

Exploring Decoy Effects on Computerized Task
Preferences in Rhesus Monkeys (*Macaca mulatta*)

Audrey E. Parrish^{1*}, Elyce Afrifa², & Michael J. Beran³

¹Psychology Department, The Citadel, Charleston, SC

² Herbert H. Lehman High School, New York, NY

³ Psychology Department & Language Research Center, Georgia State University, Atlanta, GA

Acknowledgements

Support for this research was provided by NICHD (grant HD-060563). Correspondence should be addressed to Audrey Parrish (audrey.parrish1@gmail.com). We thank the animal care and enrichment staff at the Language Research Center of Georgia State University for maintaining the health and wellbeing of the primates and making this research possible.

Exploring Decoy Effects on Computerized Task

Preferences in Rhesus Monkeys (*Macaca mulatta*)

Choice behavior reveals a wealth of information regarding one's preferences, perceptions, thoughts, and ideas, and, of equal importance, the factors that impact decision-making. To this latter point, choice behavior does not occur in a vacuum. Rather, choices are largely context-dependent in terms of the environment in which decisions are made. One clear example of context-dependent choice behavior that is prevalent across a variety of domains and cognitive tasks, and includes a growing number of species is the asymmetric dominance effect (ADE), also referred to as the decoy effect (for a review, see Huber, Payne, & Puto, 2014). In the decoy effect, a decision-maker chooses among two options that differ on multiple dimensions and the relative preference between original options is altered following the introduction of a third weaker option (the decoy). In the original choice set, the first option (e.g., an expensive 5-star restaurant) dominates the second option (e.g., a less-expensive 3-star restaurant) on one dimension (quality) whereas the second option dominates the first option on a separate dimension (price). The decision-maker may experience indifference or a slight preference between these options if both dimensions (restaurant quality and monetary savings) are of equivalent value. A third weaker option known as the decoy is introduced to the choice set that is asymmetrically dominated by one of the original options (e.g., an even more expensive 4-star restaurant is weaker on both dimensions of price and quality relative to the 5-star restaurant). The decoy is rarely chosen as it is seen as inferior or even non-viable. However, it can serve to increase the decision maker's preference for the original option that dominates it (e.g., the original 5-star restaurant).

According to rational choice theory, the third inferior decoy option is not expected to play a part in choice behavior as options should be evaluated independently of one another,

leading to stable preferences among options regardless of the introduction of additional alternatives (Luce, 1977). However, the decoy often results in a preference shift for the original options (away from indifference or an increase/decrease in the preference for one of the original options; Huber, Payne, & Puto, 1982). The decoy effect has been studied extensively within behavioral economics, with a considerable amount of research concerning consumer decision-making scenarios among human adults (e.g., Doyle, O'Connor, Reynolds, & Bottomley, 1999; Huber et al., 1982; Parducci, 1965; Pettibone & Wedell, 2000; Wedell, 1991; Zhang & Zhang, 2007), as well as mate preference (Sedikides, Ariely, & Olsen, 1999) and political elections (Herne, 1997; Pan, O'Curry, & Pitts, 1995).

The decoy effect also has been documented among a wide variety of nonhuman animals, beginning with compelling work with starlings (*Sturnus vulgaris*: Bateson, 2002) and hummingbirds (*Selasphorus rufus*: Bateson, Healy, & Hurly, 2002), and extending to honeybees and gray jays (*Apis mellifera* and *Perisoreus canadensis*: Shafir, Waite, & Smith, 2002), cats (*Felis catus*: Scarpi, 2011), and primates (*Cebus apella*: Cohen & Santos, 2017; *Macaca mulatta*: Parrish, Evans, & Beran, 2015). For example, Shafir et al. (2002) documented preference shifts in a foraging task with honeybees and gray jays that were presented with binary (2-alternative) choices versus trinary (3-alternative) choice options that contained a decoy alternative. Bees, for instance, were presented with artificial flowers that varied on two dimensions: sucrose volume (i.e., preferred food type) and flower tube length (i.e., effort expenditure to obtain sucrose). The binary choice set presented a 40 mm tube/2 μ l sucrose flower versus a 50 mm tube/3 μ l sucrose flower. Half of the bees experienced decoy flowers that were dominated based on tube length (100 mm tube/3 μ l decoy flowers were dominated by the original 50 mm tube/3 μ l flower) and half of the bees experienced decoy flowers that were

dominated based on sucrose volume (40 mm tube/1 μ l decoy flowers were dominated by the original 40 mm tube/2 μ l flower). The bees' relative preference between the two original flowers was altered such that there was a greater proportion choice behavior for the option that was most similar to the decoy (e.g., the original 50/3 flower was chosen at a higher rate than the original 40/2 flower when the 100/3 decoy flower was introduced). Similar effects were documented for jays in which preference for a target option was increased following the inclusion of a decoy option that was dominated on one of two dimensions. Thus, the bees' and jays' choice options were not valued independently of the alternative choices; decisions were seemingly made upon a comparative basis in which both preferred choices and non-preferred alternatives (i.e., the decoy) shaped the insects' and birds' choice behavior. Different tasks have been developed in the comparative literature that vary how choices are presented, providing substance to the argument that decoy effects are far-reaching, emerging across a variety of contexts and among a diverse group of species. Such comparative evidence indicates that context effects have been at work in choice behavior well before the evolution of modern humans and likely plays a widespread role in decision-making.

In our own work investigating choice behavior among primates, we presented rhesus macaques (*Macaca mulatta*) with a computerized perceptual discrimination task to investigate the decoy effect as the first study to assess this phenomenon among a non-human primate species (Parrish et al., 2015). We were interested in whether decoy effects might emerge using a relatively simple perceptual choice task modified from the human literature (Trueblood, Brown, Heathcote, & Busmeyer, 2013), which would provide support for the idea that these decisional biases are early emerging, quickly generated, and widespread across species and contexts. When presented with a size-judgment task, monkeys successfully discriminated two rectangles that

varied in size and orientation (horizontally or vertically oriented). Monkeys performed well in the baseline binary task, successfully choosing the larger of two rectangles across a variety of different difficulty levels in terms of size discrepancy. When introduced with a third rectangle smaller in size than both rectangles, monkeys rarely chose this inferior ‘decoy’ option. However, their performance in selecting the largest rectangle from the remaining two choices during these probe trials was increased relative to baseline when the decoy was oriented in the same direction as the largest rectangle (e.g., both the decoy and largest rectangle were horizontal, increasing its likelihood of selection). Alternatively, if the decoy rectangle’s orientation was incongruent with the truly largest rectangle, performance suffered (e.g., both the decoy and second-to-largest rectangle were horizontal, increasing likelihood of selection of the latter). These comparative results from Parrish et al. (2015) indicated that rhesus monkeys responded similarly to decoy stimuli in a perceptual discrimination task as human adults (Trueblood et al., 2014). The use of this version of a perceptual decoy paradigm also highlighted that context effects of this nature are not exclusive to complex decision-making, such as consumer choice behavior or political elections, or to inherently valuable and prepotent stimuli common for comparative tasks, such as choices among appetitive food options. Rather, such decoy effects emerge within a wide range of contexts and across a variety of species.

In the current study, we extended these findings to a different kind of assessment of the decoy effect. Here, we used choice options and decoys that were not perceptual or appetitive. Rather, we gave monkeys choices between computerized tasks that they could perform with decoy choices sometimes presented to see how those inferior alternatives affected the relative preference among non-decoy options. In this paradigm, the tasks were represented by visual icons, which the monkeys could select to indicate their task preference. All tasks varied on

multiple dimensions including effort to obtain reward outcomes. Importantly, the emergence of the decoy effect among the same species across paradigms (i.e., from a basic, early-emerging perceptual level to a more complex and multi-faceted decisional task) would shed light on the degree to which decisional biases impact choice behavior in a variety of settings and across a range of cognitive complexity.

This new task also assesses whether representational or symbolic decoy effects occur in other species. In fact, many examples of human decoy effects occur among choice options that contain symbolic representations rather than being choices directly comparable in terms of perceptual features (e.g., abstract policy decisions when comparing potential political candidates or comparisons of price and quality such as when one compares potential car purchases rather than rectangle width and height). Thus, for humans, decoy effects occur “early” in decision-making, at the level of perceptual experience, but also “later” in terms of evaluating options on the basis of non-perceptual factors (see Trueblood et al., 2013). Such evidence would indicate that decisional biases for representational stimuli are not reliant on language, culture, or any human-specific factors, and likely are evolutionarily ancient, preserved, and perhaps even widespread among other species.

In the current task, monkeys were presented with several task types (each represented by a unique icon) that varied in effort expenditure (to complete a trial). After learning to associate each icon with a specific task and its parameters, and ensuring that monkeys showed reliable preferences among those tasks, we introduced decoy icons. The tasks associated with these decoy icons were objectively inferior to the original task type in terms of being more difficult and thus requiring more effort to complete trials. Using this choice paradigm, we measured preference behavior and subsequent shifts in preferences by presenting monkeys with the option

of completing one of two or three tasks (binary choice set vs. trinary choice set). We predicted that the presence of the decoy task option in the trinary choice set would impact choice behavior, such that an asymmetrically dominated option (i.e., one that is rarely selected itself) would lead to overall higher preferences for the similar non-decoy task.

We established a context for potential decoy effects during computerized tasks by making use of the SELECT experimental procedure employed in our laboratory where monkeys have learned to use a joystick to control a cursor on the computer screen. Washburn, Hopkins and Rumbaugh (1991) originally described the SELECT procedure. They presented rhesus macaques with a choice among different icons on a computer screen, and each icon represented a different experimental task. They varied the parameters to generate objectively easier or more difficult tasks to see if monkeys would learn to use the icons to show preferences for tasks. Monkeys learned these icons, and established predictable, reliable, and stable choice patterns among tasks. Washburn et al. (1991) also found that the use of the SELECT framework for testing monkeys produced other interesting outcomes. For example, monkeys performed better on some tasks when they had chosen them (i.e., choice trials) than when the same tasks were simply assigned to them (i.e., forced trials). Later work replicated and extended this result with capuchin monkeys (*Cebus apella*; Beran, Klein, Evans, Antworth, & Chan, 2007). Beran et al. (2007) reported that monkeys again showed improvements on some tasks when they could choose task order rather than have tasks presented in random order, or even in an order that matched their own preferences but was still determined by the software rather than through the monkeys' own choices (also see Perdue, Evans, Washburn, Rumbaugh, & Beran, 2014).

This SELECT paradigm lends itself well to assessing potential decoy effects in terms of choice behavior and preference shifts, thus its use in the present study. We first trained monkeys

to associate four icons with two versions of two different tasks. One task was a psychomotor task called PURSUIT that required the monkeys to track a moving target with their cursor, and then maintain contact with that moving target. The other task was an identity matching-to-sample (MTS) task that required selecting a visual stimulus from two options that matched a presented sample image. These two tasks are well-known games for these monkeys, but we also manipulated each to attempt to generate a favored version and an objectively inferior or dominated (decoy) version in terms of effort. For the PURSUIT task, the decoy version increased the duration of required continued contact with the moving target, making the task harder. For the MTS task, we greatly slowed the speed of the cursor in the decoy version, so that the monkeys had to work longer to make the same matching response for the same food reward compared to the non-decoy version of MTS. Thus, the decoy version of each task required a greater degree of effort to complete a trial, making each decoy objectively less rewarding.

First, monkeys gained experience with each task (normal version and decoy version) and its SELECT icon by being presented with only one choice icon, and then one trial of the task associated with that icon. These icons were interspersed and randomly presented across the first four trials of each block of 10 training trials. Thus, all icons and their associated tasks were experienced to an equivalent degree. Then, in the last six trials of each 10-trial block in training, monkeys were given the MTS and PURSUIT icons to choose between. Monkeys remained in the training phase until they showed choices that were not extreme for one or the other of these icons and tasks (MTS or PURSUIT). Finally, in the test phase, MTS and PURSUIT were presented as the two choices, as were each of those tasks with their respective decoy versions. The crucial test trial types were those in which MTS and PURSUIT were options along with one of the two decoy icons. Here, the prediction was that monkeys would increase their relative choice of the

PURSUIT task to the MTS task when the PURSUIT decoy was present, but increase their relative choices of the MTS task when the MTS decoy was present. This pattern would reflect the decoy effect, and would highlight that this effect occurs in nonhuman species even in contexts in which the decoy stimuli are representations for subsequent tasks that the monkeys still had to perform.

In addition to the manipulations that would let us assess decoy effects, our use of the SELECT task allowed us to further study these monkeys' preferences for tasks that vary in the dimensions of effort and outcome. Although not a central feature of the design, such data also are informative and will reflect another benefit of the SELECT task in assessing monkey preferences.

Experiment 1

Method

Participants. We tested seven adult male rhesus monkeys between the ages of 13 and 34 years. All monkeys previously had been trained to use the computerized apparatus and they had extensive experience with the MTS and PURSUIT tasks (Evans, Beran, Chan, Klein, & Menzel, 2008; Richardson, Washburn, Hopkins, Savage-Rumbaugh, & Rumbaugh, 1990), including in tests in which the SELECT procedure was used (Beran et al., 2007; Perdue et al., 2014). Monkeys had access to the computer in test sessions that typically ranged from 4 to 8 hours during which time the software program was available onscreen. They could engage with the computerized apparatus as they chose, and they otherwise rested or engaged with other enrichment in their enclosure throughout these sessions. Monkeys always had access to water, and were given a daily meal each afternoon independent of whether and how much they worked

206 on the computer task. Monkeys also spent time each week with outdoor access during which
207 time they did not work on computerized tasks.

208 **Apparatus.** The monkeys were tested using the Language Research Center's
209 Computerized Test System, which consisted of a personal computer, digital joystick, color
210 monitor, and pellet dispenser (Evans et al., 2008; Richardson et al., 1990). Monkeys manipulated
211 the joystick with their hands so as to move a cursor onscreen during tasks. Monkeys earned 94-
212 mg banana-flavored chow pellets as food rewards (Bio-Serv, Frenchtown, NJ), and those pellets
213 were delivered via a pellet dispenser that was connected to the computer. The software for the
214 tasks was written in Visual Basic 6.0.

215 **Design and Procedure**

216 *Task Descriptions*

217 *PURSUIT task.* In this task, monkeys moved the cursor onscreen using their joystick to
218 capture a moving target (see Figure 1). At the start of each trial, the cursor appeared at a random
219 position on the monitor screen, and a green circle (called the target) also appeared randomly on
220 the screen. Deflection of the joystick in any direction by the monkey led to simultaneous
221 movement of the cursor and the target. When the cursor entered the target, the target changed
222 color as long as the cursor remained inside of it. When the target reached an edge of the screen, it
223 reversed direction in such a way that it appeared to bounce off the edge of the screen. If the
224 monkey stopped moving the cursor when the cursor was not in the target, the target also stopped
225 moving. But, if a monkey stopped moving the cursor when the cursor was inside of the target,
226 the target would keep moving, and the cursor would lose "contact" with it. After two minutes, if
227 the monkey did not successfully track the target for the full duration, the trial ended.

For the non-decoy version of the task, the monkey initially had to maintain contact of the cursor inside the target for 1 second to generate a 1-pellet food reward, a melodic tone, and then return to the SELECT screen. For the decoy version, the monkey had to maintain contact inside the target for 5 seconds, and received a 1-pellet reward and the melodic tone. If necessary, the parameter of contact duration was adjusted at the end of sessions (see below for details).

MTS Task. In this task, monkeys moved the cursor to a sample clip-art stimulus presented in the center of the screen, at which time two comparison clip-art stimuli were presented in the top left and top right corners of the screen. The sample also remained present onscreen (see Figure 1). One of the two comparison stimuli was identical to the sample and was the correct choice. If the correct stimulus was contacted with the cursor, the monkey received a single food pellet and melodic auditory feedback. An incorrect response (i.e., contact with the non-matching stimulus) resulted in a time-out penalty of 5 s and buzzing auditory feedback. After two minutes, if the monkey did not select a match option, the trial ended.

In the non-decoy version of the MTS task, initial movement of the cursor to one of the two matching options took approximately 1 second of continuous joystick deflection to complete, whereas in the decoy version of the task, it took a minimum of 5 seconds to make the same response. If necessary, this parameter of cursor speed was adjusted (see below for details).

SELECT Task Training and Testing

The task was a modified version of the SELECT task that had previously been presented to monkeys at the LRC (e.g., Beran et al., 2007; Washburn et al., 1991). In this modified version, four arbitrarily designated icons were used to represent the four tasks, and they could appear in any of four locations to the left, right, top or bottom center of the screen (see Figure 1). These

icons were novel to the current task, thus the monkeys could not have memorized the presented task icons from previous studies. Each session occurred in four phases:

Training phase. This phase consisted of blocks of 10 trials. Within each block, the first four trials consisted of presenting only one icon to the monkey. Within these four randomly arranged trials, one trial was a forced MTS trial, one trial was a forced PURSUIT trial, one trial was a forced decoy-MTS trial, and one trial was a forced decoy-PURSUIT trial. These trials were designed to train the monkeys to associate each icon with each specific task. For the remaining six trials in each block, the monkey was presented with two icons, and the monkey had to choose one of those icons to then be given the associated task. This comparison was MTS vs. PURSUIT. The resulting data from those trials constituted the baseline preference for each monkey for each of these two tasks.

After a block of 50 choice trials (MTS vs. PURSUIT) was presented, the program assessed whether a monkey showed an extreme selection bias for the MTS task over the PURSUIT task or vice versa. If either icon was selected on more than 80% of the trials in this comparison, the program modified the task parameters for the next block. If parameters needed to be adjusted because of extreme preferences for the PURSUIT icon over the MTS icon, we then increased how long contact had to be maintained inside the PURSUIT target to generate the 1-pellet food reward, as well as slowing the cursor in the decoy-PURSUIT task. If parameters needed to be adjusted because of extreme preferences for the MTS icon over the PURSUIT icon, we slowed the cursor in the MTS task so that it took longer to complete those trials, and we also slowed the cursor equivalently in the decoy-MTS task. In this way, we could vary parameters across sessions to ensure that we found levels at which neither PURSUIT nor MTS was too strongly preferred relative to the other task. Monkeys advanced to the test phase in a session only

when they completed a block of 50 MTS vs. PURSUIT trials without an extreme preference for one task over the other. If a monkey was still in the training phase when a session ended, the monkey continued at those parameters in the next session.

Test phase. The test phase consisted of 250 trials of each of the five trial types: MTS vs. decoy MTS, PURSUIT vs. decoy-PURSUIT, MTS vs. PURSUIT, MTS vs. PURSUIT vs. decoy-PURSUIT, and MTS vs. decoy-MTS vs. PURSUIT. These last two trial types were given to assess possible decoy effects. In these trials, three icons were presented including the MTS and PURSUIT icons and either the decoy-MTS icon or the decoy-PURSUIT icon. Each of these five trial types was presented once in each block of five trials.

The experiment ended after 250 test trials of each type were completed. If a monkey did not complete these trials all in one session, the monkeys were given another session the next day, or as soon as they were available again for testing.

Proposed Analyses

We will report qualitative information about the single icon phase of the experiments. Given the small sample size, we will report for each monkey the mean trial durations for the PURSUIT and PURSUIT decoy tasks. We will report the percentage of trials correct for the MTS and MTS decoy tasks.

The first formal analysis will be to compare choices among each of the paired icons in the training phase. First, we will report the overall choice percentages in each pair as well as how many trials were required for a monkey to progress to the test phase.

For data from the test phase, we will assess for each monkey the proportion of trials selecting the MTS icon and the PURSUIT icons as a function of whether the decoy is for MTS or PURSUIT. We will do this using a 3x2 Chi Square test for independence for each monkey and as

296 a function of session number. We also will compare the proportion of choices of the binary
297 versus trinary choices (i.e., compare the choices of the MTS task and the PURSUIT task when
298 those two icons were paired in the non-decoy trials to the proportions of choice of those icons
299 when each decoy also was presented), to determine if the presence of a decoy affected the
300 relative choice preferences for the two non-decoy tasks.

301 Finally, as a partial replication of previous research (Beran et al., 2007; Washburn et al.,
302 1991), we will examine performance for each monkey on trials in the training phase that
303 occurred after only a single icon was offered (Forced trials) and when two icons were offered
304 (Choice trials) to determine if monkeys performed better at tasks they chose to complete in
305 choice trials compared to those that were, in essence, assigned to them without a choice in forced
306 trials. We will do this at the group level using paired t-tests for mean target capture durations in
307 the PURSUIT task and percentage of trials correct in the MTS task. We also will analyze this for
308 each monkey using non-parametric tests such as those outlined above.

309 **Expected Outcomes and Implications**

310 We expect that monkeys will show significant preferences for each non-decoy task over
311 its related decoy version. This is a critical outcome necessary for publication of these results and
312 all subsequent analyses. In essence, this result highlights that monkeys recognize the inferiority
313 of decoy choices to the options that they otherwise resemble in terms of task parameters and
314 goals.

315 The central question was whether decoy icons would serve to produce decoy effects in
316 the form of changing preferences of monkeys for tasks they were highly familiar with
317 performing. The “classic” decoy effect occurs when an inferior but related option, which is
318 dominated by one of the other two options in terms of rarely being chosen itself, comes to make

that other similar option more appealing in relation to a third option than when a decoy is not present. In our task, this means that a decoy effect occurred if presence of the MTS decoy icon resulted in a higher likelihood of the monkeys selecting MTS over PURSUIT whereas a PURSUIT decoy icon led to a higher likelihood of monkeys selecting PURSUIT over MTS. Such an outcome would show that for monkeys, like humans, a non-preferred, rarely selected choice impacts how individuals evaluate other relative choice options.

In addition, our task allows us to quantify the impact of the decoy effect on subsequent performance patterns, if it is present, by examining performance with and without decoy icons as options during the SELECT phase. The MTS vs. PURSUIT trials serve as baseline preference measures against which the decoys can be evaluated. We predict a significant effect of decoys on choice behavior, and such an outcome would highlight a psychological continuity among primate species for this type of well-known framing effect in behavioral economics. This framing effect would occur for choices that are made among stimuli other than food items, and choices that are not perceptual in nature but are conceptual and symbolic (i.e., each icon has an established degree of preference based on what it leads to, in terms of the task the monkey performs to ultimately have the chance to earn food reward).

Finally, we predict that we will replicate past research showing that choice behavior can affect subsequent task performance. By comparing trials with and without choice over what task will be completed, we can determine if these monkeys benefit (in terms of accuracy and response time efficiency) from having the option to choose what task they perform next relative to when they cannot choose the task. If such an effect is replicated, we can discuss the implications for such cognitive tests as these when used with nonhuman animals, as well as to integrate the effect

341 of choice and the decoy effect with regard to broader commentary on the nature of studying
342 choice behavior across species.
343

References

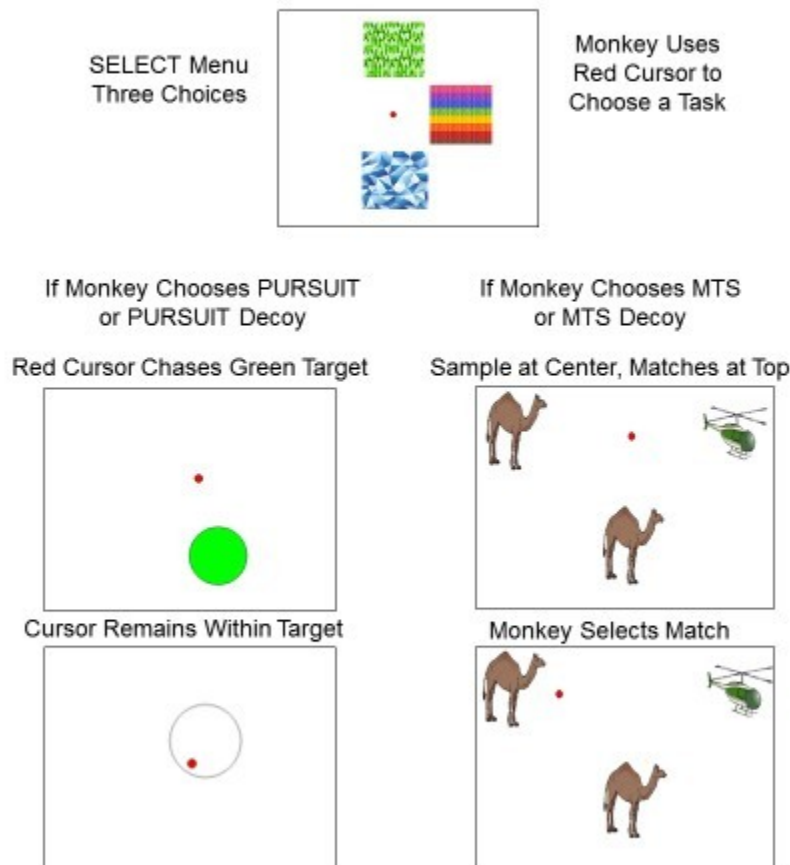
- 344
345 Bateson, M. (2002). Context-dependent foraging choices in risk-sensitive starlings. *Animal*
346 *Behaviour*, 64, 251–260.
- 347 Bateson, M., Healy, S. D., & Hurly, T. A. (2002). Irrational choices in hummingbird foraging
348 behaviour. *Animal Behaviour*, 63, 587–596.
- 349 Beran, M. J., Klein, E. D., Evans, T. A., Antworth, R., & Chan, B. (2007). Perceived control,
350 motivation, and task performance in capuchin monkeys. In P. R. Zelick (Ed.), *Issues in*
351 *the Psychology of Motivation*. Hauppauge, NY: Nova Science Publishers.
- 352 Cohen, P. M., & Santos, L. R. (2017). Capuchins (*Cebus apella*) fail to show an asymmetric
353 dominance effect. *Animal Cognition*, 20, 331–345.
- 354 Doyle, J. R., O'Connor, D. J., Reynolds, G. M., & Bottomley, P. A. (1999). The robustness of the
355 asymmetrically dominated effect: Buying frames, phantom alternatives, and in-store
356 purchases. *Psychology & Marketing*, 16, 225–243.
- 357 Evans, T. A., Beran, M. J., Chan, B., Klein, E. D., & Menzel, C. R. (2008). An efficient
358 computerized testing method for the capuchin monkey (*Cebus apella*): Adaptation of the
359 LRC-CTS to a socially housed nonhuman primate species. *Behavior Research Methods,*
360 *Instruments, & Computers*, 40, 590–596.
- 361 Herne, K. (1997). Decoy alternatives in policy choices: Asymmetric domination and compromise
362 effects. *European Journal of Political Economy*, 13, 575–589.
- 363 Huber, J., Payne, J. W., & Puto, C. (1982). Adding asymmetrically dominated alternatives:
364 Violations of regularity and the similarity hypothesis. *Journal of Consumer Research*, 9,
365 90–98.
- 366 Huber, J., Payne, J. W., & Puto, C. P. (2014). Let's be honest about the attraction effect. *Journal*
367 *of Marketing Research*, 51(4), 520–525.

- 368 Luce, R. D. (1977). The choice axiom after twenty years. *Journal of Mathematical Psychology*,
369 15, 215-233.
- 370 Mishra, S., Umesh, U., & Stem, J. E. (1993). Antecedents of the attraction effect: An
371 information-processing approach. *Journal Of Marketing Research*, 30, 331-349.
- 372 Pan, Y., O'Curry, S., & Pitts, R. (1995). The attraction effect and political choice in two
373 elections. *Journal of Consumer Psychology*, 4, 85-101.
- 374 Parducci, A. (1965). Category judgment: A range-frequency model. *Psychological Review*, 72,
375 407-418.
- 376 Parrish, A. E., Evans, T. A., & Beran, M. J. (2015). Rhesus macaques (*Macaca mulatta*) exhibit
377 the decoy effect in a perceptual discrimination task. *Attention, Perception, &*
378 *Psychophysics*, 77, 1715-1725.
- 379 Perdue, B. M., Evans, T. A., Washburn, D. A., Rumbaugh, D. M., & Beran, M. J. (2014). Do
380 monkeys choose to choose? *Learning & Behavior*, 42, 164-175.
- 381 Pettibone, J. C., & Wedell, D. H. (2000). Examining models of nondominated decoy effects
382 across judgment and choice. *Organizational Behavior and Human Decision Processes*,
383 81, 300-328.
- 384 Richardson, W. K., Washburn, D. A., Hopkins, W. D., Savage-Rumbaugh, S. E., & Rumbaugh,
385 D. M. (1990). The NASA/LRC computerized test system. *Behavior Research Methods*,
386 *Instruments, & Computers*, 22, 127-131.
- 387 Scarpi, D. (2011). The impact of phantom decoys on choices in cats. *Animal Cognition*, 14, 127-
388 136.
- 389 Sedikides, C., Ariely, D., & Olsen, N. (1999). Contextual and procedural determinants of partner
390 selection: Of asymmetric dominance and prominence. *Social Cognition*, 17, 118-139.

- 391 Shafir, S., Waite, T. A., & Smith, B. H. (2002). Context-dependent violations of rational choice
392 in honeybees (*Apis mellifera*) and gray jays (*Perisoreus canadensis*). *Behavioral Ecology*
393 *and Sociobiology*, 51, 180–187.
- 394 Trueblood, J. S., Brown, S. D., Heathcote, A., & Busemeyer, J. R. (2013). Not just for
395 consumers: Context effects are fundamental to decision making. *Psychological Science*,
396 24, 901–908.
- 397 Washburn, D. A., Hopkins, W. D., & Rumbaugh, D. M. (1991). Perceived control in rhesus
398 monkeys (*Macaca mulatta*): Enhanced video-task performance. *Journal of Experimental*
399 *Psychology: Animal Behavior Processes*, 17, 123-129.
- 400 Wedell, D. H. (1991). Distinguishing among models of contextually induced preference
401 reversals. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 17,
402 767–778.
- 403 Zhang, T., & Zhang, D. (2007). Agent-based simulation of consumer purchase decision-making
404 and the decoy effect. *Journal of Business Research*, 60, 912-922.
- 405

406

Figures and Captions



407

408 *Figure 1.* A schematic outline of the task. Monkeys first saw the panel at top, in which the
 409 SELECT menu offered them one, two, or three icons to choose from. In this example, the icon
 410 for PURSUIT is at bottom, the icon for MTS is at top, and the icon for decoy-PURSUIT is at
 411 right. If the monkey chose the icon for PURSUIT or decoy-PURSUIT, the task progressed as
 412 shown in the left column. If the monkey chose the icon for MTS or decoy-MTS, the task
 413 progressed as shown in the right column. At the end of each trial, the SELECT menu reappeared
 414 with the icons, which were randomly assigned to any of the four locations around the cursor's
 415 start location.

416

417