Further investigation of the Monty Hall Dilemma in pigeons and rats

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ABSTRACT

In the Monty Hall Dilemma (MHD), three doors are presented with a prize behind one and participants are instructed to choose a door. One of the unchosen doors not containing the prize is revealed, following which the participant can choose to stay with their chosen door or switch to the other one. The optimal strategy is to switch. Herbranson and Schroeder (2010) found that humans performed poorly on this task, whereas pigeons learned to switch readily. We found that pigeons performed only slightly better than humans and that pigeons stayed nearly exclusively when staying and switching were reinforced equally and when staying was the optimal strategy (Stagner et al., 2013b). In Experiment 1 of the present research, rats were trained under these same conditions to observe if possible differences in foraging strategy would influence performance on this task. In Experiment 2, pigeons were trained in an analogous procedure to better compare the two species. We found that both species were sensitive to the overall probability of reinforcement, as both switched significantly more often than subjects that were reinforced equally for staying and switching or reinforced more often for staying. Overall, the two species performed very similarly within the parameters of the current procedure.

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1. Introduction

Further Investigation of the Monty Hall Dilemma in Nonhumans: The Monty Hall Dilemma (MHD) has been of interest to both researchers and the general public largely because humans consistently fail at using the optimal strategy to perform on this task. In the MHD, participants are given three alternatives to choose from, one of which contains a prize. After making their choice but not revealing what it is, the participant is shown that one of the unchosen alternatives does not contain the prize. The participant is given the opportunity to stay with his or her initial choice or switch to the remaining alternative. Switching will produce the prize 2/3 of the times because if the prize is one of either of the unchosen alternatives, the revealed alternative will always be the losing one. Thus, the game is biased because the host of the game knows where the prize is and will never reveal the winning door. Only if the prize was the alternative already chosen, will staying be better, but that will be only 1/3 of the time.

People tend to make the mistake of misjudging the probability of winning associated with staying and switching. That is, people do not see an advantage to switching to the remaining unchosen door because they perceive the odds to be 50% either way but the optimal strategy is always switch. Even when participants are given 50 trials with feedback they learn to switch only about 2/3 of the time (Granberg and Brown, 1995). Herbranson and Schroeder (2010) conducted a comparative study with humans and pigeons using the MHD. Humans were given 200 trials with feedback to observe whether even more experience with the task would increase participants' use of the optimal switching strategy, but instead they found a result very similar to that of Granberg and Brown (1995). However, even though pigeons showed a stronger initial bias to stay with their initial choice than human participants, they acquired the switching strategy and used it almost exclusively (95% of the time) after 30 sessions of training. Thus, it appears that although the initial stay bias is similar for the two species, only pigeons learned to consistently switch (Herbranson and Schroeder, 2010). Regarding the above human performance, Klein et al. (2013) found a very similar effect when they gave both humans and monkeys 500 trials of experience with the MHD task. They found great variability in performance between subjects and as a group, neither humans nor monkeys learned the optimal switching strategy.

When humans sometimes show a strong stay bias it might be related to an endowment or ownership effect (Thaler, 1980). That is, humans tend to believe that other things being equal, what they have chosen (for whatever reason) is better than the alternative (Granberg and Brown, 1995). Thus, once they have made an initial choice they tend to stick with it. To examine whether pigeons might

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be induced to show an endowment effect Stagner et al. (2013b) gave pigeons the same task as Herbranson and Schroeder (2010) but for one group they increased the effort required to make the initial choice. There is evidence that requiring greater effort to obtain stimuli associated with reinforcement results in a preference for those stimuli over stimuli that require less effort to obtain (e.g., Clement et al., 2000). However, pigeons required to peck 20 times to make their initial choice actually acquired the optimal switching strategy faster than those in the control condition that were only required to peck once, so no endowment effect was found.

Although Stagner et al. (2013a,b) found strong use of the switching strategy in pigeons, they did not replicate the exclusive usage of this strategy that Herbranson and Schroeder (2010) found; nor did Mazur and Kahlbaugh (2012). Much like Stagner et al. (2013b), Mazur and Kahlbaugh (2012) found that pigeons switched about 60% of the time at Session 30. Stagner et al. (2013b) continued training and found that their pigeons switched about 80% of the time after 80 sessions of training.

It may not be feasible to tease apart what makes the MHD a difficult task for human subjects, given their decision-making biases. However, nonhuman subjects provide a way to test different aspects of the MHD free of these influences. Recently, evidence has been found that rats show more behavioral flexibility and will alternate and switch choices more readily than pigeons (Rayburn-Reeves et al., 2013). This result was found after giving rats experience with a spatial midsession reversal-learning task. For the first half of a test session, one response lever would be correct. Midway through the session, responses to this lever were no longer reinforced and responses to the previously incorrect lever were reinforced. When given a similar task, pigeons' showed perseverative errors; that is they would continue to choose the first correct stimulus after it was no longer reinforced. Unlike pigeons, rats showed very little perseveration associated with the previously correctly lever and also, little anticipation of the reversal point in that there were few choices to the second lever before feedback was given that it was correct. Rats performed very well on this reversal learning task in which switching was a crucial part of optimal performance, whereas pigeons previously have shown difficulty switching (Cook and Rosen, 2010; Rayburn-Reeves et al., 2013; Stagner et al., 2013a).

The difference in the performance of this reversal learning task may be because rats have evolved a different foraging strategy from pigeons. Rats tend to deplete their food source in one feeding, while pigeons will return to the same patch of food many times before they deplete it. Thus, rats have a natural tendency to vary their choices whereas pigeons tend to return to the same location or stimulus (Olton and Samuelson, 1976). Additionally, rats are omnivores and are occasionally predators whereas pigeons are preyed upon in nature. Thus, rats appear to be better prepared than pigeons to shift to an alternative not recently chosen and that is why they may perform better on the MHD task. The goal of investigating the MHD with rats in the present study was to allow for testing free of human decision-making biases and previous experience that might interfere with human performance on this task. Another goal of the current experiments was to observe performance by rats on the MHD (Switch) task as well as two modified MHD tasks, one that will be referred to as the Stay condition in which staying was reinforced 67% of the time and another in which both staying and switching were equally reinforced 50% of the time (Control group). Additionally, the same three conditions were run with pigeons in order to allow for better comparison of the performance of the two species.

The Switch condition is analogous to the original MHD with regards to probabilities of winning associated with both staying and switching, if rats in this condition demonstrate the same ability to use local feedback cues from reinforcement and nonreinforcement following choice of staying or switching as has been previously observed in reversal learning, and they were able to assess probabilities over trials, rats should learn the optimal switching strategy readily. It was predicted that rats would perform better than humans and may also perform better than pigeons. Alternatively, rats may be less sensitive to the differences in the probability of reinforcement for staying and switching and like humans, show a variety of different behavioral patterns while attempting to maximize reinforcement.

In the Stay condition, if rats used local feedback cues and was able to assess the probability of staying and switching over trials, they should learn to stay with their initial choice. However, rats' natural tendency to alternate may make the task more difficult and thus it may take them longer to acquire the optimal stay strategy (Montgomery, 1952a,b). It is possible that rats will learn to stay with their initially chosen lever but will not perform as well as pigeons have on this task because pigeons have a natural tendency to stay (Mazur and Kahlbaugh, 2012).

In the Control condition, there would be no obvious advantage for staying or switching because reinforcement is the same for either response. The results of this condition will tell us if rats have a natural tendency to switch when they are not differentially reinforced for doing so. Stagner et al. (2013b) gave pigeons this same control task and found that pigeons chose to stay 65% of the time, even though there was no advantage for them to do so. This result supports the hypothesis that pigeons have a bias to stay with their initial choice. Rats, on the other hand, may show a propensity to switch, even though it perhaps would require a bit of additional effort to move from lever to lever when there is no additional incentive to do so.

In order to test for any differences in performance between the control and stay groups, a planned comparison will be run in which any significant difference between the two will be evident. Additionally, a planned comparison will be run to test for significant differences between performance of the switch group and the stay and control groups combined. It is predicted that the control and stay groups will not differ from one another significantly, but that the switch group will perform significantly better than the two other groups.

2. Experiment 1

2.1. Method

2.1.1. Subjects

Subjects were 13 albino rats (*Sprague-Dawley*) from 12–14 weeks old, obtained from another laboratory on the university campus (Lexington, KY). The rats were maintained on a feeding schedule that allowed for continued growth but also did not impact their level of motivation throughout the experiment. Specifically, the standard growth curve from Taconic was used to ensure that each subject was obtaining enough food each day between their experimental session (around 2.5 g) and the amount given after their session was completed (roughly 13–15 g). They were housed during the day consistently in either pairs or sets of three. They were individually housed overnight in polystyrene cages with free access to water in a colony room maintained on a 12-h/12-h light/dark cycle. They were single housed over night to allow for measurements of each individual rat's overnight food consumption. The rats were maintained in accordance with a protocol approved by the Institutional Animal Care and Use Committee at the University of Kentucky.

2.1.2. Apparatus

The experiment was conducted in a standard rodent operant chamber (Coulbourn Instruments, Lehigh Valley, PA) measuring