke more feminine and less masculine play. In the present study, children were given the opportunity to use eyes in their objects during the free play period. We chose to include the eyes in the free play sets in order to give children the tools to create a structure that resembled a living thing, thus affording more relational play. However, less than half of the participants chose to do so, and there were no gender differences in their use and there was no difference in the masculinity ratings for objects with or without eyes. One possible reason for children's underuse of the eye pieces were that they were potentially more difficult to

manipulate (i.e., they were very small and difficult to affix to the larger LEGO® bricks). Additionally, eyes are more likely to appear at the side and front of an object, but LEGO® bricks have connectors only on the top. Eye placement requires a special piece or careful planning. Similarly, although wheels are also typically affixed to the side of an object, LEGO® has solved this problem by connecting wheels to axel pieces that can be attached from at the top. A similar engineering solution could increase the use of eyes and thus broaden the type of structure that children can envision creating with a standard set of LEGO® bricks. Future research should look for other components that would encourage less gender-scripted free play.

Limitations and Future Research Directions

There are limitations to the interpretation of our findings. First, the sample consisted of primarily White children from the southern United States. Future research should include greater diversity in race and geographic location of the participants. No research of which the authors are aware has examined access to and style of play with LEGO® bricks at the intersection of race and gender. If access to toys promoting spatial skills does indeed differ among children from different racial and ethnic backgrounds, it is important that research considers that the types of play and reliance on gendered scripts for LEGO® play might differ as well. Furthermore, our sample of boys and girls reported overall high levels of interest in and experience with LEGO® toys. It would be interesting to investigate if children with less familiarity with LEGO® play may draw more on activated identities and scripts when approaching such a novel task.

Second, the observations of LEGO® play took place in a laboratory setting with a prescribed set of blocks and thus were not naturalistic. It is possible that the contrived setting may have changed some of children's play behaviors in reaction to the presence of the researchers. For example, children finished their free play in about as much time as it took them to complete the instructed play. It is likely that, had the play taken place at home or school, children would have played with bricks longer when creating their own design. It is possible that children perceived this task as similar to the instructed task and tried to finish quickly.

Additionally, the objects were chosen from the LEGO® company's provided instructions. Future studies should investigate objects that children rate as masculine or feminine. Individual differences in stereotyping may impact how vulnerable children are to gendered toys. It may be that girls who are particularly adherent to gender-role rules may find the brick color and object type to be more salient than more flexible girls do. Future studies should investigate these questions as a function of baseline stereotype scores.

Practice Implications

The results of our study have implications for the relationship between gendered play and the shaping of children's aspirations. Toys marketed to and subsequently favored by girls and boys are designed to be consistent with gendered adult roles. One function of toys is that they afford children an opportunity to imagine their future lives as adults (Black et al. 2013). The toys provided to girls, including LEGO® Friends sets, emphasize a focus on home and family, whereas boys' toys are more focused on future lives outside the home (Nelson 2005). Research on the gendered nature of children's favorite toys showed that boys' toys were more likely than were girls' toys to emphasize spatial skills and manipulation, encouraging learning about mechanics, technology, and robotics (Francis 2010). Our findings showed that girls remain less interested and engaged in LEGO® play than boys do, which carries over into the way that they play with spatial toys when presented with them.

Because building and construction toys continue to focus on masculine themes and remain firmly entrenched in the domain of "boys' toys," girls are missing out on opportunities to build up interest, competence, and self-efficacy with a set of skills that are relevant to STEM fields (Klugman 2000). Indeed, adult women, as well as men who report that they engaged in more masculine play in childhood, perform better on several spatial tasks (e.g., the water level test) and on math grades in college than those who did not engage in such play (Doyle et al. 2012). Importantly, our results suggest that the relationship between the gendering of LEGO® toys (making them more "girly") and girls' interest and style of engagement with the toys is complicated and bidirectional.

More play with spatial and construction toys could increase girls' spatial skills and result in increased efficacy for such tasks. Interventions that include practice with spatial tasks have been shown to increase spatial skills, regardless of age or gender. (However, in one sample, girls improved more so than did boys, even though boys started with a higher pre-score; Safhalter et al. 2016.) These findings have important implications given the manner in which spatial skills are taught and tested in STEM classes; specifically, standardized tests of spatial abilities and teaching in STEM classes may rely on examples with which male students have more experience (e.g., throwing a ball, building a structure; Reed et al. 2007, Wellesley College and American Association of University Women 1995). The skills that girls practice with feminine construction sets (e.g., LEGO® Friends) may not translate to broader tasks and may be packaged with a cultural message that there is a difference between the ways that boys and girls build. Thus, the toys may fail to increase girls' efficacy and proficiency in spatial domains.

Conclusions

Creating more girl-targeted and "girl"-color LEGO® sets may be an important gatekeeping step to increasing girls' play and efficacy with LEGOs®, while at the same time restricting the kinds of structures and play in which they engage. Thus creating a separate line of LEGO® toys for girls, although it may be intended to be a separate-but-equal gesture, may be falling short of achieving the goal of improving girls' skills and confidence in a domain that is essential for a wide range of careers. It is important that future research explores, as an alternative to creating more pink and relational-themed boys' toys, additional ways to engage and encourage girls in spatial play.

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Compliance with Ethical Standards The research reported on in the manuscript, Building a Pink Dinosaur: The Effects of Gendered LEGO sets on Girls' and Boys' Play complies with ethical standards for research as directed by the American Psychological Association. The project was approved by the Institutional Review Boards at Washington and Lee University and the University of Texas at Tyler. Parents of participants gave written informed consent and children gave verbal assent before participating in data collection.

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