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ORIGINAL PAPER

Waiting for what comes later: capuchin monkeys show self-control even for nonvisible delayed rewards

Bonnie M. Perdue[1] · Jessica L. Bramlett[2] · Theodore A. Evans[2] · Michael J. Beran[2]

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Abstract Self-control tasks used with nonhuman animals typically involve the choice between an immediate option and a delayed, but more preferred option. However, in many self-control scenarios, not only does the more impulsive option come sooner in time, it is often more concrete than the delayed option. For example, studies have presented children with the option of eating a visible marshmallow immediately, or foregoing it for a better reward that can only be seen later. Thus, the immediately available option is visible and concrete, whereas the delayed option is not visible and more abstract. We tested eight capuchin monkeys to better understand this potential effect by manipulating the visibility of the response options and the visibility of the baiting itself. Monkeys observed two food items (20 or 5 g pieces of banana) each being placed either on top of or inside of one of the two opaque containers attached to a revolving tray apparatus, either in full view of monkeys or occluded by a barrier. Trials ended when monkeys removed a reward from the rotating tray. To demonstrate self-control, monkeys should have allowed the smaller piece of food to pass if the larger piece was forthcoming. Overall, monkeys were successful on the task, allowing a smaller, visible piece of banana to pass from reach in order to access the larger, nonvisible banana piece. This was true even when the entire baiting process took place out of sight of the monkeys. This finding suggests that capuchin monkeys succeed on self-control tasks even when the delayed option is also more abstract than the immediate one—a situation likely faced by primates in everyday life.

Keywords Self-control · Capuchin monkeys · Delay of gratification · Inhibition

Introduction

Studies of nonhuman animal self-control typically involve choices between different amounts of food rewards presented after different durations of time. Individuals/species that can tolerate longer delays to obtain greater food rewards are considered more self-controlled. Most often, these choice options are presented in pairs in what is known as a temporal discounting, delay choice, or intertemporal choice (ITC) task. In this task, one response option represents a relatively small or less preferred, but more immediately available food reward, and the other response option represents a relatively large or more preferred food reward that is available after some longer delay (e.g., Ainslie 1974; Tobin et al. 1993; Stevens et al. 2005a). A large variety of animal species have been tested with this method ranging from insects to nonhuman primates, and the degree to which animals discount the delayed reward varies across species and as a function of different environmental/task parameters (for a review, see Logue 1988; or Berns et al. 2007).

In a less commonly used self-control task, animals choose when to take an amount of food that grows over time as additional items are added to it one by one (e.g., Anderson et al. 2010; Beran 2002; Beran and Evans 2006;

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✉ Bonnie M. Perdue
bonnie.m.perdue@gmail.com

[1] Agnes Scott College, Decatur, GA, USA

[2] Language Research Center, Georgia State University, Atlanta, GA, USA

Parrish et al. 2014; Vick et al. 2010). Such accumulation (ACC) tasks have been presented to fewer species, with a larger focus on nonhuman primates. Nonetheless, as in the ITC tasks, researchers have examined a variety of variables that can influence how long animals delay gratification in an accumulation task including things like accumulation rate, item visibility, and distraction strategies that may be employed to facilitate better delay of gratification (e.g., Beran and Evans 2006; Evans and Beran 2007; Evans et al. 2012).

While the ITC and ACC tasks have been used most often to investigate self-control in animals, other unique food-based tasks also have been presented, including the spatial discounting task (choosing between a lesser nearby food and a greater but more distant food; e.g., Evans and Westergaard 2006; Stevens et al. 2005b) and the exchange task (giving back a smaller or less preferred food item in exchange for a larger or more preferred food item; e.g., Dufour et al. 2007, 2012; Pelé et al. 2010, 2011). Altogether, the results of these tasks show that, like humans, animals undervalue rewards that are available later in time, although several species are able to tolerate delay intervals of multiple seconds or even minutes to obtain greater rewards (e.g., Beran and Evans 2006; Pelé et al. 2010).

A noteworthy characteristic of these approaches is that the two response options are similar in nature. For example, both the "impulsive" and the "self-controlled" options may involve concrete outcomes such as food, but those outcomes differ in quantity, quality, or the delay to obtain the items. Conversely, both options might be represented by an abstract symbol (choosing arbitrary stimuli that represent smaller-sooner or larger-later, e.g., Ainslie 1974). This differs from many real-life self-control scenarios faced by humans (and perhaps nonhuman animals) in which an immediate, concrete alternative must be contrasted with a delayed, abstract one when making decisions. For instance, one must resist eating a piece of chocolate cake (immediate, concrete option) in favor of long-term health and fitness (delayed, abstract option). Or one must choose to spend money in hand (concrete option) or to deposit it to save for retirement (abstract option). Humans are often—although certainly not always—able to employ self-control in these situations in which concrete and abstract alternatives are pitted against one another. It is likely that nonhuman primates and other animals in the wild face similar conflicts between immediately available, concrete opportunities and more delayed but valuable opportunities. For example, they might have to choose between eating fruit that is currently available, but not of ideal ripeness, and traveling to a distant food source where the food quality might be greater based on past experience or other seasonal or environmental cues.

A limitation of much of the nonhuman animal work looking at delay of gratification is that this type of scenario (concrete versus abstract) is rarely assessed. A more in-depth evaluation of performance on this type of task may yield insight into the similarities and differences between human and nonhuman self-control. Here we explore this issue in capuchin monkeys (*Cebus apella*) using a recently developed self-control task. Bramlett et al. (2012) presented food items to capuchin monkeys on a tray that automatically rotated in a circular direction. There were two arms, and on critical self-control trials, the less valuable/smaller quantity food item was placed on the arm that would pass within reach of the monkey first, and the more valuable option came second. Only one item could be taken off the tray and eaten, and so monkeys had to let the smaller or less preferred item pass within reach and inhibit taking it in order to obtain the better reward. Most monkeys were successful on this task and inhibited grabbing the less preferred piece of food. Critically, the entire problem space (i.e., the immediate reward and the delayed reward) was visually apparent to the monkey throughout the trial, making it an intuitive self-control task because the monkeys could watch as the better reward drew closer.

For the present study, the rotating tray task was used again, but instead of always placing constantly visible food items on the two arms, small containers were attached to the arms. Food items were placed either on top of the containers where they remained visible to the monkeys during the rotation (much like in Bramlett et al. 2012) or inside of the containers and thus remained not visible to monkeys during the rotation of the tray. Nonvisible items are more abstract than visible items because they require a memory representation rather than direct perceptual contact. This allowed us to contrast various pairings of more or less concrete choice options to explore the role that the degree of abstraction might have on self-control in capuchin monkeys.

We hypothesized that monkeys would be able to exert self-control even when the visibility of food items was varied; however, we predicted a decline in performance when the baiting itself was not visible.

Method

Subjects

Subjects included three adult female (Wren, Nala, and Lily) and five adult male (Liam, Logan, Griffin, Gabe, and Drella) capuchin monkeys. Subjects were group housed and voluntarily separated into individual enclosures for testing. All capuchins had 24-h access to water and were fed manufactured chow following test sessions, as well as various fruits and vegetables between 1600 and 1700 h. All monkeys had participated in at least one prior study of self-

control behavior, including one previous study that involved the rotating tray apparatus used here (Bramlett et al. 2012; Evans and Beran 2014; Evans et al. 2012, 2014; Paglieri et al. 2013).

Materials

The apparatus was a 38-cm-diameter revolving plastic disk affixed to a rolling cart (Fig. 1). The disk was mounted on the top of a motor that rotated at three revolutions per min. Two arms extended from opposite positions on the tray (i.e., 180° apart). Each arm was a 10 cm (l) × 5 cm (w) × 6 (h) plastic box with a hinged lid. One box had a white lid and the other had a black lid. The black container always reached the monkey first when the tray was rotating. Each lid had a small tab near the monkey's side of the box so that the lid could be easily lifted open. Food items could be placed either inside of or on top of the boxes at the onset of a trial. A Lexan barrier with a 20 cm × 10 cm rectangular opening was attached to the front of the cart so that monkeys were prevented from reaching around the side of the text box to take the food before it was in front of them.

Procedure

Memory test

We first conducted a brief training phase to confirm that monkeys could remember the location of an out-of-sight food item (placed inside one of the plastic boxes) for the duration of time required for that item to reach the monkey. One experimenter conducted each trial. To prevent cuing, the experimenter stepped to the side and out of direct sight of the monkey once the trial began. Once a food container was selected (touched by the monkey), the experimenter stopped the revolving tray by electronic switch and then pulled back the cart (i.e., the monkey could only respond to one of the two boxes, not both; see Supplementary Materials for a video demonstration). All trials were 60 s long regardless of which food item was selected.

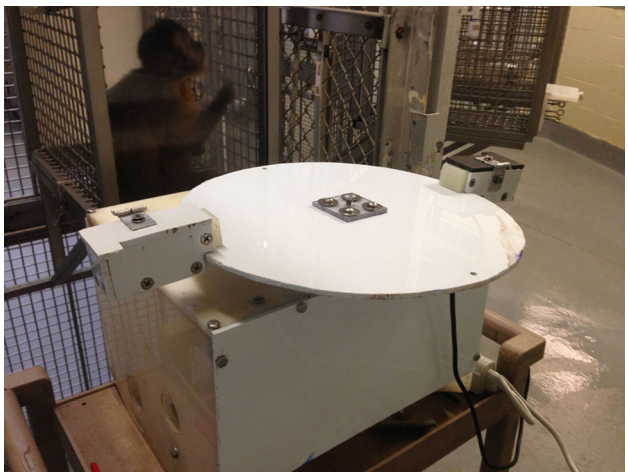

Fig. 1 Rotating tray apparatus. Food items could be placed either into or on top of the containers on each of the arms

A dried blueberry was placed inside one of the two boxes on the tray. The covers of both boxes were touched, lifted, and re-covered by the experimenter to control for sound and position cues, but the food item was only placed in one location. This was done in full view of the monkey. Four trials were completed in each session: two trials with food placed in box 1 (the first to come within reach) and two trials with food placed in box 2 (the second to come within reach). In all trials, 5 s elapsed before box one reached the monkeys, and 15 s elapsed before box two reached the monkey. Testing continued until each monkey was perfect in choosing only the box with the blueberry for two consecutive sessions (8/8 correct, $p < .05$, binomial distribution). The memory test occurred first for all monkeys.

Self-control test: visibility of food items

In the first testing phase, banana slices were presented to monkeys on the rotating tray with baiting fully visible. Two variables were manipulated in this first test: order and visibility. We manipulated the order by presenting either the smaller banana on the first arm and the larger banana on the second arm *or* the larger banana on the first arm and the smaller banana on the second arm. We manipulated visibility of food items by placing items either inside or on top of the arms. There were three possible presentations: (1) both of the items were visible, (2) the food on the first arm was visible (and the second arm was not visible), or (3) the food on second arm was visible (and the first arm was not visible). We fully crossed these variables to create six trial types (see Table 1). The order of these trial types was random in each session. We conducted ten trials of each of the control trials, ten trials of the fully visible trials, and 20 trials of each of the critical self-control trials (smaller food first). The smaller banana slices were 5 g (±1 g), and the larger banana slices were 20 g (±1 g). Items were baited in full view of the monkeys and placed either on top of or into the containers on the rotating tray. Thus, only the visibility of the food items once on the tray was manipulated. The self-control trials involved the smaller piece of banana being placed on the first arm of the tray (smaller-sooner), and the larger piece was placed on the second arm (larger-later). Monkeys had to inhibit taking the smaller piece of banana and instead let it pass by them in order to gain access to the larger piece. In one type of trial, the food

Table 1 Trial counts for different trial types in the visibility of food items test

	Both arms visible	First arm visible	Second arm visible
Smaller banana on first arm	10 Trials "Standard"	20 Trials "More difficult"	20 Trials "Less difficult"
Larger banana on first arm (control trials)	10 Trials	10 Trials	10 Trials

Table 2 Trial counts for different trial types in the visibility of baiting test

	First arm visible	Second arm visible
Smaller banana on first arm	10 Trials "More difficult trial"	10 Trials "Less difficult trial"
Larger banana on first arm (control trials)	10 Trials	10 Trials

items were both placed in the visible position (on top of the boxes), replicating the procedure of Bramlett et al. (2012). In the critical manipulation for this experiment, we had two additional self-control trial types. The smaller-sooner item was either visible (and the larger-later item was not visible) or not visible (and the larger-later item was visible). We predicted that it would be more difficult to allow a smaller piece of banana to pass by when it was visible and the larger (yet to come) item was not visible, than when the smaller item was hidden and the larger (yet to come) item was visible. We also included control trials in each of these visibility combinations in which the larger piece of banana was placed on the first arm to reach the monkey and the smaller piece on the later arm. We included these to ensure that monkeys did not adopt a strategy of simply avoiding the first item on all trials.

Self-control test: visibility of baiting

For this phase of testing, the method generally remained the same, but the baiting process took place behind an occluder that prevented monkeys from seeing the food items actually being placed into or onto the containers. Thus, we added a layer of abstraction by not ever showing the actual contents of the hidden container. We also discontinued the condition in which both items were visible because this was mainly an effort to replicate previous work and would negate the purpose of the occluder.

The experimenter first placed the occluder in between the monkey and the apparatus before beginning the baiting procedure. Then, each food item was held above the occluder, in view of the monkey, before being placed into or onto a container. Thus, the monkey saw the items one at a time, but did not know where those items were placed on the tray until the occluder was later removed. On every baiting event, the experimenter touched, opened, and closed each of the containers, even though the food item was only placed in or on one of the two containers. This was to ensure that auditory or positional cues could not be used to determine food location. Once the baiting was complete, the occluder was removed, and the trial began.

Again, we had self-control trials in which the smaller piece of banana was on the first arm, and the visibility of the arms was manipulated (either the first arm or the second arm was visible, and the other was not). We also included control trials in which the larger piece of banana was placed onto or into the first arm to ensure that monkeys were not simply avoiding the first arm completely (Table 2).

Results

Memory test

Some monkeys reached the criterion of 4/4 trials correct in the first two consecutive sessions before self-control testing began. Three monkeys (Drella, Liam, and Nala) required additional training to reach this criterion including trials in which only the baited box was touched (as compared to the memory trials in which both boxes were touched, but only one was actually baited). Once this initial pre-training was completed, these monkeys reached criterion on the memory task in 5, 5, and 3 sessions, respectively.

Visibility of food items

On the control trials in which the larger banana was placed on the first arm and the smaller piece was on the second arm, monkeys performed at very high levels. On trials in which both items were visible, monkeys averaged 97.8 % correct (i.e., choosing the larger piece of banana). On control trials in which the first item was the only one visible, performance was 100 % correct across monkeys, and finally, when the second item was the only one visible, monkeys averaged 98.9 % correct. In all cases, preference for the larger piece of food over the smaller piece of food was statistically significant for each monkey, all $p < .05$, binomial test.

On self-control trials in which the monkey had to let a smaller banana piece pass by to obtain a larger piece, results were much in line with predictions. On the "standard" version in which both items were visible, the overall mean performance was 88 % correct. On the most difficult trials in which a smaller, visible piece of banana had to pass by a monkey in order for them to obtain a larger, nonvisible piece of banana, monkeys were only 75.6 % correct. On the easiest trials in which the smaller piece was not visible, but the larger piece was visible, monkeys averaged 92.5 % correct.

Figure 2 shows individual patterns of performance. For analyses, we compared performance to "indifference", or a 50 % chance of choosing either of the arms. Of particular interest was the comparison between trials in which the smaller, visible item was first to come within reach versus trials in which the smaller, nonvisible piece came within reach first. Logan, Liam, Nala, Griffin, Lily, and Wren all were significantly more likely to obtain the larger food item than expected if they were indifferent on both of these conditions, all $p < .05$, binomial test, and none of these monkeys showed a statistically significant difference between these two conditions, all $p > .48$, two-tailed Fisher's exact test. Drella's performance was significantly better in the condition where the nonvisible smaller reward came first and the visible, larger reward came second, $p < .001$. Gabe was significantly less likely to obtain the large reward than the small reward on trials where the small, visible reward came first, $p < .01$, binomial test, and he was significantly poorer at obtaining the larger food reward in this condition compared to the other condition, $p < .005$, two-tailed Fisher's exact test.

Visibility of baiting

On the control trials in which the larger banana was placed on the first arm and the smaller piece was on the second arm, monkeys were 100 % correct regardless of which of the two items was visible. This performance was statistically above indifference levels for each monkey, all $p < .05$, binomial test.

On self-control trials, performance was again consistent with predictions. On the more difficult trials in which the smaller-sooner item was visible but the larger-later item was not visible, monkeys averaged 70 % correct overall. On the trials in which the smaller-sooner item was not visible, but the larger-later item was, monkeys averaged 90 % correct. Figure 3 shows individual patterns of performance. Logan, Liam, Griffin, and Lily were significantly more likely to obtain the larger food item than if they were indifferent on both of these conditions, all $p < .05$, binomial test. None of these monkeys showed a statistically significant difference between these two conditions, all $p > .90$, two-tailed Fisher's exact test. Wren was significantly more likely than indifference to obtain the larger food item than on trials where the smaller, visible item came first, $p < .05$, binomial test, but not for the condition where the smaller, nonvisible item came first. However, she showed no significant difference between these two conditions, $p = 1.00$, two-tailed Fisher's exact test. Gabe and Nala were not significantly different than indifference in obtaining the larger food item in either condition, all $p > .10$, binomial test. And, neither of these monkeys showed a difference in performance between these two conditions, all $p > .16$, two-tailed Fisher's exact

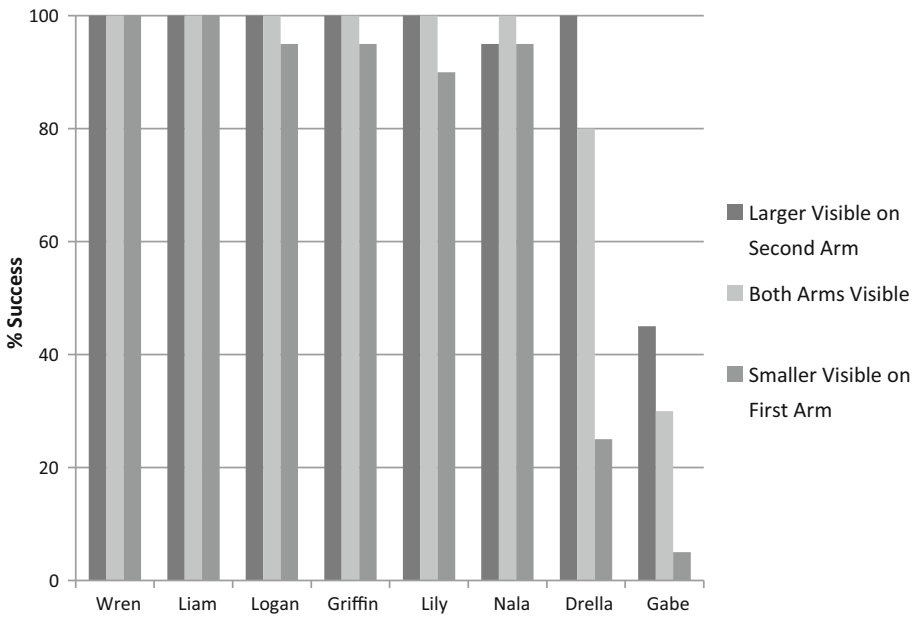

Fig. 2 Performance on self-control trials in which baiting occurred in full view of subjects. Success is defined as obtaining the larger food reward on the trial

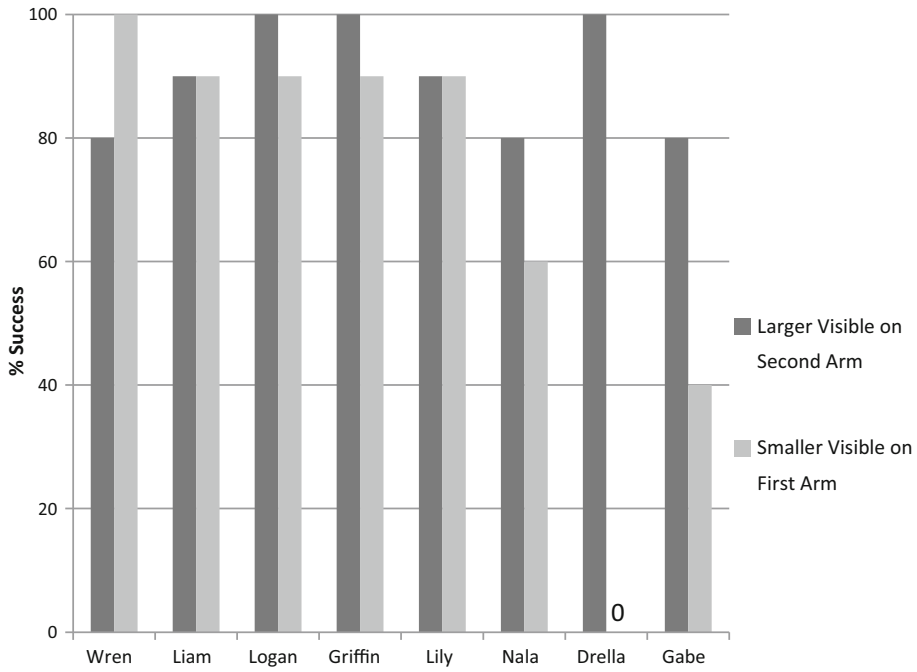

Fig. 3 Performance on self-control trials in which baiting was occluded from view of subjects. Success is defined as obtaining the larger food reward on the trial

test. Drella was significantly more likely than indifference to obtain the larger reward than the smaller reward on trials where the small, nonvisible reward came first, $p < .01$, binomial test, and he was significantly less likely to obtain the larger reward than the smaller reward on trials where the smaller, visible reward came first, $p < .01$, binomial test. His performance was significantly different between these two conditions, $p < .005$, two-tailed Fisher's exact test.

We also compared performance on the self-control trials in which the smaller-sooner item was visible to performance when the baiting process was fully visible, but there was not a significant difference, $t(7) = -.772$, $p = .465$ (see Fig. 4).

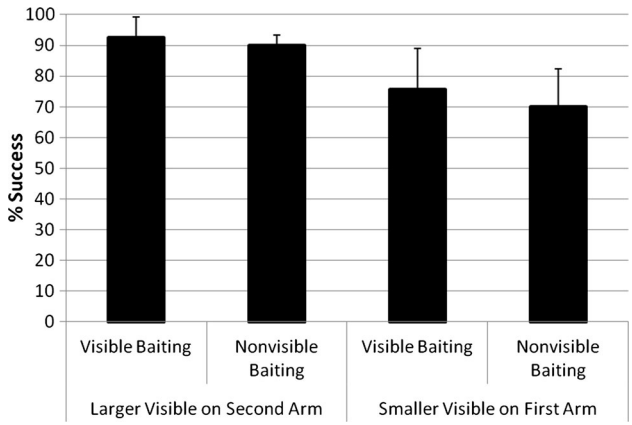

Fig. 4 Average percentage of success (obtaining the better reward) for the critical self-control trials in the visible and nonvisible baiting conditions. *Error bars* indicate the standard error

Discussion

Capuchin monkeys were successful on a self-control task even when the more delayed option was not visible. Surprisingly, this performance did not decline significantly even when the baiting process was completely occluded. Monkeys, in general, were still able to forego a small piece of banana when it passed within reach in order to receive a larger piece that they could not see in the second arm, *nor* had they seen it placed into that arm. Overall, this provides clear support for self-control in this species.

Past research with capuchin monkeys has led to mixed results in terms of their self-control performance, and often those mixed results could have been attributed to either different methods for assessing self-control (e.g., Addessi et al. 2013) or perhaps concerns about the proper interpretation of data from variations of tasks such as the ITC task (Paglieri et al. 2013). Bramlett et al. (2012) offered a new approach that was intuitive for these animals because all options were visible and remained visible throughout a trial, and the temporal delays to each option also intuitively elapsed as the food moved within reach. This approach engendered success in most capuchins, including animals that had shown much less success with other methods (Evans et al. 2012). This was important because some degree of success was necessary to begin to investigate other environmental factors that might affect capuchin self-control in ways similar (or dissimilar) to self-control in humans.

For humans, and especially children, visibility of rewards can play a complicated role in self-control (e.g., Mischel and Ebbesen 1970). When the immediate reward remains visible (as opposed to being hidden), performance typically suffers, whereas having the delayed reward (for which one is waiting) visible sometimes improves self-control but other times does not (Mischel and Ebbesen 1970). The Bramlett et al. (2012) task used with capuchin monkeys kept both rewards visible and thus likely presented the monkeys with a conflict from a visible and present (and moving toward them) immediate reward that likely was tempting, but also a visible and present (and also moving toward them) delayed reward that offset some of that temptation. This made it difficult to determine the exact effects on delay of gratification of visibility of either reward type with both present. The present results addressed this limitation.

When delayed rewards were not visible, but instead moved within reach while in an opaque container, most monkeys continued to wait for those delayed rewards on the majority of trials. Although performance was lowest when the delayed reward was also the nonvisible reward, it was still good, and in most cases, for most monkeys it was statistically as good as when the delayed reward was the visible reward. This is the condition in which the smaller, sooner reward likely was at its most tempting, as there was nothing else visible for the monkeys to focus on during the trial in terms of prepotent, appetitive stimuli. But the monkeys learned that better food was in the second container and that they should still allow the visible, but smaller, food item to move past them.

More impressively, many monkeys exhibited self-control for a larger banana even when they had *never* directly seen the item go into the more delayed container, nor was it visible at the time of selection. Thus, it was not possible for them to track the bigger food item and then simply rely on object permanence as a means of recognizing that the item was still where they saw it placed—into the more delayed container. Again, this was a relatively more difficult condition compared to conditions where the delayed reward was visible, but most monkeys were still successful on the majority of trials.

These findings suggest that self-control is influenced by the abstractness of the options, but—perhaps surprisingly—not completely hindered as the items become more abstract (as when the more delayed food item was not visible, nor was it even seen being placed into the container). One possibility, however, is that with experience, the monkeys began to follow a rule such as "always forego the small piece" rather than recognizing the potential contents of the two containers. This would still require self-control, but perhaps to a lesser extent than forming a representation of the larger (but unseen) item. At the end of the formal experiment, we assessed this possibility. We presented four sessions with each monkey (four trials each) in which the larger piece of banana was shown to the monkey, but then placed on the cage adjacent to the monkey rather than behind the occluder and into one of the containers. The smaller piece was shown and baited as normal on top of the first arm. If monkeys were simply following the rule "always forego small", we would expect them to continue to wait for the second arm on all trials (even though the larger banana was visible on the cage next to them). Only two monkeys did this consistently, and so those monkeys may have relied on such a rule. The other six monkeys either let the small piece pass on only one or two trials of the sixteen trials (two monkeys) or always selected the smaller piece (four monkeys). This indicated that for most monkeys, the observed self-control at least appears to be related to a representation of the larger, yet unseen, food item, in that experimental presentation. However, it is possible that some monkeys in some trials came to avoid small banana slices even when those were the only items that could be obtained. Perhaps they expected the larger slice on the adjacent cage still to be presented, in which case this would have been an adaptive response, but it is also possible these reflect true errors in judgment of what could be obtained.

The use of this apparatus allows for a number of other context manipulations such as the requirement that the monkeys make inferences about food location. This method also could be combined with an accumulation procedure (e.g., Beran 2002; Beran and Evans 2006; Evans and Beran 2007) to assess just how long the monkeys would wait if the baited arms that were, at each choice point, further away kept being improved (through adding more food to them). To date, capuchin monkeys have not proven capable as very good subjects in an accumulation test (e.g., Paglieri et al. 2013), but with the use of the rotating tray this might change, in large part because of the manner in which the monkeys can constantly see how the delayed reward continues to improve. Thus, we can chart the depth and breadth of their delay of gratification using this method, toward the goal of seeing what helps and what hurts efforts at exhibiting self-control.

These results also allow for a more accurate assessment of self-control situations regularly faced by humans. For instance, if being healthier was a visible and concrete comparison to eating a piece of cake, one would likely not struggle as much to resist the cake (which is why many people use images of their formerly skinnier selves to motivate them to stay on a diet). It is likely that primates in the wild face similar scenarios in which delayed rewards are more abstract than immediate ones, and this research moves self-control testing in laboratories closer to a real-life scenario. Here, monkeys were sometimes able to resist

the immediate, visible, and concrete option in favor of the more delayed, nonvisible, and more abstract option. However, this scenario proved more challenging than the typical self-control choice, and this opens an important line of inquiry into primate self-control.

Conflict of interest None.

Ethical standard This study complies with the ethical standards for research in the USA.

References

Addessi E, Paglieri F, Beran M, Evans T, Macchitella L, De Petrillo F, Focaroli V (2013) Delay choice vs. delay maintenance: different measures of delayed gratification in capuchin monkeys (Cebus apella). J Comp Psychol 127:392–398

Ainslie G (1974) Impulse control in pigeons. J Exp Anal Behav 21:485–489. doi:10.1901/jeab.1974.21-485

Anderson JR, Kuroshima H, Fujita K (2010) Delay of gratification in capuchin monkeys (Cebus apella) and squirrel monkeys (Saimiri sciureus). J Comp Psychol 124:205–210. doi:10.1037/a0018240

Beran MJ (2002) Maintenance of self-imposed delay of gratification by four chimpanzees (Pan troglodytes) and an orangutan (Pongo pygmaeus). J Gener Psychol 129:49–66. doi:10.1080/00221300209602032

Beran MJ, Evans TA (2006) Maintenance of delay of gratification by four chimpanzees (Pan troglodytes): the effects of delayed reward visibility, experimenter presence, and extended delay intervals. Behav Process 73:315–324. doi:10.1016/Jbeproc.2006.07.005

Berns GS, Laibson D, Loewenstein G (2007) Intertemporal choice—toward an integrative framework. Trends Cognit Sci 11:482–488. doi:10.1016/Jtics.2007.08.011

Bramlett JL, Perdue BM, Evans TA, Beran MJ (2012) Capuchin monkeys (Cebus apella) let lesser rewards pass them by to get better rewards. Anim Cognit 15:963–969

Dufour V, Pele M, Sterck EHM, Thierry B (2007) Chimpanzee (Pan troglodytes) anticipation of food return: coping with waiting time in an exchange task. J Comp Psychol 121:145–155

Dufour V, Wascher CAF, Braun A, Miller R, Bugnyar T (2012) Corvids can decide if a future exchange is worth waiting for. Biol Lett 8:201–204

Evans TA, Westergaard GC (2006) Self-control and tool-use in tufted capuchin monkeys (Cebus apella). J Comp Psychol 120:163–166. doi:10.1037/0735-7036.120.2.163

Evans TA, Beran MJ (2007) Chimpanzees use self-distraction to cope with impulsivity. Biol Lett 3:599–602. doi:10.1098/rsbl.2007.0399

Evans TA, Beran MJ (2014) Monkeys wait to begin a computer task when waiting makes their responses more effective. Anim Behav Cognit 1:36–50

Evans TA, Beran MJ, Paglieri F, Addessi E (2012) Delaying gratification for food and tokens in capuchin monkeys (Cebus apella) and chimpanzees (Pan troglodytes): when quantity is salient, symbolic stimuli do not improve performance. Anim Cognit 15:539–548. doi:10.1007/s10071-012-0482-1

Evans TA, Perdue BM, Parrish AE, Beran MJ (2014) Working and waiting for better rewards: self-control in two monkey species (Cebus apella and Macaca mulatta). Behav Process 103:236–242

Logue AW (1988) Research on self-control: an integrating framework. Behav Brain Sci 11:665–709. doi:10.1017/S0140525X00053978

Mischel W, Ebbesen EB (1970) Attention in delay of gratification. J Personal Soc Psychol 16:329–337

Paglieri F, Focaroli V, Bramlett J, Tierno V, McIntyre J, Addessi E, Evans TA, Beran MJ (2013) The hybrid delay task: Can capuchin monkeys (Cebus apella) sustain a delay after an initial choice to do so? Behav Process 94:45–54

Parrish AE, Perdue BM, Stromberg EE, Bania AE, Evans TA, Beran MJ (2014) Delay of gratification by orangutans (Pongo pygmaeus) in the accumulation task. J Comp Psychol 128:209–214

Pelé M, Dufour V, Micheletta J, Thierry B (2010) Long-tailed macaques display unexpected waiting abilities in exchange tasks. Anim Cognit 13:263–271. doi:10.1007/s10071-009-0264-6

Pelé M, Micheletta J, Uhlrich P, Thierry B, Dufour V (2011) Delay maintenance in Tonkean Macaques (Macaca tonkeana) and Brown Capuchin Monkeys (Cebus apella). Int J Primatol 32:149–166. doi:10.1007/s10764-010-9446-y

Stevens JR, Hallinan EV, Hauser MD (2005a) The ecology and evolution of patience in two New World monkeys. Biol Lett 1:223–226. doi:10.1098/rsbl.2004.0285

Stevens JR, Rosati AG, Ross KR, Hauser MD (2005b) Will travel for food: spatial discounting in two New World monkeys. Current Biol 15:1855–1860

Tobin H, Chelonis JJ, Logue AW (1993) Choice in self-control paradigms using rats. Psychol Rec 43(3):441–453

Vick S-J, Bovet D, Anderson J (2010) How do African grey parrots (Psittacus erithacus) perform on a delay of gratification task? Anim Cognit 13:351–358. doi:10.1007/s10071-009-0284-2