

# Effect of Enrichment Items on the Aggression and Competition Levels of Captive Orangutans

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*ABSTRACT: This paper explores competition among captive orangutans at the Sacramento Zoo. Novel food and non-food enrichment items were introduced into the orangutan exhibit and the resulting competitive behaviors were recorded. Baseline data were compared to the experimental condition. Hypotheses are that: 1) the orangutans would exhibit a higher number of aggressive behaviors during the experimental conditions; and 2) the individual orangutans would differ in both the frequency of aggressive behaviors and the competitiveness of those behaviors in each of the study conditions. Results indicated that the orangutans were not more aggressive in the study conditions; however, there were differences in the level of competitiveness among the individuals, specifically showing a higher level of competitiveness in the food enrichment condition.*

## INTRODUCTION

This project examines the effects of enrichment on the three captive Sumatran orangutans (*Pongo pygmaeus abelii*) at the Sacramento Zoo with the intention of gaining an understanding of aggressive and competitive behavior. Research has demonstrated that introducing enrichment items into enclosures stimulates captive animals' natural behavior (Anderson and Chamove 1983; Baker 1999; Bitnoff 1996; Dewey 1989; Markowitz 1982; Reinhardt 1993). Captive animals may be restricted from their species-typical behavior, thus enrichment can help alleviate boredom and aberrant behavior. Generally, captive orangutans are not placed in similar social groupings as they experience in the wild. Orangutans in the wild live semisolitary lives, where aggregations occasionally occur, usually in large food patches or in a mating context (Utami et al. 1997). Competition occurs among wild orangutans, especially during food scarcity (Utami et al. 1997), thus it is expected that aggression and competition will occur among the captive orangutans at the Sacramento Zoo for the enrichment items. The

social behavior of orangutans (Bramblett 1994; Hamilton and Galdikas 1994; Rodman 1988; Tobach et al. 1989; Utami et al. 1997; VanSchaik and Van Hooff 1996), as well as competition among other animals (Colegrave 1994; Gause 1964; Hammerstein 1998; Jones 1980; Maier 1998; Mason and Mendoza 1993; Moynihan 1998; Riechert 1998), have been studied in depth; however, I am unaware of any literature addressing competition among captive orangutans.

## RELEVANT BACKGROUND AND THEORY

### GAME THEORY

In general, game theory predicts behavior for many animal groups. Game theory, derived from economics, is used to explain competition as the force behind economic efficiency and adaptation. In biology, it is used to explain the evolutionary process of competition for survival and reproduction (Hammerstein 1998). Game theory evaluates whether an animal will behave as an ally or a traitor, i.e., whether they are expected to cooperate or compete (Strier 2000), and is used to predict optimal outcomes of inter-

actions between animals (Maier 1998). Maynard Smith (1973, 1974) applied game theory to explain how animals develop strategies that take into account their competitors' behaviors. Animals in competition for limited resources must take into consideration a competing animal's behavior (Maier 1998), and the costs and benefits of their behavior. In an evolutionary stable strategy, individuals could follow the "tit-for-tat" rule of cooperation and altruism (Strier 2000). For example, in many primate societies, low ranking members often groom higher ranking members for a longer amount of time (Strier 2000). The high ranking members may in turn help their subordinates. However, if one fails to reciprocate, retaliation may result in the form of direct attacks (Strier 2000).

Hammerstein (1998:4) describes a classical game as "a model in economic decision theory describing the potential interactions of two or more individuals whose interests do not entirely coincide." When there is disagreement on the use of a limited resource, there is competition. If food is substituted for a limited resource, the theory can be applied to animal behavior since it still refers to costs and benefits for survival. Maynard Smith and Price (1973) note that some animals develop a strategy of ritualized fighting (i.e., threat displays) or escalated fighting (i.e., behavior capable of injuring an opponent), and they conclude that the evolutionarily stable strategy is to be capable of responding to escalation from an opponent with escalation. Reichert (1998:65) concludes that "game theory has demonstrated that animal conflict can be explained in terms of individual costs and benefits."

Conflicts, or contests, can often be settled without escalated fighting after an initial assessment phase (Reichert 1998). Individuals gain information on potential character states, such as experience, size,

age, and sex, which might determine the outcome of the contest without actual fighting (Reichert 1998). These states give an individual a greater resource-holding power than its opponent (Reichert 1998). A difference in payoff, relative to what its opponent would achieve, is another factor that would have to be assessed. Reichert (1998) states that payoffs influence the level of fighting that individuals are willing to engage in. If the payoff value is high, then escalated fighting is predicted, regardless of other factors that might influence the outcome.

#### *AGGRESSION AND COMPETITION LITERATURE*

There is a large volume of research addressing competition among animals. Moynihan (1998:4) defines competition as "whenever one individual occupies or pre-occupies a resource that would otherwise be available to, and possibly or probably be appropriated by, another individual of the same or another species." Competition occurs over limited resources, such as food, mates, territory, and group membership (Colegrave 1994; Jones 1980; Maier 1998; Reichert 1998). When an individual impinges on the interests of another, conflict results and aggression accompanies it (Mason and Mendoza 1993). Aggression "includes overt attack in all its forms, ranging from violent blows or strikes to simple intention movements, such as friendly advances toward a rival or opponent" (Moynihan 1998:5). Aggression is also an adaptation that allows an animal to cope with competition (Moynihan 1998), and is a product of circumstances (Jolly 1972).

Social animals employ different competitive strategies. According to Mason and Mendoza's (1993) Minimax Model, individual primates strive to have their own way wherever they can; primates want to move freely

within the group; interact with whomever and whatever; they want unimpeded access to goods; and to accomplish all with as little pain as possible. Individuals are looking to maximize satisfaction while minimizing discomforts and frustration (Mason and Mendoza 1993).

In closed systems, such as zoos, animals have the choice of how to compete, but not of leaving the area, thus they are unable to avoid competition (Colegrave 1994). They can accept the presence of others and compete passively, or they can actively try to exclude others (Colegrave 1994). The latter is a common mechanism of resource defense called direct competition. Direct competition differs from exploitation competition where better competitors take more of the limiting resource (Riechert 1998). The crux of the aggressive competition theory is whether it is more beneficial for an animal to behave passively or aggressively.

#### AGGRESSIVE COMPETITION THEORY

Popp and DeVore (1979) state that aggressive competition will occur when the benefits of taking possession of the disputed resource outweigh the costs to the actor, and if it is in the actor's own evolutionary interests to behave aggressively. An actor will try to increase its competitor's effort while reducing its own effort for gaining the disputed resource, thus making it unprofitable and maladaptive for the opponent to gain access to the resource (Popp and DeVore 1979).

The first individual to terminate its aggressive behavior is the *loser*; the last individual to terminate its aggressive behavior will normally gain access to the resource and be defined as the *winner*. Natural selection will favor those individuals who develop defensive strategies, i.e., behaviors that are less costly than fighting. Popp and DeVore (1979)

conclude that as a result, it is not necessary for an aggressive actor to inflict physical injury on an opponent for the actor's behavior to be adaptive; it is sufficient that the actor force his opponent to adopt a defensive strategy that is costly in time and energy.

#### RELATED HYPOTHESES

Hypotheses related to game theory are the hawk and dove strategies, and conditional strategies. The hawk and dove strategies relate to intraspecies confrontations over resources where the hawk strategy is to fight, and the dove strategy is to back off (Maier 1998). Maier (1998) goes on to explain that if there were several doves, there would be an advantage to becoming a hawk as it could win every encounter. As the number of hawks increased, the chance of having an encounter with another hawk would increase and the possibility of losing a fight would be costly. In this scenario, there would be an advantage to remaining a dove because an encounter with a hawk will only involve minimal loss. Although the animal will lose the resource, but it will not be injured or spend time fighting (Maier 1998). The participants in the hawk-dove game play the role they choose or the role they inherit (Cushing 1995). As suggested by game theory, if a dove is aware of its opponent and can determine its opponent's intentions, a dove can and will avoid a hawk (Cushing 1995). However, if a dove retreats, it does not necessarily mean that the hawk is the winner. As long as the dove remains in the vicinity of the hawk, then it could still represent a potential competitor (Cushing 1995).

In conditional strategies, an animal may fight when there is a good chance of winning, but back off when there is a significant chance of losing. Threats and bluffs enhance the effectiveness of a conditional approach, and prevent an opponent from

anticipating at what point the animal will back down (Maier 1998).

The above theories and strategies for aggressive and competitive behavior provide a basis for studying competition among orangutans. In order to understand captive orangutan social behavior, aggression, and competition, it is necessary to draw parallels with their wild counterparts.

### *WILD ORANGUTAN BEHAVIOR*

Wild orangutans have three social modes: adult females and their offspring; solitary adult males; and juvenile groups (Tobach et al. 1989). Orangutans live semisolitary lives, but come together only occasionally for food and mating (Hamilton and Galdikas 1994; Utami et al. 1997). Females tend to be solitary and the strongest social relationship is the mother-offspring dyad (Van Schaik and Van Hooff 1996). When it is not fruiting season, adult males are also solitary. Their ranges are neither exclusive nor stable and the resident male is not necessarily the dominant male (Van Schaik and Van Hooff 1996). Orangutans have a roving male promiscuity system, where males have large overlapping areas where they can search for receptive females (Van Schaik and Van Hooff 1996).

Three types of aggregations occur in the wild: travel bands, temporary aggregations, and consorts (Utami et al. 1997). The first two aggregations are related to different food availabilities (Utami et al. 1997). During periods of food scarcity, orangutans may experience competition for food. Two types of food competition occur within groups: scramble competition, which results in smaller benefits for individuals in larger groups; and contest competition, which leads to larger benefits for dominant individuals (Utami et al. 1997). Wild orangutans in temporary aggregations experience

contest, but not scramble, competition (Utami et al. 1997; Van Schaik and Van Hooff 1996). Utami et al. (1997) found that few displacements occurred between adult males in large fig trees; however, displacements between adult females occurred. These scientists also stated that all adult males were dominant over all subadult males and adult females; although, the presence or absence of a dominant individual did not significantly affect the foraging behavior of subordinate individuals (Utami et al. 1997).

Orangutans need large amounts of food; however, they are selective feeders (Van Schaik and Van Hooff 1996). Fruits dominate orangutans' diet, and they prefer fruit over leaves and bark (Rodman 1988; Van Schaik and Van Hooff 1996). They have been observed eating soil, insects, and eggs (Barbiers 1985). Orangutans deplete all ripe fruit at one source and they compete for food if they forage together, especially among large adult males (Hamilton and Galdikas 1994). Orangutans generally spend more than 95% of their waking hours feeding, resting, and moving between feeding and resting sites (Rodman 1988). Morning and evening feeding peaks are in fruiting trees, and afternoon feedings are on leaves during afternoon travel periods (Rodman 1988).

### *CAPTIVE ORANGUTAN BEHAVIORS*

Captive orangutans obviously do not need to spend time foraging and their movement is generally restricted. Several researchers have studied activity levels and social behaviors of captive orangutans. While some primate species perform aberrant behaviors in limited captive environments, orangutans are not noted for abnormal stereotypes; however, they consistently exhibit low activity levels and high obesity levels (Wright 1995). In observing orangutans at the Cheyenne Mountain Zoo in Colorado Springs,

Colorado, it was discovered that novel items reduced lethargy in the primates (Wright 1995). Object manipulation, investigation and play behavior occurred at a high level during the enrichment times for the orangutans, when compared to their activity during baseline and follow-up (Wright 1995). Idle behavior decreased during the experimental phases, but later increased during follow-up observations. Wright (1995) suggests that “behavioral rebound” could be avoided if novel enrichment is continued.

Tripp (1985) found that the orangutans’ activity increased at the Topeka Zoo in Kansas after adding manipulable material to the exhibit. The orangutans were exposed to three conditions. The orangutans were least active during the bare exhibit (baseline) condition, activity increased when manipulable materials were introduced, and the orangutans were most active when edibles were tossed into the exhibit with manipulable items present (Tripp 1985). Manipulation and locomotion behaviors increased for most of the orangutans.

Perkins (1992) observed captive orangutans in nine zoological parks in the southeastern United States in an attempt to identify and quantify which enrichment items specifically influenced the primates’ activity levels. She discovered that a large enclosure is part of a “set of related variables” that increases orangutan activity. The large space allows for more animals and more “playthings”, or movable objects. Perhaps movable objects are more appealing to orangutans because they resemble branches and vines used in the wild (Perkins 1992). Wild orangutans are solitary animals, but in captivity orangutans are not required to forage for their food (Perkins 1992), thus their social behaviors change in captivity. Perkins (1992) maintains that orangutans are quite capable of forming steadfast social attachments.

At the Sedgwick County Zoo in Wichita, Kansas, Tobach et al. (1989) observed social interactions among their captive orangutans. The researchers found that with their study group, the adult female orangutans had a complex relationship, and the male was found in a number of social dyads, both of which are contrary to their wild counterparts’ social behavior (Tobach et al. 1989). Given their captive circumstances, the adult animals associated with each other more than in their natural habitat (Tobach et al. 1989).

Poole (1987) also concluded that captive orangutans chose to make social relationships different than those they would have in the wild. Orangutans were observed on an artificial island at the Singapore Zoological Gardens in order to examine their social behavior. The island provided for high levels of potential social contact, which are opposite from their wild state. Results were as follows: older male orangutans spent more time alone, but spent more time in proximity to other individuals; social play was exhibited mostly by adult females and juveniles, but rarely by adult males; adult females groomed most often; play relationships were between adolescents and subadults; and there was no obvious dominance hierarchy and no aggression (Poole 1987). Poole (1987) suggests allowing captive orangutans the opportunity to form social groups if they choose to do so, as it creates an enriched environment.

The above studies suggest that orangutans in captivity can be socially flexible compared to their wild counterparts, and that enrichment items appear to promote positive activities.

#### *ENRICHMENT LITERATURE*

In order to better understand this project, it is important to know about the



background and purpose of introduced items, or enrichment. Early primate research was conducted to understand human psychological processes as well as primate anatomy (Bramblett 1994). Concerns about animal welfare emerged from these early primate studies. The Animal Welfare Act, amended in 1985, by the U.S. Congress required primate researchers to promote animals' psychological well-being (Novak and Suomi 1988). Psychological well-being can be assessed from physical health and fecundity (Wright 1995). It is difficult to define well-being, but it is generally accepted that non-human animals can experience suffering. Primatologists who study captive groups face ethical issues during research, primarily that the animals are kept in an unnatural, confined environment and may demonstrate behaviors different from those expressed in natural habitats.

Enrichment is "the act of making something better by the addition, or increase, of some desirable quality, attribute, or ingredient" (Guerrero 1997:1). A number of researchers (Anderson and Chamove 1983; Baker 1999; Barbiers 1985; Bitnoff 1996; Dewey 1989; Markowitz 1982; Perkins 1992; Reinhardt 1993; Tripp 1985; Wright 1995) have shown that enrichment benefits captive primates by reducing abnormal behaviors and increasing normal activity. Normal primate behaviors refer to those observed in the wild.

Another purpose of enrichment for captive orangutans is to allow them to behave more like free-ranging orangutans, since they are restricted from their full range of normal behaviors observed in the wild. Thus, it is important to provide a captive environment where animals can choose, even on a limited basis, various aspects of their environment (Cocks et al. 1999; Markowitz 1982) while increasing activity.

Current orangutan enrichment at the

Sacramento Zoo includes the following: 1) scatter food (vines, dried nuts and fruits, seeds, puffed wheat or rice, and popcorn), 2) coconuts, or other seasonal fruits/vegetables, 3) frozen fruit, 4) clothes, 5) boxes, 6) bamboo, and 7) sheets and towels (personal communication with Leslie Field and Lynette Elia). The Sacramento Zoo keepers get enrichment ideas from other keepers and volunteers (personal communication with Leslie Field).

Introducing novel items into captive primates' enclosures provides a means to enrich captive animals. Although this paper is not addressing well-being, the inclusion of introduced items provides an avenue for observing captive behavior, such as aggression and competition, while enriching the study group's lives. It is anticipated that because enrichment has been shown to increase activity and manipulation, as well as reduce lethargy in captive orangutans (Tripp 1985, Wright 1995), that competitive behavior and aggression levels will also increase during the enrichment phase.

#### *HYPOTHESES*

The effects of aggression and competition among the Sacramento Zoo orangutans were observed after introducing enrichment items into their enclosure. This paper addresses the question: *Do the orangutans at the Sacramento Zoo compete for enrichment items as wild orangutans do for food, and if so, do they compete more for food or non-food enrichment?* In an artificial environment, such as the Sacramento Zoo, there is not an overt need to aggressively compete for resources (e.g., food, mates, and territory). Competition may take on a subtle form in relation to enrichment items because orangutans are subtle in their behaviors (personal communication with Leslie Field).

I observed the orangutans at the Zoo during their normal condition, i.e., baseline condition, when they did not have any introduced items in their enclosure. I then compared the baseline condition to the experimental conditions, when the orangutans received introduced items in their enclosure. My hypotheses are as follows: 1) baseline hypothesis - overall, the orangutans will exhibit a higher number of aggressive behaviors during both the food and nonfood enrichment conditions than during the baseline conditions and, 2) aggressive and competitive behavior hypothesis - the individual orangutans will differ in both the frequency of their aggressive behaviors, and the competitiveness of those behaviors in each of the study conditions. Enrichment items may take on a similar meaning that highly prized food items do for wild orangutans (where dominance, status, age, sex, access to mates, and sharing are factors) because enrichment items are novel and rare. I believe the items *and* the resulting aggressive and competitive behavior for the items will serve as enrichment for the orangutans. Introducing items into the orangutan enclosure provides an avenue for observing captive aggressive and competitive behavior.

## MATERIALS AND METHODS

### *SUBJECTS*

Observations were made on the three orangutans housed at the Sacramento Zoo (see Table 1). To understand the orangutans' aggressive and competitive behaviors, it is necessary to learn the orangutans' backgrounds and interactions. The information was obtained from Zookeeper, Lynette Elia, and lead keeper/supervisor over mammals, Leslie Field.

**Table 1 Sacramento Zoo Orangutan Profiles<sup>†</sup>**

Name	Sex	Origin	Date of Birth	Health Conditions	Weight
Urban	M	Sacramento Zoo	Feb. 1981	none	252 lbs.*
Ginger	F	wild caught	approx 1955	arthritis	110 lbs.**
Sayang	F	Sedgewick County Zoo	Nov. 1983	none	102 lbs.***

<sup>†</sup>(personal communication with Leslie Field and Lynette Elia)

\*December 1999

\*\*February 2000

\*\*\*January 2000

The orangutans' enclosure consists of an open-air exhibit, while their sleeping dens are inside, behind the scenes. The orangutans are fed inside between 8:00-8:30 A.M., and at 4:00 P.M. when they are brought back inside. Their daily enrichment items are already in the open-air exhibit when the animals are released at approximately 9:00 A.M. Occasionally, enrichment items are thrown into the open-air exhibit for special occasions or presentations.

### *PROCEDURES*

In order to collect baseline behaviors, I observed the orangutans for 15 hours during September 2000. For the experimental phase, I constructed the enrichment items following the Zoo's guidelines and approved projects. Food items included: frozen water and juice blocks with fruit, boxes with browse materials, frozen peanut butter tubes, frozen yogurt tubes, raisin boards, frozen apple sauce tubes, Jell-O tubes, peanut butter "sandwiches" (made from cardboard), marshmallow "kabobs", unshucked corn cobs, tangerines in socks sprinkled with cinnamon, apple sauce and raisins in PVC pipe, seeds, and wrapping paper tubes with browse items (see Table 2). Non-food items included: socks with extract essences, socks with tea, flowers in socks, boxes, toilet paper roll "necklaces", pillow cases sprinkled with cinnamon in boxes, sheet "hammocks", and hats (see Table 2). The Zookeepers distrib-

uted the items to the orangutans, usually by throwing the items into the enclosure or by placing them in the exhibit before the animals were released, as I observed and recorded the animals' behaviors. All of the orangutans were together when exposed to the enrichment items. A schedule was created with predetermined, alternating days of when and what items were to be introduced. I collected 21 hours of experimental data during September – November 2000.

**Table 2 List of Enrichment Items Used**

Food Enrichment Items:
Frozen blocks (water) with grapes
Boxes with browse (popcorn and raisins)
Frozen peanut butter tubes (in paper towel rolls)
Frozen yogurt tubes (in paper towel rolls)
Raisin boards (2"x4"x6" of Douglas fir with drilled holes and raisins in holes)
Frozen blocks (diluted Kool-Aid) with apples
Frozen apple sauce tubes (in paper towel rolls)
Jell-O tubes (PVC pipe with caps on ends and holes drilled in pipe, with gelatin inside)
Peanut butter "sandwiches" (in square cardboard pieces)
Marshmallow "kabobs" (marshmallows skewered on sticks)
Unshucked corn cobs
Tangerines in socks sprinkled with cinnamon
Apple sauce in PVC pipe with raisins plugged in holes
Seeds spread on ground outside
Wrapping paper tubes with browse items
Non-food Enrichment Items:
Socks with extract essences in knots
Socks with tea inside
Flowers in socks
Boxes
Toilet paper roll "necklaces" (rolls on twine)
Pillow cases sprinkled with cinnamon inside boxes
Sheet "hammocks" (sheets tied to resemble hammocks)
Sombreros

In order to test the aggressive behaviors, I observed the orangutans using continuous recording of specific aggressive behaviors (aggressive display, approach, beg, take, and temper tantrum).

A scale from 0-4 was used to determine the level of competition (see Table 3). The competition scale scores for levels of contact among animals; however, competition can be inferred in a subjective manner. As previously discussed, in closed systems, such as zoos, animals are often unable to avoid competition, but they can choose to

compete passively or actively (Colegrave 1994). For example, in the hawk-dove hypotheses (Cushing 1995), an animal that remains nearby another individual could still represent a potential competitor. Thus, the mere proximity of another animal could be competitive behavior. Goodall (1986) states that the most common overt competitive behavior is when one chimpanzee approached another who promptly left the feeding place. When I scored for competitive interactions, competition began when one orangutan displayed interest in another's item that was introduced into the enclosure. The competitive interaction ended when one orangutan attained the desired item and left, or gave up after unsuccessfully taking the item and moving away a significant distance. Levels 0-1 indicate no competition; levels 2-4 indicate competition. When orangutans continued competing for the item, the competitive interactions were continually scored. The individual instigating the interaction and who received the interaction was recorded.

**Table 3 Level of Competition**

Competition Level	Description
0	orang appears to have to interest in introduced item
1	orang looks over at other orang with item and looks away
2	orang approaches other orang with item and looks intently at item
3	orang approaches other orang and tries to take item
4	orang takes item from other orang

## DATA ANALYSIS

For the baseline hypothesis (the orangutans would exhibit a higher number of aggressive behaviors during both the food and nonfood enrichment conditions than during the baseline conditions), the independent variable was the study condition with the following three levels: 1) baseline, 2) food enrichment, and 3) non-food enrichment. The dependent variable was the average rate of aggressive behaviors observed per 30



minutes. The data for this hypothesis were analyzed using a one-way analysis of variance (ANOVA). For the aggressive and competitive behavior hypothesis (the orangutans would differ in both the frequency of their aggressive behaviors and the competitiveness of those behaviors in each of the study conditions), the independent variable was the individual orangutans: 1) Urban, 2) Ginger, and 3) Sayang. The dependent variables were the average competitiveness score of each orangutan (as measured by the level of competition rating scale) and the number (frequency) of initiating aggressive behaviors. A series of three one-way ANOVA's (one for each study condition) was used to determine if the orangutans differed qualitatively in their competitiveness in each study condition. Tukey multiple comparisons were used for post hoc tests whenever significant ANOVA was found. Similarly, a series of three Chi Square Goodness-of-fit tests were used to determine if the orangutans differed in the number of aggressive acts each engaged in for each study condition. An alpha level of 0.05 significance was selected *a priori*. The statistical package SPSS (version 10.0) was used to analyze data.

## RESULTS

### BASELINE HYPOTHESIS

The mean number of aggressive behaviors per 30 minutes for the baseline, non-food enrichment, and food enrichment conditions was 4.00 ( $SD = 3.76$ ), 4.70 ( $SD = 2.96$ ), and 4.00 ( $SD = 3.25$ ), respectively. The ANOVA results did not indicate a significant difference in the overall rate of aggressive behaviors across the three study conditions,  $F(2, 72) = 0.39$ ,  $p > .05$ , where  $p = .68$ . These results do not support the baseline hypothesis that enrichment items would result in significantly more overall

aggressive behaviors in the orangutans. Although there appeared to be slightly more aggression during the non-food enrichment condition than during the other two study conditions, the differences among them did not reach statistical significance and hence cannot be considered "real" differences.

### AGGRESSIVE AND COMPETITIVE BEHAVIOR HYPOTHESIS

The results of the series of the Chi Square tests for the baseline [ $c^2(2, N = 118) = 80.56$ ,  $p > .05$ ] food enrichment [ $c^2(2, N = 139) = 24.09$ ,  $p > .05$ ], and non-food enrichment [ $c^2(2, N = 60) = 24.30$ ,  $p = .04$ ] conditions all indicated that at least one orangutan had a higher number of aggressive behaviors than did the other orangutans. These findings support the aggressive and competitive behavior hypothesis.

The number of aggressive acts each orangutan engaged in for each study condition is presented in Table 4. Specifically, regardless of the study condition, Sayang engaged in a higher number of aggressive behaviors than did either Ginger or Urban. Ginger and Urban did not differ significantly in their numbers of aggressive behaviors in any of the study conditions. In terms of the frequency of initiating aggressive behaviors, Sayang was consistently more aggressive than either Urban or Ginger.

**Table 4**  
Number of Aggressive Acts of each Orangutan for each Study Condition

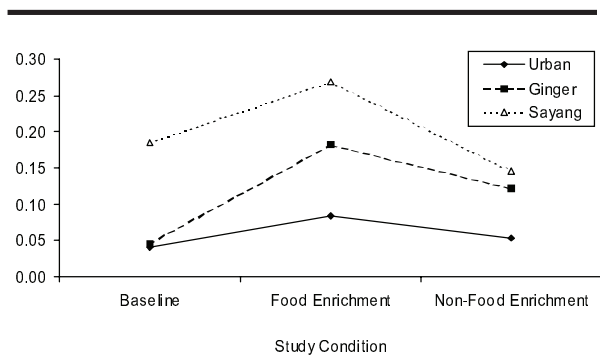
Orangutan	Baseline	Enrichment		
		Food	Non-Food	Total Enrichment
Urban	12	38	11	49
Ginger	21	27	11	38
Sayang	85	74	38	112

**Table 5**  
**Mean and Standard Deviation Competitiveness Score of each Orangutan for each Study Condition**

Orangutan	Enrichment					
	Baseline		Food		Non-Food	
	M	SD	M	SD	M	SD
Urban	0.04	0.36	0.08	0.53	0.05	0.42
Ginger	0.05	0.42	0.18	0.64	0.12	0.55
Sayang	0.19	0.74	0.27	0.86	0.15	0.66

The mean and standard deviation competitiveness ratings of each orangutan for each of the study conditions are presented in Table 5. The results of the ANOVA for the baseline condition indicated that at least one orangutan was more competitive than at least one of the others,  $F(2, 2454) = 21.77, p < .05$ . Results of Tukey post hoc tests indicated that Sayang was more competitive than both Urban and Ginger ( $ps < .05$ ), and that Urban and Ginger did not significantly differ in their level of competitiveness ( $p > .05$ ). Results of the ANOVA for the food enrichment condition also indicated that at least one orangutan was more competitive than at least one of the others,  $F(2, 2652) = 14.76, p < .05$ . Tukey post hoc tests showed that Sayang was again more competitive than both Urban and Ginger ( $ps < .05$ ). However, the results also indicated that Ginger was more competitive than Urban during food enrichment ( $p < .05$ ). As such, Urban was the least competitive, Ginger was in the middle, and Sayang was the most competitive. The non-food enrichment ANOVA also indicated a difference in the orangutans' competitiveness,  $F(2, 1305) = 3.41, p < .05$ . The post hoc tests showed that Sayang was more competitive than Urban ( $p < .05$ ), but was not more competitive than Ginger ( $p > .05$ ). In addition, Ginger and Urban also did not differ in their level of competitiveness during non-food enrichment ( $p > .05$ ). The relationship between the means is illustrated in Figure 1.

**Figure 1**  
**Mean competitiveness of each orangutan in each study condition**



Overall, these results indicate that Ginger was more active during the enrichment conditions than during baseline, that Urban's behavior did not change much relative to the other orangutans (he was always the least competitive), and that Sayang was always highly competitive relative to the others (although equally as competitive as Ginger during non-food enrichment), as measured by both the quantity of aggressive behaviors and the competitive quality of those behaviors.

## DISCUSSION

There were differences in the relative levels of competitiveness of the orangutans across the different study conditions, specifically showing a higher level of competitiveness in the food enrichment condition. Urban never became more competitive, but Sayang was always competitive. Ginger changed her intensity, but not frequency, of competitiveness depending upon the condition. During the baseline condition, Ginger was just as uncompetitive as Urban; however, during the non-food enrichment condition, Ginger's competitiveness increased, and during the food enrichment condition, her level of competitiveness was significantly higher than Urban's. But Ginger was still less competitive than Sayang in both frequency

and quality in all conditions except non-food enrichment.

Perhaps Sayang's competition scores were always high because her general activity was high, possibly because she is young and energetic. Although Urban is only two years older than Sayang, her activity level was higher than Urban's, possibly due to other factors, such as sex differences. For example, Tobach et al. (1989) found that among their captive study group, the orangutan males were idle and solitary. Compared to Ginger, Sayang's youth could possibly be a factor that made her a better competitor. It was mentioned previously that while Ginger is older than Sayang, she is more playful (personal communication with Field); however, during my observations, I noticed Sayang was more active and playful than Ginger. It appeared that Sayang's defensive strategy was to take, steal, and hoard enrichment items (i.e., resources). She collected all enrichment items regardless of what they were, even if she had her own. Sayang did not necessarily try to actively exclude others, rather she accepted the presence of others and competed somewhat passively, because the others allowed her to. Perhaps Sayang was able to assess the character states (e.g., experience, size, age, and sex) of Ginger and Urban and knew when she could take advantage of a situation (i.e., take or steal items). It was Sayang's lower level of competitiveness, paired with a slight increase in Ginger's competitiveness that accounts for the fact that the results showed them to be equally aggressive during non-food enrichment.

Ginger's old age could account for her low competition scores; however, her competition increased relative to the others during both of the enrichment conditions. Ginger employed a different competitive strategy than Sayang. In the hawk and dove strategies previously discussed, Ginger is a

dove. The dove's strategy is to back off, even if it costs the individual the resource. Ginger cannot afford to lose energy and time struggling over a resource, so she generally succumbed to the others. She seemed to know when to back off, especially when there was a chance of losing. When it came to food, however, Ginger's competition level increased because it was in her own evolutionary interests to behave more competitively.

Urban can also be considered a dove as he was generally passive. In some instances, he was overtly aggressive, hovering over the females or charging for the items, but it was not a significant amount to affect his competition score. Urban spent a large amount of time idle and solitary, which is typical of both wild and captive orangutans. Thus his low competition level should not be surprising. Perhaps the items were not sufficiently enticing or complicated to increase his competition scores in the enrichment conditions. Urban was more interested in the food enrichment items, although it is not reflected in his scores. He generally came out from under his box in the cave just to eat or inspect the items, then usually returned to his former position. Perhaps Urban has not had to deal with other males who were competing with him for female attention (personal communication with Kristina Casper-Denman), which may account for his general idle behavior.

There were other behaviors that occurred during the observation sessions that could not be scored, but were noted, such as walking, climbing, playing, foraging, etc. Since this study focuses on aggressive competition, only specific behaviors were recorded. Readers should not be biased that Urban and Ginger are usually idle just because their aggression and competition scores were low in this particular study; all orangutans performed active behaviors.

There were also aggressive and competitive behaviors that occurred but could not be scored because they were not occurring during the timed interval. Another subject to consider is sharing, which occurred but was not recorded. The act of taking an item was scored, but some instances could have been considered sharing.

Tobach et al. (1989) and Poole (1987) found the orangutans' were capable of being socially flexible compared to their wild counterparts, as I also noted. While Urban is mostly solitary, he has contact with Sayang and Ginger, which would not generally happen in the wild. Females are also solitary in the wild, yet Ginger and Sayang have almost constant interactions. The enrichment items seemed to provide an avenue for which the orangutans could interact, and for which their flexible social behavior could be observed.

It is difficult to describe primate behavior, especially without anthropomorphizing - a common issue in anthropology. However, there is substantial information that the emotional physiological states of other primates are homologous to humans (Harlow 1958, Harlow and Mears 1979). It is safe to say from the data at hand that while the enrichment items did not significantly increase aggressive behavior among the orangutans, their competitiveness was affected, especially for food enrichment. Food enrichment *may* have indeed taken on a similar meaning that highly prized food items do for wild orangutans. Their resulting competitive behavior for the enrichment could have itself been enriching.

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#### REFERENCES

- Anderson, J.R. and A.S. Chamove.  
1983 Allowing Captive Primates to Forage. [http://www.animalwelfare.com/Lab\\_animals/biblio/ufaw-2~1.html](http://www.animalwelfare.com/Lab_animals/biblio/ufaw-2~1.html).  
Electronic document.
- Baker, K. C.  
1999 Straw and Forage Material Ameliorate Abnormal Behaviors in Adult Chimpanzees. *Zoo Biology* 16:225-236.
- Barbiers, R. B.  
1985 Orangutans' Color Preference for Food Items. *Zoo Biology* 4:287-290.
- Bitnoff, J. A.  
1996 The Effect of Physical Environment on the Behavior of Captive Chimpanzees: A Comparison of Three Northern California Zoos. M.A. Thesis. San Jose State University.
- Bramblett, C. A.  
1994 *Patterns of Primate Behavior*. Prospect Heights, IL: Waveland Press, Inc.
- Cocks, L., C. Baker, G. Harris, and F. Butcher  
1999 Behavioral Enrichment for Nonhuman Primates. *Laboratory Primate Newsletter* 38(1):14-15.



- Colegrave, N.  
1994 Game theory models of competition in closed systems: asymmetries in fighting and competitive ability. *Oikos* 71:499-505.
- Cushing, B. S.  
1995 When a Hawk can Damage a Dove: An Extension of Game Theory. *Journal of Theoretical Biology* 175:173-176.
- Dewey, R. A. Jones  
1989 Assessing the Cost-Effectiveness of Specific Enrichment Items for Captive Chimpanzees. M.A. Thesis. University of Colorado.
- Gause, G.F.  
1964 *The Struggle for Existence*. New York: Hafner Publishing Co.
- Goodall, J.  
1986 *Chimpanzees of Gombe: Patterns of Behavior*. Cambridge, MA: Belknap Press.
- Guerrero, D.  
1997 Enrichment 101: A Basic Overview. Electronic document.  
<http://www.arkanimals.com/E/Enrich101.html>
- Harlow, H. F.  
1958 *Biological and Biochemical Bases of Behavior*. Madison: University of Wisconsin Press.
- Harlow, H. F. and C. Mears  
1979 *The Human Model: Primate Perspectives*. Washington: V. H. Winston.
- Hamilton, R. A. and B. M. F. Galdikas  
1994 A Preliminary Study of Food Selection by the Orangutan in Relation to Plant Quality. *Primates* 35:255-263.
- Hammerstein, P.  
1998 What Is Evolutionary Game Theory? In *Game Theory and Animal Behavior*. Lee Alan Dugatkin and Hudson Kern Reeve, eds. Pp. 3-15. New York: Oxford University Press.
- Jolly, A.  
1972 *The Evolution of Primate Behavior*. New York: MacMillan Company.
- Jones, C. B.  
1980 The Functions of Status in the Mantled Howler Monkey, *Alouatta palliata* Gray: Intraspecific Competition for Group Membership in a Folivorous Neotropical Primate. *Primates* 21:389-405.
- Maier, R.  
1998 *Comparative Animal Behavior: An Evolutionary and Ecological Approach*. Boston: Allyn and Bacon.
- Markowitz, H.  
1982 *Behavioral Enrichment in the Zoo*. New York: Van Nostrand Reinhold Co.
- Mason, W. A. and S. P. Mendoza  
1993 Primate Social Conflict: An Overview of Sources, Forms, and Consequences. In *Primate Social Conflict*. William A. Mason and Sally P. Mendoza, eds. Pp. 1-11. New York: New York Press.
- Maynard Smith, J.  
1974 Theory of Games and the Evolution of Animal Conflicts. *Journal of Theoretical Biology* 47:209-221.
- Maynard Smith, J., and G.R. Price  
1973 The Logic of Animal Conflict. *Nature* 246:15-18.
- Moynihan, M.  
1998 *The Social Regulation of Competition and Aggression in Animals*. Washington, D.C.: Smithsonian Institution Press.
- Novak, M. A. and S. J. Suomi  
1988 Psychological Well-Being of Primates in Captivity. *American Psychologist* 43:765-773.
- Perkins, L. A.  
1992 Variables that Influence the Activity of Captive Orangutans. *Zoo Biology* 11:177-186.

- Poole, T. B.  
1987 Social Behavior of a Group of Orangutans (*Pongo pygmaeus*) on an Artificial Island in Singapore Zoological Gardens. *Zoo Biology* 6:315-330.
- Popp, J. L. and I. DeVore  
1979 Aggressive Competition and Social Dominance Theory: Synopsis. In *The Great Apes*. D.A. Hamburg and E.R. McCown, eds. Pp. 317-338. Menlo Park, CA: Benjamin/Cummings Publishing Co.
- Reinhardt, V.  
1993 Enticing Nonhuman Primates to Forage for Their Standard Biscuit Ration. *Zoo Biology* 12:307-312.
- Riechert, S. E.  
1998 Game Theory and Animal Contests. In *Game Theory and Animal Behavior*. Lee Alan Dugatkin and Hudson Kern Reeve, eds. Pp. 64-93. New York: Oxford University Press.
- Rodman, P. S.  
1988 Diversity and Consistency in Ecology and Behavior. In *Orang-utan Biology*. J. H. Schwartz, ed. Pp. 31-50. New York: Oxford University Press.
- Strier, K.  
2000 *Primate Behavioral Ecology*. Boston: Allyn and Bacon.
- Tobach, E., G. Greenberg, P. Radell, and T. McCarthy  
1989 Social Behavior in a Group of Orang-Utans (*Pongo pygmaeus abelii*) in a Zoo Setting. *Applied Animal Behaviour Science* 23:141-154.
- Tripp, J.K.  
1985 Increasing Activity in Captive Orangutans: Provision of Manipulable and Edible Materials. *Zoo Biology* 4:225-234.
- Utami, S., S. A. Wich, E. H. M. Sterck, and J. A. R. A. M. van Hoof  
1997 Food Competition Between Wild Orangutans in Large Fig Trees. *International Journal of Primatology* 18:909-927.
- Van Schaik, C. P. and J. A.R.A.M. Van Hooff  
1996 Toward an Understanding of the Orangutan's Social System. In *Great Ape Societies*. William C. McGrew, Linda F. Marchant and Toshisada Nishida, eds. Pp. 3-15. Cambridge: Cambridge University Press.
- Wright, B. W.  
1995 Novel Item Enrichment Program Reduces Lethargy in Orangutans. *Folia Primatol* 65:214-218.