

City University of New York (CUNY)

CUNY Academic Works

Theses and Dissertations

Hunter College

Spring 5-15-2020

Presence and Degree of Contrafreeloading in African Grey Parrots (*Psittacus erithacus*)

Gabriella E. Smith
CUNY Hunter College

[How does access to this work benefit you? Let us know!](#)

More information about this work at: https://academicworks.cuny.edu/hc_sas_etds/602

Discover additional works at: <https://academicworks.cuny.edu>

This work is made publicly available by the City University of New York (CUNY).
Contact: AcademicWorks@cuny.edu

Presence and Degree of Contrafreeloading in African Grey Parrots

Presence and Degree of Contrafreeloading in African Grey Parrots (*Psittacus erithacus*)

by

Gabriella E. Smith

Submitted in partial fulfillment
of the requirements for the degree of Masters of Arts
Animal Behavior and Conservation
Hunter College
The City University of New York

2020

5/15/2020
Date

Irene M. Pepperberg, PhD
Thesis Sponsor

5/15/2020
Date

Diana Reiss, PhD
Second Reader

Table of Contents

List of Figures.....3
Abstract.....4
Introduction.....5
General Methods.....9
 Subjects and Housing.....9
 Materials/Apparatus.....10
 Procedure.....10
Experiment 1.....11
 Rationale.....11
 Procedure.....12
 Results.....13
 Initial Food Item Preferences.....13
 Food Item Preferences During Testing.....14
 Food Item Preferences: Before versus During Testing.....14
 Food Item Contrafreeloading.....15
 Food Items Paired with Empty Cups.....18
 Empty Cup Contrafreeloading.....19
 Discussion.....20
Experiment 2.....22
 Rationale.....22
 Procedure.....22
 Results.....23
 Discussion.....24
General Discussion.....24
References.....29

List of Figures

Figure 1	11
Figure 2	12
Figure 3	16
Figure 4	17
Figure 5	18
Figure 6	20
Figure 7	22
Figure 8	23

Abstract

Contrafreeloading is the choice to perform a physical task to access food over freely available food. This study examined the presence and degree of contrafreeloading in two Grey parrots (*Psittacus erithacus*), Griffin and Athena. Experiment 1 presented subjects with container pairs holding more- or less-preferred free or enclosed food items. Degrees of contrafreeloading were classified as: calculated contrafreeloading (working to access preferred food over less-preferred freely available food); classic contrafreeloading (working to access food equal in value to freely available food); and super contrafreeloading (working to access a less-preferred food over freely available food). Griffin (male, 24 years-old) significantly preferred classic and calculated contrafreeloading; Athena (female, 6 years-old) significantly preferred calculated contrafreeloading. Experiment 2 examined more ecologically relevant contrafreeloading, using shelled and unshelled almonds: Athena significantly preferred cracking an almond's shell; Griffin did not. Differences in contrafreeloading between the two Grey parrot subjects are considered here as individual differences in which task is considered self-reinforcing play. Contrafreeloading and its intersection with play could offer a metric of welfare of captive animals.

Keywords: Contrafreeloading, Play, Grey Parrot, Welfare, Optimal Foraging Theory

Presence and Degree of Contrafreeloading in African Grey Parrots (*Psittacus erithacus*)

Contrafreeloading pertains to performing a physical task to access food instead of consuming food that is freely available (freeloading) (Inglis et al., 1997; Osborne, 1977). According to the general form of optimal foraging theory (Charnov, 1973; Charnov & Orians, 2006; Pyke, 1984; Schoener, 1987), contrafreeloading should not exist: Animal subjects should aim to maximize reward (e.g. food) over cost (e.g. waiting time or physical work, like search), not vice versa (Inglis et al., 1997; Logan, 1960; Reynolds, 1968; Tolman, 1955; Yoshioka, 1929). In many studies, this preference for work is classified as earning behavior, subjects performing a physical task to ‘earn’ a reward (Alferink, Crossman, & Cheney, 1973; Carder & Berkowitz, 1970; Carlson & Riccio, 1976).

Historically, studies of contrafreeloading observed animal subjects in Skinner boxes contrafreeloading through a physical task (e.g. lever pressing or key pecking) to retrieve food equal in value to that which was freely available (Coburn & Tarte, 1976; Carlson, & Riccio, 1976; Herrnstein & Loveland, 1972; Singh, 1970; Tarte, Townsend, & Vernon, 1973). These studies of contrafreeloading are problematic because animal subjects were often kept in conditions with little to no choice, control, or alternative activity in their environment, and were often food or water-deprived (Taylor, 1972, 1975). Considering Maslow’s Hierarchy of Needs, motivation to express a certain behavior is contingent upon other physiological and social needs being met (Maslow, 1943). Thus, many additional possible explanations likely exist for the lack or presence of early contrafreeloading behavior, not the least being sheer boredom (Coburn & Tarte, 1976; Gardner & Gardner, 1988).

Most modern explanations of contrafreeloading reside in learning and motivational theories. According to the information primacy theory, subjects may contrafreeload to access

Presence and Degree of Contrafreeloading in African Grey Parrots

and learn about novelty in their environment (Havelka 1956; Inglis et al., 1997) or to explore foraging sites (Bean, Mason, Bateson, 1999; Forkman, 1993; Inglis & Ferguson, 1986).

Contrafreeloading may also reside in competence or volitional control theories in which a subject finds self-reinforcement in manipulating whatever it can access in its environment (Barto, 2013; Kavanau & Havenhill, 1976; Ogura, 2011; Pintrich, 1999; White, 1959). Similarly, drive reduction theory claims that a subject may be motivated to perform a certain behavior to quell its instinctual motivation to do so, like raccoons' instinct to 'wash' food (Breland & Breland, 1961; Lyall-Watson, 1963; Seward, 1956), even when the act may prevent access to food (Timberlake, 1983; Williams & Williams, 1969).

The theories of contrafreeloading that I tend to prefer pertain more to individual or species-specific behaviors. Jensen (1963) defined contrafreeloading as an individual's preference for the intrinsic value of the physical task of accessing food over the caloric value of food, and Carder and Berkowitz (1970) indicated that the physical task involved in contrafreeloading must be reminiscent of natural consummatory behaviors. Examples of the interaction of these theories involve studies on pigs (*Sus scrofa*). Young and Lawrence (2003) trained pigs to press a lever to receive food and then provided them with the option to use the lever or to choose food that was freely available. The study revealed that pigs preferred to choose the free food, and therefore did not contrafreeload. However, a later experiment by de Jonge et al. (2008) took a more ecologically relevant approach to the task, presenting the pigs with a foraging task versus free food. This later study found that pigs preferred to access food by foraging in substrate and therefore contrafreeload, these two studies highlighting a preference for foraging versus lever-pressing in pigs, as well as a clear link between consummatory and contrafreeloading behaviors.

Presence and Degree of Contrafreeloading in African Grey Parrots

Given the relevance of foraging to contrafreeloading, other studies have included aspects of consummatory behavior in their contrafreeloading experimental designs. Studies employing this type of paradigm found that grizzly bears (*Ursus arctos horribilis*) (McGowan et al., 2010), maned wolves (*Chrysocyon brachyurus*) (Vasconcellos, Adania, & Ades, 2012), rhesus macaques (*Macaca mulatta*) (Reinhardt, 1994), stump-tailed macaques (*Macaca arctoides*) (Anderson & Chamove, 1984), chimpanzees (*Pan troglodytes*) (Menzel, 1991), and giraffes (*Giraffa camelopardalis*) (Sasson-Yenor & Powell, 2019) consumed food in situations that required a foraging-like task in the presence of free identical food.

Clearly, contrafreeloading is best expressed in the context of a natural behavior or tendency like foraging. In this study, I aim to combine Jensen's (1963) theory of contrafreeloading as an intrinsic attraction to performing a physical task, with Carder and Berkowitz's (1970) suggestion of the strong connection of contrafreeloading with consummatory behavior. Taken further, I argue that play is a necessary variable of contrafreeloading, play defined here as a self-reinforcing pleasure (Humphreys & Einon, 1981), and expressed more frequently during a natural behavior (Held & Špinka, 2011). Specifically, I argue that when a subject personally considers an ostensibly effortful task (e.g., rooting in substrate; cracking a nutshell) as play, the subject is likely to contrafreeload; and if the subject personally considers the task as work, it is not likely to contrafreeload. Importantly, a corollary to this theory is that different subjects given the same task may or may not contrafreeload depending upon how self-reinforcing they themselves consider the task.

Contrafreeloading has been observed in many bird species, but there is a dearth of literature examining this behavior in psittacines. Contrafreeloading has been observed in birds such as pigeons (Neuringer, 1969), domestic fowl (Duncan & Hughes, 1972), and jungle fowl

Presence and Degree of Contrafreeloading in African Grey Parrots

(Lindqvist & Jensen, 2009); songbirds like starlings (*Sturnus vulgaris*) (Bean et al., 1999; Inglis & Ferguson, 1986) and crows (*Corvus brachyrhynchos*) (Powell, 1974) have also been observed to contrafreeload. Avian studies on “contrafreeloading-like” behaviors such as delayed gratification and foraging motivation are also relevant because of similarities in these tasks in function and purpose to those of contrafreeloading. Delayed gratification has been demonstrated in crows and ravens (Hillemann et al., 2014), Goffin cockatoos (*Cacatua goffin*) (Auersperg et al., 2013), and Grey parrots (*Psittacus erithacus*) (Koepke et al., 2015); and motivation to forage based on physical effort has been seen in Amazon parrots (*Amazona amazonica*) (Rozek & Millam, 2011). I have, however, found no experiments fully devoted to examining contrafreeloading in psittacines prior to this study.

African Grey parrots make good candidates to explore contrafreeloading given their known innovative behaviors (Pepperberg, 1983; Pepperberg, 2015), as well as their theorized capacity for solving spatial and temporal ecological problems (Auersperg, 2015). In captivity, Grey parrots have been seen to contrafreeload on foraging toys installed to improve welfare conditions (Coulton, Waran, & Young, 1997; Lumeij & Hommers, 2008; Rodríguez-López, 2016; van Zeeland et al., 2009; van Zeeland et al., 2013). Interestingly, a study comparing economic decision-making via token exchange in parrots inadvertently revealed the contrafreeloading tendency of Grey parrots: When compared with macaw species, Grey parrots significantly preferred selecting a token providing access to food of equal value to that of freely available food, expending unnecessary effort to obtain their reward (Krasheninnikova et al., 2018). The authors hypothesize that the Greys found the tokens more “fun,” preferring the self-rewarding value of the tokens and their exchange to the lower energy expense of obtaining freely available food.

Presence and Degree of Contrafreeloading in African Grey Parrots

The present study examines the presence and degree of contrafreeloading in African Grey parrots (*Psittacus erithacus*) in the context of the theories presented by Jensen (1963) and Carder and Berkowitz (1970), as well the theory of contrafreeloading as a preference for play that I suggest here. Taking these theories into account, this study is the first of its kind in parrots to compare a non-ecologically relevant paradigm in conjunction with an ecologically relevant paradigm of contrafreeloading. Of additional interest is the extent to which food preferences affect the presence or extent of contrafreeloading; that is, how behavior might differ when the food rewards are of various desirability. This comparison aims to determine any presence of contrafreeloading among various types and degrees of contrafreeloading, and importantly how it depends on what each individual considers play.

General Methods

Subjects and Housing

The two subjects in this study were Griffin, a male Grey parrot, 24 years old at the start of the experiment, and Athena, a female Grey parrot, 6 years old at the start of the experiment. Both have been the subject of cognitive and communicative studies since their respective acquisition at 7.5 weeks of age and 4 months old. Only one experiment with Griffin, on delayed gratification (Koepke et al., 2015), had any (albeit indirect) relationship to the current task (see above). Housing and care outside of sleeping conditions are described in Pepperberg & Wilkes (2004); conditions were maintained after moving to Harvard University in July 2013.

Birds were never food or water-deprived; however, experimenters waited at least one hour after the parrots had finished eating a standard meal or engaged in other studies involving food rewards before performing trials. Given the parrots' high metabolic rate compared to that of mammals of similar weight (Hudson, Isaac, & Reuman, 2013), such a time interval is likely to

Presence and Degree of Contrafreeloading in African Grey Parrots

be sufficient to ensure that a bird will be interested in the foods that are offered.

Note that Griffin suffers from arthritis in his left foot that, when painful, may affect his ability to shift his weight and thus his right/left decisions on choice tasks. For that reason, he was monitored on a daily basis in an attempt to avoid trials when he demonstrated discomfort prior to test sessions. Tests that inadvertently occurred just prior to monthly pain-reduction laser treatments were re-run in case discomfort had not been noted in a timely manner.

Materials/Apparatus

Birds were tested individually on T-stands, a tray with cups presented in front of them on a stool of appropriate height. The T-stand, stool, and tray were familiar from numerous previous experiments (e.g. Pepperberg et al., 2013). Containers were two 2-oz BPA-free plastic salad dressing cups with removable lids, which were attached with Velcro onto a circular felt-covered tray 4 inches apart from each other and 1 inch away from the edge. Felt circles of the same color as the tray were inserted into each cup to hide the Velcro below. Cups were used during food preference tests to ensure birds would be habituated to their use.

Procedure

Procedures remained consistent between Experiment 1 and 2. The researcher sat across from the bird on the T-stand and showed each food item to the bird (both eyes, both sides, always starting with the experimenter's left) before inserting it into a cup. In Experiment 1 in which lids were used, the lids were half-fastened to avoid excessive difficulty opening the containers by the birds or the cups being pulled off the tray during opening. After insertion (and lidding, when applicable), the experimenter lifted the tray up and presented the cups to the bird at eye-level (both eyes, both sides, starting on the left) to ensure the subject was paying attention. Once the bird was visibly interested, the tray was placed on the stool just beyond beak range, the

Presence and Degree of Contrafreeloading in African Grey Parrots

imaginary center line between the cups aligned with the center of the bird. The researcher covered both cups with her hands briefly, so that the bird would be unlikely to favor the cup more recently handled (e.g., lidded), removed her hands, said “choose,” and pushed the tray towards the bird to allow the bird to choose his or her desired cup with their beak (**Figure 1**). After the subject was allowed to eat the food item and/or play with a lid, the tray was removed to avoid subsequent selection of the second cup.

Figure 1

Griffin Removing a Lid instead of Accessing Free Pasta.



Experiment 1: Contrafreeloading in Lidded versus Unlidded Cups

Rationale

Experiment 1 examined Jensen’s (1963) contrafreeloading theory regarding the reinforcing pleasure of performing a physical task in-and-of-itself. Experiment 1 explored whether the birds would contrafreeload for food in cups with lids or freeload for the paired food in cups without lids. Through combinations of food pairs of same or different desirability, the goal of Experiment 1 was to establish the degree to which each bird considered which food

Presence and Degree of Contrafreeloading in African Grey Parrots

“worth” the effort, or for which food they preferred the task itself.

Procedure

Preference trials were performed at the start of Experiment 1 to determine the birds' preferences for food item pairs and acted as baseline data from which to analyze contrafreeloading behavior. General preferences for foods were already known through daily care and interaction with the birds, but were formalized by presenting vegetable-based organic dry pasta, organic unsalted almonds, and raw organic unsalted cashews of equal sized-pieces in pairs of lidless containers and recording selections made by the birds individually (**Figure 2**). Food preferences were consistent between the two Grey parrots and were found to be cashew>almond>pasta (details in Experiment 1 **Results**).

Figure 2

Griffin Performing Preference Testing.



Experimental trials followed preference trials. Five trials per bird per day were performed presenting paired choices (pasta, almonds, cashews, empty) in cups with or without lids [e.g. pasta (lid) vs. cashew (lidless)]. Food preference trials were included to determine

Presence and Degree of Contrafreeloading in African Grey Parrots

whether preferences remained stable throughout testing, a necessary condition for comparing types of contrafreeloading. All permutations—identical content pairs were excluded—including tests for left/right preference, and experimental food item preference, were randomized and replicated five times. Twenty trials testing preference for empty (lid) vs. empty (lidless) were performed post hoc to test for preferences of lidded versus lidless cups. All trials were compiled via Random.org. Overall, the experiment consisted of a total of 290 trials per bird.

All behaviors exhibited by the birds were noted. Degrees of contrafreeloading are defined as follows: Removing a lid (performing a manipulation) for a better reward than that which is freely available is “calculated contrafreeloading;” removing a lid to access the same reward as that which is freely available is “classic contrafreeloading;” and removing a lid to access a less-preferred reward than that which is freely available is “super contrafreeloading.” Binomial and chi square tests were performed to examine any side biases, presence of contrafreeloading, preferences for specific types (degrees) of contrafreeloading, preference for the lid in empty cup controls, and differences in contrafreeloading between the subjects.

Results

Initial Food Item Preferences

Birds demonstrated clear food item preferences before experimental trials and did not differ between each other in these preferences. In trials prior to experimental trials, Griffin chose the cashew instead of almond 18/18 trials (100%), which was significantly different from chance (binomial test, $p < .001$, one-tailed); and a nut (either cashew or almond) instead of pasta 7/7 trials (100%), also significantly different from chance (binomial test, $p = .008$, one-tailed). Athena chose the cashew instead of almond 20/20 trials (100%; binomial test, $p < .001$, one-tailed); and chose a nut (cashew or almond) instead of pasta 7/7 trials (100%, binomial test, $p =$

.008, one-tailed). These trials found that food item preferences before experimental trials were cashew>almond>pasta for both birds. Because both birds were at ceiling, it was not necessary to test for side preferences or inter-individual difference in food item preference trials.

Food Item Preferences During Testing

During experimental trials, comparisons of different foods, both in lidless cups, were performed to test food preferences during contrafreeloading trials. Importantly, there were no side biases for either bird during experimental food item preference tests, with identical resulting chi-square values for both birds: $X^2(1, N = 30) = 0.133, p = .72$. Thus right/left data could be combined for the individual birds. During experimental trials, comparisons of different foods, both in lidless cup pairs, were performed to examine food preferences during testing. Griffin chose the cashew instead of almond 9/10 trials (90%; binomial test, $p = .011$, one-tailed); and a nut (cashew or almond) instead of pasta 20/20 trials (100%, binomial test $p < .001$, one-tailed). Athena similarly chose the cashew instead of almond 9/10 trials (90%, $p = .011$, one-tailed); and chose a nut instead of pasta 20/20 trials (100%, $p < .001$, one-tailed).

Food Item Preferences: Before versus During Testing

Chi square tests with Yates corrections revealed that food item preferences were consistent for both birds before versus during experimental trials. Yates corrections were performed as some of the data entries were small and the Yates corrections are a more conservative method to test for independence. For Griffin, a chi square test of independence revealed no significant difference in preference for cashews over almonds before versus during experimental trials, $X^2(1, N = 28) = 0.092, p = .76$, with Yates corrections; as well as no significant difference in preference for nuts over pasta before versus during experimental trials, $X^2(1, N = 27) = 0.048, p = .83$, with Yates corrections. For Athena, a chi square of

Presence and Degree of Contrafreeloading in African Grey Parrots

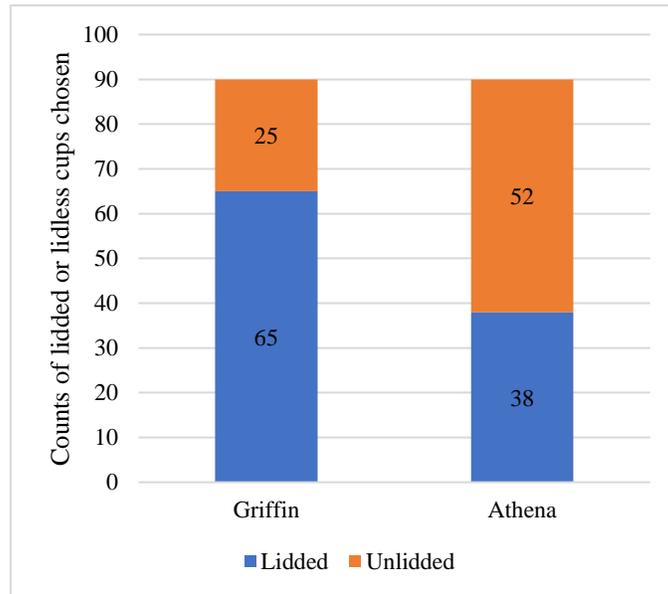
independence also revealed no significant change in her food item preference for cashews over almonds before versus during experimental trials, $X^2(1, N = 30) = 0.129, p = .72$, with Yates corrections, as well as no significant difference in her preference for nuts over pasta before versus during experimental trials, $X^2(1, N = 27) = 0.048, p = .83$, with Yates corrections.

Food Item Contrafreeloading

Griffin and Athena performed very differently during Experiment 1. In contrafreeloading trials with various food item pairs (cashew, almond, or pasta) and lid treatments (lid or no lid), Griffin selected the lidded cup on 65/90 trials overall (72%), which was significantly different from chance (binomial test, chance of $\frac{1}{2}$, $p < .001$, one-tailed). Athena selected the lidded cup on 38/90 total contrafreeloading trials (42%), which was not significantly different from chance (binomial test, chance of $\frac{1}{2}$, $p = .085$, one-tailed) (**Figure 3**). A chi square test of independence revealed a significant difference in overall contrafreeloading between Griffin and Athena, $X^2(1, N = 180) = 16.5, p < .001$, with Griffin preferring to contrafreeload for food inside cups with lids more than Athena.

Figure 3

Overall Food Item Contrafreeloading



Note. Counts of lidded cups chosen out of 90 total trials indicate occurrence of overall contrafreeloading.

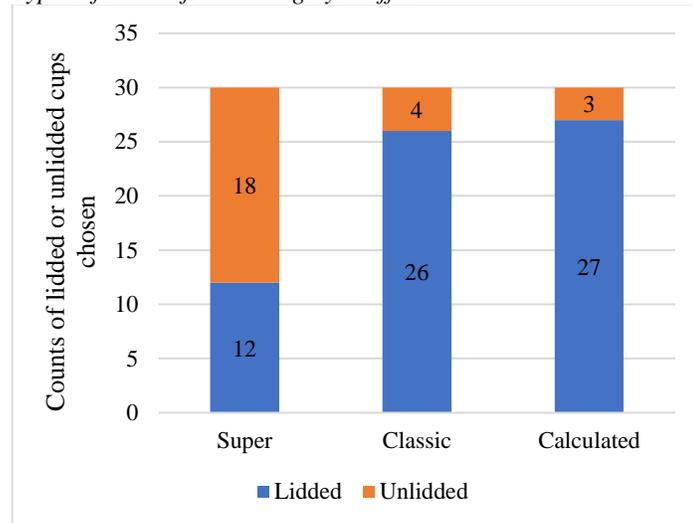
The parrots also differed with respect to the types of contrafreeloading in which they engaged. Griffin super contrafreeloaded in only 12/30 trials (40%), which was not significantly different from chance (binomial test, chance of $\frac{1}{2}$, $p = .181$, one-tailed). He classically contrafreeloaded on 26/30 trials (87%), which was significantly different from chance (binomial test, chance of $\frac{1}{2}$, $p < .001$, one-tailed). He performed calculated contrafreeloading on 27/30 trials (90%), which was also significantly different from chance (binomial test, chance of $\frac{1}{2}$, $p < .001$) (**Figure 4**). For Griffin, a chi square test of independence revealed a significant difference among the types of contrafreeloading he preferred, $X^2(1, N = 90) = 6.492$, $p = .0389$, two-tailed, with a higher relative preference for classic and calculated contrafreeloading. Griffin also had a left-side preference (his left) during super contrafreeloading, $X^2(1, N = 30) = 8.533$, $p = .0035$. Within the 12 trials in which Griffin super contrafreeloaded, he had a left-side preference $X^2(1, N = 12) = 5.333$, $p = .029$; and within the 18 trials in which Griffin did not super contrafreeload, he had a slight left-side bias of no notable significance, $X^2(1, N = 18) = 3.556$, $p = .0593$. For

Presence and Degree of Contrafreeloading in African Grey Parrots

the other types of contrafreeloading, Griffin did not have a side-preference during classic, $X^2(1, N = 30) = 0.533, p = .465$, nor calculated $X^2(1, N = 30) = 0.133, p = .72$.

Figure 4

Types of Contrafreeloading by Griffin



Note. Counts of lidded cups chosen out of 30 trials indicate the occurrence of each type of contrafreeloading.

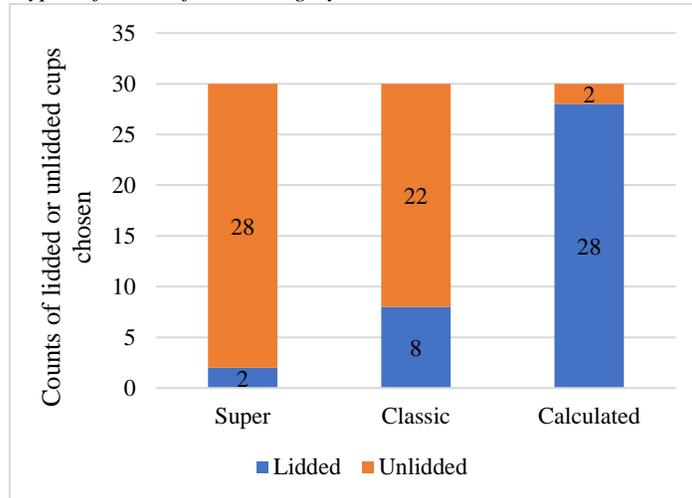
Athena performed differently from Griffin in the types of contrafreeloading she exhibited. Athena failed to super contrafreeload, doing so only on 2/30 trials (7%), which was statistically significantly different from chance (binomial test, chance of $\frac{1}{2}$, $p < .001$, one-tailed). She also failed to classically contrafreeload, doing so on only 8/30 trials (27%), which was statistically significantly different from chance (binomial test, chance of $\frac{1}{2}$, $p < .008$, one-tailed). Athena did, however, engage in calculated contrafreeloading on 28/30 trials (93%), which was statistically significantly different from chance (binomial test, chance of $\frac{1}{2}$, $p < .001$, one-tailed) (**Figure 5**). A chi square test of independence also revealed a significant difference between her contrafreeloading types, $X^2(1, N = 90) = 29.263, p < .001$, two-tailed, with a higher relative preference for calculated contrafreeloading. A chi square revealed no significant difference in side preference for Athena in calculated contrafreeloading trials, $X^2(1, N = 30) = 0.533, p = .4652$; super contrafreeloading, $X^2(1, N = 30) = 0.533, p = .4652$; and classic contrafreeloading,

Presence and Degree of Contrafreeloading in African Grey Parrots

$$X^2(1, N = 30) = 0.533, p = .4652.$$

Figure 5

Types of Contrafreeloading by Athena



Note. Counts of lidded cups chosen out of 30 trials indicate the occurrence of each type of contrafreeloading.

Occasionally, the birds chose a lidded cup rather than a lidless food item—but did not consume the food item beneath the lid. Although the behavior was relatively rare, Griffin chose the lidded cup and did not consume the food underneath rather than choose the food in the lidless cup 14/90 times (16%), which was statistically significantly different from chance (binomial test, chance of $\frac{1}{2}$, $p < .001$, one-tailed). Athena chose the lidded cup instead of the lidless food item and did not consume the food under the lid even less often, only on 4/90 trials (4.4%), which was statistically significantly different from chance (binomial test, chance of $\frac{1}{2}$, $p < .001$, one-tailed). Between Griffin and Athena, Griffin tended to choose the lidded cup and not consume the food underneath rather than choose the food in the lidless cup more often than Athena, $X^2(1, N = 180) = 0.025$, $p < .05$, with Yates corrections.

Food Items Paired with Empty Cups

Griffin, but not Athena, sometimes chose a lidded empty cup instead of free food, his choice depending on the quality of the food. Of the trials in which there was a lidless food item

Presence and Degree of Contrafreeloading in African Grey Parrots

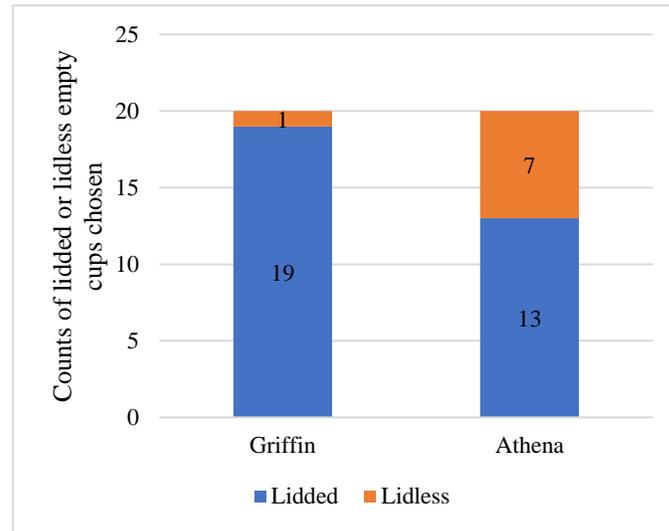
paired with a lidded empty cup, Griffin chose the empty lidded cup 12/30 trials (40%), which was not significantly different from chance (binomial test, chance of $\frac{1}{2}$, $p = .1808$). Of the 12 lidded cups chosen, 10 of the lidless cups in these pairs contained pasta (83%), 1 contained cashew (8%), and 1 contained almond (8%), indicating Griffin chose the lidded empty cup more often when paired with a lidless pasta rather than a lidless cashew or almond, $X^2 (1, N = 12) = 13.5$, $p = .001$, two-tailed. A chi square between the birds revealed a significant difference in choosing the lidded empty cup versus the lidless food item, $X^2 (1, N = 60) = 12.604$, $p < .001$, with Yates corrections, with Griffin preferring to choose the lidded empty cup rather than the lidless food item more than Athena.

Empty Cup Contrafreeloading

Empty control trials, lidded and unlidded cups void of food items, tested whether a bird had an inherent preference for lidded cups themselves. Griffin selected the lidded cup on 19/20 trials (95%), which was significantly different from chance (binomial test, chance of $\frac{1}{2}$, $p < .001$, one-tailed). Athena selected the lidded cup on 13/20 trials (55%), which was not significantly different from chance (binomial test, $p = .132$, one-tailed) (**Figure 6**). A chi square test of independence revealed a significant difference in empty cup trials between birds, with Griffin choosing the lidded empty cups significantly more than Athena: $X^2 (1, N = 40) = 3.9062$, $p < .05$, with Yates corrections.

Figure 6

Empty Cup Contrafreeloading



Note. Counts of lidded cups chosen out of 20 total trials indicate the occurrence of empty cup contrafreeloading.

Another chi square test comparing lid-selection in empty and food item contrafreeloading trials was performed to determine whether contrafreeloading occurred as to the presence of the food inside or the lid itself. Results revealed no significant difference in overall lidded cup contrafreeloading versus empty lidded cup selection by Griffin, $X^2(1, N = 110) = 3.53, p = .06$, with Yates corrections. For Athena, a chi square of independence also revealed no significant difference in overall cup contrafreeloading versus empty cup selection, $X^2(1, N = 110) = 3.414, p > .05$, with Yates corrections.

Discussion

Experiment 1 found that the two parrots exhibited individual differences in cup contrafreeloading: Griffin preferred classic and calculated contrafreeloading, whereas Athena preferred only calculated contrafreeloading. Neither bird altered their contrafreeloading behavior between the empty controls and the experimental food item trials, indicating a consistency in their individual preferences for removing lids, Griffin preferring the behavior more than Athena. The data therefore suggest that whereas Griffin may have treated lid removal

Presence and Degree of Contrafreeloading in African Grey Parrots

as a form of play, Athena did not. Athena may have, however, considered the amount of ‘work’ involved was ‘worth’ the effort in calculated contrafreeloading, but not in super contrafreeloading. Similarly, Griffin also did not perform super contrafreeloading to any significant extent.

An important note, however, is that Griffin had a left-side bias during super contrafreeloading. Of the 30 super contrafreeloading trials, in the 12 trials in which Griffin chose to super contrafreeload, he chose the left 10 times. Of the 18 remaining trials in which he did not choose to super contrafreeload, he curiously he had a non-significant, slight left-side bias. These results indicate that Griffin’s arthritic foot (discussed above) did not play a part in his super contrafreeloading trials and is it therefore unlikely that discomfort affected his performance on other types of contrafreeloading trials.

Because the 20 empty controls were performed after 270 experimental trials, one could argue that the birds were primed to contrafreeload on the empty cups after contrafreeloading for food. However, the fact that both birds performed super contrafreeloading to some degree—albeit minor—indicates that they were willing to remove a lid even for a “less favorable” reward. Further, on a few occasions, the birds—Griffin more than Athena—would choose the lidded instead of lidless food item, but not consume the food item inside under the lid. This, along with Griffin’s choice of an empty lidded cup instead of a lidless food item (usually pasta), indicates that he removed lids for the self-reinforcing aspect of the task and not for the cup contents. Moreover, Athena did not choose the lidded cup in control trials to any significant extent. These results point to Griffin’s preference for removing lids, and but also indicates that it is unlikely either bird was primed to choose the lidded cup in the empty control trials.

Experiment 2: Corknut Contrafreeloading

Rationale

Experiment 2 tested a type of classic contrafreeloading via Carder and Berkowitz's (1970) theory of the relevance of foraging in contrafreeloading by exploring the parrots' preferences for a "corknut" (almond in the shell) versus a shelled almond. The corknut was considered an ecologically significant stimulus to use in this study given psittacines' theorized morphological evolution of their beaks specifically to crack nuts (Gregory, 1927; Sereno et al., 2009). Further, Griffin and Athena are given a corknut every night, and are therefore familiar with its association with food.

Procedure

Experiment 2 adapted corknuts to the cup paradigm of Experiment 1. Corknuts and shelled almonds were presented in the cups without any lids, as the shell acted as the 'lid' in this case (**Figure 7**). For the sake of statistical analysis, corknut contrafreeloading is considered here as a type of classic contrafreeloading. Binomial and chi square tests were performed to determine the presence of contrafreeloading for corknuts by each bird and to test for differences between birds.

Figure 7

Athena Performing Corknut Contrafreeloading

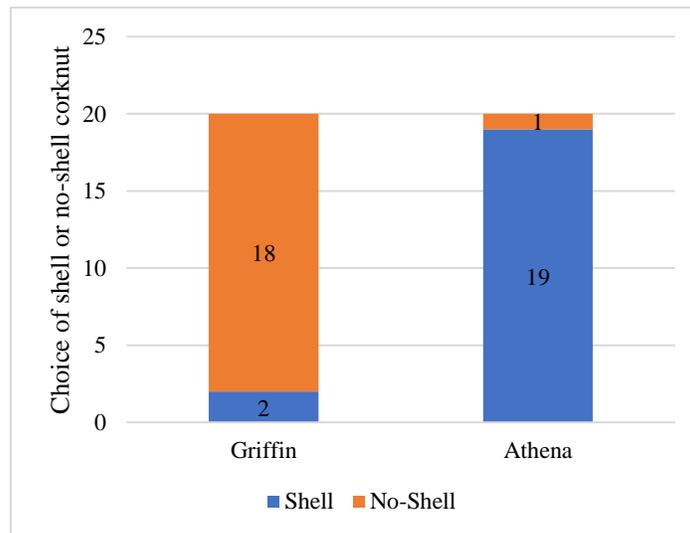


Results

The birds differed in their corknut contrafreeloading behavior. Griffin failed to contrafreeload, selecting the almond-in-shell on 2/20 trials (10%), which was significantly different from chance (binomial test, chance of $\frac{1}{2}$, $p < .001$, one-tailed). Athena, in contrast, consistently contrafreeloaded, selecting the almond-in-shell on 19/20 trials (95%), which was also significantly different from chance (binomial test, chance of $\frac{1}{2}$, $p < .001$, one-tailed) (**Figure 8**). A chi square test of independence revealed a significant difference in corknut contrafreeloading between Griffin and Athena, $X^2(1, N = 40) = 25.66$, $p < .001$, with Yates corrections, with Athena preferring to contrafreeload corknuts significantly more than Griffin.

Figure 8

Corknut Contrafreeloading



Note. Counts of shell chosen out of 20 total trials indicate the occurrence of corknut contrafreeloading.

A chi square test compared overall classic contrafreeloading in cups (Experiment 1) to corknut contrafreeloading to explore the relevance of the work task (plastic lid versus nutshell) to each bird. A chi square test of independence revealed a significant difference in classic cup contrafreeloading versus almond-in-shell selection by Griffin, $X^2(1, N = 50) = 25.60$, $p < .05$, with Yates corrections, with a trend towards classic contrafreeloading with lidded cups. A chi

Presence and Degree of Contrafreeloading in African Grey Parrots

square of independence revealed a significant difference in classic cup contrafreeloading versus almond-in-shell selection by Athena $X^2(1, N = 50) = 19.90, p < .05$, with Yates corrections, with a trend towards almond-in-shell contrafreeloading.

Discussion

In Experiment 2, Griffin refused to contrafreeload for corknuts whereas Athena preferred doing so. Compared with overall classic contrafreeloading in cups, Griffin preferred contrafreeloading in cups versus corknut contrafreeloading, while Athena preferred the opposite. Curiously, Griffin is known to verbally request corknuts in contexts considered ‘special’ such as when a guest enters the lab (personal observation), indicating some sort of significance attached to the food item; he also shells them every evening when that is the only way to obtain the nut (personal observation). Despite this, Griffin did not contrafreeload for corknuts, indicating that Carder & Berkowitz’s (1970) theory of the ecological relevance in contrafreeloading did not play a part in Griffin’s behavior, but likely did in Athena’s. Due to the differences between the birds, it is likely that their behavior was based on their personal consideration of the task as work or play, suggesting my theory of the significance of individual preference to contrafreeloading behavior.

General Discussion

This study indicates that differences in contrafreeloading behavior likely reside in the self-reinforcing play inherent in a physical task, that task necessarily relevant at the species-level as well as the individual-level. For Griffin, cups with lids are self-reinforcing, whereas cracking the shell of a corknut to access the almond inside is not. For Athena, the opposite is true: She prefers to contrafreeload for corknuts rather than for food in cups but will perform calculated contrafreeloading when the food is more preferable than that which is freely available. Athena’s

Presence and Degree of Contrafreeloading in African Grey Parrots

calculated contrafreeloading behavior in Experiment 1 highlights this theorized line between work and play, when the removal of a lid was ‘worth’ the effort to access the food inside. Other contrafreeloading studies describe a similar threshold, in which animals will contrafreeload until the task at hand becomes too effortful, opting to freeload on the available food instead (Neuringer, 1970).

Contrafreeloading contradicts general optimal foraging theory in that subjects will choose to perform work for food instead of accessing freely available food (Inglis et al., 1997). Unlike previous claims of earning theory or work ethic (Clement et al., 2000), this study proposes to redefine contrafreeloading as the self-reinforcing nature of performing a physical task (Jensen, 1963) and the tendency to evaluate an action as play versus work in relation to the relevance of the task to the subject’s life history (Carder & Berkowitz, 1970). Other studies have shown the significance of foraging tasks for the expression of contrafreeloading, and that was clearly true for Athena, who preferred the more ecologically relevant corknut to the plastic cups. Further, I add my theory that individuals must personally consider the task self-reinforcing in order to expend any energy to perform it. My results show that the presence and degree of contrafreeloading is contingent upon what the individual considers play.

One could argue that the birds’ contrafreeloading behavior could be explained by the habit strength gained by performing the operant task of removing a lid or cracking a shell, and therefore by training (Davidson, 1971; Inglis et al., 1997; Kleinman et al., 1976; Stolz & Lott, 1964; Tarte & Rasmussen, 1979). Given that trials of various food item pairs and pairs including empty cups were intentionally randomly intermixed, in addition to the fact that a free food item was always available in contrafreeloading trials, removal of the lid was a choice and unlikely out of habit.

Presence and Degree of Contrafreeloading in African Grey Parrots

It is also unlikely that training contributed to corknut contrafreeloading behavior. A previous Grey parrot in the Pepperberg lab, Alex, was known to crack a corknut and toss the almond, preferring to continue to gnaw on the shell than eat the nut (I. Pepperberg, personal communication, March 25, 2020). Similarly, removing the shell of a corknut was enjoyable for Athena, but not for Griffin. A future test could, however, test this contrafreeloading-by-training explanation in corknuts by presenting an empty corknut shell with an intact corknut to explore the significance of the nut inside to the birds' contrafreeloading behavior, in a control paradigm parallel to the empty cups in Experiment 1.

If performed again, this study could be improved in several ways. First, a larger sample size would be important to examine the effects of sex, age, and experience on personal preference of contrafreeloading. Second, an analysis of the individual parrots' preferences in trials over time could provide contextual information regarding one's choice based on previous trial choice. Because both birds also undergo daily cognitive and communicative trials involving toys of varying substrates (e.g. plastic, wood, stone), consideration of the parrots' laboratory 'umwelt' could offer insight into their individual preferences for the self-reinforcing tasks involved in their contrafreeloading behavior.

Future contrafreeloading work could also take into consideration the variable of environment of both captive and wild animals. Research shows that subjects in stimulus-deprived environments tend to contrafreeload more than subjects in non-stimulus-deprived environments (Coburn & Tarte, 1976; Davis et al., 1975), indicating that the complexity of one's environment influences contrafreeloading behavior. Further, less-satiated subjects tend to freeload more than their satiated counterparts, these conditions potentially analogous to satiation levels of wild versus captive animals, respectively (Inglis & Ferguson, 1986; Knutson & Carlson,

1973; Morgan, 1974; Robertson & Anderson, 1975). Therefore, there exists an interesting interplay between environment as well as food stability in contrafreeloading, these variables offering an interesting perspective into future work comparing contrafreeloading behavior of wild and captive subjects.

Contrafreeloading behavior expression by wild and captive animals could offer important information for the welfare of captive animals. As revealed by Krasheninnikova et al.'s (2018) study of economic decision-making in parrot species—and similarly revealed by the results of this study—individual preference for the self-reinforcing nature of a physical task indicates the important role this behavioral aspect plays in the expression of contrafreeloading behavior and how it might affect studies of cognitive abilities. Further, preliminary work exploring optimism in tool-use by New Caledonian crows found that subjects were more optimistic after constructing a tool (McCoy et al., 2019). The proposed interaction between contrafreeloading and self-reinforcing play—in concert with the existing use of play as an indicator for welfare in captive animals (Haslam, 2013; Oliveira et al., 2010)—could act as a useful metric for the emotional welfare states of captive animals. Similar research could also offer insight into the emotional states of subjects that preferred to “work” to access a non-food reward when it was simultaneously freely available (Hogan, 1967; Ogura, 2011; Singh & Query, 1971; Tarte, 1981).

This study of contrafreeloading in African Grey parrots found that expression of this behavior depended on the individuals' consideration of self-reinforcing play in performing specific physical tasks. Given this demonstrated role of play in contrafreeloading, as well as the theorized tendency of neophilic subjects to contrafreeload more than their neophobic counterparts (Mitchell & White, 1977; Mitchell, Williams, & Sutter, 1974), future studies plan to perform a cross-species study of contrafreeloading, comparing contrafreeloading behavior of the

Presence and Degree of Contrafreeloading in African Grey Parrots

Grey parrots in this study to that of kea parrots (*Nestor notabilis*), a species known for their playful, neophilic behavior (Gajdon et al., 2014). Further, future research plans to compare the contrafreeloading behavior of captive subjects of specific parrot species, such as keas and cockatoos, to that of their wild counterparts. Given parrot species' known differences in play propensities, this future research would examine the role of individual preferences in contrafreeloading behavior at the species-level, in both wild and captive subjects, and offer insight into developing welfare tools for animals of varying life histories.

References

- Alferink, L.A., Crossman, E.K., & Cheney, C.D. (1973). Control of responding by a conditioned reinforcer in the presence of free food. *Animal Learning & Behavior*, 1(1), 38-40. <https://doi.org/10.3758/BF03198996>
- Anderson, J. R. & Chamove, A. S. (1984). Allowing captive primates to forage. In: *Standards in Laboratory Animals Management (Part 2)* (pp. 253–256). Potters Bar, UK: Universities Federation of Animal Welfare.
- Auersperg, A.M.I. (2015). Chapter 3 – Exploration Technique and Technical Innovations in Corvids and Parrots in A.B. Kaufman & J.C. Kaufman (Eds.) *Animal Creativity and Innovation: Explorations in Creativity Research* (pp. 45-72), Cambridge, Massachusetts: Academic Press.
- Auersperg, A.M.I., Laumer, I.B., & Bugnyar, T. (2013). Goffin cockatoos wait for qualitative and quantitative gains but prefer ‘better’ to ‘more’. *Biology Letters*, 9(3). <https://doi.org/10.1098/rsbl.2012.1092>
- Barto, A.G. (2013). Intrinsic Motivation and Reinforcement Learning. In: Baldassarre, G., & Mirolli, M. (Ed.s). *Intrinsically Motivated Learning in Natural and Artificial Systems*. Springer, Berlin, Heidelberg.
- Bean, D., Mason, G., & Bateson, M. (1999). Contrafreeloading in starlings – a test of the information hypothesis. *Behaviour*, 136, 1267-1282. <https://doi.org/10.1163/156853999500712>
- Breland, K., & Breland, M. (1961). The misbehavior of organisms. *American Psychologist*, 16(11), 681-684. <https://doi.org/10.1037/h0040090>
- Carder, B., & Berkowitz, K. (1970). Rats’ preference for earned in comparison with free food.

Presence and Degree of Contrafreeloading in African Grey Parrots

- Science*, 167(3922), 1273-1274. <https://doi.org/10.1126/science.167.3922.1273>
- Carlson, C.W., & Riccio, D.C. (1976). Experience with the reinforcer and the preference for earned rather than free reinforcers in rats. *Animal Learning & Behavior*, 4, 269-272. <https://doi.org/10.3758/BF03214048>
- Charnov, E.L. (1973). *Optimal foraging—some theoretical considerations* (Doctoral thesis, University of Washington, Seattle, Washington).
- Charnov, E., & Orians, G.H. (2006). Optimal foraging: Some theoretical explorations. *Biology Faculty & Staff Publications*.
- Clement, T.S., Feltus, J.R., Kaiser, D.H., Zentall, T.R. (2000). “Work ethic” in pigeons: reward value is directly related to the effort or time required to obtain the reward. *Psychonomic Bulletin & Review*, 7(1), 100-106. <https://doi.org/10.3758/BF03210727>
- Coburn, J.F., & Tarte, R.D. (1976). The effect of rearing environments on the contrafreeloading phenomenon in rats. *Journal of the Experimental Analysis of Behavior*, 26(2), 289-294. <https://doi.org/10.1901/jeab.1976.26-289>
- Coulton, L.E., Waran, N.K., & Young, R.L. (1997). Effects of foraging enrichment on the behaviour of parrots. *Animal Welfare*, 6(4), 357-363.
- Davis, S.F., Beighley, B.G., Libretto, J.S., Mollenhour, M.N., & Prytula, R.E. (1975). Contrafreeloading as a function of early environmental rearing conditions. *Bulletin of the Psychonomic Society*, 6, 595-597. <https://doi.org/10.3758/BF03337576>
- Davidson, A.G. (1971). Factors affecting keypress responding by rats in the presence of free food. *Psychonomic Science*, 24(3), 135–137. <https://doi.org/10.3758/BF03331788>
- de Jonge, F.H., Tilly, S.L., Baars, A.M., & Spruijt, B.M. (2008). On the rewarding nature of appetitive feeding behavior in pigs (*Sus scrofa*): Do domesticated pigs contrafreeload?

Presence and Degree of Contrafreeloading in African Grey Parrots

Applied Animal Behaviour Science, 114, 359-372.

<https://doi.org/10.1016/j.applanim.2008.03.006>

Duncan, I.J.H., & Hughes, B.O. (1972). Free and operant feeding in domestic fowls. *Animal Behaviour*, 20(4), 775-777. [https://doi.org/10.1016/S0003-3472\(72\)80150-7](https://doi.org/10.1016/S0003-3472(72)80150-7)

Forkman, B.A. (1993). Self-reinforced behavior does not explain contra-freeloading in the Mongolian Gerbil. *Ethology*, 94(2), 109-112. <https://doi.org/10.1111/j.1439-0310.1993.tb00551.x>

Gardner, R.A., & Gardner, B.T. (1988). Feedforward versus feedbackward: An ethological alternative to the law of effect. *Behavioral and Brain Sciences*, 11(3), 429–493. <https://doi.org/10.1017/S0140525X00058258>

Gajdon, G.K., Lichtnegger, M., & Huber, L. (2014). What a parrot's mind adds to play: The urge to produce novelty fosters tool use acquisition in kea. *Open Journal of Animal Sciences*, 4(2), 51-58. <https://doi.org/10.4236/ojas.2014.42008>

Gregory, W.K. (1927). The Mongolian life record. *Scientific Monthly*, 24, 169–181.

Haslam, M. (2013). 'Captivity bias' in animal tool use and its implications for the evolution of hominin technology. *Philosophical Transactions B: Biological Sciences*, 368(1630). <https://doi.org/10.1098/rstb.2012.0421>

Havelka, J. (1956). Problem-seeking behaviour in rats. *Canadian Journal of Experimental Psychology*, 10(2), 91-97. <https://doi.org/10.1037/h0083663>

Held, S.D.E. & Špinková, M. (2011). Animal play and animal welfare. *Animal Behaviour*, 81(5), 891-899. <https://doi.org/10.1016/j.anbehav.2011.01.007>

Herrnstein, R.J., & Loveland, D.H. (1972). Food-avoidance in hungry pigeons, and other perplexities. *Journal of the Experimental Analysis of Behavior*, 18(3), 369–383.

Presence and Degree of Contrafreeloading in African Grey Parrots

<https://doi.org/10.1901/jeab.1972.18-369>

Hillemann, F., Bugnyar, T., Kotrschal, K., & Wascher, C.A.F. (2014). Waiting for better, not for more: corvids respond to quality in two delay maintenance tasks. *Animal Behaviour*, 90, 1-10. <https://doi.org/10.1016/j.anbehav.2014.01.007>

Hogan, J. A. 1967. Fighting and reinforcement in the Siamese fighting fish (*Betta splendens*). *Journal of Comparative and Physiological Psychology*, 64, 356–359.

<https://doi.org/10.1037/h0088042>

Hudson, L.N., Isaac, N.J.B., & Reuman, D.C. (2013). The relationship between body mass and field metabolic rate among individual birds and mammals. *Journal of Animal Ecology*, 82(5), 1009-1020. <https://doi.org/10.1111/1365-2656.12086>

Humphreys, A.P., & Einon, D.F. (1981). Play as a reinforcer for maze-learning in juvenile rats. *Animal Behaviour*, 29(1), 259–270. [https://doi.org/10.1016/S0003-3472\(81\)80173-X](https://doi.org/10.1016/S0003-3472(81)80173-X)

Inglis, I.R., & Ferguson, N.J. (1986). Starlings search for food rather than eat freely-available, identical food. *Animal Behaviour*, 34(2), 614–617. [https://doi.org/10.1016/S0003-3472\(86\)80136-1](https://doi.org/10.1016/S0003-3472(86)80136-1)

Inglis, I.R., Forkman, B., & Lazarus, J. (1997). Free food or earned food? A review and fuzzy model of contrafreeloading. *Animal Behavior*, 53(6), 1171-1191.

<https://doi.org/10.1006/anbe.1996.0320>

Jensen, G.D. (1963). Preference for bar pressing over "freeloading" as a function of number of rewarded presses. *Journal of Experimental Psychology*, 65(5), 451–454.

<https://doi.org/10.1037/h0049174>

Kavanau, J.L., & Havenhill, R.M. (1976). Compulsory regime and control of environment in animal behaviour III. Light level preferences of small nocturnal mammals. *Behaviour*,

Presence and Degree of Contrafreeloading in African Grey Parrots

59(3/4), 203-225. <https://doi.org/10.1163/156853976X00361>

Kleinman, K.M., McLaughlin, R.J., Gerard, I.V., Boxza, D.A. & Clipper, R.C. (1976). Rats' preference for the more effortful of two responses as a function of prior training.

Psychological Reports, 38, 931–937. <https://doi.org/10.2466/pr0.1976.38.3.931>

Knutson, J.F., & Carlson, C.W. (1973). Operant responding with free access to the reinforcer: A replication and extension. *Animal Learning & Behavior*, 1, 133-136.

<https://doi.org/10.3758/BF03214579>

Koepke, A.E., Gray, S.L., & Pepperberg, I.M. (2015). Delayed gratification: A Grey parrot (*Psittacus erithacus*) will wait for a better reward. *Journal of Comparative Psychology*,

129(4), 339–346. <https://doi.org/10.1037/a0039553>

Krasheninnikova, A., Höner, F., O'Neill, L., Penna, E., & von Bayern, A.M.P. (2018).

Economic decision-making in parrots. *Scientific Reports*, 8(1).

<https://doi.org/10.1038/s41598-018-30933-5>

Lindqvist, C., & Jensen, P. (2009). Domestication and stress effects on contrafreeloading and spatial learning performance in red jungle fowl (*Gallus gallus*) and White Leghorn layers. *Behavioral Processes*, 81(1), 80-84.

<https://doi.org/10.1016/j.beproc.2009.02.005>

Logan, F.A. (1960). *Incentive*. New Haven, Connecticut: Yale University Press.

Lumeij, J.T., & Hommers, C.J. (2008). Foraging 'enrichment' as treatment for pterotillomania.

Applied Animal Behaviour Science, 111(1-2), 85-94.

<https://doi.org/10.1016/j.applanim.2007.05.015>

Lyall-Watson, M. (1963). A critical re-examination of food "washing" behaviour in the raccoon (*Procyon lotor* Linn.). *Proceedings of the Zoological Society of London*, 141(2).

Presence and Degree of Contrafreeloading in African Grey Parrots

<https://doi.org/10.1111/j.1469-7998.1963.tb01617.x>

Maslow, A. H. (1943). A theory of human motivation. *Psychological Review*, 50(4), 370-96.

<https://doi.org/10.1037/h0054346>

McCoy, D.E., Schiestl, M., Neilands, P., Hassall, R., Gray, R.D., & Taylor, A.H. (2019). New Caledonian crows behave optimistically after using tools. *Current Biology*, 29(16).

<https://doi.org/10.1016/j.cub.2019.06.080>

McGowan, R.T.S., Robbins, C.T., Alldredge, J.R., Newberry, R.C. (2010). Contrafreeloading in grizzly bears: implications for captive foraging enrichment. *Zoo Biology*, 29(4), 484-

502. <https://doi.org/10.1002/zoo.20282>

Menzel, E. W. (1991). Chimpanzees (*Pan troglodytes*): Problem seeking versus the bird-in-hand, least-effort strategy. *Primates*, 32(4), 497–508.

<https://doi.org/10.1007/BF02381940>

Mitchell, P. & White, K. G. (1977). Responding in the presence of free food: differential exposure to the reinforcement source. *Bulletin of the Psychonomic Society*, 10(2), 121–

124. <https://doi.org/10.3758/BF03329299>

Morgan, M. J. (1974). Do rats like to work for their food? *Learning and Motivation*, 5, 352–

368. [https://doi.org/10.1016/0023-9690\(74\)90017-4](https://doi.org/10.1016/0023-9690(74)90017-4)

Neuringer, A.J. (1969). Animals respond for food in the presence of free food. *Science*,

166(3903), 399-401. <https://doi.org/10.1126/science.166.3903.399>

Neuringer, A.J. (1970). Many responses per food reward with free food present. *Science*,

169(3944), 503-504. <https://doi.org/10.1126/science.169.3944.503>

Ogura, T. (2011). Contrafreeloading and the value of control over visual stimuli in Japanese macaques (*Macaca fuscata*). *Animal Cognition*, 14(3), 427-431.

Presence and Degree of Contrafreeloading in African Grey Parrots

<https://doi.org/10.1007/s10071-010-0377-y>

Oliveira, A.F.S., Rossi, A.O., Silva, L.F.R., & Lau, M.C. (2010). Play behaviour in nonhuman animals and the animal welfare issue. *Journal of Ethology*, 28(1), 1-5.

<https://doi.org/10.1007/s10164-009-0167-7>

Osborne, S.R. (1977). The free food (contrafreeloading) phenomenon: A review and analysis. *Animal Learning & Behavior*, 5(3), 221-235. <https://doi.org/10.3758/BF03209232>

Pepperberg, I.M. (1983). Interspecies communication: Innovative vocalizations of the African Grey parrot. Paper presented at Animal Behavior Society Meeting (Abst.). Lewisburg, PA.

Pepperberg, I.M. (2015). Chapter 1 – Creativity and Innovation in the Grey Parrot (*Psittacus erithacus*) In Kaufman, A.B., & Kaufman, J.C. (Ed.s). *Animal Creativity and Innovation: Explorations in Creativity Research* (pp. 3-29), Cambridge, Massachusetts: Academic Press.

Pepperberg, I.M., Koepke, A., Livingson, P., Girard, M. & Hartsfied, L.A. (2013). Reasoning by inference: further studies on exclusion in Grey parrots (*Psittacus erithacus*). *Journal of Comparative Psychology*, 127(3), 272-281. <https://doi.org/10.1037/a0031641>

Pepperberg, I.M. & Wilkes, S. (2004). Lack of referential vocal learning from LCD video by Grey parrots (*Psittacus erithacus*). *Interaction Studies*, 5(1), 75-97.

<https://doi.org/10.1075/is.5.1.05pep>

Pintrich, P.R. (1999). Taking control of research on volitional control: challenges for future theory and research. *Learning and Individual Differences*, 11(3), 335-354.

[https://doi.org/10.1016/S1041-6080\(99\)80007-7](https://doi.org/10.1016/S1041-6080(99)80007-7)

Powell, R.W. (1974). Comparative studies of the preference for free vs response-produced

Presence and Degree of Contrafreeloading in African Grey Parrots

reinforcers. *Animal Learning & Behavior*, 2(3), 185-188.

<https://doi.org/10.3758/BF03199173>

Pyke, G.H. (1984). Optimal foraging theory: A critical review. *Annual Review of Ecology and Systematics*, 15(1), 523-575. <https://doi.org/10.1146/annurev.es.15.110184.002515>

Reinhardt, V. (1994). Caged rhesus macaques voluntarily work for ordinary food. *Primates*, 35(1), 95-98. <https://doi.org/10.1007/BF02381490>

Reynolds, G.S. (1968). *A Primer of Operant Conditioning*. Glenview, Illinois: Scott, Foresman and Company.

Robertson, L.C., & Anderson, S.C. (1975). The effects of differing type and magnitude of reward on the contrafreeloading phenomenon in rats. *Animal Learning & Behavior*, 3, 325-328. <https://doi.org/10.3758/BF03213454>

Rodríguez-López, R. (2016). Environmental enrichment for parrot species: Are we squawking up the wrong tree? *Applied Animal Behaviour Science*, 180, 1-10. <https://doi.org/10.1016/j.applanim.2016.04.016>

Rozek, J.C., & Millam, J.R. (2011). Preference and motivation for different diet forms and their effect on motivation for a foraging enrichment in captive Orange-winged Amazon parrots (*Amazona amazonica*). *Applied Animal Behaviour Science*, 129(2-4), 153-161.

<https://doi.org/10.1016/j.applanim.2010.11.009>

Sasson-Yenor, J., & Powell, D.M. (2019). Assessment of contrafreeloading preferences in giraffe (*Giraffa camelopardalis*). *Zoo Biology*, 38(5), 414-423.

<https://doi.org/10.1002/zoo.21513>

Sereno, P.C., Xijin, Z., & Lin, T. (2009). A new psittacosaur from Inner Mongolia and the parrot-like structure and function of the psittacosaur skull. *Proceedings of the Royal*

Presence and Degree of Contrafreeloading in African Grey Parrots

- Society B*, 277(1679). <https://doi.org/10.1098/rspb.2009.0691>
- Seward, J.P. (1956). Drive, incentive, and reinforcement. *Psychological Review*, 63(3), 195–203. <https://doi.org/10.1037/h0048229>
- Singh, D. (1970). Preferences for bar-pressing to obtain reward over free-loading in rats and children. *Journal of Comparative and Physiological Psychology*, 73(2), 320-327. <https://doi.org/10.1037/h0030222>
- Singh, D. & Query, W. T. (1971). Preference for work over ‘freeloading’ in children. *Psychonomic Science*, 24, 77–79. <https://doi.org/10.3758/BF03337901>
- Schoener, I.W. (1987). A brief history of optimal foraging ecology. In Kamil, A.C., Krebs, I., & Pulliani H.R. (Ed.s). *Foraging Behavior* (pp. 5-67). New York, New York: Plenum.
- Stolz, S.B., & Lott, D.F. (1964). Establishment in rats of a persistent response producing a net loss of reinforcement. *Journal of Comparative and Physiological Psychology*, 57(1), 147–149. <https://doi.org/10.1037/h0042991>
- Tarte, R.D. (1981). Contrafreeloading in humans. *Psychological Reports*, 49(3), 859-866. <https://doi.org/10.2466/pr0.1981.49.3.859>
- Tarte, R.D., Townsend, S.G., & Vernon, C.R. (1973). Housing environments and the barpressing vs freeloading phenomenon in rats. *Bulletin of the Psychonomic Society*, 2(2), 69-71. <https://doi.org/10.3758/BF03327716>
- Tarte, R.D. & Rasmussen, C.T. (1979). Training effects on contra-freeloading in rats housed in operant chambers. *Animal Learning & Behavior*, 7(1), 69–74. <https://doi.org/10.3758/BF03209660>
- Taylor, G.T. (1972). A limitation of the contrafreeloading phenomenon. *Psychonomic Society*, 29(3), 173-174. <https://doi.org/10.3758/BF03342584>

Presence and Degree of Contrafreeloading in African Grey Parrots

Taylor, G.T. (1975). Discriminability and the contrafreeloading phenomenon. *Journal of Comparative and Physiological Psychology*, 88(1), 104-109.

<https://doi.org/10.1037/h0076222>

Timberlake, W. (1983). Rats' responses to a moving object related to food or water: A behaviour-systems analysis. *Animal Behaviour*, 11(3), 309-320.

<https://doi.org/10.3758/BF03199781>

Tolman, E.C. (1955). Principles of performance. *Psychological Review*, 62(5), 315-326.

<https://doi.org/10.1037/h0049079>

van Zeeland, Y.R.A., Shoemaker, N.J., & Lumeij, J.T. (2009). *Contrafreeloading in Grey parrots*. Proceedings of the Association of Avian Veterinarians (p. 9): Milwaukee, Wisconsin.

van Zeeland, Y.R.A., Shoemaker, N.J., Ravesteijn, M.M., Mol, M., & Lumeij, J.T. (2013). Efficacy of foraging enrichments to increase foraging time in Grey parrots (*Psittacus erithacus*). *Applied Animal Behaviour Science*, 149, 87-102.

<https://doi.org/10.1016/j.applanim.2013.09.005>

Vasconcellos, A.d.S., Adania, C.H., Ades, C. (2012). Contrafreeloading in maned wolves: Implications for their management and welfare. *Applied Animal Behaviour Science*,

140(1-2), 85-91. <https://doi.org/10.1016/j.applanim.2012.04.012>

White, R.W. (1959). Motivation reconsidered: The concept of competence. *Psychological Review*, 66(5), 297-333. <https://doi.org/10.1037/h0040934>

Williams, D.R., & Williams, H. (1969). Automaintenance in the pigeon: Sustained pecking despite contingent non-reinforcement. *Journal of Experimental Analysis of Behavior*, 12(4), 511-520. <https://doi.org/10.1901/jeab.1969.12-511>

Presence and Degree of Contrafreeloading in African Grey Parrots

Yoshioka, J.G. (1929). Weber's law in the discrimination of maze distance by the white rat.

University of California Publication of Psychology, 4, 155-184.

Young, R.J. & Lawrence, A.B. (2003). Do domestic pigs in controlled environments

contrafreeload? *Journal of Applied Animal Welfare Science*, 6(4), 309-318.

https://doi.org/10.1207/s15327604jaws0604_5