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Sex Differences in Infants' Visual Interest in Toys

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Abstract Evidence indicating that sex-linked toy preferences exist in two nonhuman primate species support the hypothesis that developmental sex differences such as those observed in children's object preferences are shaped in part by inborn factors. If so, then preferences for sex-linked toys may emerge in children before any self-awareness of gender identity and gender–congruent behavior. In order to test this hypothesis, interest in a doll and a toy truck was measured in 30 infants ranging in age from 3 to 8 months using eye-tracking technology that provides precise indicators of visual attention. Consistent with primary hypothesis, sex differences in visual interest in sex-linked toys were found, such that girls showed a visual preference ($d > 1.0$) for the doll over the toy truck and boys compared to girls showed a greater number of visual fixations on the truck ($d = .78$). Our findings suggest that the conceptual categories of "masculine" and "feminine" toys are preceded by sex differences in the preferences for perceptual features associated with such objects. The existence of these innate preferences for object features coupled with well-documented social influences may explain why toy preferences are one of the earliest known manifestations of sex-linked social behavior.

Keywords Toy preferences · Infants · Eye-tracking · Sex differences

Introduction

Children's play materials include many small replicas of real world objects, including vehicles, household items, animals, and people. A well-established finding is that not all of these objects appear to be enjoyed or valued equally by boys and girls. Boys generally prefer interacting with model objects that represent vehicles, tools, and construction materials, whereas girls generally prefer interacting with model objects that represent people and household items (Alexander & Hines, 1994; Connor & Serbin, 1977; Fagot, 1977; for review, see Ruble, Martin, & Berenbaum, 2006). These sex differences in children's play emerge in the second year of life (Connor & Serbin, 1977; Servin, Bohlin, & Berlin, 1999; Smith & Daglish, 1977) and are well-established in children by 36 months of age (Fagot, 1977; Fagot, Leinbach, & Hagan, 1986; O'Brien & Huston, 1985; Servin et al., 1999).

Significantly, unlike their real world counterparts, miniaturized objects marketed as toys can be easily manipulated and acted on by children and so provide unique opportunities for cognitive growth (for discussion, see Younger & Johnson, 2006). Consistent with this observation, others have suggested that the differential toy choices of boys and girls may support activities (e.g., play mothering, manipulation of objects) that influence the development of sex-linked cognitive abilities (Connor & Serbin, 1977; Fagot & Littman, 1976; Robert & Heroux, 2004; Serbin & Connor, 1979; Voyer, Nolan, & Voyer, 2000), sex-linked personality traits (Eisenberg, Murray, & Hite, 1982), and adult social interaction patterns (Maccoby, 1998). Therefore, understanding the ontogeny and development of toy preferences may have broad implications for theories of sex differences in human behavior.

The similarity of toy preferences to the stereotypical activities and interests of adult women and men (Liben & Bigler, 2002) has suggested that toy preferences result largely from gender socialization and the cognitive processes associated with an understanding of gender identity and the internalization of gender role stereotypes (Ruble et al., 2006). Certainly, modeling and reinforcement of gender-typical toy

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play are well documented in both naturalistic (e.g., Fagot, 1978) and experimental investigations (Pasterski et al., 2005). Parents, for example, may reinforce gender-typical toy play and punish gender-atypical toy play explicitly (e.g., by providing overt praise or criticism of the activity) or implicitly (e.g., by joining the child in the activity or withdrawing from the child) (for other examples, see Pasterski et al., 2005).

Social experiences also inform developing gender schemas, a cognitive network of associations between gender and the activities, interests, and beliefs prescribed by society to that gender (Martin & Halverson, 1981). Considerable empirical support exists for the hypothesis that gender schemas act as filters through which the child's world is perceived and as guides for the production of gender–congruent behavior (Martin, Ruble, & Szkrybalo, 2002). However, as a child's awareness of gender categories and gender group membership (i.e., gender identity) is central to the development of gender schemas, others have noted that it may be problematic for gender schema theory that sex differences in toy preferences are observed before the age when children can label the sex of others (Campbell, Shirley, & Caygill, 2002). On the other hand, learned associations between toys and gender in young children may exist as implicit and not explicit knowledge (Lewis & Weinraub, 1979). Research using looking behavior, for example, has provided evidence that children have acquired the necessary association between gender and toys at 18 months of age by demonstrating infants' eye gaze following a verbal prompt ("Where's my toy?") can match gender (a picture of a boy or girl) with gender-typical toys (Serbin, Poulin-Dubois, Colburne, Sen, & Eichstedt, 2001). Interestingly, the correspondence between model objects (e.g., toy car) and real objects (e.g., family car) is also recognized by infants around 20 months of age (Younger & Johnson, 2006). Therefore, it seems reasonable that learned associations between gender and real world objects (women and household objects, men and vehicles or tools) can also generalize to their toy counterparts in the second year of life and contribute to the development of gender-typical toy preferences after that time.

Whether sex differences in toy preferences are present in the first year of life, however, remain an unresolved empirical question. This gap in our knowledge exists, in part, because typical measures of toy preferences (e.g., verbal reports, toy interaction) are not possible in research on preverbal infants with limited motor skills. A strategy for extending research on toy preferences to infancy is suggested by research using the spontaneous visual preference paradigm. By presenting two stimuli simultaneously to infants for a brief interval of time and measuring the amount of visual attention to each stimulus, for example, investigators have demonstrated that boys and girls at 3–4 months of age have visual preferences for attractive nonhuman faces over unattractive faces (Quinn, Kelly, Lee, Pascalis, & Slater, 2008) and visual preferences for particular color hues (Zemach, Chang, & Teller, 2007).

Versions of the visual preference paradigm have been reported in two previous investigations of toy preferences in infancy. In one (Campbell, Shirley, & Heywood, 2000), 29 male and 19 female infants were presented with five pairs of pictures depicting a variety of sex-typed toys (e.g., doll, oven, dustpan versus ball, blocks, cars) at 3, 9, and 18 months of age. Observer ratings of children's looking times during 30 s presentations of the stimuli indicated that gender–congruent toy preferences were present in boys at 9 months of age but were not yet evident in girls at 9 or 18 months of age. In the other report (Serbin et al., 2001), 8 male and 12 female infants around 12 months of age were presented with pictures depicting dolls and trucks. Observer ratings of children's looking times across 24 5-s trials showed a visual preference in both sexes for dolls compared to trucks. Additional findings from this research indicated sex-linked toy preferences in both sexes were present in children tested at 18 months of age.

Reconciling the results of the two earlier investigations of toy preferences in infancy is difficult because the studies used very different methodologies and study designs. Further, the primary measure of behavior in both reports was looking time, a global measure of behavior with a microstructure that includes active information processing and what has been described as "blank stares" (Aslin, 2007). The contribution of active information processing to total looking time is variable across subjects and across stimuli, such that identical looking times may contain different amounts of active information processing. For that reason, research using measures of active visual processing of toys would constitute a stronger test of the hypothesis that males and females differ in their preferences for those objects.

Measures of information processing (i.e., visual fixations) and the precise identification of what is processed (i.e., the location of those fixations) can be obtained using eye-tracking technology, a tool applied increasingly in infant research (Hayhoe, 2004). Therefore, the goal of the present research was to use eye-tracking technology to examine whether infants in the first year of life would show a visual preference for a gender–congruent toy over a gender–incongruent toy using a simple spontaneous visual preference paradigm. We hypothesized: (1) infant girls would show a greater number of visual fixations on a doll compared to a toy truck; (2) infant boys would show a greater number of visual fixations on a toy truck compared to a doll; (3) infant girls would fixate more than boys on the doll; and (4) infant boys would fixate more on than girls on the truck.

Method

Participants

Participants were 17 boys (M age = 5.5 months, SD = 1.5 months) and 13 girls (M age = 6.1 months, SD = 1.8 months). The sex difference in age was small ($d = 0.36$), where $d = M_1 - M_2/\sigma_{\text{pooled}}$ (Cohen, 1977), and not statistically significant. Parents' names were obtained from multiple sources, including birth announcements in the local newspaper and commercially produced lists and were then contacted by letters and follow-up phone calls. Parents were offered $5 reimbursement for their travel expenses or received an infant-sized T-shirt for their son or daughter.

Materials and Apparatus

In contrast to the two earlier reports of toy preferences in infancy (Campbell et al., 2000; Serbin et al., 2001), the stimuli in this research were three-dimensional objects and not pictures of these objects. A doll and a toy truck were selected for use as stimuli because both are differentially preferred by boys and girls in the second year of life (Zosuls et al., in press), differentially preferred by older boys and girls (Alexander & Hines, 1994), and differentially preferred by male and female vervet monkeys (Alexander & Hines, 2002). The two toys (see Fig. 1) were of similar size but differed predictably in color (blue versus pink).

The testing apparatus was similar to a puppet theatre. Specifically, it consisted of a wooden cubicle (185 cm × 85 cm × 45 cm) with cream-colored walls and equipped with a muslin-covered shade that could be raised and lowered at the start and end of each trial. A 20 watt fluorescent bulb was mounted to each inside wall of the apparatus 94 cm above the floor. The bulbs were positioned so that they were not visible to infants. A cream-colored object platform (1.5 cm × 60 cm × 19 cm) at the back of the apparatus supported the toys and was centered between the left and right walls. Infants were isolated from any other visual stimuli in the testing room by a cream-colored curtain.

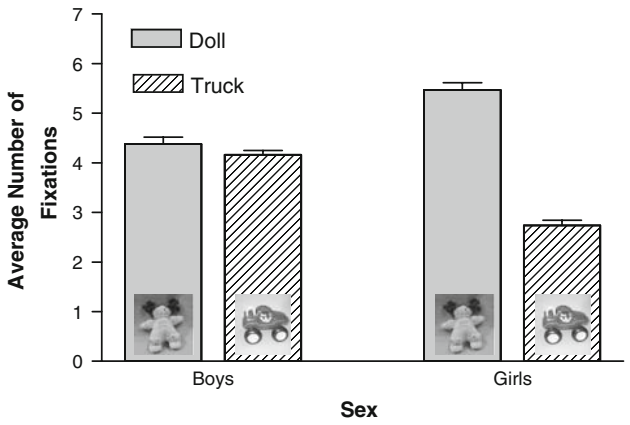

Fig. 1 Infants' visual fixations (mean, SEM) on gender-linked toys showing an early onset of sex-linked object preferences

An infra-red eye-tracker with remote optics (Model R6, Applied Science Laboratories) measured eye movements during test trials. The eye-tracker measures gaze position with a margin of error consistent with the natural function of the human eye, using corneal and retinal reflections of infra-red light to determine eye gaze. The camera was situated directly below the testing apparatus and not visible to infants. A magnetic head tracker (Flock of Birds®, Ascension Technology Corporation) was worn by infants to limit any disruption in eye tracking as a function of head movement. A scene camera was positioned slightly above and to the right of the infant's head. The scene camera recorded the three-dimensional event and imported it into the eye-tracking system. Gaze points were superimposed on the video image by Gazetracker Premium Academic software.

Procedure

Infants were positioned in car seats so that the camera to eye distance was approximately 56 cm. To obtain reliable and valid eye movement data, three gaze positions covering over 80% of the viewing area were first collected. To do so, the experimenter used small lights to direct the infants' attention to each of the three points successively and an eye-tracker operator set the system to correspond. Next, a stimulus (e.g., a bright or b) was moved to each of the three calibration points and infants' looking behavior was used to determine the accuracy of the calibration. If calibration was not accurate, then the procedure was repeated. This process took approximately 3 min.

After successful calibration, each infant participated in two 10-s trials in which the model truck and a doll were presented simultaneously. Each toy appeared once on the left side and once on the right side. The initial side of presentation of the objects was randomized across infants. Toys were presented in the same orientation on each trial: the doll was presented face forward and the toy truck was presented in side view. During the experiment, the apparatus lights were the only lighting source in room. Two experimenters worked together to produce the two events. The first wore a black glove and positioned the toys. The second raised and lowered the muslin shade.

Results

Look zones included the doll, the truck, and any part of the display that was not the doll or the truck. Each toy was defined as an area of interest and the dependent variables were the

number of fixations and the total looking time in each area of interest. Fixations were system defined as a period of at least 100 ms during which point of regard did not change by more than 1-degree visual angle (i.e., a distance on the display of less than 1.3 cm). As object manipulation emerges between 3 and 5 months of age and is established in older infants (e.g., Rochat, 1989), age group was also included as a factor in the analyses of eye movements.

Total Looking Time

A 2 (sex) × 2 (age: 3–5 months vs. 6–8 months) × 2 (stimulus type: doll versus toy truck) analysis of variance (ANOVA) showed no significant main effects of sex or toy, and no sex by toy interaction (Doll: $M = 3.45$ s $\pm$ 2.46 for boys vs. $M = 4.13$ s $\pm$ 2.07 for girls; Truck: $M = 3.62$ s $\pm$ 1.92 for boys vs. $M = 2.47$ s $\pm$ 1.63 for girls). The sex difference in looking times on the doll was smaller than the sex difference in looking times on the truck ($d = 0.29$ vs. $d = 0.64$). This resulted because looking times on the doll and truck were very similar in boys ($d = 0.07$), but toy type showed a large effect on girls' looking time ($d = 0.89$).

Fixations

Figure 1 shows the average number of fixations in each area of interest as a function of sex. A 2 (sex) × 2 (age: 3–5 months vs. 6–8 months) × 2 (stimulus type: doll versus toy truck) ANOVA showed a main effect of toy, $F(1, 26) = 7.15$, $p = .013$, and a sex by toy interaction, $F(1, 26) = 5.16$, $p = .038$, but no significant age group effects on visual attention. Overall, the number of visual fixations on the doll was greater than the number of visual fixations on the toy truck ($d = 0.73$). However, tests of the simple effects of toy within each level of sex showed infant girls fixated more on the doll compared to the toy truck ($d = 1.27$, $p < .01$) (Hypothesis 1). Boys fixated more on the toy truck compared to the doll ($d = 0.39$) (Hypothesis 2), but the effect was not significant. Tests of the simple effects of sex within each level of toy showed the number of fixations on the doll was greater in girls compared to boys ($d = 0.29$) (Hypothesis 3), but the effect was also not significant. In contrast, fixations on the truck were significantly greater in boys compared to girls ($d = 0.78$, $p < .05$) (Hypothesis 4).

Discussion

Against a background of visual features defining the three-dimensional testing apparatus (e.g., curtains, angles, textures), infant girls in this research showed a large ($d > 1.0$) spontaneous visual preference for a doll over a toy truck, whereas infant boys showed no significant visual preference for either object. Visual attention on the toy truck also showed a sex difference, such that boys fixated more often on that toy than did girls. Thus, eye-movements in infants measured during the simultaneous presentation of a doll and toy truck showed that sex differences in interest in some model objects are present before 9 months of age.

Our novel findings have clear implications for theories of sex difference in human behavior. At a phenomenon-specific level, they indicate that the emergence of sex differences in toy interests does not require the motor abilities to support sex-typed toy play activities, such as the feeding or dressing of dolls and the rolling or racing of cars. As such, our results do not support the suggestion that the origins of toy preferences are innate preferences for the activities that are supported by toys (Hassett, Siebert, & Wallen, 2008). Unless future research can demonstrate that infants younger than 9 months of age have cognitive structures such as gender schemas, our findings also indicate that the emergence of sex-linked toy preferences does not require the cognitive abilities to support gender identity and the recognition of gender–congruent behavior. Rather, the findings from the present research are consistent with the hypothesis that males and females may show different patterns of attention to toys because they are attracted to different visual characteristics of objects (Campbell et al., 2000).

Preferences for gender–congruent toys and activities have been characterized as an affective component of gender development, a term originally used to describe the child's motivation to act in accordance with gender stereotypes (Martin & Halverson, 1981). Although evidence of preferences for sex-typed toys in the second year of life has suggested that the affective component may precede the acquisition of behavioral and cognitive components of gender development (Serbin et al., 2001), it seems unlikely that object interests in infants younger than 9 months of age are a result of an internal motivation to conform to external referents of gender role behavior. However, the positive value of objects for males and females in infancy may still be acquired or *experience-dependent*. For example, parents provide children with gender–congruent toys even during infancy (Pomerleau, Bolduc, Malcuit, & Cossette, 1990) and toys may acquire positive affective properties through familiarity or associations with other rewarding stimuli (e.g., caregivers).

In addition, the early sex differences in toy interests observed in this research are consistent with converging evidence from human and nonhuman research suggesting that some aspects of sex-linked object preferences are *experience-independent*. Girls and boys shortly after birth, for example, show visual preferences for the natural movement of a human face and the mechanical motion of a mobile, respectively (Connellan, Baron-Cohen, Wheelwright, Batki, & Ahluwalia, 2000). Further, sex differences in toy preferences have been observed in two nonhuman primate species

(Alexander & Hines, 2002; Hassett et al., 2008) and these findings are compelling evidence that sex differences in toy preferences can exist without an understanding of the gender-appropriateness of objects or experiencing the social pressures to engage in gender-typical behavior. The possibility that the sexual differentiation of the brain contributes to a sex-linked affective response to objects is supported by other research demonstrating that, compared to unaffected children, girls with a masculinized prenatal environment resulting from an endocrine disorder show stronger preferences for male-typical toys and weaker preferences for female-typical toys (Berenbaum & Hines, 1992; Nordenstrom, Servin, Bohlin, Larsson, & Wedell, 2002). From this perspective, then, the sexual differentiation of the brain in prenatal and early postnatal life may be another explanation for the sex differences in object interest that we observed in early development.

Innate influences on toy preferences are likely enhanced by the continuous process of gender socialization (Hines & Alexander, 2008) and the contribution of innate and acquired components to the sex differences in object interests at different ages of development is unknown. It may be informative that the present findings were consistent with our earlier results from research on vervet monkeys (Alexander & Hines, 2002). Specifically, like the infants observed in this research, female vervets showed preferences for female-typical toys over male-typical toys but male vervets showed no preference for either toy category. However, like the male infants observed in this research, male vervets compared to female vervets also showed more interest in male-typical toys. Although the similar results suggest that the sex differences observed in this research may represent innate object interests that are minimally affected by social and cognitive development, other evidence of sex-typed toy preferences in rhesus monkeys is not entirely consistent with this pattern of results (Hassett et al., 2008). In that research comparing wheeled toys and plush toys, male monkeys showed preferences for wheeled toys (primarily model vehicles) but female monkeys showed no preference for either toy category. However, methodological differences between the two primate studies (the type of female-typical toy exemplars, the method of toy presentation) may explain the different results and this possibility suggests that a comparison of methods in human and animal research may be important in increasing our understanding of the relative contribution of innate and acquired components of object preferences (for discussion, see Hines & Alexander, 2008).

Innate object preferences may have an important functional significance in the development of human sex differences (Alexander, 2003). Infants early on in life are sensitive to sex-linked perceptual cues, such as voice (Miller, Younger, & Morse, 1982) or body movements (Mather & Murdoch, 1994), and an early sensitivity to perceptual categories of male and female likely facilitates the construction of the conceptual categories of "masculine" and "feminine" behavior. Males and females may also have evolved preferences for perceptual features associated with human gender-typed object categories because such visual biases may optimize the development of sex-dimorphic behaviors with adaptive significance (Alexander, 2003; Geary, 1999). Infants of both sex have preferences for face-like stimuli (Johnson & Morton, 1991) and it seems reasonable that a doll, an object with a face, was attractive to infants in our research for that reason. However, a stronger visual preference for a doll in girls compared to boys may exist because selection pressures in females favor responsiveness to object cues associated with an animate form (e.g., face, shape), a possibility consistent with an earlier observation that infant girls prefer toys with faces (Goldberg & Lewis, 1969). Responsiveness to such cues, for example, may promote the elaboration of social behaviors in adults that enhance reproductive success, such as interest in infants (Higley, Hopkins, Hirsch, Marra, & Suomi, 1987) and social groups (Silk, Alberts, & Altmann, 2003). Thus, very early preferences for objects such as toys may indicate a biological preparedness for gender roles that for full expression requires the subsequent coupling of these early sex-linked perceptual preferences with the social experiences imposed by contemporary gender socialization.

Finally, our conclusions and speculations are based on the presentation of only two strongly sex-typed toys for two 10-s intervals. The procedure was very similar to that used to demonstrate visual preferences for attractive animal faces (Quinn et al., 2008) and the design permits a clear analysis of the presence or absence of a spontaneous visual preference for specific visual stimuli in infancy. However, internal validity always comes at a cost. For example, including a larger number of toys would have increased the generalizability of our findings to broader categories of "masculine" and "feminine" toys. Similarly, the sex differences we observed across the two 10-s trials may or may not be evident in more natural situations, where toys are in view for much longer periods of times and appear in the context of other stimuli. We *can* conclude on the basis of our method, however, that sex differences in early visual interest in two objects that are differentially preferred by older girls and older boys are present during infancy. This finding is, therefore, strong support for the hypothesis that cognitive and social processes in later development build on pre-existing preferences for specific toy categories (Block, 1983) and suggest that eye-tracking technology may be a useful tool in research on emerging human sex differences. By using larger stimuli that would permit definition of more discrete areas of interest (e.g., eyes, wheels), for instance, it may be possible to identify and compare the characteristics of a doll or a toy truck that are of interest to children of both sexes.

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