

2009

# Sexually Differentiated Object Preference in Rhesus Monkeys (*Macaca mulatta*)

Jamie Berkowitz

*University of Massachusetts Amherst*

Follow this and additional works at: <https://scholarworks.umass.edu/theses>

---

Berkowitz, Jamie, "Sexually Differentiated Object Preference in Rhesus Monkeys (*Macaca mulatta*)" (2009). *Masters Theses 1911 - February 2014*. 227.

Retrieved from <https://scholarworks.umass.edu/theses/227>

This thesis is brought to you for free and open access by ScholarWorks@UMass Amherst. It has been accepted for inclusion in Masters Theses 1911 - February 2014 by an authorized administrator of ScholarWorks@UMass Amherst. For more information, please contact [scholarworks@library.umass.edu](mailto:scholarworks@library.umass.edu).

SEXUALLY DIFFERENTIATED OBJECT PREFERENCE IN RHESUS MONKEYS

*(MACACA MULATTA)*

A Thesis Presented

by

JAMIE L. BERKOWITZ

Submitted to the Graduate School of the University of Massachusetts Amherst in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

February 2009

Neuroscience and Behavior Program



SEXUALLY DIFFERENTIATED OBJECT PREFERENCE IN RHESUS MONKEYS  
(*MACACA MULATTA*)

A Thesis Presented

by

JAMIE L. BERKOWITZ

Approved as to style and content by:

---

Melinda A. Novak, Chair

---

Gordon A. Wyse, Member

---

Jerrold S. Meyer, Member

---

Jerrold S. Meyer, Director  
Neuroscience and Behavior Program

ABSTRACT

SEXUALLY DIFFERENTIATED OBJECT PREFERENCE IN RHESUS MONKEYS

(*MACACA MULATTA*)

FEBRUARY 2009

JAMIE L. BERKOWITZ, B.S., UNIVERSITY OF MASSACHUSETTS AMHERST

M.S., UNIVERSITY OF MASSACHUSETTS AMHERST

Directed by: Professor Melinda A. Novak

Children have strong preferences for sex-typed toys; boys prefer trucks, whereas girls prefer dolls. These preferences appear to be driven by complex interactions of hormones and the socio-cultural environment. The relative contribution of each of these factors in children is impossible to isolate given ethical limitations. Non-human primate species afford the opportunity to examine preferences in the absence of societal values and influences that children experience. In two previous studies with non-human primates, one with vervet monkeys and one with rhesus monkeys, monkeys showed sex-typed object preferences that paralleled those of children. However, several uncontrolled variables could have influenced these preferences. Our study considered object characteristics and we controlled for possible color preferences. We also tested monkeys individually to eliminate the effects of social facilitation and dominance rank. In experiment 1, monkeys were given a choice between similar objects of different colors (Phase A) and moving vs. non-moving objects (Phase B). In experiment 2, monkeys were given a choice between dolls and trucks (Phase A) and

subsequent phases looked at the influence of moving wheels (Phase B) and hardness (Phase C). Contrary to previous findings, monkeys did not show sex-typed object preferences. Instead, the monkeys preferred blue objects, hard PVC objects such as trucks and hard dolls, and dolls with wheels. The influence of previous reward based cognitive testing, familiarity of substrate materials and rearing condition are considered as possible explanations for these findings.

# TABLE OF CONTENTS

	Page
ABSTRACT.....	iii
LIST OF TABLES.....	vii
LIST OF FIGURES .....	viii
CHAPTER	
1. INTRODUCTION .....	1
Sex Differences in Human Children.....	1
Emotional Behavior .....	2
Social Behavior.....	3
Play Behavior and Toy Preferences .....	6
Sex Differences in Rhesus Monkeys .....	8
Emotional Behavior .....	8
Social Behavior.....	9
Play Behavior and Toy Preferences .....	10
Relative Social and Biological Factors.....	11
Sex Biased Object Manipulation in Monkeys .....	14
Previous Studies and Limitations.....	14
Objectives of this Project.....	18
Hypotheses and Predictions .....	20
2. METHOD .....	21
Subjects and Housing.....	21
Experiment 1: Object Preference .....	23
Materials .....	24
Phase A: Color .....	24
Phase B: Moving Parts.....	24
Procedure .....	25
Experiment 2: Sex-typed Object Preference.....	26
Materials .....	27
Phase A: Masculine vs. Feminine Objects.....	27
Phase B: Moving Wheels vs. Fixed Wheels Objects.....	29

Phase C: Hard PVC vs. Stuffed Canvas Objects .....	29
Procedure .....	31
Objects Placed Outside the Cage .....	31
Objects Placed Within the Cage .....	32
Behavioral Scoring System and Reliability .....	33
Data Analysis .....	33
3. RESULTS .....	36
Experiment 1: Object Preference .....	36
Outside Cage Condition .....	36
Phase A: Color .....	36
Phase B: Moving Parts .....	37
Experiment 2: Sex-typed Object Preference .....	39
Outside Cage Condition .....	39
Phase A: Masculine vs. Feminine Objects .....	39
Phase B: Moving Wheels vs. Fixed Wheels Objects .....	40
Phase C: Hard PVC vs. Stuffed Canvas Objects .....	41
All Phases Outside Cage Condition .....	43
Experiment 2: Sex-typed Object Preference .....	44
Inside Cage Condition .....	44
Phase A: Masculine vs. Feminine Objects .....	44
Phase B: Moving Wheels vs. Fixed Wheels Objects .....	45
Phase C: Hard PVC vs. Stuffed Canvas Objects .....	47
Trends Across Phases For Experiment 2 .....	49
4. DISCUSSION .....	51
BIBLIOGRAPHY .....	59

## LIST OF TABLES

Table	Page
1. Summary of Monkey Information .....	22
2. Summary of Experiment 1 and Conditions.....	23
3. Summary of Experiment 2 and Conditions.....	26
4. Object Characteristics .....	28
5. Individual Preferences Outside Cage.....	44
6. A comparison of individual preferences across both inside and outside cage conditions.....	49

## LIST OF FIGURES

Figure	Page
1. Home cage objects .....	23
2. Jackeroos; red left, blue right.....	24
3. Moving parts objects.....	25
4. Aerial view of experiment/Experimenter B's view .....	26
5. Doll and doll design.....	27
6. Truck and truck design.....	28
7. Doll with moving wheels and design.....	29
8. PVC doll and design .....	30
9. Canvas truck and design .....	30
10. Experiment 1 Red and blue objects frequency .....	37
11. Experiment 1 Red and blue objects duration .....	37
12. Experiment 1 Moving parts frequency .....	38
13. Experiment 1 Moving parts duration .....	38
14. Experiment 2 Doll and truck frequency.....	39
15. Experiment 2 Doll and truck duration .....	40
16. Doll w/wheels vs. truck w/stationary wheels frequency .....	41
17. Doll w/wheels vs. truck w/stationary wheels duration .....	41
18. Hard doll and soft truck frequency .....	42
19. Hard doll and soft truck duration .....	42
20. All phases outside cage condition.....	43
21. Experiment 2 In cage doll and truck frequency .....	45
22. Experiment 2 In cage doll and truck duration.....	45
23. Experiment 2 In cage doll w/wheels vs truck w/stationary wheels frequency .....	46
24. Experiment 2 In cage doll w/wheels vs. truck w/stationary wheels duration .....	47
25. Experiment 2 In cage hard doll and soft truck frequency .....	48
26. Experiment 2 In cage hard doll and soft truck duration.....	48
27. Experiment 2 All phases inside cage .....	50

## CHAPTER 1

### INTRODUCTION

Sex differences in mammalian species, including humans and non-human primates, extend beyond the obvious contributions to reproduction. In children, research suggests that there are many behavioral differences between boys and girls. These differences appear to originate from complex interactions between biological (e.g., genes and hormones) and socio-cultural environmental factors. The relative contributions of each of these factors in humans are essentially impossible to isolate given the complex interactions and the ethical limitations.

In non-human primate species, such as Rhesus monkeys (*Macaca mulatta*), studies demonstrated behavioral sex differences that parallel those in humans. One of the most common reported sex differences in humans, and more recently in non-human primates by Alexander and Hines (2002) and Hassett, Seibert and Wallen (2008), is the strong, rigid preference males show for masculine typed objects such as trucks. However, unlike in human studies, studies with non-human primates afford the opportunity to observe how biological factors influence these behavioral preferences without the presence of the same socio-cultural environmental factors that influence human behavior.

#### Sex Differences in Human Children

Much of the research examining sex differences in children falls into three major behavioral categories: emotional behavior, social behavior and play behavior. These broader categories can be further divided into many different activities. For example, emotional behavior includes aggression, fear and other states of arousal, social behavior



includes many kinds of interactions with parents and peers, and play includes both social and solitary activities that include toy manipulations and preferences.

Researchers use a variety of techniques for studying sex differences in children; ranging from observation in a natural setting with no interaction, to passive observation in a laboratory setting, to experimentally manipulated research involving specific kinds of interaction. Some of the research emphasizes socio-cultural influences on sex differences, such as a parent or caregivers' interactions with a child, whereas other research tends to focus on biological influences, such as the effects of hormone levels. Researchers, consistently report similar sex differences in the categories of emotional, social and play behaviors.

### Emotional Behavior

With respect to emotional behavior, sex differences are reported in aggression and sensation-seeking or risk-taking behaviors. Aggressive behaviors are generally defined as behaviors with the intention to hurt or harm others (Crick, 1996). Typically, preschool age boys show more aggression, particularly more physical aggression, than preschool age girls do (Juliano, Werner, & Cassidy, 2006; J. L. Martin & Ross, 2005; Ostrov & Keating, 2004). This sex difference in aggressive behaviors persists in school age children (Serbin, O'Leary, Kent, & Tonick, 1973). Crick and Grotpeter (1995) divided aggressive behavior into two forms: overt and relational aggression. Overt aggression (also referred to as physical aggression by some researchers) is described as "harming others through physical aggression, verbal threats, [and] instrumental intimidation" while relational aggression is "harming others through purposeful manipulation and damage of their peer relationships" (p. 711). Though boys show more aggression overall, when

researchers divide aggression based on the two forms (overt and covert/relational), girls are reported to show more relational or covert aggression (Crick, Casas, & Mosher, 1997; Ostrov & Keating, 2004).

In an observational study examining risk taking behavior at the zoo, Ginsburg and Miller (1982) found that boys were more likely than girls to partake in risky activities. Activities assessed by the authors as risky included elephant rides, interacting with a donkey that could bite, feeding animals alone at the petting zoo, and climbing a steep embankment and walking on a narrow ledge of a river. In each example, boys were more likely than girls to partake in these risky activities. It also appears that sex differences in sensation seeking or risk taking behavior persists into adulthood. In a study using the Sensation Seeking Scale undergraduate men scored higher than undergraduate women (O'Jile, Ryan, Parks-Levy, Betz, & Gouvier, 2004). Furthermore, men in a hurry were more likely to engage in a potentially risky situation, such as crossing a street without a red light, than women (Rosenbloom, 2006).

### Social Behavior

In addition to sex differences in emotional behaviors, research suggests that social behaviors differ between the sexes when examining parent-child interactions, adult-child interactions and peer interactions. It appears, in part, that parents may encourage or subtly discourage behaviors based on a child's sex. Parents and teachers may also communicate differently with a child depending on the child's sex.

Caldera, Huston and O'Brien (1989) found that parents subtly reinforced, by responding more positively and with more excitement, to their child's interactions with sex-appropriate toys. For example, when a daughter played with a doll, a mother would

react more positively than when her daughter played with a truck. Both mothers and fathers showed these subtle responses; however, neither parent blatantly discouraged play with toys considered to be appropriate for the opposite sex. In another study, such subtle reinforcement was linked only to boys. Both mothers and fathers responded more negatively to their sons play with girls' toys (Pasterski et al., 2005). This was not the case when daughters were playing with boys' toys. Perhaps parents found it socially acceptable for their daughters to play with trucks, but they did not consider it acceptable for their sons to play with dolls.

These socially acceptable standards are also present in other activities such as those related to teaching, technology and science. Parents were more likely to encourage computer usage for boys more than for girls (Simpkins, Davis-Kean, & Eccles, 2005) and were more likely to explain scientific activities to boys than to girls (Crowly, Raymond, Mikulich-Gilbertson, Thompson, & Lejuez, 2006). In addition to these activities, parents also differed in their teaching style. Mothers of infant sons ages 6, 9 and 14 months old were more likely to provide instructional means of communication instead of conversational means of communication (Clearfield & Nelson, 2006). In contrast, mothers of same age infant daughters communicated in a more conversational manner and generally spent more time interacting with their daughters. These differences in teaching style also extend to the classroom. Teachers appeared to communicate differently with a child based simply on the child's sex. Teachers provided more direction to boys than to girls (Serbin et al., 1973).

Not only do parents and other adults interact differently with a child based on sex, but children interact differently with one another based on sex. Group behaviors and

preference for working in groups or in pairs seems to be influenced by sex. When girls interact they typically split off into pairs, while boys tend to interact more in groups. Benenson and Heath (2006), in a study with ten year olds, found that boys were more likely to perform collectively as a group in same-sex group interactions, whereas girls were more likely to pair off within the same-sex group if put into larger group situations. In unstructured group interactions, preschool age boys were more likely to play in same sex groups and girls were more likely to play in same-sex pairs (Fabes, Martin, & Hanish, 2003).

Overall, children are more likely to select same sex peers as playmates (Colwell & Lindsey, 2005; Fabes, Martin & Hanish 2003). However, Alexander and Hines (1994) reported that play styles, and not sex alone, had an influence on selection of peers for play. Alexander and Hines study looked at children's preference for same sex peers and play styles using various cards with images drawn of boy and girl characters as well as play objects. Children were shown these cards and asked which playmate they preferred. Researchers reported that younger girls, ages 4-5, were more likely to select a same sex playmate, regardless of feminine play style. However, older girls, ages 6-8, were more likely to select playmates with feminine play styles, regardless of sex. Boys selected playmates based on masculine play styles, regardless of the playmates sex.

When children do play with peers of the opposite sex or are placed in coed pairs, behaviors may become more sex-typed. This exaggeration of an already existing bias is especially evident in boys. Boys tend to show greater adherence to masculine behaviors during coed play (Banerjee & Lintern, 2000; Green, Bigler, & Catherwood, 2004; Tarja Raag, December 1999). Serbin, Connor, Burchardt, and Citron (1979) reported that the

presence of an opposite sex peer influenced children's toy preferences. In this study, an observer watched children through a one-way mirror during periods of solitary play as well as play with peers. Children interacting with opposite sex peers were less likely to play with opposite sex-typed toys than when alone. Trautner (1995) looked at pairs of children playing in same-sex pairs compared to solitary play. In situations where children played in mixed sex pairs and had the option to select a figurine of a man or woman, they were more likely to select a figurine that had a sex congruent with their own, as opposed to selecting a figure of the opposite sex. In this study, boys seemed most influenced by the presence of another peer.

#### Play Behavior and Toy Preferences

One of the most significant sex differences in behavior both in human and non-human primates has been in play. The data consistently show sex differences in the styles of play behavior and in toy preferences. Harlow first used the term "rough and tumble play" in 1962 to describe behaviors observed in rhesus monkeys:

"rough-and-tumble play is strictly for the boys. I am convinced that these data have almost total generality to man. Several months ago I was present at a school picnic attended by 25 second graders and their parents. While the parents sat and the girls stood around or skipped about hand in hand, 13 boys tackled and wrestled, chased and retreated. No little girl chased any little boy, but some little boys chased some little girls (p. 5)."

Since the early, insightful observations of Harlow, other researchers have gone on to study play behaviors in children. Rough and tumble play in children is described by Pellegrini and Smith (1998) as "vigorous behaviors such as

wrestling, grappling, kicking and tumbling that would appear to be aggressive except for the playful context; chasing is sometimes included in this definition . . .”(p. 579). These authors also emphasize that rough and tumble play is “necessarily social”. In children, sex differences are similar to what Harlow observed in rhesus monkeys; that boys show more rough and tumble play than girls (Pellegrini, 1988; Pellegrini & Smith, 1998; Scott & Panksepp, 2003).

Also widely reported in the category of play behaviors, are sex differences in toy preference. According to Blakemore and Centers (2005) “. . . the fact that boys and girls prefer and play with different toys is one of the most well-established features of gender development in children’s early years.”(p. 620). This preference is such that boys and girls when given masculine, feminine and neutral typed toys regularly select toys typed for their particular sex. For example a truck is considered a masculine toy, a doll a feminine toy and an educational book a neutral toy (Campenni, 1999). Boys prefer masculine toys and girls prefer feminine toys (Alexander, 2003; Berenbaum & Hines, 1992; Blakemore & Centers, 2005; Campbell, Shirley, Heywood, & Crook, 2000; Eisenberg-Berg, Boothby, & Matson, 1979; O'Brien & Huston, 1985; Pasterski et al., 2005). Both boys and girls show equal preference for toys that fall into the neutral category. This sex-typed toy preference appears in very young children and seems to be present in other countries such as Sweden, which is considered more gender neutral than the United States (Nelson, 2005).

Children as young as 18 months show this preference for same sex-typed toys (Serbin, Poulin-Dubois, Colburne, Sen, & Eichstedt, 2001). In a similar study, Campbell et al. (2000) used looking times in young infants and found that boys at 9 months

preferred to look at masculine toys over feminine toys, but girls of the same age showed no preference. These data follow the idea suggested by Banerjee (2000) that girls may be less likely to adhere to gender typing as compared to boys which seem to have a stronger adherence to gender typed play and activities. Martin, Wood and Little (1990) suggest that children as young as 38 months recognize sex-typed toys and are more likely to select toys for themselves and others deemed appropriate for a particular sex. Children this age also recognize the sex of others and will select toys based on another peer's sex.

### Sex Differences in Rhesus Monkeys

Just as do humans, rhesus monkeys show a variety of sex differences in three major behavioral categories: emotional behavior, social behavior and play behavior. Similarly to the behaviors described of children, these broad behavioral categories include many different activities. Emotional behavior includes aggression, fear, and other states of arousal; social behavior includes parent-offspring, adult-offspring and peer interactions; and play includes both social interaction and solitary behaviors that include toy preferences.

#### Emotional Behavior

As in humans, male rhesus monkeys are generally more aggressive than females. However, just as in humans, the types of aggression may vary by sex and may differ with age. Mitchell (1979) reported that females threatened more, whereas males actually attacked more. Similar findings were noted by Bernstein, Gordon and Rose (1974). Although males attacked more often, “females supported and instigated the aggression of adult males in their group” (p. 9). These differences seem to parallel those of children wherein boys show more overt aggression and girls show more covert or relational

aggression. In rhesus monkeys, the recipient may also affect the outcome. In a study observing sex differences in adolescent rhesus monkeys, males showed significantly more aggressive behaviors such as biting and hitting toward other males, than toward females (Bernstein, Judge, & Ruehlmann, 1993).

Like humans, male rhesus monkeys are more likely to be sensation seekers or risk takers compared to females. This difference may, in part, be explained by the fact that rhesus monkey males emigrate from their natal troop between 3-5 years of age. When rhesus males emigrate they are essentially on their own and encounter dangers such as other stronger males or other xenophobic troops. When researchers examined serotonin levels in the cerebral spinal fluid of young males, low levels were correlated with aggression, social instability and premature death later in life (Howell et al., 2007). Low levels of serotonergic activity have also been linked with aggression and impulsivity in humans (Stanley et al., 2000).

#### Social Behavior

As in humans, parental behaviors vary as a function of the sex of the offspring. In rhesus monkeys, the mother is the primary care-giver. Thus, infants have more maternal influence than paternal influence. Mothers restrain and retrieve female infants more, but interact more and exhibit more play behaviors with male infants (Mitchell, 1979). Furthermore, mothers responded more to male infant “separation-rejection vocalizations” than to female cries (p. 273; Tomaszycski, Davis, Gouzoules, and Wallen, 2001). However, Brown and Dixson (2000) failed to find differences in mother-infant interactions based on the sex of the infant. Reported sex differences between mother-infant interactions may differ, but the literature is clear about peer interactions.



Just as in human children, juvenile and adolescent male and female rhesus monkeys show a strong preference for same sex peers. Bernstein et al. (1993) found that rhesus monkeys aged 2.5 and 4.5 years old preferred same sex peers for grooming, play and proximity of partners. One reason for this preference may be related to social structure. Rhesus monkeys exist in nature as troops containing female monkey matriline, their young offspring and adult males. Whereas females generally remain in the troop they were born into, males emigrate between 3-5 years of age (Berard, 1999). Early sex differences in social behaviors could be preparatory behaviors for emigration and later adult behaviors.

#### Play Behavior and Toy Preferences

Similar to sex differences in play behaviors observed in children, male infant rhesus monkeys exhibit significantly more rough and tumble play than do females. Young male rhesus monkeys tend to exhibit more play behaviors in general (Bernstein et al., 1974; Brown & Dixson, 2000; Lovejoy & Wallen, 1988; Mitchell, 1979; Wallen, 1996). Wallen (2005) describes rough and tumble play as “wrestling play, characterized by grappling and whole body involvement. Play may involve more than two animals. . .” (p.9). Recall Pellegrini and Smith’s (1998) definition of “necessarily social” rough and tumble play in children: “vigorous behaviors such as wrestling, grappling, kicking and tumbling that would appear to be aggressive except for the playful context; chasing is sometimes included in this definition . . .”(p. 579). The behaviors and contexts of rough and tumble play are so similar for both species, that if a definition were provided without a specific application to a human or non-human primate species it would be difficult to determine which species is being described.

### Relative Social and Biological Factors

Clearly there is interplay between social factors and biological factors that shape observed sex differences in human and non-human primate behaviors. In order to determine the relative contributions of biological factors without significant social influence, researchers have examined naturally occurring anomalies such as Congenital Adrenal Hyperplasia (CAH) in women and have utilized non-human primate models. Such research suggests that sexually dimorphic behaviors such as rough and tumble play, aggression and sex-typed toy preference may be strongly influenced by hormonal factors.

CAH is a condition in which females are exposed to unusually high levels of androgens during prenatal development. The level of androgen exposure varies from individual to individual with some cases classified as severe, whereas others are classified as mild. In severe cases of CAH, high levels of androgens not only disrupt internal organization of the central nervous system, but also influence development of external genitalia. In severe cases, individuals' genitalia become ambiguous or masculinized. In cases where CAH is identified early, individuals receive corrective surgery shortly following birth; however no such corrective measures exist for altering the organizational effects that androgens have on the brain during development. CAH girls typically display masculine typed-behaviors such as a higher frequency of rough and tumble play, increased aggressive behaviors and a preference for masculine typed toys (Berenbaum & Hines, 1992; Pasterski et al., 2005; Pasterski, Hindmarsh, Geffner, Brook, Brain & Hines, 2007; Servin, Nordenström, Larsson, & Bohlin, 2003).

As discussed earlier, aggressive behaviors appear to be sexually dimorphic at least with respect to types of aggressive behaviors, with girls being more covertly aggressive

and boys showing more overtly aggressive behaviors. A recent study by Pasterski et. al. (2007) suggests that this dimorphism in behavior may have biological roots. In a questionnaire style-report mother's were asked to rate their child's behaviors, questions included: "My child is physically aggressive with peers" and "My child gets into fights with other children" (p.4). The groups of children ranged in age from 3-11 years old, and consisted of CAH girls, unaffected sisters, CAH boys and unaffected brothers. CAH girls were shown to have increased levels of aggression and activity compared to unaffected controls. The authors of this study did not differentiate between overt and covert aggression. However, based on the questions provided in the questionnaire, it appears that the emphasis was on physical aggression. These data imply that hormonal influences and their internal organizing effects impact [physical] aggression and activity level. Aggressive behaviors of CAH girls also appear to persist into adulthood. Mathews, Fane, Conway, Brook, & Hines (2008) found that CAH women ages 12-44 years old, displayed more physical aggression and showed less interest in infants than women who were unaffected by this condition

Researchers have also studied characteristics of children's free drawings. Iijima, Arisaka, Minamoto, & Arai, (2001) examined differences between 5-6 year old CAH girls, unaffected girls, and boys. Unaffected girls and boys significantly differed in the objects that they drew and the colors that they used. Girls were much more likely to draw people, especially girls or women, whereas boys were much more likely to draw moving objects such as vehicles or trains. Generally girls used warmer colors such as reds and pinks and boys used fewer colors which tended to be cooler. Consistent with the findings on play and aggression, CAH girls' drawings more closely resembled unaffected boys'

drawings than unaffected girls' drawings. CAH girls were more likely to use cooler colors and draw masculine typed objects such as vehicles.

Research looking at toy preferences in CAH girls directly coincides with the results of the drawing study previously described, namely that CAH girls prefer to play with masculine typed objects (e.g., trucks) rather than feminine type objects (e.g., dolls). The toy preferences of CAH girls suggest that hormones may have a strong influence on children's preferences for particular objects or toys. However, it is essentially impossible and unethical to isolate the social or biological influences on children's toy preferences. In a study Pasterski et al. (2005) looked at parental influences on children with CAH and their siblings. The study reports that though parents tended to give more positive feedback to their CAH daughters when the girls were playing with girl's toys as compared to their unaffected daughters, the data only approached significance. Also, the CAH girls were reported to prefer boy-typed toys regardless of the presence or absence of their parents. This result suggests perhaps that parental influence was being overridden by hormonal influences. However, this study was conducted in a laboratory playroom setting, and each child was observed for only 24 minutes maximum. The artificial setting and short period of time each child was observed gives researchers only a glimpse of parent-child interactions.

Since it nearly impossible to isolate social or biological factors influencing sex differences in human behaviors, researchers have turned to non-human primate models. Rhesus monkeys are the primary non-human primate preferred by researchers because of their physiological and genetic closeness to humans (Consortium et al., 2007) as well as their availability for research. Due to their complex cognitive abilities and the elimination

of human societal factors, rhesus monkeys provide an excellent model for examining biological influences on cognition and behavior.

### Sex Biased Object Manipulation in Monkeys

#### Previous Studies and Limitations

Thus far, two studies examining toy preferences using non-human primates have been conducted. Both indicate that the preference for gender-specific toys may have evolved earlier in the primate lineage and may be present in old world monkeys. The earlier of the two studies used vervet monkeys (*Cercopithecus aethiops sabaesus*) (Alexander & Hines, 2002). In this study, a total of 2 masculine, 2 feminine and 2 neutral typed (commercially available) children's toys were provided to three different groups of socially housed vervet monkeys. The feminine toys were a soft doll and a red cooking pan. The masculine toys were a ball and a police car. The neutral toys were a picture book and a stuffed dog. Each group of monkeys ranged from 18-23 members. Each group received a preliminary "familiarization trial" to accustom animals to the objects and the experimenter, and then received either 1 or 2 test trials separated by a one week interval. For each trial, all six toys were presented individually to each group for 5 minutes. The trials were videotaped and later scored for approach and contact. In this study, males had a higher contact scores with the masculine toys whereas females spent more of their time with the feminine toys.

The second study used rhesus monkeys as a non-human primate model (Hassett et al. 2008). In this study, 61 female and 21 male rhesus monkeys, all housed in a large social group, were given an opportunity to manipulate six masculine or "wheeled" toys and seven feminine or "plush" toys. The six wheeled toys were a wagon, a truck, a car, a

construction vehicle, a shopping cart, and a dump truck. The seven plush toys were a Winnie-the-Pooh™, Raggedy-Ann™, a koala bear hand puppet, an armadillo, a teddy bear, a Scooby-Doo™ and a turtle. The researchers explain that the toy sets were selected based on specific properties which made the categories comparable to stereotypical gender assignments, though such properties were not discussed. They also noted that the objects ranged in length from 16-46cm, and that there was considerable variation in shape and color. Seven trials of 25 minutes were conducted and frequency and duration of behaviors were recorded. Each trial was conducted as follows: monkeys were moved to the indoor part of the pen and then one plush and one wheeled object were placed in the outdoor part of the pen. To prevent side biases, object were placed on the right and the left across trials. Monkeys were then released into the outdoor area, and interactions with each object were videotaped. Videotapes were later coded for interaction with a specific object, monkey and rank, and specific behaviors directed toward an object such as: “hold, sit on, carry in mouth, throw” (p.3). Researchers report that male monkeys showed a greater preference for wheeled objects, and female monkeys did not show a strong preference for either type object. When researchers considered rank and age in their analysis of preference, neither factor was found to be significant. However, rank did affect total object interaction in females, with higher ranking females showing more interaction with objects.

Although both studies suggest that gender specific toy preference may exist in old world monkeys, the methodologies leave room for improvement. Specific problems relate to the length of the test sessions, the number of test sessions, how the objects were presented, the nature of the objects, and the social testing situation. With respect to the

length and number of test sessions, the vervet monkey study data are quite limited.

Vervet monkeys housed in 3 social groups had only two 5-minute testing sessions in which to manipulate objects, and in the case of one group, weather conditions reduced the number of sessions to a single 5-minute testing session. The rhesus monkeys had more (7) and longer testing sessions (25 minutes) but the group size of 82 and the tendency of rhesus monkeys to monopolize objects when first encountered may still be problematic. When testing animals in large social groups, it is important to provide sufficient trials and sufficient time per trial in order to insure that a reasonable number of animals actually get to manipulate the objects for a measurable period of time.

For each study, the objects were presented in different ways. For the vervet monkeys, the objects were presented in series rather than simultaneously. Objects should have been presented simultaneously so that monkeys could actually select one object over the other, and researchers could record a choice. By presenting objects individually and serially, the monkey's 'preferences' could be due to an order effect; the presentation of one object before the next object influences the monkey's perception of it and therefore makes the object more or less desirable. Or conversely, the monkeys might grow less interested in objects across a session (i.e. habituation). In the rhesus monkey study, the objects were presented simultaneously, mitigating these concerns.

A third consideration that researchers in both studies seem to have overlooked is the suitability of objects. Researchers in the vervet monkey study used a picture book and a stuffed dog as neutral typed objects. However, it is questionable how neutral a stuffed dog is compared to a plush doll, at least from a monkey's perspective. In the rhesus monkey study, all plush objects were grouped into a feminine category. Objects were

defined as masculine or feminine by specific object properties, but these properties were not described. Another consideration that may have biased preferences in the rhesus monkey study was the variability between the objects. The researchers noted that the objects ranged in length from 16 to 46cm, with one object being more than double the size of another. The color and shape of the objects also varied considerably. Thus, it was possible that monkeys were choosing on the basis of size or color and not on the basis of sex-typed toys.

Finally, a significant problem with both studies is the presentation of objects to socially housed monkeys. There are several issues that arise when testing animals in social settings. First, there is the tendency for monkeys to monopolize objects which in a time-limited session decreases the chances for other monkeys to interact with the objects. Some animals may choose a less desired object because they can access it, not because they prefer it. Did the rhesus monkey females end up with the plush objects because the males had priority of access to the wheeled objects? Additionally, another confounding variable is social facilitation. Rhesus monkeys are influenced by conspecifics and tend to show parallel toy play when manipulating objects (Wechkin, 1970; Novak, Musante, Munroe, & O'Neill, 1993). Lastly, because the behavior of animals in social groups is not independent, it could be argued that the rhesus monkey study represented only one case. In that regard, the vervet monkey study at least had 3 social groups. Clearly to eliminate both social facilitation and the independence problem, monkeys should be tested individually.



## Objectives of this Project

The purpose of this project was to examine the hypothesis that rhesus monkeys show a sex-typed toy preference similar to the preferences reported for humans. This project was divided into 2 parts. In the first part, the focus was on determining how color and moving parts influenced toy selection in rhesus monkeys. The second part was concerned with testing preferences of rhesus monkeys for sex-typed toys as based on the human literature (i.e., doll vs. truck) and determining the basis of that preference. For each experiment, animals were tested individually in their home cage.

Because sex-biased toys may also differ on a number of dimensions, it is important to initially test for such preferences. For example, colors may strongly affect object choice, although the evidence for a sex bias in color is stronger in children than in monkeys. As noted previously, boys prefer cooler colors such as blues, whereas girls prefer warmer colors such as reds and pinks (Alexander, 2003; Iijima et al., 2001; Picariello, Greenberg, & Pillemer, 1990). In the vervet monkey study, the authors' reasoning for using the red pan as a feminine toy was because "color may provide an important cue for female interest (p. 474)". Higley, Hopkins, Hirsch, & Marra (1987) found that rhesus females showed a preference for infants whose faces had been dyed pink in comparison to normal colored infants, and infants whose faces had been dyed green. However, a more recent study by Gerald, Wait and Maestriperi (2006) using digitally colored photographs of rhesus infants failed to find a difference based on the coloration of the infant photos. Although rhesus infants are born pink faced, adult female rhesus also show characteristic reddening of hind quarters as a sexual attractant signal to males

(Waite, Gerald, Little, & Kraiselburd, 2006). Therefore, with rhesus monkeys, red may be an attractive color to both sexes.

The presence of moving parts may also affect toy preference. Gramza (1976) reported that children prefer play objects that afford the opportunity for manipulability, with this preference being stronger for boys. Another study examining activity level and toys, suggests that masculine typed toys such as tools, a train, and a truck promote activity (O'Brien & Huston, 1985). Authors of the vervet monkey study explained the use of the ball and the truck as "objects with an ability to be used actively" (p. 475). It also seems that the researchers in the rhesus study took manipulability into consideration because all their masculine typed objects had wheels.

In the first part of this project, both color and mobility were examined. In Phase A, we examined the monkey's preference for red and blue objects. In Phase B we examined preference for objects with a moving part (a ring with a fixed attached ring vs. a ring with a movable attached ring).

The purpose of the second part of this project was to confirm the results of previous human and nonhuman primate studies, namely, male preference for masculine typed toys and female preference for feminine toys. In the vervet monkey study, the authors were aware of color preferences and provided reasons for the use of the red pan but did not control for the colors of the masculine and feminine objects. There was no control over color preferences in the rhesus monkey study. To control for possible color preferences, all studies were conducted using white stimuli because white is thought to be an essentially neutral color. A white PVC truck served as a masculine toy and a white canvas doll served as feminine toy. Both dolls and trucks have been consistently

described as masculine and feminine toys, respectively. (Alexander, 2003; Blakemore & Centers, 2005; Berenbaum & Hines 1992; Campbell et al., 2000).

### Hypotheses and Predictions

Hypothesis 1: Monkeys will show a sex bias in their preference for colored objects and for objects with moving parts.

#### Predictions

1. Male monkeys will prefer the blue jackeroo toys compared to red jackeroo toys
2. Female monkeys will prefer the red jackeroo toys compared to the blue jackeroo toys.
3. Male monkeys will prefer the object with moving parts.
4. No prediction is made with respect to female monkeys and moving parts

Hypothesis 2: Monkeys will show a sex biased preference for masculine and feminine toys.

#### Predictions

1. Male monkeys will prefer the truck over the doll.
2. Females will prefer the doll over the truck.
3. Male monkeys will prefer the truck because of particular characteristics such as the wheels and the hard material.
4. Female monkeys will prefer the doll because of the plush material.

## CHAPTER 2

### METHOD

#### Subjects and Housing

Subjects are 10 rhesus monkeys (*Macaca mulatta*), eight of which are surrogate peer-reared (4 males and 4 females ranging in age from 4-7 years) and two of which are mother peer-reared rhesus monkeys (2 females ranging in age from 18-20 years). The surrogate-peer reared monkeys were raised for the first year of life at the National Institutes of Health Animal Center in Poolesville, Maryland. The surrogate-peer reared rhesus monkeys were reared according to the protocols at the NIH in which they were removed from their mothers at birth and were placed in incubators and raised with fleece covered, floor mounted, rocking surrogates. After the first 4 weeks, infants received daily interaction with like-reared peers for about an hour a day. This rearing condition has been shown to promote virtually all normal species typical behaviors including appropriate social interactions (Novak, O'Neill, & Suomi, 1992). At approximately 1 year of age, monkeys were transferred to the UMass Primate Facility in Amherst, Massachusetts. The mother-peer reared monkeys were obtained from the University of Massachusetts Medical Center in Worcester, Massachusetts when the females were 18 and 20 years of age. Other than a general statement about mother-peer rearing, the early history of these animals is largely unknown. See Table 1 below for detailed information on each monkey.

Table 1: Summary of Monkey Information

Monkey	Sex	Age	Housing conditions	Housing Dimensions (w x h x l in meters)	Institution of Origin	Rearing Condition
6NS	F	23	Pair housed with 3E2	Standard quad cage	Unknown	Mother-reared
3E2	F	24	Pair housed with 6NS	Standard quad cage	Unknown	Mother-reared
V38	F	9	Individually housed	1.2192 x 1.8228 x 1.8228	NIH	Surrogate Peer-reared
V42	F	9	Housed with 2 offspring	1.2192 x 1.8228 x 1.8228 Sleep cage 0.635m off floor: 0.9144 x 0.9144 x 1.2192	NIH	Surrogate Peer-reared
V43	M	9	Individually housed	1.2192 x 1.8228 x 2.4384	NIH	Surrogate Peer-reared
V27	M	9	Individually housed	2 each: 1.2192 x 1.2192 x 2.1336	NIH	Surrogate Peer-reared
ZA54	M	6	Individually housed	Allentown Units 1.778 x 08636 x 2.0193	NIH	Surrogate Peer-reared
ZA56	F	6	Pair housed with ZA65	Allentown Units 1.778 x 08636 x 2.0193	NIH	Surrogate Peer-reared
ZA63	M	6	Individually housed	Allentown Units 1.778 x 08636 x 2.0193	NIH	Surrogate Peer-reared
ZA65	F	6	Pair housed with ZA56	Allentown Units 1.778 x 08636 x 2.0193	NIH	Surrogate Peer-reared

At the UMass Primate Lab, monkeys have access to water at all times and are fed Purina monkey chow in standard rations, twice daily. The chow diet is supplemented with treats and vitamins in the morning from a list of items that include fresh and dried fruits and vegetables, rice cakes, cereals, peanuts, and monkey dough (Bioserv). Cages are cleaned twice daily, in the mornings and afternoons. Colony room ambient temperatures average around 32°C and monkeys are housed in a 13-11 hour light-dark cycle. Monkeys are provided with daily enrichment in accordance with USDA regulations for enrichment and well-being guidelines.

All animals had been used previously in other types of cognitive testing in which they are required to reach out of their cages to select objects. However, none of the other tests examined sex-typed object preference and therefore, monkeys had no prior exposure to masculine or feminine typed objects such as dolls or trucks. Monkeys did have gender neutral objects in their home cages such as hard rubber Kong toys, other hard rubber or plastic balls, Nylabone plastic bones or barbells, and PVC rods at all times which provide environmental enrichment (See Figure 1). The types of objects used for the described experiments were novel in shape at the beginning of testing; however, some of the materials and colors were the same materials as the monkeys' home-cage objects. The described study consists of two experiments: 1: Object Preference and 2: Sex-typed Object Preference.



Figure 1 Home cage objects

### Experiment 1: Object Preference

Experiment 1 served to establish monkeys' preferences for particular characteristics of objects, specifically color and moving parts. Thus, Experiment 1 had two conditions, Phase A: Color Preference and Phase B: Moving Parts Preference (See Table 2 below).

Table 2: Summary of Experiment 1 and Conditions  
Experiment 1-Object Preference

Phase	Condition	Test paradigm
A	Color	outside cage
B	Moving Parts	outside cage

## Materials

### Phase A: Color

In phase A: Color, the monkeys were presented with Jackeroo hard rubber objects (See Figure 2). These objects were small enough for the monkeys to manipulate, but large enough so that they could not be pulled into cage. The two objects were identical, except for color; with one object colored red and the other colored blue. All monkeys had previous exposure to both red and blue objects, as well as the hard rubber material the Jackeroos were made from. However, the Jackeroos were novel due to their unique shape.



Figure 2: Jackeroos; red left, blue right

### Phase B: Moving Parts

In phase B: Moving Parts, the objects used were a moving object and a non-moving object. Each object consisted of white interlocking PVC rings, with one of the interlocking rings slightly smaller than the other (See Figure 3). The rings were small and light-weight so that the monkeys could easily pick them up and manipulate them, but they could not be pulled into the cages. The moving object consisted of two interlocking, freely moving rings. The fixed object consisted of two interlocking, fixed rings. Both the moving and the fixed objects were identical in shape, color and size.



Figure 3: Moving parts objects  
Non-moving left, moving right

### Procedure

For each phase, each pair of objects was simultaneously presented to each monkey outside the cage. The position of the objects was alternated to control for possible side bias. Prior to the beginning of each testing session, two experimenters (A and B) silently entered a colony room and set up a camera, angled for optimal viewing, in front of the monkey's cage. Experimenter A placed both objects at floor level in front of the monkey's cage but out of its reach. The video camera was set to record, and both experimenters faced the monkey's cage (See Figure 4). During the session, the experimenters remained silent, unless the monkey did not notice the objects; in this case the experimenter may have called the monkey's name and tapped the floor between the two objects to get the monkey's attention. Once experimenter B started the camera recording, experimenter A simultaneously pushed the two objects directly in front of the monkey's cage, while avoiding eye contact. Once the objects were placed within the monkey's reach, experimenter A moved away from the monkey's cage and experimenter B started the 5 minute timer. Each time the monkey contacted either object with any body part including hands, feet or mouth, experimenter B recorded contacts on a data sheet. If the monkey moved an object out of reach, experimenter A returned the object to the original position and experimenter B marked a reset on the a data sheet. Once the object was replaced, experimenter A moved away from the monkey's cage. At the end of the 5



minute session, experimenter B stopped the camera recording and experimenter A retrieved the objects. At the completion of the session, the experimenters silently exited the rooms with all experimental supplies. The objects were then washed with water and a mild detergent and dried with disposable paper towels.

In order for monkeys to move on from Experiment 1: Object Preference to Experiment 2: Sex-typed Object Preference, and consecutively through each phase of Experiment 2, they must have manipulated objects during Experiment 1.

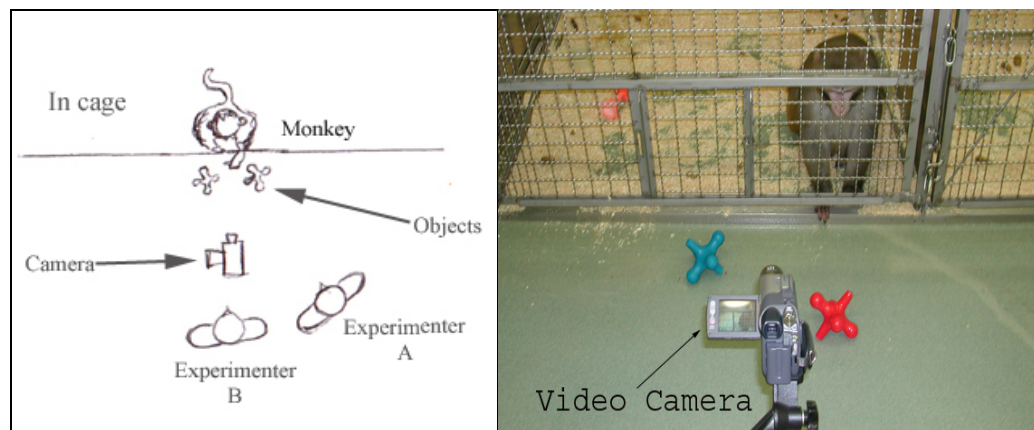


Figure 4: Aerial view of experiment    Experimenter B's view: V27 has moved red object away

### Experiment 2: Sex-typed Object Preference

This experiment served to examine monkeys' preferences for masculine or feminine typed objects and consisted of three phases: Phase A: Masculine vs. Feminine Objects, Phase B: Moving Wheels vs. Fixed wheels, and Phase C: Hard PVC vs. Stuffed Canvas. The first two phases in experiment 2 had two testing paradigms: objects placed outside the cage and objects placed within the cage. (See Table 3).

Table 3: Summary of Experiment 2 and Conditions  
Experiment 2- Sex-typed Object Preference

Phase	Condition	Test paradigm
A	Masculine vs. Feminine Objects	in/outside cage
B	Moving Wheels vs. Fixed Wheels	in/outside cage
C	Hard PVC vs. Stuffed Canvas	in/outside cage

## Materials

### Phase A: Masculine vs. Feminine Objects

The objects presented to the monkeys were a doll and a truck. The truck weighed approximately 800 grams and the doll weighed approximately 300 grams. Both objects were approximately 20.32 cm long and measured about 15.24 cm across. This weight and size allowed the monkeys to easily manipulate each object while maintaining characteristics that categorize the doll as a feminine object and the truck as a masculine object.

The doll was constructed of heavy duty white canvas, stuffed with pine shavings. The seams were double stitched with a sewing machine and reinforced by hand. A piece of PVC was placed inside the doll's head to prevent the monkeys from being able to pull it into the cage during the out of cage testing paradigm. A 0.635cm pipe of PVC measuring 12.5 cm long was also placed inside to stabilize the neck of the doll. The doll was semi-flexible and was similar to a stuffed, commercially available doll. The doll's face was drawn with a black Sharpie marker and consisted of two eyes, two nostrils and a single line for a mouth (See Figure 5).

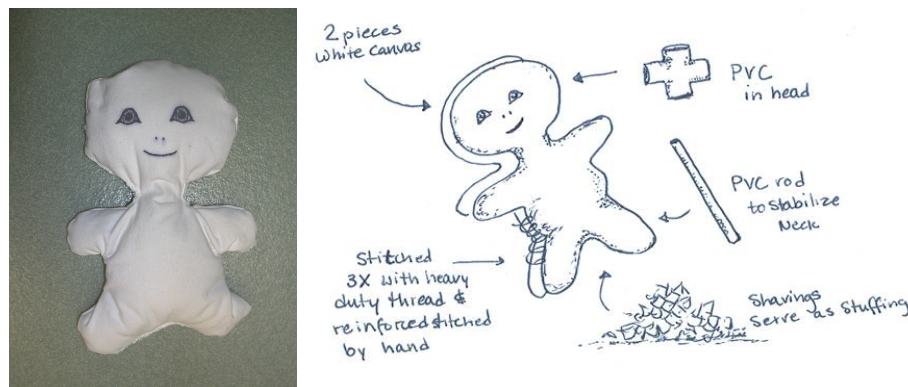
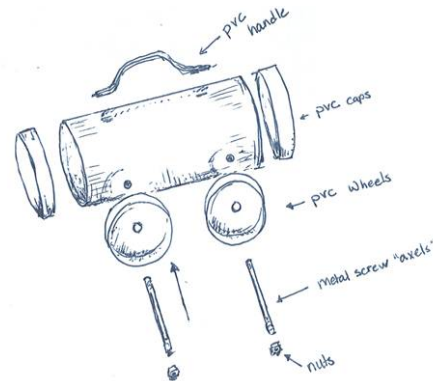


Figure 5: Doll and doll design

The truck was constructed of white PVC. It had a 10.16 cm PVC pipe measuring 15.24 cm long serving as the body. Each end of the pipe was closed with 10.16 cm PVC caps, secured with PVC adhesive. Four 6.35 cm PVC caps served as the wheels for the truck. The wheels were able to freely rotate on 0.635 cm metal rods serving as axels. Metal nuts were used to secure the wheels onto the rods and the ends of the rods were hammered to prevent the wheels and/or nuts from coming off. A PVC strip/handle was attached with PVC adhesive to the dorsal surface of the truck so the monkeys could grip the object better. The four wheels and nuts were able to rotate freely and independently of each other; though the wheels could rotate simultaneously if the truck was rolled along a surface (See Figure 6).



Figure 6: Truck and truck design



After the initial testing of the doll and truck, certain characteristics of the doll and the truck (moving parts and softness) were manipulated to determine what might drive sexually differentiated preference. See Table 4 for the object characteristics to be manipulated.

Table 4 Object Characteristics

Phase	Doll	Truck
B	Moving Wheels	Fixed Wheels
C	Hard PVC	Stuffed Canvas

### Phase B: Moving Wheels vs. Fixed Wheels Objects

In this phase, the objects were nearly identical to the objects in Experiment 2 Sex-typed Object Preference Phase A Doll vs. Truck conditions, except the doll had moving PVC wheels attached with metal axels and metal nuts (See Figure 7). The truck had the same components except the wheels and nuts were fixed so the wheels could not rotate and monkeys were not able to move them.

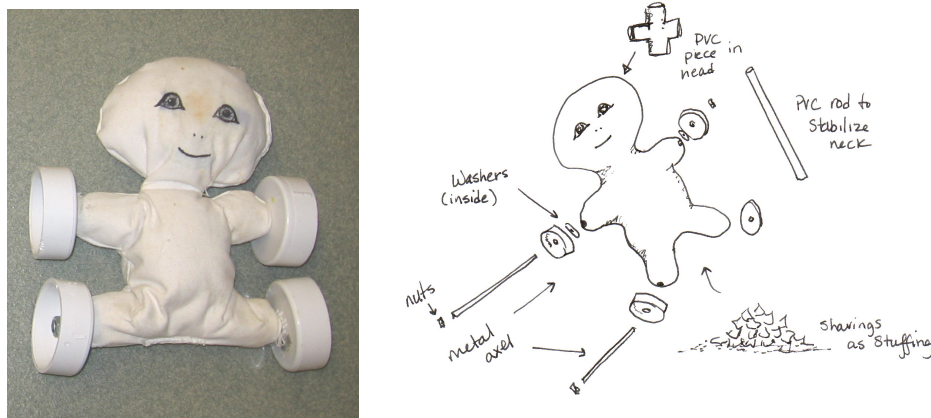


Figure 7 Doll with moving wheels and design

### Phase C: Hard PVC vs. Stuffed Canvas Objects

For this phase, the doll was constructed of white PVC. It had a 10.16 cm PVC pipe, serving as the trunk of the doll. The doll's head consisted of 2, 10.16 cm, caps secured together with PVC glue and a flat piece of PVC inside served as a reinforcement component. The head was attached to the body on the inside with metal screws. The doll's limbs were 0.635cm pipes, closed off with PVC end caps and secured with PVC glue. The doll was about 30.48 cm long (from the tip of the head to the end of the legs) and had a width, from the end of one arm to the other, of 25.4 cm. Additionally, inside the doll's main trunk, a PVC elbow adhered the doll's legs with PVC glue to ensure durability and stability. A PVC connector, inside the main trunk of the doll, attached to

the two arms with PVC glue, provided durability and stability of the doll's arms. The doll's face was drawn with a black Sharpie marker and consisted of two eyes, two nostrils and a single line for a mouth. (See Figure 8)

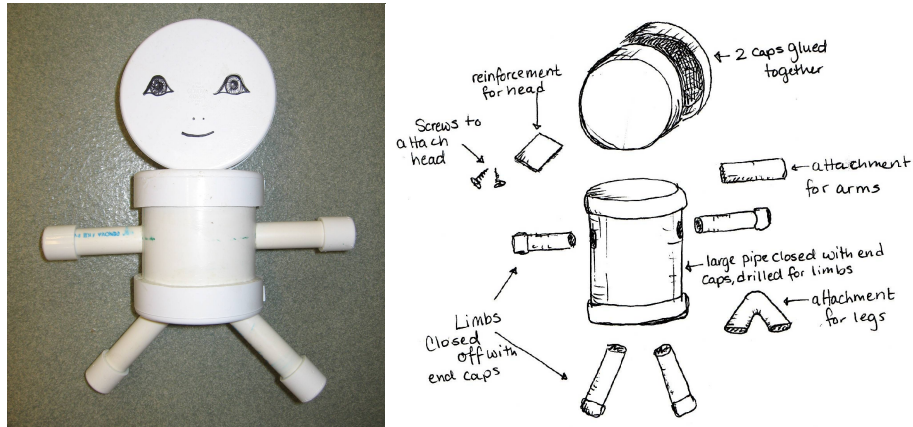


Figure 8 PVC doll and design

The truck, for this phase, was constructed from white canvas stuffed with shavings. The seams were double stitched with a sewing machine and reinforce-stitched by hand. Four “wheels”, which were doughnut shaped pillows, were constructed from white canvas and stuffed with shavings. These “wheels” were sewn onto the main cylindrical body of the truck. The “wheels” on the soft truck object did not rotate. The truck's body measured 22.6 cm long and 12.7 cm across, from wheel to wheel. Each wheel was 7.62 cm. (See Figure 9).

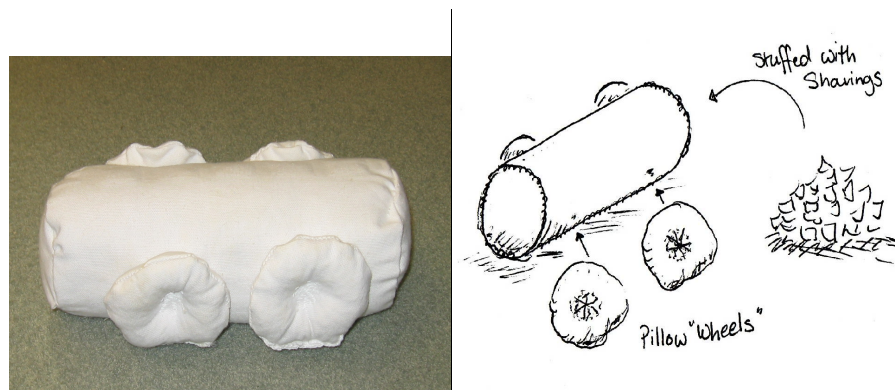


Figure 9 Canvas truck and design

## Procedure

### Objects Placed Outside the Cage

The general procedure for objects outside the cage was the same as in Experiment 1, except at the end of the session stuffed objects were wiped clean with a damp paper towel and sprayed with a pet safe deodorizer, such as pet safe Febreze.

Since the monkeys had no previous exposure to masculine or feminine typed toys, a minimum of five, 5-min sessions, was necessary to establish preferences. Monkeys were tested until they ceased contact with objects for three consecutive sessions, or until they had six sessions in which contact with an object had occurred. A session with contact was considered any session in which a monkey contacted an object with a hand, foot or mouth at least one time. If a monkey was given a five minute session and no contact occurred, the next testing session was considered a re-run of the previous session. See example 1 and 2 below. In example 1 the monkey did not contact during the first session, so the next session was set-up as a rerun of the first. The monkey then consecutively contacted objects until six sessions were scored. In example 2 the monkey ceased contacting objects after day two and that cessation lasted for three consecutive sessions.

Example 1

<b>Day</b>	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
<b>Session #</b>	Session 1	Session 1 re-run	Session 2	Session 3	Session 4	Session 5	Session 6
<b>Contact</b>	No	Yes	Yes	Yes	Yes	Yes	Yes

Example 2

<b>Day</b>	Day1	Day2	Day3	Day4	Day5
<b>Session #</b>	Session 1	Session 2	Session 3	Session 3 re-run	Session 3 re-run
<b>Contact</b>	Yes	Yes	No	No	No

### Objects Placed Within the Cage

After testing monkeys with the objects outside the cage, a single session was run with the objects placed inside the cage. The purpose of this was to see if we could obtain any additional information about specific behavioral interactions with the objects beyond the type of contacts we may have observed outside the cage. Prior to the beginning of each session, two experimenters (A and B) silently entered a colony room and set up the camera in front of the monkey's cage angled for optimal viewing (typically from an aerial perspective). Experimenter A divided the monkey's cage, using a partition to section the cage into the *empty side* and the *monkey side* (the side with the monkey). Then experimenter A opened the *empty side* and placed the objects side by side but not touching, equidistant to the area where the monkey would enter the cage area. Next, experimenter A closed the cage and then removed the partition allowing the monkey to enter the area with the objects (formerly the *empty side*). Experimenter B started the camera as the monkey approached the objects. Experimenter A was in charge of monitoring the video camera and adjusted the view in order to record optimum video. Experimenter B started the timer as soon as the monkey made an initial contact with either object. Experimenter B recorded the number of contacts the monkey had with an object using any body part including a hand, foot, mouth, or sitting on an object. Each session lasted 10 minutes starting from the monkey's initial contact of either object and timed out after 20 minutes if no contact was made. Each monkey was given a single session.

### Behavioral Scoring System and Reliability

Measures of frequency of contact and duration of contact were obtained through behavioral coding using computer software, a camcorder, and a television. A television and camcorder were used to view videos of test sessions. Contact frequency and duration were scored using JWatcher, version 1.0 data capture program (2000-2007--Daniel T. Blumstein, Janice C. Daniel, & Christopher S. Evans) software that was set up on a laptop computer. The laptop was placed next to the television so the experimenter was able to view the television screen as well as utilize the laptop to score the videos. Videos were scored by two experimenters and in some cases a third experimenter re-scored videos. Experimenters needed to become reliable on each monkey at a 90% level of confidence before scoring videos. Frequency-of-contact data collected with JWatcher were spot checked against frequency of contact data collected by experimenter B during testing sessions. Reliability was checked at a 90% level of confidence. If inter-observer reliability did not meet the 90% level of confidence criterion, then sessions were re-scored from video by a third experimenter. Twelve sessions needed to be re-scored from video by the third experimenter, because the original scores failed to meet the inter-observer reliability criterion..

### Data Analysis

Frequency of contact and duration of contact data collected during the test paradigm outside the cage were analyzed as follows: Monkeys participated in a different number of sessions in each phase, and thus raw frequency of contact scores were summed for each monkey and divided by the number of sessions each monkey participated in, giving an average frequency of contact score (for each monkey) for each phase.



Similarly, raw duration of contact scores were summed for each monkey, divided by the number of sessions the monkey participated in, thus providing an average duration of contact score (for each monkey) for each phase. Analyses were obtained using MYSTAT Data Analysis Program (Version 12, SYSTAT, Inc.). Average scores for individual monkeys were log transformed due to heterogeneity of variance. The data were then analyzed with a mixed design ANOVA with sex as the between subjects variable and object type as the within subject variable with the probability level set at  $p < .05$ . Because the question of interest concerned whether there was sex bias in object preference, the relevant factor in the ANOVA was the interaction term (sex by object type). In the results section, the interaction effects are described first followed by the main effect of object type (whether all animals regardless of sex preferred one object over the other). Any main effects of sex (whether one sex had a higher response rate compared to the other sex regardless of object type) are only reported if there was a significant difference. The ANOVA provides an overall view of grouped responses. However, object preferences at an individual level were also considered with binomial probabilities using 0.50 as the chance probability and employing one tailed test or two tailed tests based on specific predictions. Raw frequency of contact scores for individual monkeys were summed across sessions for each phase, both by object and by contacts overall. These data provided individual proportion of contact scores for each object and respective phase.

For the testing paradigm inside the cage, contact frequencies and durations were analyzed essentially the same as the outside cage testing, as reported above. The only exception was that a single trial was run for each monkey during the in cage testing,

therefore there was no need to calculate individual averages. Individual preferences were analyzed using binomial probabilities.

## CHAPTER 3

### RESULTS

#### Experiment 1: Object Preference

##### Outside Cage Condition

##### Phase A: Color

In contrast to findings in the human literature, rhesus monkeys did not show a sex-typed preference for red or blue objects. There was no significant interaction of sex by object type for either frequency ( $F(1,8)=0.717$ ,  $p=0.422$ ) or duration ( $F(1,8)=0.311$ ,  $p=0.592$ ). Instead, monkeys as a group preferred the blue object to the red object. Thus, there was a significant main effect for object type both for frequency ( $F(1,8)=9.09$ ,  $p=0.017$ ) and for duration ( $F(1,8)=8.248$ ,  $p=0.021$ ). See Figure 10 and 11. Using binomial probabilities, six of the ten monkeys showed a preference for blue objects at an individual level. Three out of six females preferred the blue objects, whereas the other three females showed no significant preference. Three out of four males showed a preference for the blue object, whereas one male showed no significant preference (See Table 5).

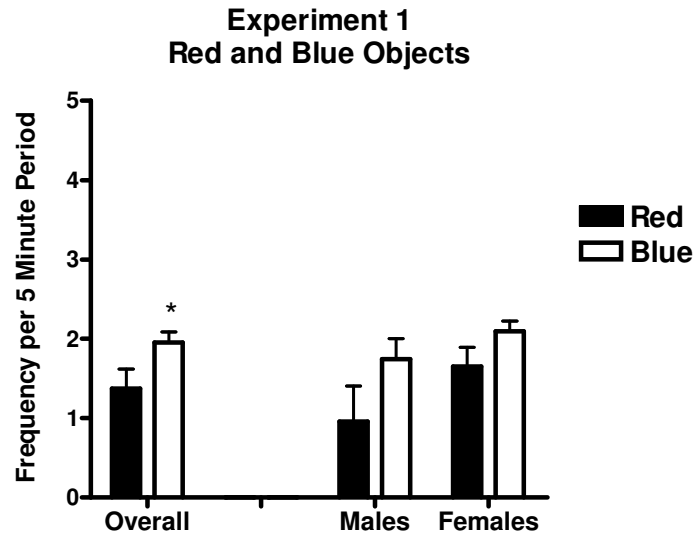


Figure 10: Experiment 1 Red and blue objects frequency

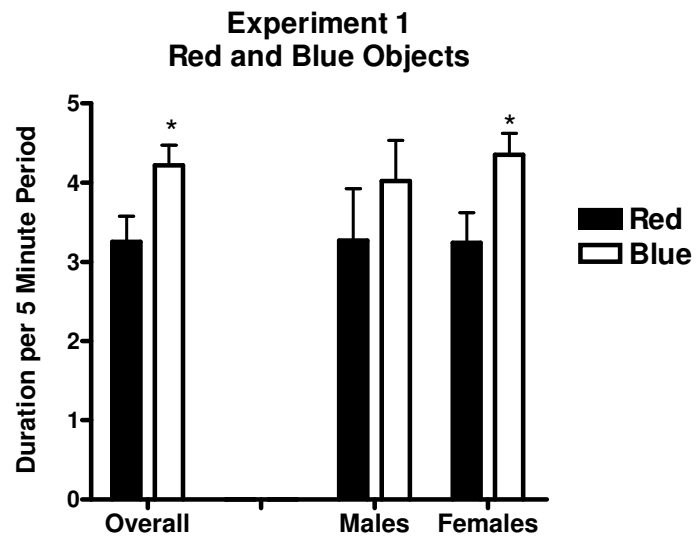


Figure 11: Experiment 1 Red and blue objects duration

Phase B: Moving Parts

In contrast to the expectation that males would prefer moving versus non-moving parts, no significant preference was observed for the moving or stationary interlocking PVC rings as a function of the interaction of sex with object type for frequency ( $F(1,8)=0.209, p=0.662$ ) or duration ( $F(1,8)=0.003, p=0.959$ ). Furthermore, there was no

overall main effect for object type for frequency ( $F(1,80) 0.0, p=0.991$ ) or duration ( $F(1,8)=0.043, p=0.841$ ) (See Figures 12 and 13). On an individual level, two monkeys, one female and one male, showed a preference for the moving rings over the stationary rings (See Table 5).

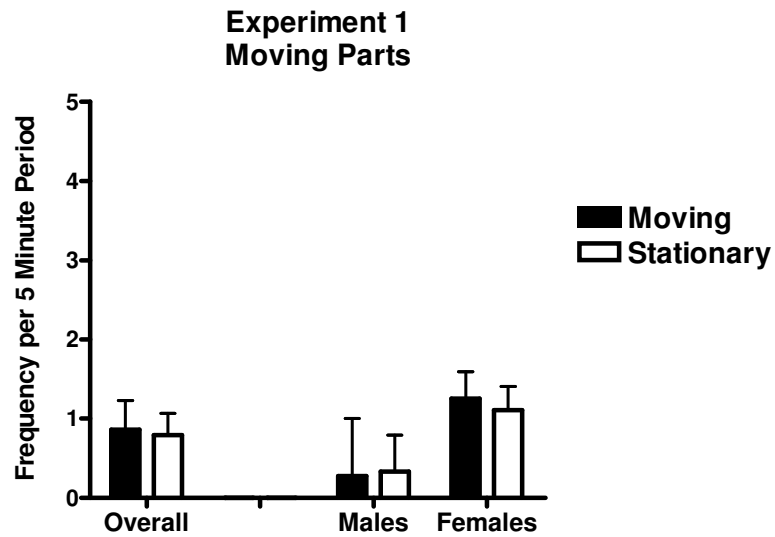


Figure 12: Experiment 1 Moving parts frequency

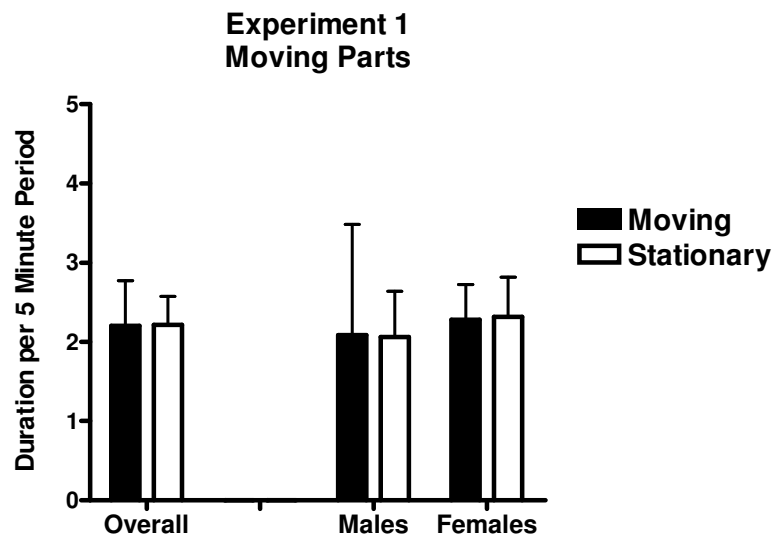


Figure 13: Experiment 1 Moving parts duration

## Experiment 2: Sex-typed Object Preference

### Outside Cage Condition

#### Phase A: Masculine vs. Feminine Objects

In contrast to the human literature and previous studies, there was a no gender biased preference for the doll and truck. Thus, there was no significant interaction of sex with object type either for frequency ( $F(1,8)=0.719$ ,  $p=0.421$ ) or duration ( $F(1,8)=2.355$ ,  $p=0.163$ ). Nor was there any overall main effect of object type (frequency  $F(1,8)=0.155$ ,  $p=0.316$  and duration  $F(1, 8)=3.033$ ,  $p=0.120$ ) (See Figures 14 and 15). However, at an individual level, females were more likely to show a preference than males. Four out of six females showed a significant preference (two for the doll and two for the truck) whereas only one male showed a preference (truck). Four monkeys showed no preference, and one monkey failed to contact either object (See Table 5).



Figure 14: Experiment 2 Doll and truck frequency

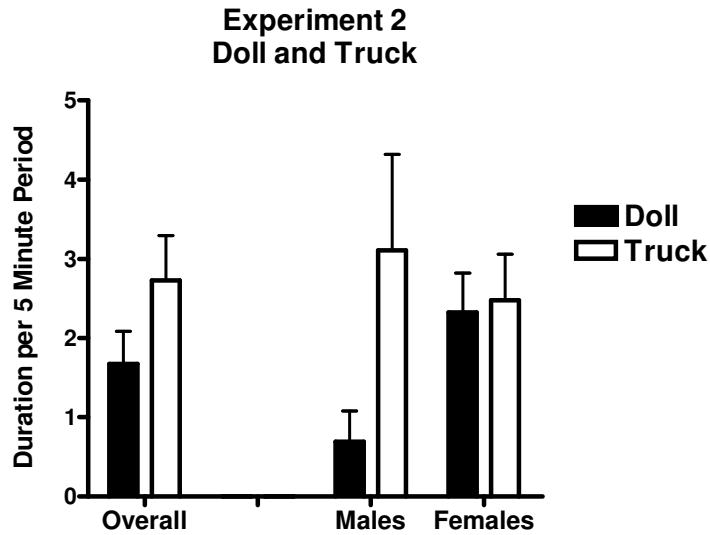


Figure 15: Experiment 2 Doll and truck duration

#### Phase B: Moving Wheels vs. Fixed Wheels Objects

In contrast to the prediction that males would prefer the doll with the moving wheels, there was no significant interaction of sex with object type (Frequency  $F(1,8)=0.341$ ,  $p=0.575$  and duration  $F(1,8)=0.397$ ,  $p=0.546$ ). However, there was a significant main effect of object type with monkeys preferring the doll with the moving wheels over the truck with stationary wheels both for frequency ( $F(1,8)=6.461$ ,  $p=0.035$ ) and for duration ( $F(1,8)=12.987$ ,  $p=0.007$ ) (See Figures 16 and 17). On an individual level eight monkeys showed a significant preference for the doll with the wheels (five females and three males). One female showed no significant preference and one male failed to contact the objects (See Table 5).

**Experiment 2  
Doll with Moving Wheels vs.  
Truck with Stationary Wheels**

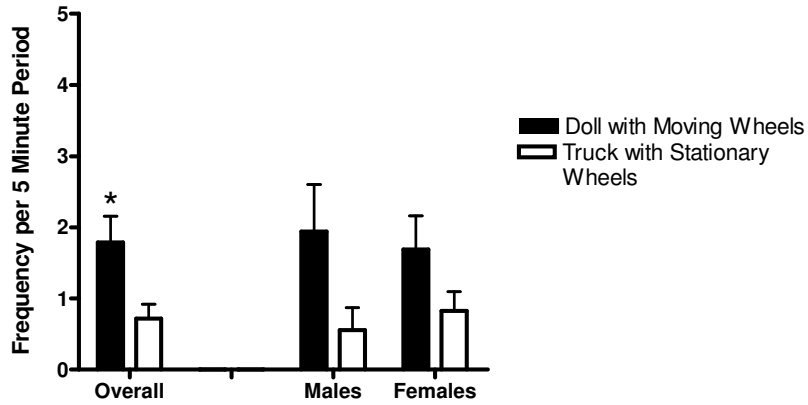


Figure 16: Doll w/wheels vs. truck w/stationary wheels frequency

**Experiment 2  
Doll with Moving Wheels vs.  
Truck with Stationary Wheels**

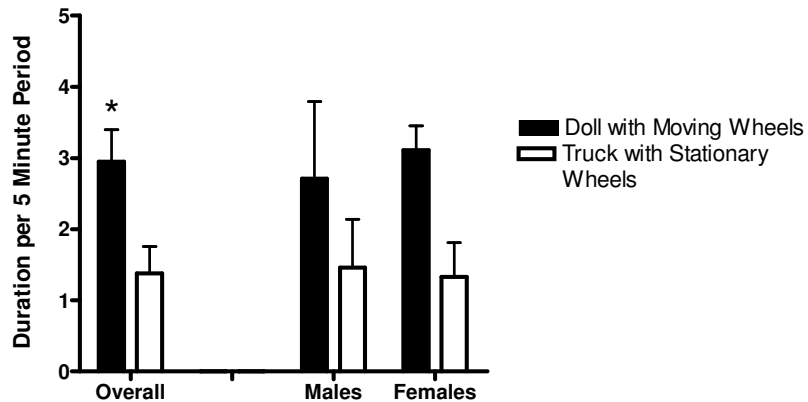


Figure 17 Doll w/wheels vs. truck w/stationary wheels duration

Phase C: Hard PVC vs. Stuffed Canvas Objects

In contrast to our predictions, there was no gender bias for the hard PVC doll and the stuffed canvas truck either for frequency ( $F(1,8)=1.129, p=0.319$ ) or duration ( $F(1,8)=0.673, p=0.436$ ). There was no main effect of object type either for frequency ( $F(1,8)=0.370, p=0.560$ ) or duration ( $F(1,8)=0.441, p=0.525$ ). However, there was significant sex effect for frequency only indicating that females made more contacts in



this condition than males ( $F(1,8)=10.077, p=0.013$ ; males = 0.450 and females = 1.517) (See figures 18 and 19). All six females showed significant preferences on an individual level. Four females preferred the hard doll, whereas two females preferred the soft truck. One male showed a preference for the hard doll. Two other males failed to respond and the third male did not show a significant preference for either object (See Table 5).

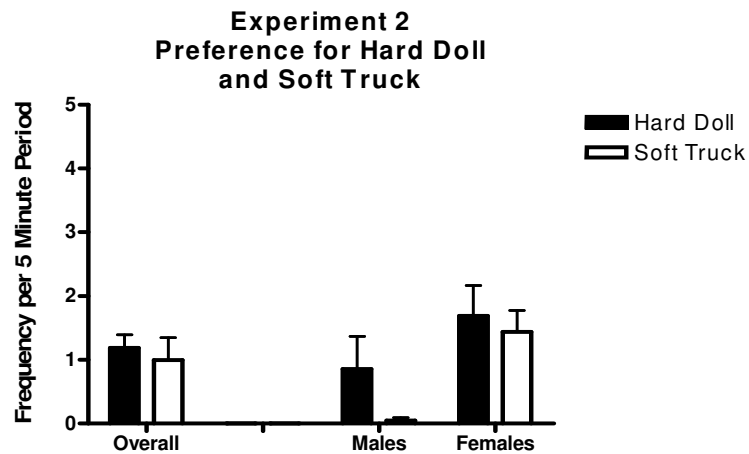


Figure 18: Hard doll and soft truck frequency

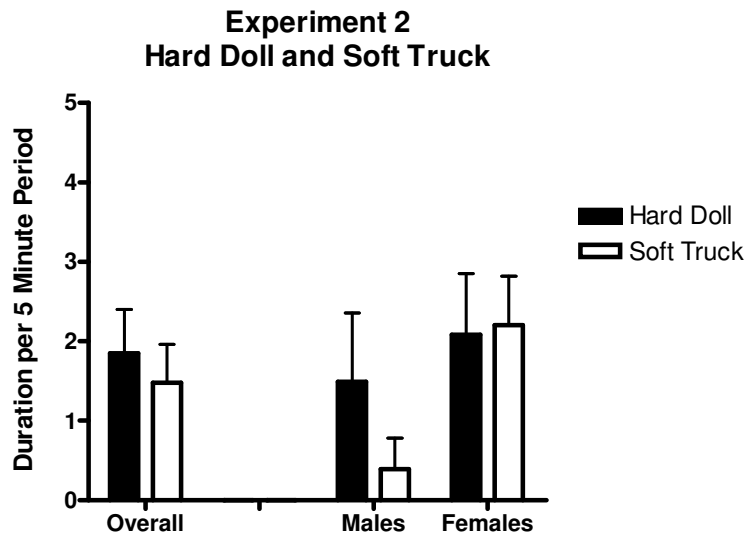


Figure 19: Hard doll and soft truck duration

All Phases Outside Cage Condition

To examine the possibility that monkeys were showing habituation to the testing situation (the monkeys never received any reinforcement for playing with the objects), the total number of contacts made across each condition was examined (See Figure 20 below). Responses were similar across all conditions except for the preliminary test of moving versus nonmoving rings where the responses were lower than all other conditions. Responses did not dramatically change over the three phases of the gender bias experiment (Experiment 2: Phases A, B, and C).

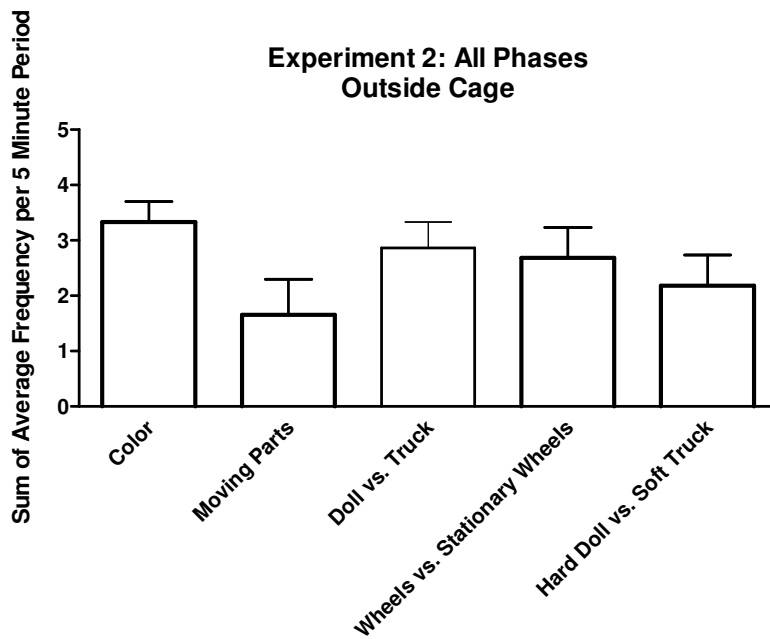


Figure 20: All phases outside cage condition

Table 5: Individual Preferences Outside Cage

Monkey	Sex	Color	Moving Parts	Phase A	Phase B	Phase C
3E2	F	p<0.06	NS	NS	p<0.02	p<0.02
6NS	F	NS	NS	p<0.0006	p<0.02	p<0.006
V38	F	p<0.02	p<0.03	p<0.001	p<0.001	p<0.01
V42	F	p<0.01	NS	p<0.001	p<0.02	p<0.01
ZA56	F	NS	NS	NS	p<0.01	p<0.01
ZA65	F	NS	NS	p<0.001	NS	p<0.02
V27	M	p<0.01	p<0.05	NS	p<0.002	No Response
V43	M	p<0.01	NS	No Response	No Response	No Response
ZA54	M	NS	NS	p<0.001	p<0.001	p<0.001
ZA63	M	P<0.02	NS	NS	p<0.001	NS

Experiment 2: Sex-typed Object Preference

Inside Cage Condition

Phase A: Masculine vs. Feminine Objects

In contrast to the predictions that females would prefer the doll and males would prefer the truck, but consistent with our previous findings for objects presented outside of the cage, there was no gender bias. Thus, there was no significant sex-by-object-type interaction for frequency ( $F(1,8)=0.395$ ,  $p=0.547$ ) or duration ( $F(1,8)=0.002$ ,  $p=0.963$ ). However, all monkeys showed a significant preference for the truck for both frequency ( $F(1,8)=33.369$ ,  $p<0.000$ ) and duration ( $F(1,8)=41.678$ ,  $p<0.000$ ). This overall preference was not observed during the test outside the cage with the same objects. See Figures 21 and 22 and compare with Figures 14 and 15. During this phase of testing, seven monkeys showed a significant preference for the truck. Three of the six females preferred the truck, whereas the other three females showed no preference. All four males preferred the truck during the in cage testing. A comparison of choices made by the monkeys across both the inside and outside cage condition is presented in Table 6. More monkeys showed preferences in this condition than in the outside cage condition (seven compared to five respectively). However, in this phase (doll vs. truck), there was little overlap of choice. Of the three females that showed a preference for the truck, only one, V42, also showed a

significant preference for the truck during the outside cage testing (compare table 5 and 6). Of the four males who preferred the truck in this condition, only one male ZA54 also showed a preference for the truck in the outside cage condition.

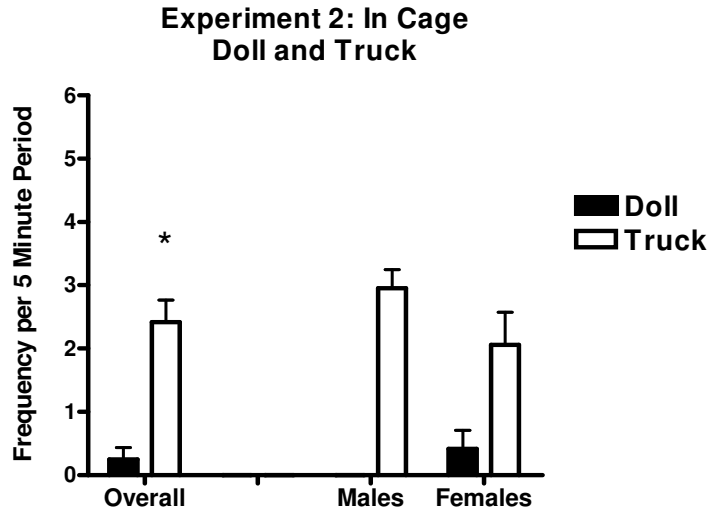


Figure 21: Experiment 2 In cage doll and truck frequency

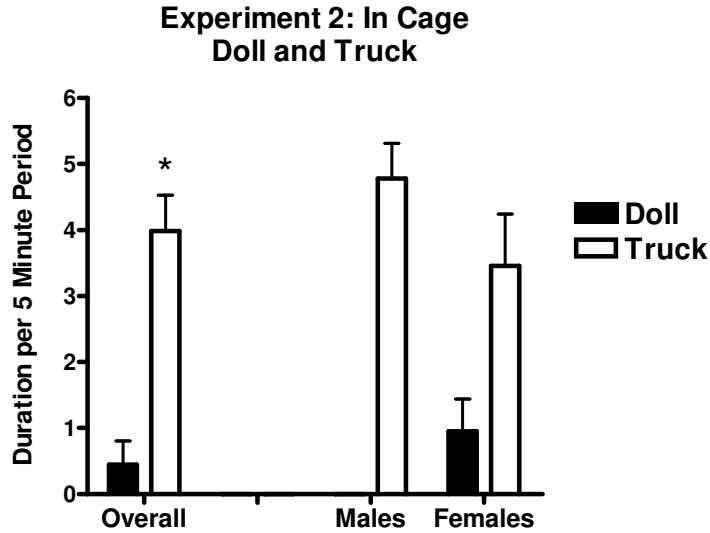


Figure 22: Experiment 2 In cage doll and truck duration

Phase B: Moving Wheels vs. Fixed Wheels Objects

Consistent with the findings from outside of the cage, there was no significant interaction of sex with object type either for frequency ( $F(1,8)=0.178$ ,  $p=0.6850$  or

duration ( $F(1,8)=0.00$ ,  $p=0.999$ ). In the outside cage condition, monkeys had shown a preference for the doll with moving wheels. However, there was no main effect of object type in the inside the cage condition either for frequency ( $F(1,8)=0.00$ ,  $p=0.999$ ) or duration ( $F(1, 8)=0.00$ ,  $p=0.983$ ) (See figures 23 and 24). On an individual level, two monkeys showed a significant preference. The female (V42) preferred the doll with the moving wheels whereas the male (ZA63) preferred the truck with the stationary wheels. Many of the monkeys (8/10) showed a significant preference for the doll with the wheels when presented outside of the cage. However, only two monkeys showed a preference in the inside cage condition and only the female in this study showed the same preference across both conditions (See Table 6).

**Experiment 2: In Cage  
Doll with Moving Wheels vs.  
Truck with Stationary  
Wheels**

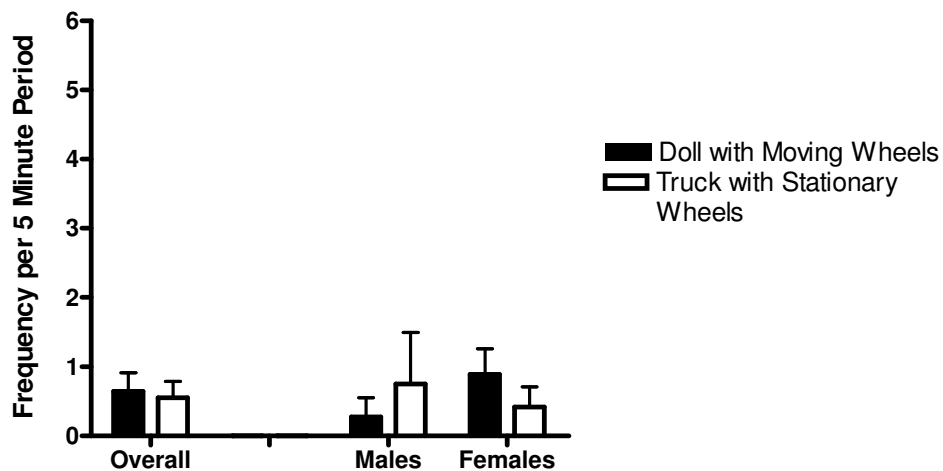


Figure 23: Experiment 2 In cage doll w/ wheels vs. truck w/stationary wheels frequency

### Experiment 2: In Cage Doll with Moving Wheels vs. Truck with Stationary Wheels

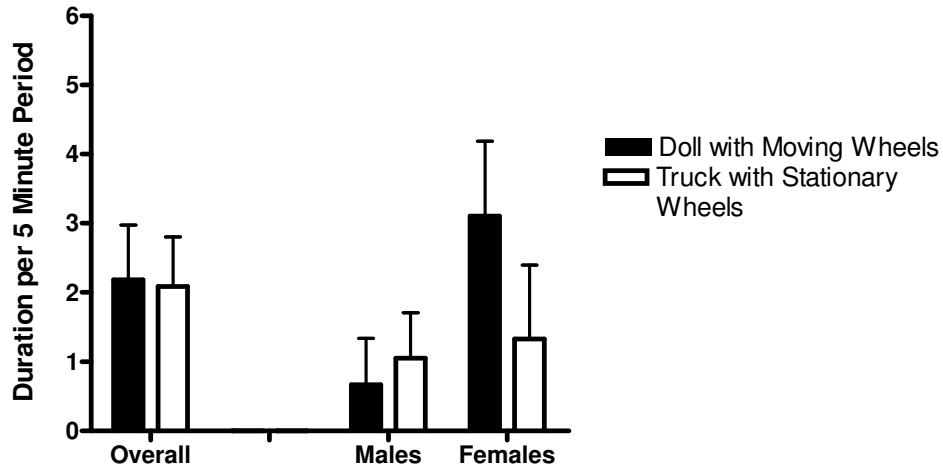


Figure 24: Experiment 2 In cage doll w/ wheels vs. truck w/stationary wheels duration

#### Phase C: Hard PVC vs. Stuffed Canvas Objects

In contrast to our predictions, there was no sex by object type interaction for the hard doll and the soft truck during the in the cage testing condition (Frequency:  $F(1,7)=0.252$ ,  $p=0.631$  and duration:  $F(1,7)=3.694$ ,  $p=0.096$ ). Additionally, there was no main effect of object type overall either for frequency ( $F(1,7)=0.855$ ,  $p=0.386$ ) or duration ( $F(1,7)=2.676$ ,  $p=0.146$ ) (See figures 25 and 26). Three monkeys showed significant individual preferences. Two males preferred the hard doll and one female preferred the soft truck (See Table 6). A comparison of choices across the two phases (inside and outside cage) revealed that more monkeys showed significant preferences outside of the cage compared to inside the cage (seven compared to three respectively). For two of the three monkeys, their choice was consistent across both conditions. A

male, ZA54, preferred the hard doll in both conditions and V42, a female, preferred the soft truck in both conditions (See Table 6).

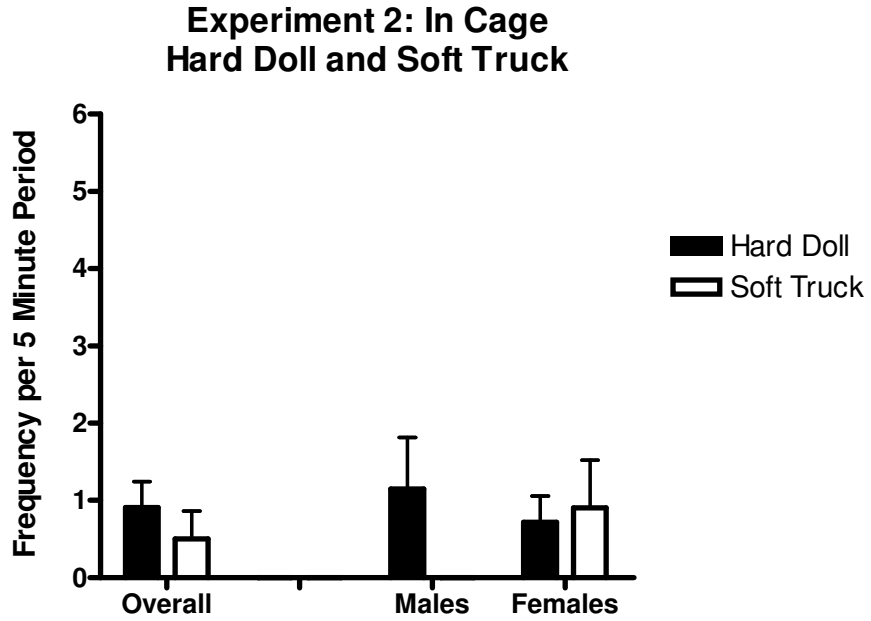


Figure 25: Experiment 2 In cage hard doll and soft truck frequency

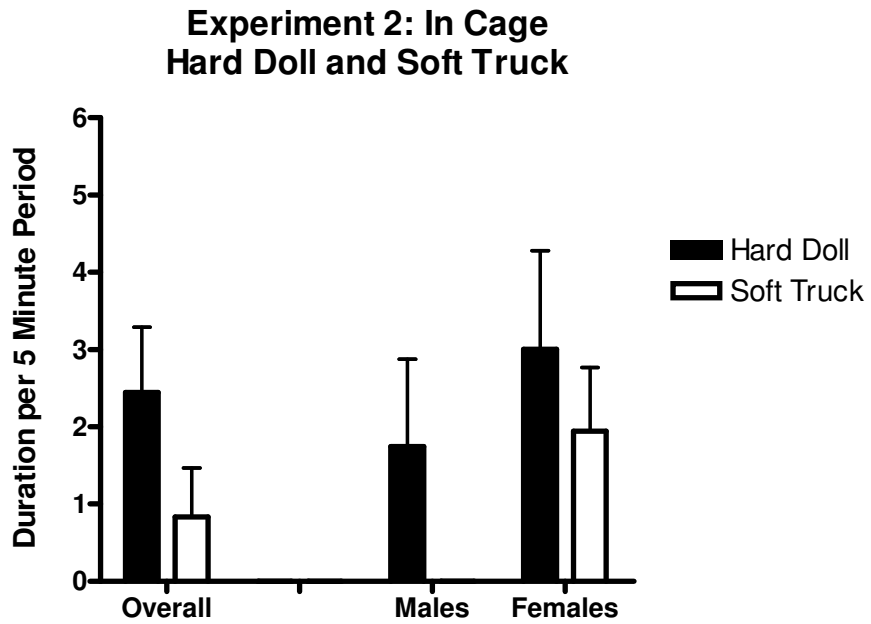


Figure 26: Experiment 2 In cage hard doll and soft truck duration

Table 6: A comparison of individual preferences across both inside and outside cage conditions

Monkey	Sex	Color	Moving Parts	Phase A outside	Phase A inside	Phase B outside	Phase B inside	Phase C Outside	Phase C Inside
3E2	F	Blue p<.06	NS	NS	Truck p<.0001	D/wheel p<.02	NS	HDoll p<.02	Not Run
6NS	F	NS	NS	Truck p<.0006	NS	D/wheel p<.02	NS	HDoll p<.006	NS
V38	F	Blue p<.02	Moving p<.03	Doll p<.001	NS	D/wheel p<.001	No response	STruck p<.01	No response
V42	F	Blue p<.01	NS	Truck p<.001	Truck p<.001	D/wheel p<.02	D/wheel p<.001	STruck p<.001	STruck P<.001
ZA56	F	NS	NS	NS	Truck p<.02	D/wheel p<.01	NS	HDoll p<.01	NS
ZA65	F	NS	NS	Doll p<.001	NS	NS	NS	HDoll p<.02	NS
V27	M	Blue p<.01	Moving p<.05	NS	Truck p<.001	D/wheel p<.002	No response	No response	No response
V43	M	Blue p<.01	NS	No response	Truck p<.001	No response	No response	No response	No response
ZA54	M	NS	NS	Truck p<.001	Truck p<.001	D/wheel p<.001	NS	HDoll p<.001	HDoll P<.004
ZA63	M	Blue p<.02	NS	NS	Truck p<.002	D/wheel p<.001	T/wheel p<.04	NS	HDoll P<.02
Total		6 Blue 0 Red	2 Move 0 Non	2 Doll 3 Truck	0 Doll 7 Truck	8 DW 0 TW	1 DW 1 TW	5 HDoll 2 Struck	2 HDoll STruck

### Trends Across Phases For Experiment 2

To examine the possibility during in cage testing that monkeys might become habituated to objects, contacts across all three phases were compared (Figure 19).

Monkeys showed a higher average frequency of contacts for Phase A: Doll vs. Truck.

However, response rates declined during Phase B: Doll with Wheels vs. Truck with

Stationary Wheels and Phase C: Hard Doll vs. Soft Truck compared to Phase A.



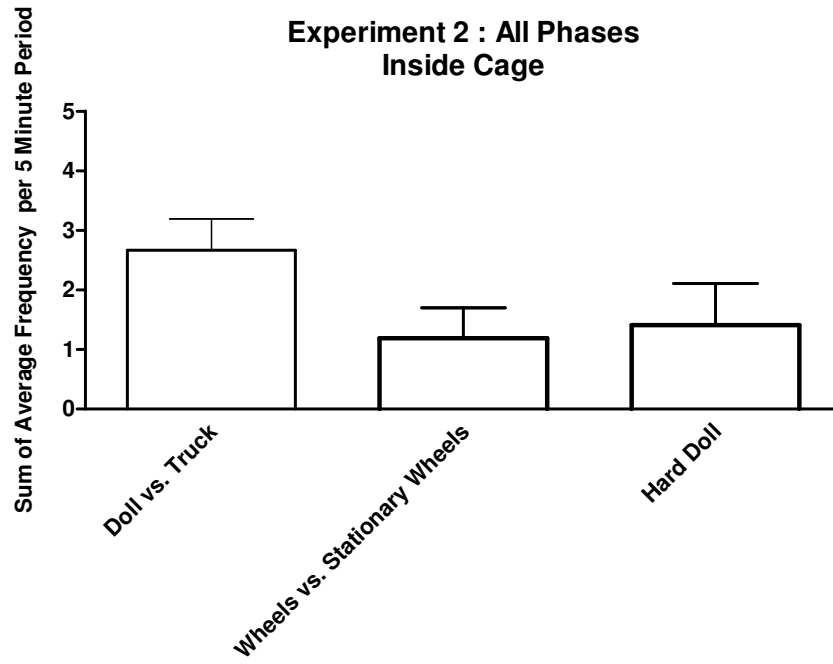


Figure 27: Experiment 2 All phases inside cage

## CHAPTER 4

### DISCUSSION

This thesis attempted to confirm previous findings of sex-typed object preference in non-human primates which parallel those preferences observed in human children. This thesis also went further in examining sex-typed object preference by considering characteristics of objects that could be driving such a preference. Additionally, we strived to eliminate and control variables that may have influenced the results of previous non-human primate studies such as characteristics of objects (color, wheels, material), testing condition, and social facilitation.

The results of the experiments presented here do not confirm previous studies showing that monkeys have a sex-typed preference for objects or for particular characteristics of objects. Furthermore, it did not matter whether the monkeys had partial contact with the objects (placed outside of the cage) or could fully manipulate the objects and carry them around (placed inside the cage). This failure to find a sex bias cannot be explained by a lack of interest in the objects. Monkeys readily manipulated objects and had various opportunities throughout testing to form preferences, both as a group and as individuals, and yet not one condition yielded a significant interaction of sex and object preference. Overall monkeys showed preferences for the blue object, the truck, the doll with the wheels and the hard doll. This brings into question overlooked variables which may have affected the sex-typed results of previous non-human primate studies and could have influenced our results.

Our first task was to conduct a preliminary test, Experiment 1, to determine if color (Phase A) or moving parts (Phase B) influenced preference. Previous non-human

primate studies did not control for color preferences. Yet, other studies have shown that color can elicit significant responses in non-human primates. In one study, female rhesus monkeys were more interested infants with pink faces. Males also showed sensitivity to the reddened hind quarters of females as a sexual attractant signal (Waite, et. al., 2006; Gerald et. al. 2006 respectively). In contrast, a recent study concluded that chimpanzees and gorillas, within species and overall, showed a preference for blue and green objects over red objects (Wells, McDonald, & Ringland, 2008). In the color phase, monkeys did not show a preference based on sex, but as a group, monkeys showed a preference for the blue object over the red object consistent with the results of the chimpanzee and gorilla study. Eight monkeys that showed a significant preference on an individual level preferred the blue object over the red object. Perhaps the color red is only significant if it has a biological context such as parental care or sexual behavior.

One of the features of male-type toys is that they have moving parts (e.g., wheels) whereas female-type toys do not. In the moving parts phase, monkeys did not show a group preference for either object. Two individuals, one male and one female showed a preference for the moving interlocking PVC rings over the non-moving rings. It is possible that the monkeys were less interested in these objects because they were both white. However, in the subsequent phases, all the objects were white, and response rates were not as low as they were in this particular phase.

The information gained from Experiment 1 was incorporated into Experiment 2: Sex-typed Object Preference. Because monkeys showed a color preference and previous non-human primate studies used objects that varied in color, our study controlled for color by using only white doll and truck type objects. Along with the challenge of

creating objects that resembled human toys, which would be also desirable to the monkeys, were the added factors of safety and durability of the objects. The objects had to be constructed of materials that would be safe for the monkeys to contact and even put in their mouths, as well as durable enough so the monkeys could not destroy them (particularly the soft objects). Because of concerns about the durability of the soft objects, monkeys received multiple test sessions outside of their cage where they could not use their canine teeth to rip up the toys but were given one inside-the-cage testing session to minimize potential damage to the toys. Another uncontrolled variable in non-human primate sex-typed object studies is social facilitation and access to the objects. Studies have shown that rhesus monkeys are influenced by conspecifics when manipulating objects (Wechkin, 1970; Novak, Musante, Munroe, & O'Neill, 1993). Both of the previous studies that examined sex-typed object preferences in non-human primates tested subjects in large social groups. In such a setting, it is essentially impossible to eliminate social facilitation. Additionally, monkeys may have manipulated an object during testing simply because they had access to it, and not necessarily because they preferred it. In a nod to social facilitation, Hassett et. al. (2008), considered social rank and toy interactions: "Social rank appeared to play a role in interactions with the toys, but only for the females as rank was unrelated to toy interactions in males (p. 17)." This study concluded that males, and not females, showed a sex-typed object preference for "wheeled toys" paralleling studies with children. But, had females from the study been tested individually, they may have shown a preference similar to the males in the study. Since females were influenced by social rank, higher ranking females may have selected one object over the other (for example the wheeled object over the plush object),

whereas lower ranking females selected whatever object remained (the plush object). Rhesus monkeys may not experience the social pressures placed on human children by parents and others, but social facilitation by members of the same sex within the rhesus monkey community may be a highly influential factor in determining object preferences.

If sex was not a factor in determining object preference, other factors may have influenced preferences for the group, such as previous experiences with other types of reward based cognitive testing, preference for novel objects made of familiar materials, and rearing condition. With respect to reward, the monkeys in this study had extensive previous experience with cognitive and behavioral tests in which they received a reward for making a choice. This study did not use food rewards, because we wanted to measure unbiased preferences, elicited simply by the objects themselves. It is possible that the lack of reward increased the variability of response. Thus responses of monkeys varied from active manipulators to non-responders. In the latter case, non-responding in a particular phase was relatively rare except for V43 who failed to respond in several phases in Experiment 2.

In an attempt to explore this issue of motivation, we conducted a pilot test after Experiment 2 was concluded using the same subjects and the same objects baited with food. Monkeys were tested with the doll and truck object (corresponding to Phase A outside the cage). Monkeys were given 10 trials per session for two sessions. A trial consisted of the objects being placed outside the subject's cage equidistant from the subject and in plain view. Treat objects, such as grapes or dried cranberries nearly identical in size and shape, were placed on top of the objects in such a way that the treats were equidistant from the subject and equally accessible. Each object had the same treat.

Next, both objects were simultaneously moved forward within the monkey's reach and the monkey was allowed to select a treat. The objects were then moved out of the monkey's reach so that the monkey could not take the treat off both objects. The object the monkey chose to take the treat from was recorded. The location of the objects was block randomized across trials. Object preferences were measured using binomial probabilities, with a level of significance of  $p < 0.05$ . The hope was to address the issue of motivation and indirectly allow the monkey to make a selection for a preferred object. In the case of V43 who stopped responding early in testing, baiting the objects did restore his "interest" in the task. None of the monkeys showed a preference for either object except for V43 who preferred the truck in this situation. But, it should be noted that this kind of testing blurs the line between preference and immediate reward. In the case where a monkey selected the treat off the same object from one trial to the next begs the question: Did the monkey select that object because it was preferred or because that was the object from which he last got the treat?

Aversion to novel materials may have also influenced response rates. Perhaps the monkeys preferred novel objects made of familiar materials (PVC) over novel objects made of unfamiliar materials (soft cloth). PVC material is familiar to the monkeys, whereas this study was the monkeys' very first exposure to stuffed canvas objects. Indeed, monkeys tended to prefer the objects with PVC components, the truck, the doll with the wheels, and the hard doll, over the plain stuffed canvas objects (the doll and the soft truck). The soft doll with the wheels is an interesting case in point. Monkeys preferred this object over the hard truck. However, typically, the monkeys grabbed the wheels to manipulate this object and appeared to pay little attention to the soft parts of the

doll. It is difficult to relate these preferences to general studies of novelty because typically the objects differ in color or shape but not in terms of softness. One study revealed that adult rhesus monkeys preferred novel objects over familiar objects, but the material substrate (rubber or PVC) was equally familiar (Platt & Novak, 1999). Another study looking at novel and familiar objects with infant rhesus monkeys reported that monkeys' object directed activities decreased for novel objects compared with familiar objects (Meunier, Nalwa, & Bachevalier, 2003). It is possible that the preferences observed in this study may have reflected an underlying aversion to the novel substrate of soft and canvas. As a counterpoint, it should be noted that nearly all of the monkeys in this study had exposure to fleece blankets in infancy. Furthermore, there appeared to be no aversion to manipulating the soft doll in the two previous monkey studies, and it is likely that they too had limited experience with soft plush objects.

A third influence of the described study may be rearing condition. The two previous studies that looked at sex-typed object preference in non-human primates did not describe the rearing history of the monkeys. However, because monkeys were housed in large social groups, it is likely that some, if not all monkeys were mother-reared. In contrast, eight of the monkeys used for the thesis described here were surrogate-peer reared. Surrogate-peer rearing eliminates all maternal influence during development. Surrogate-peer rearing has been shown to promote virtually all normal species typical behaviors including appropriate social interactions (Novak, O'Neill, & Suomi, 1992). Though, surrogate-peer reared monkeys display species typical behaviors, and even successfully rear offspring of their own, it is largely unknown whether maternal influence has an effect on object preferences, especially sex-typed object preferences. It is possible

that early exposure to biological and social interactions between an infant and its mother, such as exposure to mother's milk, scents and hormone levels, have subtle organizing effects on sex-typed behaviors, such as object preference. In the absence of these early organizational effects, sex biased preferences are either dampened or eliminated. In primates, these organizational effects are thought to take place prenatally. Thus, a possible postnatal effect is speculative at this time.

In summary, monkeys that participated in this project did not show object preferences based on sex. These data diverge from the preferences observed in humans and studies tested with other non-human primates. One major variable that we eliminated from this study was social influence, both from conspecifics and from maternal influences. The literature on children suggests that social and biological factors likely play a role in sex-typed object preference, but isolating each influence is impossible. Conducting object preference with non-human primates affords the ability to eliminate socio-cultural influences that may be a factor in studies with children, however previous studies did not eliminate social influences of rhesus monkeys. In eliminating social influences, we may have eliminated object preferences based on sex. In order to confirm the effects of social influence in rhesus monkeys, additional individual testing would be required at other facilities. Although we did not observe sex-typed object preferences we did observe overall preferences and individual preferences. The data presented here suggest that the monkeys tested preferred the color blue over red, however additional testing is required to determine if most rhesus monkeys prefer blue objects over red objects. The monkeys tested also appear to prefer novel objects created from familiar



materials. This information could be valuable when considering enrichment objects for captive rhesus monkeys.

## BIBLIOGRAPHY

- Alexander, G. M. (2003). An evolutionary perspective of sex-typed toy preferences: Pink, blue, and the brain. *Archives of Sexual Behavior, 32*(1), 7-14.
- Alexander, G. M., & Hines, M. (1994). Gender labels and play styles: Their relative contribution to children's selection of playmates. *Child Development, 65*(3), 869-879.
- Alexander, G. M., & Hines, M. (2002). Sex differences in response to children's toys in nonhuman primates (*Cercopithecus aethiops sabaesus*). *Evolution and Human Behavior, 23*, 467-479.
- Banerjee, R., & Lintern, V. (2000). Boys will be boys: The effect of social evaluation concerns on gender-typing. *Social Development, 9*(3), 397-408.
- Benenson, J. F., & Heath, A. (2006). Boys withdraw more in one-on-one interactions, whereas girls withdraw more in groups. *Developmental Psychology, 42*, 272-282.
- Berard, J. (1999). A four-year study of the association between male dominance rank, residency status, and reproductive activity in rhesus macaques (*Macaca mulatta*). *Primates, 40*(1), 159-175.
- Berenbaum, S. A., & Hines, M. (1992). Early androgens are related to childhood sex-typed toy preferences. *Psychological Science, 3*, 203-206.

- Bernstein, I. S., Gordon, T. P., & Rose, R. M. (1974). Aggression and social controls in rhesus monkey (*Macaca mulatta*) groups revealed in group formation studies. *Folia Primatologica*, 21(2), 81-107.
- Bernstein, I. S., Judge, P. G., & Ruehlmann, T. E. (1993). Sex differences in adolescent rhesus monkey (*Macaca mulatta*) behavior. *American Journal of Primatology*, 31, 197-210.
- Blakemore, J. E. O., & Centers, R. E. (2005). Characteristics of boys' and girls' toys. *Sex Roles*, 53(9), 619-633.
- Brown, G. R., & Dixson, A. F. (2000). The development of behavioural sex differences in infant rhesus macaques (*Macaca mulatta*). *Primates*, 41, 63-77.
- Campenni, Estelle, C. (Jan. 1999). Gender stereotyping of children's toys: A comparison of parents and nonparents. *Sex Roles, Volume 40*,(1-2), 121 - 138.
- Caldera, Y. M., Huston, A. C., & O'Brien, M. (1989). Social interactions and play patterns of parents and toddlers with feminine, masculine, and neutral toys. *Child Development*, 60(1), 70.
- Campbell, A., Shirley, L., Heywood, C., & Crook, C. (2000). Infants' visual preference for sex-congruent babies, children, toys and activities: A longitudinal study. *British Journal of Developmental Psychology*, 18(4), 479-498.
- Clearfield, M. W., & Nelson, N. M. (2006). Sex differences in mothers' speech and play behavior with 6-, 9-, and 14-month-old infants. *Sex Roles*, 54(1), 127-137.

- Colwell, M. J., & Lindsey, E. W. (2005). Preschool children's pretend and physical play and sex of play partner: Connections to peer competence. *Sex Roles, 52*, 497-509.
- Consortium, et al. (2007). Evolutionary and biomedical insights from the rhesus macaque genome. *Science, 316*. 222-234.
- Crick, N. R. (1996). The role of overt aggression, relational aggression, and prosocial behavior in the prediction of children's future social adjustment. *Child Development, 67*, 2317-2327.
- Crick, N. R., Casas, J. F., & Mosher, M. (1997). Relational and overt aggression in preschool. *Developmental Psychology, 33*, 579-588.
- Crick, N. R., & Grotpeter, J. K. (1995). Relational aggression, gender, and social-psychological adjustment. *Child Development, 66*(3), 710-722.
- Crowley, T. J., Raymond, K. M., Mikulich-Gilbertson, S. K., Thompson, L. L., & Lejuez, C. W. (2006). A risk-taking 'set' in a novel task among adolescents with serious conduct and substance problems. *Journal of the American Academy of Child & Adolescent Psychiatry, 45*(2), 175-183.
- Eisenberg-Berg, N., Boothby, R., & Matson, T. (1979). Correlates of preschool girls' feminine and masculine toy preferences. *Developmental Psychology, 15*(3), 354-355.
- Fabes, R. A., Martin, C. L., & Hanish, L. D. (2003). Young children's play qualities in same-, other-, and mixed-sex peer groups. *Child Development, 74*, 921-932.

- Gerald, M. S., Waitt, C., & Maestriperi, D. (2006). An experimental examination of female responses to infant face coloration in rhesus macaques. *Behavioural Processes*, 73, 253-256.
- Ginsburg, H. J., & Miller, S. M. (1982). Sex differences in children's risk-taking behavior. *Child Development*, 53(2), 426-428.
- Gramza, A. F. (1976). Responses to manipulability of a play object. *Psychological Reports*, 38(3), 1109-1110.
- Green, V. A., Bigler, R., & Catherwood, D. (2004). The variability and flexibility of gender-typed toy play: A close look at children's behavioral responses to counterstereotypic models. *Sex Roles*, 51(7), 371-386.
- Harlow, H. F. (1962). The heterosexual affectional system in monkeys. *American Psychologist*, 17(1), 1-9.
- Hassett, J. M., Siebert, E. R., & Wallen, K. (2004). Sexually Differentiated Toy Preferences in Rhesus Monkeys. *Hormones and Behavior*, 46(1), 91.
- Higley, J. D., Hopkins, W. D., Hirsch, R. M., & Marra, L. M. (1987). Preferences of female rhesus monkeys (*Macaca mulatta*) for infantile coloration. *Developmental Psychobiology*, 20(1), 7-18.
- Howell, S., Westergaard, G., Hoos, B., Chavanne, T. J., Shoaf, S. E., Cleveland, A., et al. (2007). Serotonergic influences on life-history outcomes in free-ranging male rhesus macaques. *American Journal of Primatology*, 69, 1.

- Iijima, M., Arisaka, O., Minamoto, F., & Arai, Y. (2001/9). Sex differences in children's free drawings: A study on girls with congenital adrenal hyperplasia. *Hormones and Behavior*, *40*(2), 99-104.
- Juliano, M., Werner, R. S., & Cassidy, K. W. (2006). Early correlates of preschool aggressive behavior according to type of aggression and measurement. *Journal of Applied Developmental Psychology*, *27*, 395-410.
- Lovejoy, J., & Wallen, K. (1988). Sexually dimorphic behavior in group-housed rhesus monkeys (*Macaca mulatta*) at 1 year of age. *Psychobiology*, *16*, 348-356.
- Mathews, G. A., Fane, B. A., Conway G.S., Brook, C.G.D., Hines M. (2008). Personality and Congenital Adrenal Hyperplasia: Possible effects of prenatal androgen exposure. *Hormones and Behavior*. *Accepted Manuscript*.
- Martin, C. L., Wood, C. H., & Little, J. K. (1990). The development of gender stereotype components. *Child Development*, *61*(6), 1891.
- Martin, J. L., & Ross, H. S. (2005). Sibling aggression: Sex differences and parents' reactions. *International Journal of Behavioral Development*, *29*, 129-138.
- Meunier, M., Nalwa, V. & Bachevalier, J. (2003). Reactions to familiar and novel objects in infant monkeys with neonatal temporal lesions. *Hippocampus*, *13*(4), 489-493.
- Mitchell, G. (1979). *Behavioral sex differences in nonhuman primates*. 135 West 50th Street, New York, N. Y. 10020: Van Nostrand Reinhold Company.

- Nelson, A. (2005). Children's toy collections in Sweden--A less gender-typed country? *Sex Roles, 52*(1), 93-102.
- Novak, M. A., Musante, A., Munroe, H., & O'Neill, P. L. (1993). Old, socially housed rhesus monkeys manipulate objects. *Zoo Biology, 12*(3), 285-298.
- Novak, M. A., O'Neill, P., & Suomi, S. J. (1992). Adjustments and adaptations to indoor and outdoor environments: Continuity and change in young adult rhesus monkeys. *American Journal of Primatology, 28*(2), 125-138.
- O'Brien, M., & Huston, A. C. (1985). Activity level and sex-stereotyped toy choice in toddler boys and girls. *Journal of Genetic Psychology, 146*(4), 527.
- O'Jile, J. R., Ryan, L. M., Parks-Levy, J., Betz, B., & Gouvier, W. D. (2004). Sensation seeking and risk behaviors in young adults with and without a history of head injury. *Applied Neuropsychology, 11*(2), 107-112.
- Ostrov, J. M., & Keating, C. F. (2004). Gender differences in preschool aggression during free play and structured interactions: An observational study. *Social Development, 13*, 255-277.
- Pasterski, V. L., Geffner, M. E., Brain, C., Hindmarsh, P., Brook, C., & Hines, M. (2005). Prenatal hormones and postnatal socialization by parents as determinants of male-typical toy play in girls with congenital adrenal hyperplasia. *Child Development, 76*, 264-278.

- Pasterski, V. L., Hindmarsh, P., Geffner, M. E., Brook, C., Brain, C. & Hines, M. (2007). Increased aggression and activity level in 3- to 11-year-old girls with congenital adrenal hyperplasia (CAH). *Hormones and Behavior*, 52, 368-374.
- Pellegrini, A. D. (1988). Elementary-school children's rough-and-tumble play and social competence. *Developmental Psychology*, 24(6), 802-806.
- Pellegrini, A. D., & Smith, P. K. (1998). Physical activity play: The nature and function of a neglected aspect of play. *Child Development*, 69(3), 577-598.
- Picariello, M. L., Greenberg, D. N., & Pillemer, D. B. (1990). Children's sex-related stereotyping of colors. *Child Development*, 61(5), 1453-1460.
- Platt, D.M. & Novak, M.A. (1999). Perception of Novel Changes in a Familiar Environment by Socially-Housed Rhesus Monkeys. *American Journal of Primatology*, 47(2), 117-131.
- Rosenbloom, T. (2006). Sensation seeking and pedestrian crossing compliance. *Social Behavior and Personality*, 34(2), 113-122.
- Scott, E., & Panksepp, J. (2003). Rough-and-tumble play in human children. *Aggressive Behavior*, 29, 539-551.
- Serbin, L. A., Connor, J. M., Burchardt, C. J., & Citron, C. C. (1979). Effects of peer presence on sex-typing of children's play behavior. *Journal of Experimental Child Psychology*, 27(2), 303-309.



- Serbin, L. A., O'Leary, K. D., Kent, R. N., & Tonick, I. J. (1973). A comparison of teacher response to the preacademic and problem behavior of boys and girls. *Child Development, 44*, 796-804.
- Serbin, L. A., Poulin-Dubois, D., Colburne, K. A., Sen, M. G., & Eichstedt, J. A. (2001). Gender stereotyping in infancy: Visual preferences for and knowledge of gender-stereotyped toys in the second year. *International Journal of Behavioral Development, 25*, 7-15.
- Servin, A., Nordenström, A., Larsson, A., & Bohlin, G. (2003). Prenatal androgens and gender-typed behavior: A study of girls with mild and severe forms of congenital adrenal hyperplasia. *Developmental Psychology, 39*(3), 440-450.
- Simpkins, S. D., Davis-Kean, P. E., & Eccles, J. S. (2005). Parents' socializing behavior and children's participation in math, science, and computer out-of-school activities. *Applied Developmental Science, 9*, 14-30.
- Stanley, B., Molcho, A., Stanley, M., Winchel, R., Gamaroff, M. J., Parsons, B., et al. (2000). Association of aggressive behavior with altered serotonergic function in patients who are not suicidal. *American Journal of Psychiatry, 157*(4), 609-614.
- Tarja Raag. (December 1999). Influences of social expectations of gender, gender stereotypes, and situational constraints on children's toy choices. *Sex Roles, 41*(11-12), 809 - 831.

- Tomaszycki, M. L., Davis, J. E., Gouzoules, H., & Wallen, K. (2001). Sex differences in infant rhesus macaque separation–rejection vocalizations and effects of prenatal androgens. *Hormones and Behavior*, *39*(4), 267-276.
- Trautner, H. M. (1995). Boys' and girls' play behavior in same-sex and opposite-sex pairs. *Journal of Genetic Psychology*, *156*(1), 5-15.
- Waitt, C., Gerald, M. S., Little, A. C., & Kraiselburd, E. (2006). Selective attention toward female secondary sexual color in male rhesus macaques. *American Journal of Primatology*, *68*, 738-744.
- Wallen, K. (1996). Nature needs nurture: The interaction of hormonal and social influences on the development of behavioral sex differences in rhesus monkeys. *Hormones and Behavior*, *30*, 364-378.
- Wallen, K. (2005). Hormonal influences on sexually differentiated behavior in non-human primates. *Frontiers in Neuroendocrinology*, *26*(1), 7-26.
- Wechkin, S. (1970). Social relationships and social facilitation of object manipulation in macaca mulatta. *Journal of Comparative and Physiological Psychology*, *73*, 456-460.
- Wells, D.L., McDonald, C.L., & Ringland, J.E. (2008). Color preferences in gorillas (*Gorilla gorilla gorilla*) and chimpanzees (*Pan troglodytes*). *Journal of Comparative Psychology*, *122*(2), 213-219.