Sex differences in response to children's toys in nonhuman primates (*Cercopithecus aethiops sabaeus*)

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Abstract

Sex differences in children's toy preferences are thought by many to arise from gender socialization. However, evidence from patients with endocrine disorders suggests that biological factors during early development (e.g., levels of androgens) are influential. In this study, we found that vervet monkeys (*Cercopithecus aethiops sabaeus*) show sex differences in toy preferences similar to those documented previously in children. The percent of contact time with toys typically preferred by boys (a car and a ball) was greater in male vervets ($n = 33$) than in female vervets ($n = 30$) ($P < .05$), whereas the percent of contact time with toys typically preferred by girls (a doll and a pot) was greater in female vervets than in male vervets ($P < .01$). In contrast, contact time with toys preferred equally by boys and girls (a picture book and a stuffed dog) was comparable in male and female vervets. The results suggest that sexually differentiated object preferences arose early in human evolution, prior to the emergence of a distinct hominid lineage. This implies that sexually dimorphic preferences for features (e.g., color, shape, movement) may have evolved from differential selection pressures based on the different behavioral roles of males and females, and that evolved object feature preferences may contribute to present day sexually dimorphic toy preferences in children. © 2002 Elsevier Science Inc. All rights reserved.

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1. Introduction

Boys favor construction and transportation toys, whereas girls favor toys such as dolls (Connor & Serbin, 1977; Liss, 1981). Boys are also more active (Campbell & Eaton, 1999; Eaton & Enns, 1986) and show more rough physical play than girls (DiPietro, 1981). These sexually dimorphic play styles are thought by many to derive from learning and cognitive mechanisms associated with gender socialization (see Serbin, Poulin-Dubois, Colburne, Sen, & Eichstedt, 2001 for a recent discussion). Learning theories suggest that sex differences in play activities and toy preferences arise from modeling and reinforcement of sex-typical play (Bandura, 1977; Fagot & Hagan, 1991; Langlois & Downs, 1990). Cognitive theories suggest further that children develop an understanding of their gender identity that results in schemas or mental representations of socially defined gender appropriate behavior and a positive evaluation of toys and activities associated with this gender identification (Maccoby, 1988; Martin, 1999; Martin, Wood, & Little, 1990). Sexually dimorphic play has, in turn, social and cognitive consequences. Children have strong preferences for compatible play styles and playmates of the same sex (e.g., Alexander & Hines, 1994). The resulting same-sex groupings for play appear to encourage sexually dimorphic social interaction styles (Maccoby, 1990) and may promote male-typical cognitive abilities (e.g., spatial abilities) (Sprafkin, Serbin, Denier, & Connor, 1983). Sex-typed play styles, therefore, appear to further human sex differences in social and cognitive development.

In other species, biological factors influence sex differences in related aspects of play behavior. In rats and rhesus monkeys, genetic females treated with androgen during critical periods of pre- or neo-natal development show increased "rough-and-tumble" (male-typical) play (Goy, Bercovitch, & McBrair, 1988; Meaney & McEwen, 1986), assumedly because androgen directs basic processes of neural development in relevant brain regions (Arnold & Gorski, 1984; Goy & McEwen, 1980). In humans, genetic females exposed to androgenic hormones prenatally (because of genetic disorders causing increased androgen production or because their mothers were prescribed hormones during pregnancy) also show increased male-typical behavior. In particular, androgenized girls show increased preferences for male playmates and toys typically preferred by boys (Berenbaum & Hines, 1992; Hines & Kaufman, 1994) and a reduced interest in activities and toys typically preferred by girls (Berenbaum & Hines, 1992; Dittman et al., 1990; Ehrhardt & Baker, 1974; Ehrhardt & Money, 1967). The apparent consistency of androgen effects on play across a variety of mammalian species suggests that gonadal hormones, as well as social and cognitive factors, may influence sex differences in children's play, including interests in specific types of toys, such as trucks or dolls.

However, influences of hormones on human play behavior are not universally accepted. Phenotypic masculinization, which occurs to variable degrees in girls exposed to andro-genic hormones prenatally, could alter the social environment (e.g., parents may expect or encourage androgenized girls to play in more masculine-typical ways) (Fausto-Sterling, 1992). In addition, hormone exposure could alter cognitive development related to gender (e.g., androgenized girls may develop a less firm identification as female) rather than directly influencing neural processes related to play. From these perspectives, masculinized

toy preferences in androgenized girls could reflect altered learning histories or altered cognitive development.

The present research addressed the hypothesis that toy preferences may be associated with factors other than human social and cognitive development by measuring toy preferences in a nonhuman primate, the vervet monkey (*Cercopithecus aethiops sabaeus*). Unlike humans, vervet monkeys are not subject to the specific social and cognitive influences proposed to explain human sex differences in toy preferences. To evaluate the possibility that sex differences in toy preferences can arise independent of these social and cognitive mechanisms, we therefore tested the hypothesis that vervet monkeys, like human beings, show sex differences in toy preferences.

2. Methods

Subjects were 44 male (mean age 39.2 ± 31.1 months) and 44 female (mean age 50.4 ± 46.5 months) vervet monkeys ranging in age from 2 to 185 months, living in seven, stable, social groups at the UCLA/Sepulveda Veterans Administration Non-Human Primate Laboratory. They were housed in enclosures ($5 \times 5 \times 2.5$ m or larger) in groups of $17-28$ animals. Six groups included at least three adult males, four adult females and their offspring; the seventh included only adult males. Animals in each group were identified by highly visible and unique cow-dye markings that were later matched to previously recorded subject characteristics (sex, age, and dominance ranking).

2.1. Procedures

Three groups of animals were tested in the autumn and four the following spring. Each group received two or three toy preference trials separated by intervals of 1 week. (For 32 animals, torrential rains prevented the third trial.) The first trial was used to accustom the animals to the presence of the experimenter and the procedure (introductory trial). Data were collected on the subsequent trial or trials (test trials).

For each trial, six toys were placed in the group cage, one at a time, in a random order. Each toy remained in the enclosure for 5 min. The six toys were a ball, a police car, a soft doll, a cooking pot, a picture book and a stuffed dog. These toys were categorized as "masculine" toys, "feminine" toys, or "neutral" toys on the basis of evidence that boys are more interested than girls in balls and cars (the "masculine" toy set), girls are more interested than boys in dolls and pots (the "feminine" toy set), and boys and girls are approximately equally interested in books and stuffed animals (the "neutral" toy set) (Berenbaum & Hines, 1992; Connor & Serbin, 1977; Maccoby & Jacklin, 1974). The six toys were selected because children in a broad age range categorize them as "masculine," "feminine," or "neutral" and, for those toys categorized as "masculine" or "feminine," the sex difference in toy preferences is reliable and relatively large in children.

During test trials, animals were videotaped from outside the enclosure. An observer provided a concurrent narrative of the animals' identifying markings and behaviors to aid the

scoring of the videotapes by independent raters. Reliability between raters was good (Cohen's Kappa = .84, average of 15 animals). Videotapes were coded for the duration of each of the two behavioral responses (contact and approach) to each of the toys. Contact was coded when an animal (or animals) approached a toy and made physical contact with it. Approach was coded only when an animal moved within 2 m of a toy without contacting it physically — but not coded in instances when the toy was moved towards an animal. For example, if one animal picked up the toy and moved near a second animal, a contact was coded for the first animal but an approach was not coded for the second animal. Each animal received two scores (contact and approach), ranging from 0 to 300 s, for each toy on each trial.

2.2. Preliminary analyses

There were no effects of repeated testing on behavior. Therefore, scores from two test trials (when available) were averaged and data from all 88 animals were included in the analyses of approach and contact times. Sex differences in total approach and contact time scores, although not statistically significant [$t(86) = 1.63$, $P = .11$ for approach and $t(86) = 1.76$, $P = .08$ for contact] were substantial. Effect sizes, defined in standard deviation units, d (Cohen, 1977), were 0.35 and 0.38 for approach and contact, respectively. This suggested that male animals were more likely to approach and contact toys overall. Therefore, to assess sex differences in preferences for sex-typed categories of toys, we converted raw scores to percent scores. Percent approach scores equaled approach time for each individual toy divided by total approach time to any of the six toys $\times$ 100. Similarly, percent contact scores equaled contact with each individual toy divided by total contact with any of the six toys $\times$ 100. These scores could be calculated only for animals that approached or contacted at least one of the toys. This produced a sample of 44 males and 37 females for the percent approach variable and 33 males and 30 females for the percent contact variable.

Sex differences in response to toys in the "neutral" category were first analyzed with t-tests for group differences. Approach and contact to the "masculine" and "feminine" toys were next analyzed in two 2 (toy category) $\times$ 2 (toy item) $\times$ 2 (sex) analyses of variance with sex as the grouping factor and toy category and toy item as repeated measures. Including age as a covariate in the model did not alter the pattern of significant and insignificant results reported below and there were no effects of age nor sex by age interaction effects on contact data.

3. Results

There were no sex differences in absolute approach time or percent approach time to any of the toy groupings (i.e., "masculine," "feminine," "neutral"). This finding accords with expectation, because approach is scored when an animal comes near a toy *without* contacting it. Approach often reflected an animal passing near a toy on the way to another location in the enclosure. As expected, then, total approach time and total contact time scores were uncorrelated: $r(44) = .11$, ns for males; $r(44) = .01$, ns, for females.

The contact measures, unlike the approach measures, exhibited significant effects of sex and toy category (Fig. 1). Analyses of the absolute measure of contact time using the entire sample of 44 males and 44 females showed that, compared to females, males had greater contact time with the "masculine" toy set, $F(1,86) = 5.28$, $P < .05$. Analysis of percent contact time revealed an interaction between sex and toy category, multivariate, $F(1,61) = 6.79$, $P = .01$. As hypothesized, simple planned comparisons showed females
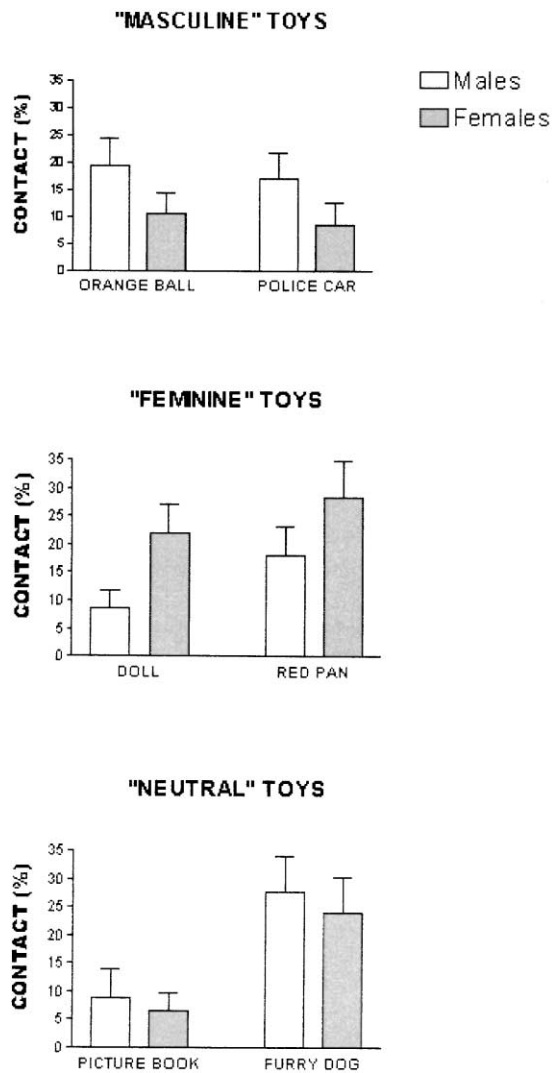

Fig. 1. Percent contact (means ± S.E.M.) with "masculine," "feminine" and "neutral" toys for male and female vervets. Percent contact with "masculine" toys is greater in male than in female animals ($P < .05$) and percent contact with "feminine" toys is greater in female than in male animals ($P < .01$). In contrast, there is no sex difference for percent contact with "neutral" toys.

compared to males had higher percent contact with the "feminine" toys, $P=.01$, and males compared to females had higher percent contact with the "masculine" toys, $P=.05$. Although the serial introduction of the toys does not permit a true contrast of the relative preference for "masculine" over "feminine" toys within each sex, a within-sex comparison of contact scores showed that female vervets had greater percent contact with "feminine" over "masculine toys," $P<.01$, but males had similar percent contact with "masculine" and "feminine" toys, $P=.19$. The lack of a three-way interaction between sex, toy item, and toy category, $F(1,61)=0.03$, $P=.97$, indicates that sex differences were consistent across the two toys grouped a priori as "masculine" or "feminine." Furthermore, a second, similar analysis of contact scores using both animal group and sex as grouping factors replicated the interaction between sex and toy category, $F(2,49)=4.34$, $P=.01$, and also showed a nonsignificant three-way interaction between sex, toy category, and animal group, $F(10,100)=1.0$, $P=.44$, indicating that the sex differences in toy contact were consistent across the different animal groups examined. In contrast to these sex differences in contact with "masculine" or "feminine" toys, no sex differences in percent contact with toys in the "neutral" category were found, $t(61)=-0.61$, $P=.54$. Confirmation of the hypothesized pattern of sex differences for percent contact, but not percent approach, scores suggests that the contact behavior was deliberate rather than accidental. In some instances, we also noted that vervet monkeys contacted toys in ways that appeared to resemble children's contact with them, such as moving the car along the ground. They also interacted with the doll in ways that resembled female vervet contact with infants, such as inspecting it physically (see Fig. 2). To examine the possibility that whether toys were animate or not was influencing the pattern of results, we also analyzed data for toys grouped as animal-like (dog, doll) or object-like (pot, pan, book, car). This analysis revealed no sex by toy category interaction in percent contact scores, $F(1,61)=0.882$, $P=.35$.

Finally, we were interested in whether dominance status could play a role in our results. Dominance rank (high$=1$, medium$=2$, low$=3$) for 25 male and 38 female animals was available as part of the archival records kept by staff at the Non-Human Primate Laboratory. Among the 38 females, dominance rank did not correlate significantly with percent contact for any of the three toy categories, $r=-.20$, $.03$, and $.12$ for "masculine," "feminine," and "neutral" toys in order (all ns). Among the 25 males, there were trends for higher ranking animals to contact "masculine" toys more ($r=-.41$, $P<.10$) and feminine toys less ($r=.43$, $P<.10$) than lower ranking animals. However, analyses using dominance rank as a covariate produced results essentially the same as the primary analyses reported above.

Some animals did not contact toys and others had low contact scores. Therefore, to ensure that low levels of contact in males or females were not biasing the analyses of contact scores reported above, we compared the distribution of difference scores (for each animal the amount of contact time spent with "masculine" toys minus the contact time with "feminine" toys) for the two sexes using a nonparametric statistic, the Mann–Whitney U test. Consistent with the earlier analysis of contact scores, sex differences were found in the distribution of difference scores based on absolute contact time obtained from 88 animals, $Z=-1.94$, $P=.05$ (mean for males $=14.51\pm91.2$ and mean for females $=-10.70\pm21.1$) and in the distribution

Fig. 2. Examples of a female and a male animal contacting toys. The female animal (left) appears to be conducting an anogenital inspection of the toy doll, similar to inspections of infant vervet monkeys. The male animal (right) appears to be moving the car along the ground in a manner similar to that a child might use.

of difference scores based on percent contact time obtained from 63 animals, $Z=-2.45$, $P=.01$ (mean for males $=0.09\pm0.61$ and mean for females $=-0.31\pm0.62$).

4. Discussion

Vervet monkeys in this research were presented with six toys, two from a ''masculine'' category (toys typically preferred by boys), two from a ''feminine'' category (toys typically preferred by girls), and two from a ''gender-neutral'' category (toys that are not preferred differentially by girls or boys). Whereas the *approach* of these Old World Primates to individual toys was unrelated to their sex or to toy category, their *contact* with the toys was. The proportion of contact time with toys typically preferred by boys was greater in male vervets compared to female vervets, whereas the proportion of contact time with toys typically preferred by girls was greater in female vervets compared to male vervets. In contrast, contact time with toys preferred equally by boys and girls was comparable in male and female monkeys. These sex differences in vervets resemble the well-documented sex differences in children's toy preferences. Prior research has documented interest in novel objects among vervets (Fedigan, 1972). Our data suggest that this interest varies with the sex of the animal and across sex-typed toy categories derived from empirical studies (Berenbaum & Hines, 1992; Connor & Serbin, 1977; Maccoby & Jacklin, 1974) of sex differences in children's object play. Children's toys, therefore, appear to have differential value for males

and females of at least two primate species, vervets and humans. This new finding provides additional support for the hypothesis that sex differences in toy preferences can arise independent of the social and cognitive mechanisms thought by many to be the primary influences on toy preferences in human beings.

4.1. Are there perceptual categories of masculine and feminine objects?

In humans, sex-typed toy preferences may be viewed as evidence of sex-typed object categories that are acquired through learning (Bandura, 1977; Fagot & Hagan, 1991; Langlois & Downs, 1990) and cognitive development (Maccoby, 1988; Martin, 1999; Martin et al., 1990). Although nonhuman primates can learn to categorize novel stimuli (Freedman, Riesenhuber, Poggio, & Miller, 2001), the monkeys we observed had no learning history with the individual toys used in this study. Additionally, there is no evidence that vervets have an understanding of their gender. Yet, even if they do have a gender identity, they would not have had the experiences with objects (e.g., police car, cooking pot, book) that might be necessary to form categories based on associations between toys and gender in humans. Sex differences in toy preferences in a species lacking relevant social and cognitive experiences suggest, therefore, that other determinants of sex-typed object categorization exist.

Object categorization (i.e., a similar response to distinct stimuli) is thought to occur when a stimulus possesses a sufficient cue or number of cues from some larger set of characteristics that define a class (Quinn & Bhatt, 2001). Although most categories are learned, there is evidence that the primate brain has evolved specialized recognition systems for categories with adaptive significance, such as emotional expressions and facial identity (for discussion, see Duchaine, Cosmides, & Tooby, 2001). In view of this evidence, our findings suggest that object features or functions associated with human sex-typed toy categories may have adaptive significance for males and females. In addition, evolved, specialized recognition systems for these object characteristics may direct object preferences in some primate species.

Information is not yet adequate to know what low-level perceptual properties may contribute to the responses to sex-typed toys by vervet monkeys and this study was not designed to evaluate these hypothetical feature preferences. However, toys preferred by girls have been described as objects that afford opportunities for nurturance (Campbell, Shirley, & Heywood, 2000; Eisenberg, Murray, & Hite, 1982; Miller, 1987), and selection pressures may favor responsiveness to object cues (e.g., an animate-like form) that signal maternal behavior because these cues enhance infant survival. A doll, for example, may be of greater interest to females than males in primate species where females interact with infants more than males do. Such species include humans (Blakemore, 1981) and vervet monkeys (Lancaster, 1971; Meaney, Lozos, & Stewart, 1990). However, as we found no sex differences in response to toy categories based on an animate-like (doll, dog) or inanimate-like (car, ball, book, pan) distinction, it appears that other characteristics contributed to the female object preferences we observed.

Color may also provide an important cue for female interest. Female rhesus monkeys have been found to show a preference for the characteristic "reddish-pink" facial coloration of infant vervets compared to yellow or green. Consistent with this female color preference, girls

are also more likely than boys to prefer warmer colors (i.e., pink and red) to cooler colors (i.e., blue and green) (Minamoto, 1985 cited in Iijima, Arisaka, Minamoto, & Arai, 2001). A preference for red or reddish pink has been proposed to elicit female behaviors to infants that enhance infant survival, such as contact (Higley, Hopkins, Hirsch, Marra, & Suomi, 1987). The hypothesis that reddish pink or red may be a cue signaling opportunities for nurturance and thus eliciting female responsiveness could explain our finding of greater female contact with both the doll (with a pink face) and the pot (colored red).

Toys preferred by boys, such as the ball and police car used in this research, have been characterized as objects with an ability to be used actively (O'Brien & Huston, 1985) or objects that can be propelled in space (Benenson, Liroff, Pascal, & Cioppa, 1997). Preferences for such objects may exist because they afford greater opportunities for engaging in rough or active play. In humans, these characteristics have in turn been suggested to relate to targeting or navigating abilities (for discussion, see Alexander, in press) that might be particularly useful for males for purposes of hunting or locating food or mates (Eals & Silverman, 1994; McBurney, Gaulin, Devineni, & Adams, 1997; Silverman & Eals, 1992). As suggested for females in regard to objects that signal nurturance, males may therefore have evolved preferences for objects that invite movement.

4.2. Implications for the development of human sex-typed toy preferences

Research on infant visual preferences (Campbell et al., 2000; Connellan, Baron-Cohen, Wheelwright, Batki, & Ahluwalia, 2000; Serbin et al., 2001) has also suggested an underlying sex difference in preferences for distinct object features that appears to precede experience with sex-typed toys. Male infants appear to prefer inanimate objects with movement, whereas female infants appear to prefer objects with animate-like qualities (form, color) (Connellan et al., 2000). Human infants use perceptual features such as voices (Miller, 1987) and faces (Leinbach & Fagot, 1993) to discriminate between males and females, and patterns of sequential touching show an awareness of sex-typed toy categories in children at 20–28 months of age (Levy, 1999). The present findings of sex-typed toy preferences in vervet monkeys suggest that perceptual features with differential adaptive significance for males and females may facilitate the formation of children's sex-typed object categories.

During critical periods of early development, gonadal hormones, particularly androgens, influence sex differences in rough, physical play in both rodents and nonhuman primates (Collaer & Hines, 1995; Meaney, 1988). In addition, androgens appear to influence the development of two primate visual pathways (Bauer, Shimojo, Gwizada, & Held, 1986; Held, Bauer, & Gwiazda, 1988) that are differentially involved in the processing of object features (such as color or shape) and object movement (Kastner & Ungerleider, 2000; Ungerleider & Mishkin, 1982). Recent findings in the rat provide direct support for the hypothesis that androgens influence the sexually dimorphic development of the visual processing pathways (Salyer, Lund, Fleming, Lephart, & Horvath, 2001). Therefore, we suggest that androgens also influence the formation of perceptual categories involved in children's sex-typical toy preferences by influencing the structure and function of the brain systems that subserve the

recognition of these object categories. Androgen effects on visual pathways providing information about object features and object movement may be relevant for understanding how atypically high levels of androgen prenatally may induce preferences for "masculine" toys (Berenbaum & Hines, 1992).

We also suggest that children's toy preferences reflect innate object preferences that are elaborated in typical human development by subsequent gender socialization. We found differences between male and female vervet monkeys that resemble the well-established differences in the toy preferences of boys and girls, consistent with the proposed existence of innate object preferences. However, although female vervets preferred "feminine" toys over "masculine" toys, male vervets did not appear to prefer "masculine" toys over "feminine" toys. This difference between male vervets and boys may indicate that toy preferences in boys are directed by gender socialization to a larger degree than are toy preferences in girls. Alternatively, in research on children's toy preferences, all the toys are presented at once and we presented toys one at a time. So, in that respect, we did not conduct a preference test. We do have a preference test from the point of view that animals interact with each individual toy rather than with nothing or each other and are more likely to do so (i.e., show a preference for doing so) with toys that are preferred by humans of their same sex. Research presenting "masculine" and "feminine" toys at the same time to vervet monkeys or individually to children would be of use in clarifying whether our findings related in part to the way in which we presented toys to the animals.

In sum, our data suggest that sex differences in preferences for object features may contribute to the formation of perceptual categories of sex-typed toys, and these preferences for features or functions appear to generalize across at least some primate species. Moreover, it seems that, like chromatic color vision, sex-related object preferences appeared early in human evolution, prior to the emergence of a distinct hominid lineage. Primate color vision appears to have evolved to facilitate foraging for fruit and edible leaves (Dominy & Lucas, 2001; Nathans, 1999; Pichaud, Briscoe, & Desplan, 1999; Regan et al., 2001). It may be that differential selection pressures based on diverse processing requirements of tasks that are conducted more by males or females (such as infant care) may have contributed to the formation of perceptual categories of objects with differential adaptive significance for males and females. Future research employing parametric manipulation of object features (color, shape, spatial frequency) or characteristics such as the objects ease or style of mobility may help further understanding of the perceptual basis of sex-typed object preferences of children, as well as clarify the reasons for a similar pattern of human and nonhuman primate response to these sex-typed object categories.

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