

CASE STUDY: DIET AND SOCIAL GROUPING HAVE AN EFFECT ON REGURGITATION AND REINGESTION IN TWO CAPTIVE GREAT APES

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Abstract

Regurgitation and reingestion (R&R) is commonly seen in zoos but is considered undesirable, since is not necessary to digestion and has not been observed in wild great apes. The causes of this behavior are multifactorial and not well understood, and not all proposed solutions work for all individuals. This makes it necessary to approach every case independently to find solutions that can reduce or eliminate R&R for each affected individual. In this case, one male western lowland gorilla (*Gorilla gorilla gorilla*) and one female northwest Bornean orangutan (*Pongo pygmaeus pygmaeus*) at Omaha's Henry Doorly Zoo and Aquarium (OHDZA) have exhibited recurring R&R. Multiple strategies, including dietary starch reduction, addition of browse, and scattered forages, have been employed to reduce this behavior with mixed results. This study observed behavior in response to varying levels of browse, both in addition to a standard diet and as a substitute for dietary greens. Housing arrangements for the orangutan also made it possible to observe whether R&R happened more frequently during hours spent alone or when housed with conspecifics. In this study, browse increased time spent feeding in both orangutan and gorilla, regardless of total diet volume. Browse reduced R&R in only the orangutan, and housing with conspecifics was associated with lower rates of R&R in the orangutan.

Introduction

Regurgitation and reingestion (R&R) is defined as the voluntary retrograde movement of food from the stomach or esophagus to the mouth, hand, or other surface. This behavior has not been seen in wild apes and is considered abnormal and undesirable in zoos (Hill, 2009). The cause of this behavior is multifactorial and still poorly understood, but many zoos have had success with dietary manipulation, including reducing digestible carbohydrates and increasing provision of forage material (Lukas, 1999; Cassella, 2012; Fuller *et al.*, 2018). The purpose of this study was to examine the effects of varying levels of daily browse on R&R and other food-related behaviors in one gorilla and one orangutan with histories of consistent R&R.

Materials and Methods

One adult male western lowland gorilla (*Gorilla gorilla gorilla*) and one adult female northwest Bornean orangutan (*Pongo pygmaeus pygmaeus*) were observed using a simple ethogram (Table 1). Behavior observations were conducted using continuous sampling method. During baseline observations, animals received their standard daily diet (Table 2). After baseline, three treatments were applied: Low Browse (defined as 2.3 kg per gorilla and 1.8 kg per orangutan of fresh cut browse), High Browse (defined as 4.5 kg per gorilla and 3.6 kg per orangutan), and Replacement (in which the High Browse amounts of browse replaced an equal weight of the mixed greens typically included in the diets). During each period, six days of observations were conducted. Randomized two-hour increments were observed on each day of observation.

Results and Discussion

This study found that additional dietary browse reduced R&R for a female orangutan (Figure 1) but had no effect for a gorilla (Figure 2), contradicting previous observations at OHDZA (Kappen, *et al.*, 2017), which indicated an opposite effect. Baseline observations during the present study indicated that incidence of R&R in the gorilla had almost entirely ceased regardless of browse availability, which suggests that previously noted beneficial effect of daily browse may have been erroneous. This gorilla previously exhibited frequent R&R when housed in a bachelor pair and appeared to continue this behavior at a somewhat reduced rate when moved to a family group. The 2017 study was conducted with this gorilla while he was housed with the family group, and provision of daily browse was associated with reduced R&R (Kappen *et al.*, 2017); however, baseline in this previous study may have coincided with unusually high rates of R&R, which we were unable to replicate in the current study. In the case of the gorilla, it appears likely that his housing change or potential unrecorded variables are more influential than dietary modifications in reducing R&R.

Previous observations indicated that the female orangutan had spent less time on R&R when housed alone versus with conspecific females (Kappen *et al.*, 2017); however, this study observed the opposite effect with higher rates of R&R when housed alone (Figure 3). Further study is needed to understand how social dynamics affect R&R in this orangutan.

Addition of browse increased time spent feeding for both gorilla and orangutan (Figures 1 & 2). Both low and high browse increased time spent feeding over baseline, which makes sense given the increased volume of diet offered. Using browse as a replacement for greens in the diet also had this effect, suggesting that browse can be used to extend feeding time even without increasing diet volume.

In conclusion, increasing dietary forage through the provision of daily browse may in certain cases be helpful in reducing R&R in zoo-housed apes, but added forage clearly increases time spent on feeding behaviors. Extended feeding time may be desirable for zoos as a primary goal, and in certain cases may also help reduce or eliminate stereotypic behaviors such as R&R.

Literature Cited

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Table 1. Ethogram used for continuous sampling observations of ape behavior

Behavior	Description
Feeding	Ingestion of any food or water
Feed manipulation	Gathering feed, stripping bark, etc. Not actually consuming feed
Feed aggression	Displacement, striking, etc. resulting from competition over feed
R&R	Regurgitation and reingestion of consumed feed
Active	Any active behavior, including walking, climbing, grooming, investigating, vocalizing, social behaviors
Inactive	Any inactive behavior, including sitting, laying, standing

Table 2. Current diets for one male western lowland gorilla (*Gorilla gorilla gorilla*) and one female northwest Bornean orangutan (*Pongo pygmaeus pygmaeus*) at OHDZA

Item	Gorilla diet (g)	Orangutan diet (g)
Seasonal fruit rotation ¹	0	110
Seasonal vegetable rotation ²	1700	1080
Mixed greens rotation ³	18700	2400
Oatmeal patty ⁴	500	360
Alfalfa hay	2000	0
Centrum Silver Chewable Multivitamin	2 tablets	0
Hard-boiled egg	0	50
In-shell peanuts	0	50
Mazuri Primate L/S Banana Biscuits (5M1G)	0	500

¹Seasonal fruit rotation can include, but is not limited to: Apple, banana, grapes, kiwi, mango, melon (various), orange, papaya, pear, pineapple, plum, strawberry.

²Seasonal vegetable rotation can include, but is not limited to: Beet, broccoli, carrot, cauliflower, cucumber, green bean, green pepper, parsnip, radish, russet potato, squash (various), sweet corn, sweet potato, tomato, zucchini.

³Mixed greens can include, but are not limited to: Cabbage, celery, collard green, dandelion green, endive, mustard green, romaine (or other lettuce), spinach, turnip green.

⁴OHDZA oatmeal patty recipe: proportions by weight are 36% rolled oats, 9% cellulose, 5% shelled sunflower seeds, 10% peeled bananas, 38% boiling water, 2% vegetable oil

Orangutan Activity Budget

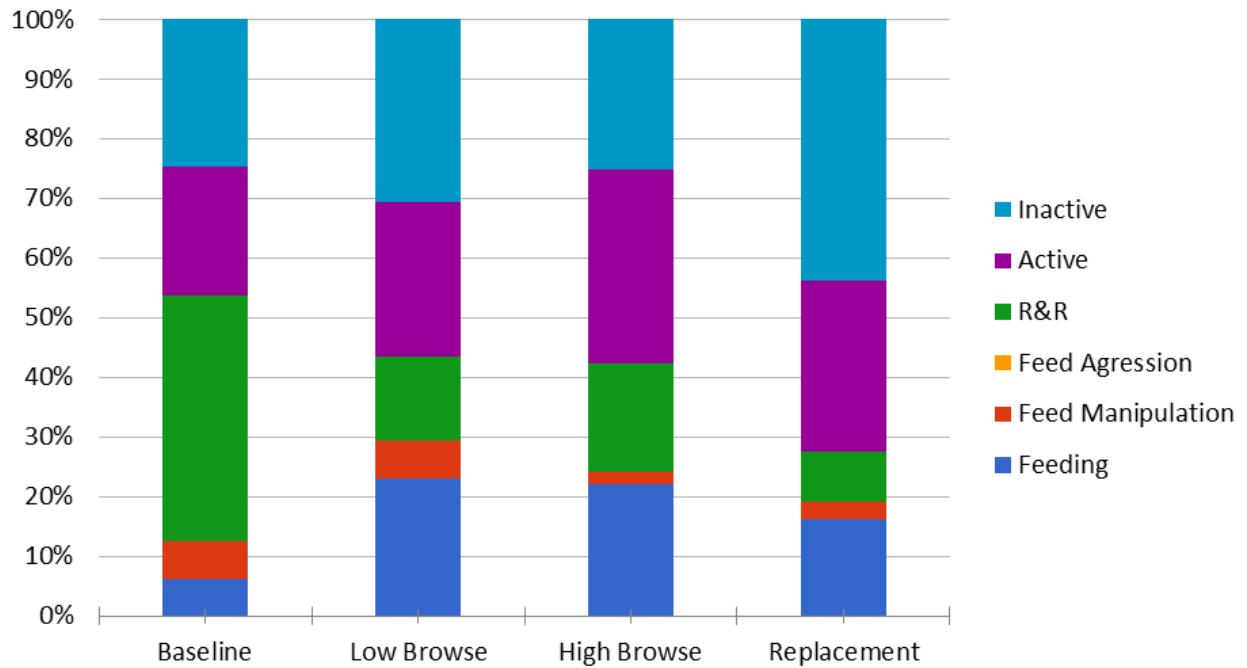


Figure 1. Average activity budget for orangutan during Baseline, Low Browse, High Browse, and Replacement periods.

Gorilla Activity Budget

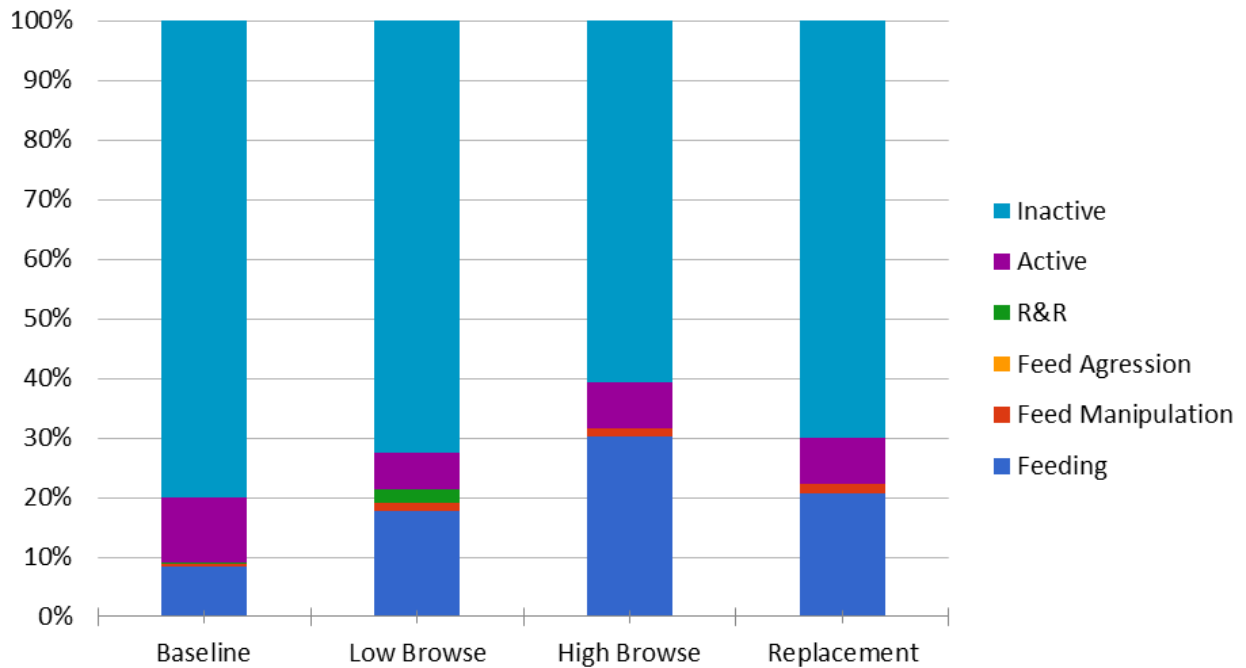


Figure 2. Average activity budget for gorilla during Baseline, Low Browse, High Browse, and Replacement periods.

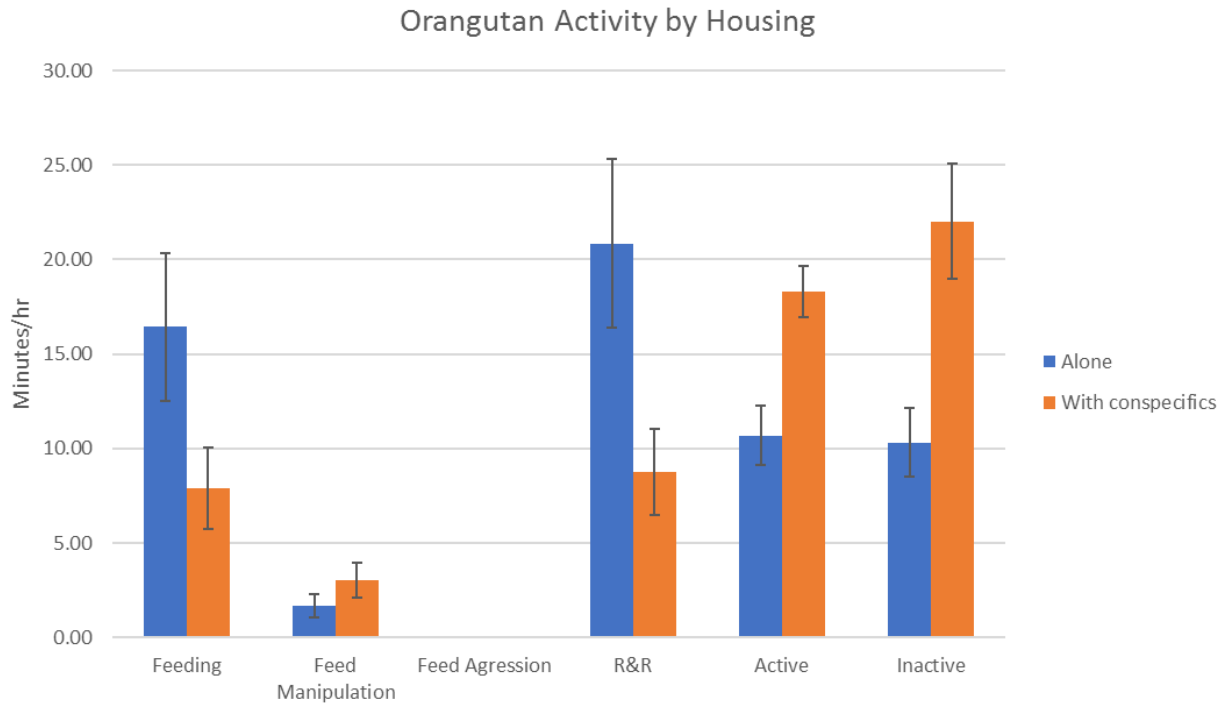


Figure 3. Time spent on Feeding, Feed Manipulation, Feed Aggression, Regurgitation & Reingestion (R&R), Active, and Inactive behaviors during hours spent alone versus with conspecifics.