

Preference for free or forced choice in Sumatran orangutans (*Pongo abelii*)

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Empirical investigations of humans, pigeons, rats, and monkeys have indicated that these species will select free over forced choice, even when faced with identical outcomes. However, the same has yet to be quantitatively confirmed in nonhuman great apes. This experiment is the first systematic investigation of preference for free or forced choice in great apes using a paradigm in which extraneous variables are highly controlled. Three orangutans were given a choice of one of two virtual routes, one that provided a choice and one that did not via a touchscreen computer program. Choice of either route was rewarded with the same type and quantity of food. Initial results indicated a preference for free choice across all three participants. However, in two control conditions, orangutans' preferences varied, suggesting a weaker tendency to exercise choice than species previously tested. We suggest further investigation of preference for free and forced choice in orangutans and other great apes through alternative experimental paradigms that focus on increasing the fidelity of free and forced choice options.

Key words: apes, choice, preference, orangutans, touch screen

Cross-cultural preference for free choice has been extensively demonstrated in humans. Results suggests that choice, or even the illusion of choice, has affective, cognitive, motivational, behavioral, and physiological benefits (Greenberger, Strasser, Cummings, & Dunham, 1989; Iyengar & Lepper, 2000; Lonsdorf, Ross, Matsuzawa, & Goodall, 2010; Winocur, Moscovich, & Freedman, 1987; Zukerman, Porac, Lathin, Smith, & Deci, 1978). As a corollary, there is evidence that an external locus of control and *lack* of free choice can be detrimental (Benassi, Sweeney, & Dufour, 1988; Goodstein, MacKenzie, & Shotland, 1984; Hill, Rapp, Capella, & the Gramercy Gentlemen, 2015; Mineka & Hendersen, 1985; Moore & Cox, 1988; Roddenberry & Renk, 2010; Ruback, Carr, & Hopper, 1986). In fact, human preference for choice is so strong that it does not appear to be contingent on reward outcomes. Despite the additional energy required to consider and make choices, when presented with equivalent option outcomes, humans choose options that lead to *more* choice (Bown, Read, & Summers, 2003; Leotti, Iyengar, & Ochsner, 2010; Suzuki, 1997). Thus, it appears that for humans, choice is an

independent motivator and reinforcer (Bown et al., 2003; Suzuki, 1997). Even when choice has no discernible benefit, humans still prefer to choose.

Origins of Control

Converging evidence indicates that preference for free choice has been adaptively selected for evolutionary survival (Leotti et al., 2010). Environmental control, exercised via conscious and unconscious decision-making, functions as a means of responding to and managing the environment (Perlmutter & Monty, 1977). Moreover, the perception of control buffers stress responses to the environment. In turn, environmental control is believed to reinforce an adaptive perception of *self-efficacy*, defined by Bandura (1977) as, "one's personal expectations of their ability to succeed" (Leotti et al., 2010). In other words, control of the environment through choice-making affirms personal beliefs in one's ability to achieve desired outcomes. The opposite is also true. A lack of choice challenges self-efficacy beliefs, generating doubt in one's ability to bring about desired results, a state of mind correlated with hopelessness and depression (Blackburn & Owens, 2015; Botti & McGill, 2006; Deci & Ryan, 2000; Devins et al., 1982; Kwasky & Groh, 2014; Leotti et al., 2010; Maddux & Meier, 1995; Pu, Hou, & Ma, 2016; Ryan & Deci, 2000; Sacco et al., 2005;

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Schwarzer, 2014; M. E. P. Seligman, 1975; Shnek et al., 1997).

Nonhuman Animals (NHAs), Choice and Control

Although analogous investigations of choice and control in nonhuman animals (NHAs) are comparatively sparse, existing data indicate that several NHA species also prefer to control their environment by exercising choice (Perdue, Clay, Gaalema, Maple, & Stoinski, 2012). Catania (1975) and Catania and Sagvolden (1980) found that when given the option between two keys, one that led to a free choice, the other to a forced choice, pigeons (*Columba livia domestica*) reliably chose the free-choice option even when food reward outcomes were equated. Similarly, when offered either a direct route, or a choice of maze routes, Voss and Homzie (1970) found that laboratory Sprague–Dawley rats (*Rattus norvegicus*) reliably selected the option that allowed choice despite the fact that both paths led to the same destination. Moreover, Singh (1970) found that rats demonstrated a preference to work for rewards by bar pressing rather than to ‘free-load’ (i.e., receive unearned rewards), thereby demonstrating a preference to control the environment by choosing *when* food becomes available. This behavior persisted even when the amount of bar pressing required to access food was varied or when food could be obtained faster by free-loading.

There is also indication that choice—or the lack thereof—has affective, motivational, and physiological effects on NHAs (Beran, Klein, Evans, Antworth, & Chan, 2007; Catania, 1975; Catania & Sagvolden, 1980; Lonsdorf et al., 2010; Suzuki, 1999; Voss & Homzie, 1970; Washburn, Hopkins, & Rumbaugh, 1991). When giant pandas (*Ailuropoda melanoleuca*) were provided a choice to access alternative exhibit areas, they exhibited fewer signs of behavioral agitation and lower urinary cortisol than when they were not provided such choice (Owen, Swaisgood, Czekala, & Lindburg, 2005). Likewise, when captive polar bears (*Ursus maritimus*) were provided the choice to access an indoor enclosure during the daytime, they demonstrated decreased stereotypies and increased social play, behaviors associated with decreased anxiety and psychological distress (Ross, 2006). Faircloth (1974) found that for

rats receiving pleasant electrical stimulation, the effectiveness of the intervention was enhanced when rats controlled treatment onset. Inversely, Weiss (1971) found that ulceration was more frequent and extensive in rats subjected to electric shock over which they had no control. Perhaps most famously, in classic studies by Seligman (1975, 1992), both laboratory rats and domesticated dogs (*Canis familiaris*) exposed to uncontrollable aversive conditions developed ‘helpless’ behavior, termed *learned helplessness* (Overmier & Seligman, 1967). After receiving shock treatment that they could not control, when these NHAs were provided the opportunity to escape the electric shocks, they no longer attempted to do so. Overmier and Seligman (1967) and Seligman and Beagley (1975) concluded that once NHAs learn that their responses have no effect on avoiding aversive stimuli (e.g., after failing to avoid electric shocks), they stop attempting to do so, even when explicitly provided an opportunity.

Several species of monkeys have also demonstrated preference for free choice. Suzuki (1999) observed that long-tailed macaques (*Macaca fascicularis*) reliably chose a free-choice option with multiple alternatives over a forced choice with a preferred alternative. Likewise, Perdue, Evans, Washburn, Rumbaugh, and Beran (2014) found that both capuchin monkeys (*Cebus apella*) and rhesus macaques (*Macaca mulatta*) showed a preference for choosing task order over having task order randomly assigned. This preference held even when the assigned task was made tangibly attractive in other respects. For example, several monkeys in Perdue et al.’s (2014) study maintained a preference to choose task order, even when the alternative was assignment to a task they had previously *preferred* over others.

Research also indicates that choice improves NHP performance on cognitive tasks. When capuchin monkeys were provided control over the order of computer-delivered tasks, they performed significantly better on several aspects than when task order was predetermined (Beran et al., 2007). Likewise, in a computer-delivered study, rhesus macaques performed better when provided a choice of *which* tasks to perform than when they were assigned tasks (Washburn et al., 1991).

Together these findings suggest that, like humans, several NHA species from varying genera, (a) value control, (b) seek opportunities to choose, and (c) benefit from exercising environmental control via provision of choice (Perdue et al., 2014).

Great Apes

Investigation of great apes' preferences for choice and environmental control have generated more diverse results. Morimura (2003) found that chimpanzees (*Pan troglodytes*) spontaneously elected to use tools to access tube feeders when they were available, irrespective of the fact that they also intermittently used their mouth and hands to access the feeders instead. Morimura argued that these results indicate chimpanzee preference for employing all choices available (i.e., mouth, hands, and tools). Lonsdorf et al. (2010) have reported that providing chimpanzees a choice of enrichment videos resulted in lower frequencies of anxiety-induced scratching than when this choice was not provided. Similarly, Kurtycz, Wagner, and Ross (2014) found that providing chimpanzees the choice to access outdoor enclosures resulted in more frequent social and self-directed behaviors (i.e., grooming and playing) and higher levels of activity. This held true even when the chimpanzees did not exploit the choice provided. They contend that these behavioral observations are collectively indicative of a general increase in chimpanzee arousal levels. Kummer (1968) has also drawn links between decision making and increased self-directed behaviors in his field studies of Hamadryas baboons (*Papio hamadryas*). However, it is important to consider that heightened arousal can also be a negative indicator of affect (e.g., anxiety is also considered a heightened state of arousal), and in great apes, self-directed behaviors can indicate distress. Therefore, Kurtycz et al.'s and Kummer's results could alternatively suggest that this type of choice or decision making was anxiety-provoking for the NHAs observed. Intriguingly, when Kurtycz et al. (2014) tested gorillas (*Gorilla gorilla gorilla*) in the same conditions, more frequent inactivity and lower levels of feeding and object manipulation were observed in the free-choice condition. Again, these behavioral observations are open to selective interpretation. Inactivity could be construed as indicators of

either boredom or relaxation. In contrast, Bloomsmith, Ross, and Baker (2000) found that provision of chimpanzee choice had no observable effects. When chimpanzees that were provided control over a computer task were compared to a yoked group who could see the same display and received the same rewards, but were only passively involved in the task, no differences in behavioral measures of well-being (i.e., levels of activity, self-directed behaviors, scratching, or stereotypes) were observed between the two groups.

Together these results suggest that humans and monkeys exhibit a preference for choice and that the ability to choose can have beneficial effects. However, great ape preferences for choice and the effects of choice on great apes remain unclear.

Modelled after Catania and Sagvolden's (1980) concurrent-chain paradigm, the purpose of this study was to explore whether orangutans prefer free or forced choice when the outcome of their choices is held constant. Orangutans have proven motivated to participate in computer-delivered empirical investigation, capable of color vision, and show sufficient visual acuity for the required study tasks, making them an ideal species for this line of enquiry (Adams & MacDonald 2018, Anderson, 2011; Tigges, 1963). This is the first systematic investigation of preference for free choice in great apes using a paradigm in which extraneous variables were highly controlled.

Method

Participants

The study group consisted of three Sumatran orangutans (*Pongo abelli*) housed at the Toronto Zoo: two females (Ramai, 32 years old, and Sekali, 25 years old), and one male (Budi, 11 years old). Participants were not related to one another and had been trained to use a dowel to operate a touchscreen computer for previous studies investigating music and visual preferences (Adams, Wilkinson, & MacDonald, 2017; Ritvo & MacDonald, 2016); however, none had participated in investigations of environmental control or choice. Research participation was voluntary and participants were not deprived of food or water at any time. Instead, food rewards were provided as positive reinforcement for participation.

Studies were conducted under the oversight of the York University Animal Care Committee, the Toronto Zoo Animal Care Committee, and followed the guidelines of the Canadian Council on Animal Care.

Apparatus and Materials

Experimental sessions were administered and recorded using an HP Desktop 260-A129 PC (“HP Desktop”, 2019) and a 21” color PC computer monitor with a Keytec Magic Touch touchscreen (“Magic Touch,” 2016) unit attached. Orangutans’ choice preferences were assessed via a custom touchscreen-delivered program written in Java. Computer hardware was mounted in a mobile wooden housing that allowed the entire unit to be positioned in front of a participant’s enclosure. Touchscreen selections were made using a wooden dowel. To motivate participation, participants received a single preferred food reward (i.e., one blueberry) for every trial that ended in a correct response.

Design

Data were collected in orangutan holding areas accessible only to zookeepers and experimenters. Participants were physically separated from one another during testing but had some auditory contact through adjoining enclosures. Participants could leave the testing area at any time. Absence from the testing area for more than 10 min resulted in the termination of that session. Experimental sessions consisted of 64 trials, and each participant completed one to two sessions per day, 3-4 days per week.

Test sessions were initiated by positioning the touchscreen in front of a participant’s enclosure. Participants initiated test sessions by approaching the experimental apparatus. Upon approach, the experimenter offered a wooden dowel to the participant and activated the touchscreen program to initiate the first trial.

Only a single selection per task parameter was accepted and participants received a single food reward for successful completion of a trial. To prevent the experimenter from cuing participants, she was positioned behind the housing unit, facing the participant, such that she could not see the display and was prompted to reward the participant

appropriately via auditory chime. The experimenter delivered rewards to participants by hand over the top-center of the apparatus so as to avoid inadvertently indicating that rewards were related to one side of the apparatus versus the other.

Orangutans’ preference for free or forced choice was assessed via a touchscreen-delivered program that mimicked Catania and Sagvolden’s (1980) six-key pigeon chamber concurrent-chain paradigm. This program allowed orangutans to choose one of two virtual routes (i.e., one that provided a free choice and one that did not). Orangutans were provided a choice of selection of one of two white circular touchscreen-displayed keys, called *initial link keys*. Initial link keys were located on the same plane, equidistant from the central axis. Selection of one initial link key led to a forced choice of a single terminal link key to the food reward, while selection of the other initial link key allowed a free choice of several terminal link keys to arrive at the same food reward (see Fig. 1 for visual example of a trial). More specifically, selection of one of the two initial link keys produced one of two terminal links:

- *Free-choice terminal link*: Three reward keys and one neutral key displayed in a row at the center of the touchscreen.
- *Forced-choice terminal link*: One reward key and three neutral keys displayed in a row at the center of the touchscreen.

In both terminal links:

- If an orangutan selected a *reward key* (i.e., a correct response) they received an auditory bridge followed by a standardized food reward before the next trial was initiated. During the 3-s ITI, the touchscreen display was black.
- If an orangutan selected a *neutral key* (i.e., an incorrect response), the next trial initiated after a 3-s ITI without an auditory bridge or reward.

To control for the potentially confounding effect of the position of the initial link keys on the display, two control conditions were also employed in which the position of the free-choice initial link key was changed from the left to the right of the display, and from the right to the top of the display (see Table 1). Furthermore, as identified by Catania and Sagvolden

Table 1
Order of delivery of training and testing stages

Chronological Order	Stage
1	Reward Color Training
2	Terminal Link Keys Color Training
3	Free-Left* (i). Initial Link Keys Side Training (ii). Testing
4	Free-Right (Control 1)** (i). Initial Link Keys Side Training (ii). Testing
5	Free-Top (Control 2)*** (i). Initial Link Keys Side Training (ii). Testing

*Free-choice initial link key located on the left side of the display. Forced-choice initial link key located on the right side of the display.

**Free-choice initial link key located on the right side of the display. Forced-choice initial link key located on the left side of the display.

***Free-choice initial link key located at the top of the display. Forced-choice initial link key located at the bottom of the display.

(1980), investigations of preference for free over forced choice are vulnerable to being confounded by the number, variety, and information value of stimuli. This paradigm controlled for these extraneous variables by making

terminal link stimuli equivalent in number, variety, and bits of information (Catania & Sagvolden, 1980). Each terminal link included four keys, one of which was a different color than the other keys in both the free- and forced-choice terminal links. Therefore, the free- and forced-choice conditions were matched for stimulus number (i.e., four keys), stimulus variety (i.e., one odd colored key among four keys), and bits of information (i.e., two bits of information to select either one of four keys or three of four keys). In addition, to control for color preference confounds, assigned reward key colors and key color pairs were randomized and counterbalanced per participant, so that an equal number of participants were rewarded for selecting red, green, or yellow keys. Budi was rewarded for selecting yellow keys among blue keys, Ramai was rewarded for selecting blue keys among yellow keys, and Sekali was rewarded for selecting red keys among green keys. The position of the odd key was also randomized and counterbalanced across trials (e.g., BAAA, ABAA, AABA, or AAAB) to control for side preference confounds.

Reward Color Training

Color training consisted of sessions in which a single reward key and a single neutral key

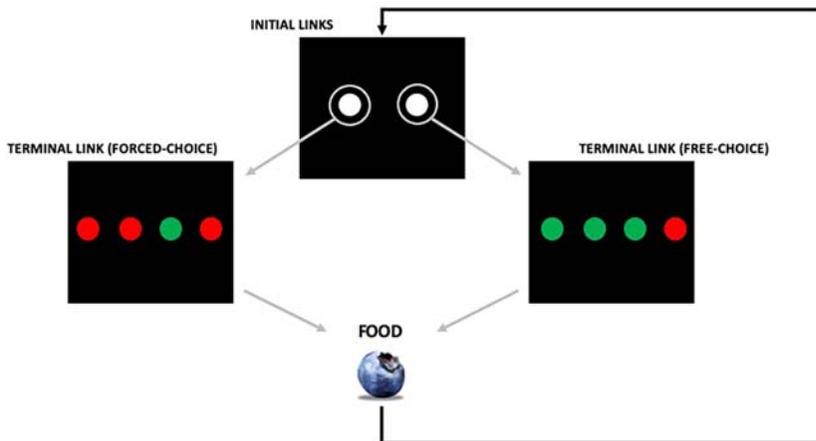


Fig. 1. Example of a testing trial in the *Free-Right* condition. In the example, the participant's reward key color is green and neutral key color is red. In the initial link (top square), two white keys are displayed. The free-choice terminal link is accessed via selection of the right initial link key, and the forced-choice terminal link is accessed via selection of the left initial link key. In the forced-choice terminal link (left square), three keys are red and one key is green. In the free-choice terminal link (right square), three keys are green and one key is red. Selection of a green key in either terminal link produced an auditory bridge, a standardized food reward (i.e., selection of a green key in either terminal link led to the same food reward), and initiation of a new trial. Selection of a red key initiated a new trial, with no reward. [Color figure can be viewed at wileyonlinelibrary.com]

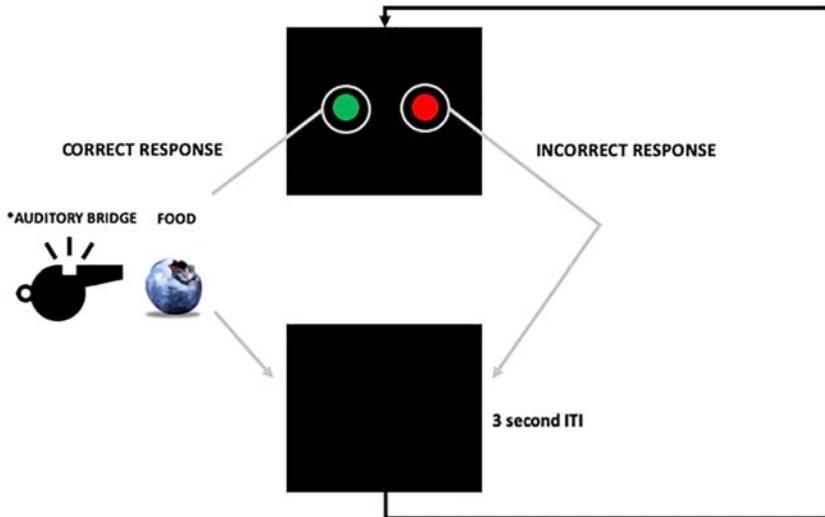


Fig. 2. Example of color training procedure. A single reward key and a single neutral key are displayed in a row at the center of the first display (top square). In the example, the participant's reward key color is green and neutral key color is red. If the participant selects the reward key, they receive an auditory bridge and a single food reward during the 3-s ITI. If the participant selects the neutral key, they do not receive a reward during the 3-s ITI. [Color figure can be viewed at wileyonlinelibrary.com]

were displayed in a row at the center of the touchscreen. If the participant selected the reward key (i.e., a correct response), they received an auditory bridge followed by a standardized food reward before the next trial initiated. During the 3-s ITI, the touchscreen display was black. If the participant selected the *neutral* key (i.e., an incorrect response), the next trial initiated after a 3-s ITI without a bridge or reward (see Fig. 2 for visual example of a trial). Color training was complete, and participants were graduated to concurrent-chains training, when each met an 80% correct criterion for three training sessions (see Table 1).

Terminal Link Keys Color Training

Concurrent-chains training started with multiple key color training. In these sessions, free-choice terminal links (i.e., three reward keys, and one neutral key) and forced-choice terminal links (i.e., one reward key, and three neutral keys) were presented individually in a randomized and counterbalanced sequence. For both terminal links, selection of reward keys was reinforced with an auditory bridge and a food reward and selection of neutral keys ended a trial with no bridge or reward. Terminal link keys color training was complete

when each participant met an 80% correct criterion for three training sessions (see Fig. 3 for visual example of a trial).

Initial Link Keys Side Training

For the concurrent-chains initial link training, a single initial link key was presented at the beginning of each trial. Depending on the side of the screen that the initial link key was presented on, selection of the initial link key initiated a free-choice terminal link or a forced-choice terminal link, respectively. As indicated previously, position of the reward- and neutral- colored terminal link keys were randomized and counterbalanced across trials. To control for the potential confounding effect of the display side that free- and forced-choice initial link keys were presented on (i.e., to ensure that participant side preferences did not confound results), three initial link key orientation conditions were trained and tested: (a) free-choice left, forced-choice right (free-left), (b) free-choice right, forced-choice left (free-right), and (c) free-choice top, forced-choice bottom (free-top). In the free-top condition, the top and bottom keys were displaced 5 cm above and below the horizontal plane where initial link keys were

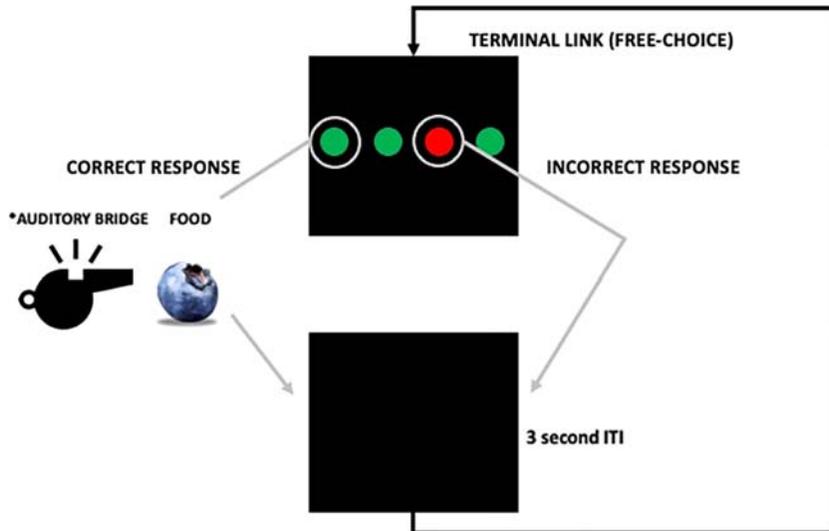


Fig. 3. Example of terminal link keys color training procedure. In the example, a free-choice terminal link is displayed. The participant's reward key color is green and neutral key color is red. Free-choice terminal links (i.e., three reward keys, and one neutral key) and forced-choice terminal links (i.e., one reward key, and three neutral keys) were presented in a randomized and counterbalanced sequence. In both conditions, selection of reward-color keys were reinforced with an auditory bridge and a food reward and selection of neutral keys ended a trial with no reward. [Color figure can be viewed at wileyonlinelibrary.com]

located in the free-left and free-right conditions. Participants were required to meet an 80% correct criterion over three sessions in each training condition before moving onto testing in the same condition type. Once testing was complete in that condition, the participant was trained and then tested in the next condition, and so on (see Table 1 for order of training and testing stages).

Testing

In the testing condition, both the free- and forced-choice keys were presented in the initial link at the beginning of each trial. Selection of the initial link key on one side of the display initiated a free-choice terminal link, and selection of the initial link key on the other side of the display initiated a forced-choice terminal link. As in previous conditions, position of the reward- and neutral-colored terminal link keys was randomized and counterbalanced across trials. Preference for free over forced choice was assessed by relative choice percentages in respective initial link keys. There were 16 distinct trial conditions (i.e., combinations of free-choice terminal link key order, and forced-choice terminal link key order). Each experimental session

consisted of four blocks of 16 trials, for a total of 64 trials per session. Each participant completed one to two sessions per day. Testing was terminated when a participant reached an 80% preference criterion for either the free- or forced-choice initial link key over four test sessions.

Results

All orangutans participated in test sessions consistently and reliably. The few instances in which orangutans declined to participate in a test session occurred during periods of unusual environmental disruption (e.g., construction to the enclosure). Results are discussed for each study condition and analyzed by individual. General trends are also reported.

Test Condition: Free-Choice Left, Forced-Choice Right (Free-Left)

Relative choice percentages from sessions in which the free-choice initial link key was accessed via the left side of the display and forced-choice initial link key was accessed via the right side of the display are provided in Figure 4. All participants demonstrated a preference for the free-choice initial link key.

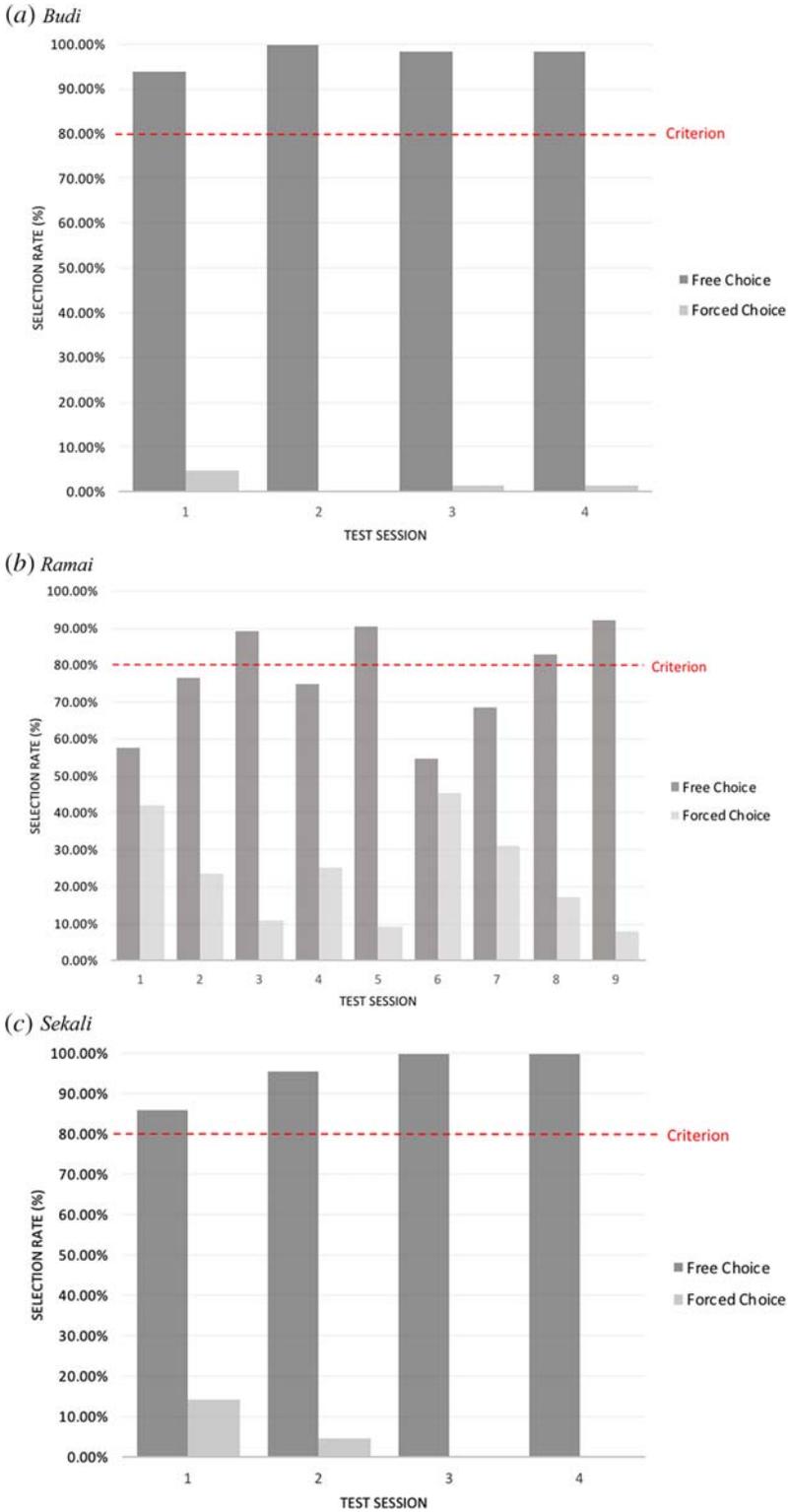


Fig. 4. a, b, and c. Frequency of free- and forced-choice initial link key selections, based on 64 trials per session, in comparison to preference criterion for each orangutan, in the first condition: *Free-Left*. [Color figure can be viewed at wileyonlinelibrary.com]

Budi and Sekali showed the strongest and most consistent preference for the free-choice condition. Both met the 80% free-choice preference criterion rate in session 1 and continued to do so in every subsequent session. Although Ramai also met the free-choice preference criterion, she took three sessions to do so and showed less consistency in her choices.

Free-Choice Right, Forced-Choice Left Condition (Free-Right)

As a control condition, the positions of the free- and forced-choice initial link keys on the display were reversed. If participants' preference for the free-choice terminal link was robust, we would expect them to stop selecting the left initial link key as observed in the free-left condition, and to instead start selecting the right initial link key. Relative choice percentages from free-right sessions are provided in Figure 5. Although Budi demonstrated a continued preference for free choice, both Ramai and Sekali did not. Specifically, Budi met the free-choice preference criterion in session 2, then dipped below criterion and briefly reached the forced-choice preference criterion in sessions 5 and 6, before climbing back to criterion for free choice in sessions 10 to 12. For the most part, Ramai and Sekali continued selecting the left initial link key as they had in the free-left condition, thereby selecting the forced choice initial link in the free-right condition. Ramai met the preference criterion for forced choice by session 4 and as in the free-right condition, showed less consistency in her choices than the other two orangutans. Notably, Ramai demonstrated a slight shift towards selection of the free-choice initial link key in sessions 12 to 14, nearly meeting the free-choice criterion in session 13. Although in Sekali's first test session, she chose the free-choice initial link key more often than the forced-choice initial link key, from session 2 onward, she chose the forced-choice initial link key 50% of the time or more. By session 10, Sekali reached the forced-choice preference criterion and continued to do so in subsequent sessions.

Free-Choice Top, Forced-Choice Bottom Condition (Free-Top)

Given the contrasting results from the free-left and free-right conditions, and the

hypothesis that learned side preference from the free-left condition may have confounded results in the free-right condition, a second control condition was tested to minimize the impact of the side of the display on which the free- and forced-choice initial link keys were located. In the free-top condition, initial link keys were changed from a horizontal to a vertical orientation, so that the free-choice initial link key was displayed above the forced-choice initial link key. Relative choice percentages from free-top sessions are provided in Figure 6. As hypothesized, once right-left side preferences were controlled for, both Ramai and Sekali demonstrated a strong and relatively consistent preference for the free-choice terminal link as they had in the first free-left condition. Sekali met the 80% free-choice preference criterion in session 3 and continued to do so for subsequent sessions. Ramai met the free-choice preference criterion immediately in session 1, and showed fairly consistent preference for free-choice thereafter, meeting criterion in sessions 3, 5, and 6, and only dipping slightly below criterion in sessions 2 and 4. Budi, in contrast to his observed preference for free choice in the free-left and free-right conditions, however, demonstrated an immediate and fairly consistent preference for forced choice in the free-top condition, meeting the forced-choice preference criterion in session 1, and sessions 3 to 5.

Discussion

In this study, Sumatran orangutans were assessed with an experimental choice paradigm modeled on that employed by Catania and Sagvolden (1980) with pigeons. Catania and Sagvolden (1980) reported that with the exception of the early conditions for one participant, each shift of the free-choice initial link key from one side of the display to the other was consistently followed by a corresponding shift in initial-link key preference. However, one of the four pigeons tested (Pigeon 18) only demonstrated this behavior in the last two conditions tested. In the present study, although all of the orangutans initially demonstrated a preference for free choice in the first condition (free-left), in the second (free-right) and third (free-top) conditions, the orangutans' preferences varied.

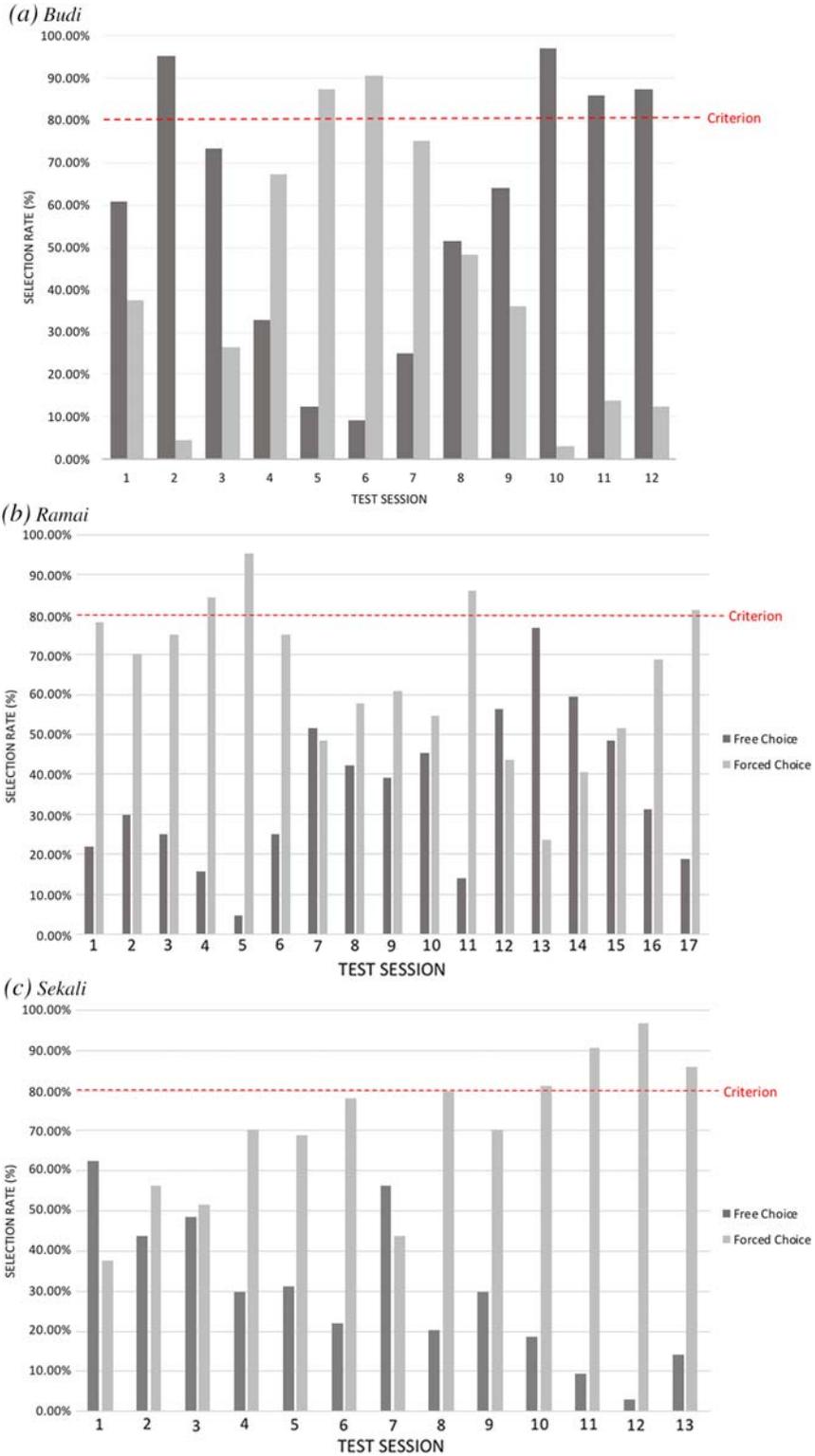


Fig. 5. a, b, and c. Frequency of free- and forced-choice initial link key selections, based on 64 trials per session, in comparison to preference criterion for each orangutan, in the second condition: *Free-Right*. [Color figure can be viewed at wileyonlinelibrary.com]

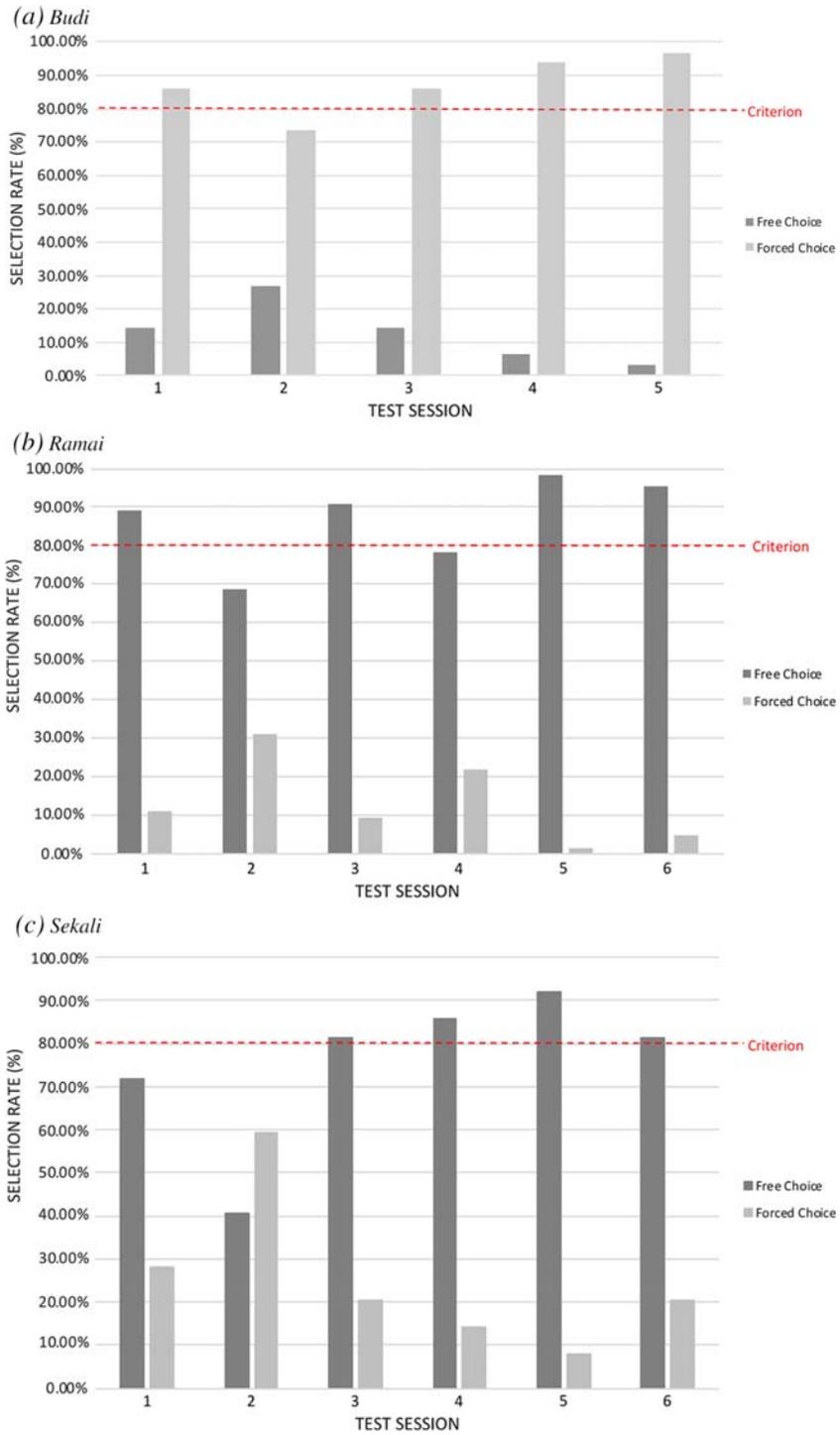


Fig. 6. a, b, and c. Frequency of free- and forced-choice initial link key selections, based on 64 trials per session, per orangutan in the third condition: *Free-Top*. [Color figure can be viewed at wileyonlinelibrary.com]

Table 2

Free- vs. forced-choice observed preference results in each condition per individual [Color table can be viewed at wileyonlinelibrary.com]

	Free-Left	Free-Right	Free-Top
Budi	Free Choice	Free Choice	Forced Choice
Ramai	Free Choice	Forced Choice	Free Choice
Sekali	Free Choice	Forced Choice	Free Choice

Ramai and Sekali both displayed a preference for forced choice in the second condition, and free choice in the third condition, and Budi maintained his preference for free choice in the second condition but preferred the forced-choice option in the third condition (see Table 2). Compared to Catania and Sagvolden's (1980) study, Ramai and Sekali's results bear some semblance to Pigeon 18's behavior. However the behavior of all three orangutans differs from the behavior of the other three pigeons tested (i.e., the majority of subjects). The results of this study also differ from other investigations of choice that have found that humans, NHPs, and rats will reliably select a free-choice option when provided the opportunity even when both options lead to equivalent outcomes (Bown et al., 2003; Catania, 1975; Catania & Sagvolden, 1980; Morimura, 2003; Perdue et al., 2014; Suzuki, 1997; Suzuki, 1999; Voss and Homzie, 1970).

If these results indicate some degree of indifference in orangutans to free or forced choice when outcomes are held constant, this conclusion would be supported by Bloomsmith et al.'s (2000) observations that provision of choice in a chimpanzee computer task did not affect behavioral measures of well-being. However, given that all three orangutans preferred the free-choice option in the first (free-left) condition, it seems unlikely that indifference is the most appropriate explanation.

Side biases often arise when participants are unsure of what is required of them, or when the rate of reinforcement is the same regardless of the participant's performance. Therefore, side bias could explain why, in this paradigm, participants selected an initial link key on one side of the display more often than the other. However, this would not explain why *all* three orangutans preferred the initial link key located on the *same* side of the display in the free-left condition. Comparative results of population-level handedness in nonhuman

primates have been inconsistent between and within species (Hopkins, 2014). For this reason, and given how close in proximity the initial link keys were positioned, it is unlikely that handedness is an explanation either. Instead, given that all three participants demonstrated a strong left initial link key preference in the *first* free-left condition (i.e., when they were naïve to the paradigm), these results suggest a weak preference for free choice when outcomes are held constant.

In Ramai and Sekali's cases, it is reasonable to suppose that a side bias, developed through the selection of, and positive association with, the free-choice initial link key in the first (free-left) condition, carried over into the second (free-right) condition. That is, when the location of the free-choice initial link key was moved from the left to the right side of the display for the second (free-right) condition, the left side bias that Ramai and Sekali learned from selecting the free-choice initial link key in the first (free-left) condition, conflicted with, and eventually outweighed their preference for the free-choice terminal link in the free-right condition. This conflict may be evidenced by several test sessions in the free-right condition in which both participants responded at near chance levels for both initial link keys (see Fig. 5 b-c). Notably, the same type of conflict in response was not observed as often for Ramai, or at all for Sekali in the first free-left condition. This explanation is supported by the fact that when left versus right side preferences were controlled for in the third condition (free-top) by changing the initial link keys to a vertical orientation, both Ramai and Sekali again exhibited a preference for free choice, by selecting the top free-choice initial link key. According to this explanation, it would appear that Ramai and Sekali preferred the free-choice option when outcomes were equated but that this preference was not strong enough to overcome a learned side bias.

Alternatively, Ramai and Sekali's conflicting results may be accounted for by orangutans' documented difficulty with single transposition scenarios. Barth and Call (2006) reported that Bornean orangutans (*Pongo pygmaeus*) did not perform as well as chimpanzees and bonobos in single spatial transpositions of baited cups. If this finding also applies to Sumatran orangutans, it could have made the transposition of

the free-choice initial link key from the left of the display (in the free-left condition) to the right of the display (in the free-right condition) difficult for Ramai and Sekali to navigate appropriately. In other words, Ramai and Sekali may not have been able to follow a hidden reward (i.e., the free-choice initial link key) as it switched locations with an adjacent identical stimulus (i.e., the forced-choice initial link key).

Unlike Ramai and Sekali, Budi demonstrated a preference for free choice in both the first (free-left) and second (free-right) conditions, but not in the third (free-top) condition. These results suggest that if Budi developed a left side bias in the first (free-left) condition, it was weaker than his preference for free choice, because in the second (free-right) condition, he quickly switched from selecting the left initial link key to selecting the right initial link key. Alternatively, if difficulty with transpositions was at issue in this paradigm, Budi may have experienced less difficulty in this regard given that he was younger and therefore likely more cognitively flexible than Ramai and Sekali.

Curiously, in the last (free-top) condition, Budi demonstrated a preference for forced choice by selecting the bottom initial link key. Again, because Budi demonstrated a strong preference for free choice in both the first and second conditions, it is unlikely that these results suggest indifference to free or forced choice. Given that this was the third condition, this behavior could be indicative of boredom or confusion with the paradigm. Budi may have been engaging in what has been termed 'hypothesis testing' in which a participant will test alternative solutions to a task as means of determining if their hypothesis about the task solution is correct. However, why Budi continually selected the forced-choice initial link key for the duration of the free-top condition, is uncertain. It's also possible that, after growing accustomed to the paradigm in the first two conditions, Budi sought out the forced-choice terminal link because of the challenge it offered—locating and selecting a single reward key, rather than selecting any of three reward keys in the free-choice terminal link. As reported above, Budi was the most engaged participant, completing test sessions more quickly and consistently than Ramai and Sekali. This behavior may be indicative of

more interest in, and attention to, the paradigm and could be attributed to boredom in the free-top condition that Ramai and Sekali did not experience. Although the reasoning behind Budi's forced-choice selection in the third condition is uncertain, at the very least, like Ramai and Sekali, Budi's results as a whole also suggest at least a weak preference for free choice.

Overall, results of all three participants suggest an inclination towards free choice (in the first free-left condition), but one that can be easily influenced by competing factors (in the subsequent free-right or free-top conditions). Given that Catania and Sagvolden (1980) observed a stronger, more consistent preference for free choice in the majority of pigeons tested using a similar paradigm, this is an unexpected result.

One potential factor in accounting for these differences is participants' experience with environmental control. In previous research, environmental control, exercised through decision-making, has been observed to reinforce an adaptive perception of what Bandura (1977) terms *self-efficacy*, "one's personal expectations of the ability to succeed" (Leotti et al., 2010). The more environmental control exercised through choice-making, the stronger one's personal beliefs in the ability to achieve desired outcomes. This amounts to a conditioning effect wherein the more extensive the individual's prior experience in choice-making, the stronger the individual's motivation to continue exercising choice. The opposite is also true. A lack of choice challenges self-efficacy beliefs, generating a perceived inability to bring about desired results, a state Seligman (1975) describes as *learned helplessness* (Blackburn & Owens, 2015; Botti & McGill, 2006; Deci & Ryan, 2000; Devins & et al, 1982; Kwasky & Groh, 2014; Leotti et al., 2010; Maddux & Meier, 1995; Pu, Hou, & Ma, 2016; Ryan & Deci, 2000; Sacco et al., 2005; Schwarzer, 2014; Shnek et al., 1997). Therefore, prior experiences in applying environmental control can strengthen or weaken tendencies to exercise choice.

The orangutans tested in this study have lived in a captive zoo setting for their lifetimes. Although enrichment is incorporated by captive animal facilities as an important part of animal care, by their very nature these facilities are limited in their ability to afford

residents control over captive environments equal to that found in natural environments. Living in an environment where free choice is limited, theoretically may have reduced these orangutans' tendencies to exercise free choice in situations where it is possible to do so. But, why would that not also hold true for pigeons (Catania and Sagvolden, 1980), rats (Voss and Homzie, 1970) or monkeys (Suzuki, 1999) that have been found to reliably demonstrate a preference for free choice over forced choice?

The fidelity of the choice paradigm employed here and by Catania and Sagvolden (1980) may have been a factor. In this choice paradigm, both the choice options and the reward outcomes are identical. The free-choice terminal link offers a choice between three identical keys and selection of any reward key in both the free- and forced-choice terminal links is rewarded with the same quantity and type of food. Thus, apart from reward key position, selection of the 'free-choice' link does not provide a variety of choice options or outcomes. It's possible that for orangutans, the free choice link in this paradigm did not provide enough tangible free choice (Russon, 1998). In other words, this paradigm may not provide enough variability to be interpreted as a free choice by orangutans and could account for the observed weak preferences for the free-choice condition. For this reason, it would be interesting to investigate if (a) similar results are observed using this paradigm with other great ape species, including chimpanzees, gorillas, bonobos and human children and (b) if a choice paradigm that provides more tangible variability in either choice options or outcomes, elicits stronger preference for free or forced choice in orangutans.

Based on the present research, we cannot speculate whether Sumatran orangutans display a weaker preference for free choice than pigeons and monkeys, or whether their preference selections reflect the inappropriateness of Catania and Sagvolden's (1980) choice paradigm for this species and other great apes. It is possible that the differences observed between this experiment and others that employed the same paradigm reflect a difference in understanding of what constitutes 'free choice' between species. Regardless, as the first systematic investigation of preference for free or forced choice in great apes using a

paradigm in which extraneous variables are highly controlled, the present research builds on knowledge of an important area of comparative cognition that can be applied to captive animal welfare.

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