Animal procrastination: Pigeons choose to defer experiencing an aversive gap or a peck requirement

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Published online: 16 December 2019
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Abstract

When humans procrastinate, they delay completing a required relatively aversive task. In the present experiments with pigeons, we considered the possibility that completing the task close to the deadline results in the formation of a stronger conditioned reinforcer. In Experiment 1, pigeons were given a choice between two chains: (a) a signaled long period, followed by a dark gap, followed by a signaled short conditioned reinforcer, and food and (b) a signaled short period, followed by a dark gap, followed by a signaled long conditioned reinforcer, and food. We found a reliable preference for the delayed gap. In Experiment 2, we let pigeons choose between two chains: (a) walking to a near panel to peck a key, followed by a long walk to peck a key for reinforcement and (b) walking to a far panel to peck a key followed by a short walk to peck a key for reinforcement. When a single peck was required to either key, the pigeons were indifferent. When ten pecks were required to the near key but only one peck to the far key, the pigeons preferred the far key. When ten pecks were required to either key, the pigeons preferred the far key. The results of both experiments suggest that pigeons prefer to defer a relatively aversive event but, in keeping with Fantino's Delay Reduction Theory, this effect may result from the development of a strong conditioner reinforcer that occurs when the event (the gap or required pecking) comes close to reinforcement.

Keywords Procrastination · Conditioned reinforcer · Delay-reduction theory · Pigeons

Introduction

The hyperbolic delay discounting function can be used to account for several examples of suboptimal choice. For example, humans will acquire considerable debt on a credit card that requires additional fees for the privilege of acquiring possessions sooner. Similarly, rats and pigeons will choose a small amount of food if it comes sooner over a larger amount of food for which they must wait. Delay discounting can also be applied to aversive tasks, but the effects generally are opposite. When applied to an aversive task it often appears as the greater aversiveness attributed to the sooner completion of the task (Steel & König, 2006). That is, the reward associated with task completion early may have lower value than when it can be deferred.

Several models of human procrastination have been proposed including temporal motivation theory (Steel & König,

2006), cumulative prospect theory (Tversky & Kahneman, 1992), and drive theory (Dollard & Miller, 1950). In all cases, motivation to complete a task increases as the deadline or target approaches. In the case of procrastination, the motivation often takes the form of increasing anxiety (McGown & Johnson, 1991) with the passage of time. An oversimplified model of human procrastination can be described as

$$\text{Procrastination} = \frac{\text{Task aversiveness} \times \text{Delay}}{\text{Reward} [\text{task completion}] \times \text{Anxiety}}$$

For a given task, Reward and Task aversiveness are constants, delay is the time between assignment of the task and the deadline, and anxiety resulting from the possibility of punishment for missing the deadline increases with time. Thus, for a given individual, the greater the reward for task completion and the greater the rate of increase in anxiety with the possibility of failure to complete the task, the sooner action will begin. However, action is deferred by the aversiveness of the task and the time to the deadline. A simplified visual depiction of this model appears in Fig. 1. We propose, however, that as the deadline approaches, conditioned reinforcement may provide an alternative account of the tendency to defer events such that they come closer to the deadline.

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Fig. 1 Traditional model of procrastination: Task aversion is relatively constant. Anxiety builds up as the deadline approaches. Relief from anxiety increases the closer task completion is to the deadline

When attempting to understand human behavior, a top-down approach is often used. Researchers first identify the behavior and then try to analyze its various components. When it comes to attempting to understand the behavior of other animals, however, a bottom-up approach is more typical. One often starts with basic principles of learning to determine if one can account for the behavior.

Imagine that an animal is trained on a task in which a particular response is required for reinforcement and the animal can choose to make the response early or wait to make the response later, but it will not affect the time to reinforcement. Considering the principle of delayed reinforcement (e.g., Catania, 1979; Kimble, 1961), one might expect the response closest to reinforcement to be strengthened, so behavior that looks like procrastination might be expected. Viewed from the perspective of the development of a conditioned reinforcement, a preference for a late rather than an early response might be anticipated.

When Mazur (1996) gave pigeons a choice between making a peck requirement early and making it late, he found that they preferred making it late. In Mazur's procedure, however, the period before the peck requirement provided intermittent reinforcement. That is, the peck requirement interrupted the food-associated cue. Consequently, the pigeons preferred to defer the offset of a conditioned reinforcer.

Fantino's (1969) delay-reduction theory may provide a better model. It suggests that signals for reinforcement become conditioned reinforcers to the extent that they predict reinforcement better when they are present than when they are absent (see also Fantino, Preston, & Dunn, 1993). The closer that the onset of a cue is to reinforcement, the better that it predicts reinforcement. In the case of procrastination, however, since the total time to the deadline would be the same whether one made the required response early or procrastinated and made the response later, it may not be obvious that the shorter stimulus would be preferred because one would have to wait a longer time to make the response. Because delay reduction theory gives less weight to cues that are farther from

reinforcement, however, the longer interval farther from reinforcement should not have as negative an effect as the long interval closer to reinforcement. Thus, delay reduction theory should predict that the long-short interval would be preferred over the short-long interval, with the same overall delay to reinforcement.

To test this prediction, Zentall, Case, and Andrews (2018) gave pigeons a choice between two chain schedules. In one chain, color A signaled a relatively long interval, followed by color B that signaled a relatively short interval, followed by food. In the other chain, color C signaled a relatively short interval, followed by color D that signaled a relatively long interval, followed by food. The intervals were such that the total time to reinforcement was the same in both chains. As would be predicted from delay reduction theory, the pigeons preferred the long-short interval to the short-long interval. This result suggests that even in the absence of an aversive event, a short delay to reinforcement is preferred over a long delay to reinforcement, even if the pigeon must wait longer to receive it. This finding leads one to suggest that task completion shortly before the deadline may have greater *conditioned reinforcing value*.

However, the task used by Zentall et al. (2018) did not include an aversive event characteristic of procrastination. In the present research we asked whether pigeons would prefer to experience a mildly aversive event later, rather than earlier, in a sequence of events. What kind of event could serve as a mildly aversive event? McDevitt, Spetch, and Dunn (1997) found that preference for a conditioned reinforcer was greatly reduced if that conditioned reinforcer was delayed by 5 s, even if reinforcement did not occur any later. That is, it appears that inserting a dark gap into a stimulus-response chain is somewhat aversive. In Experiment 1, we attempted to replicate the preference for a long-short interval over a short-long interval found by Zentall et al. (2018) with the addition of a mildly-aversive, short (4-s) dark gap inserted between the initial link color and the terminal link color (see Fig. 2). Two other

small changes were made in this experiment. First, to strengthen the conditioned reinforcing value of the stimuli associated with the short intervals, the short interval was reduced from 5 s to 2 s. Second, to ensure that the total time from choice to reinforcement was the same for both alternatives, the initial and terminal link schedules were changed from fixed interval schedules (in which a peck was required) to fixed time schedules (in which pecking was not required).

Experiment 1

Subjects

The subjects were 12 unsexed white Carneau pigeons, 5–8 years old, purchased from the Palmetto Pigeon Plant, Sumter, South Carolina. All the pigeons had prior experience with simultaneous color discriminations. All the pigeons had free access to water and grit in a climate-controlled colony room that was maintained on a 12:12-h light/dark cycle. The pigeons were trained and tested during the light phase of the cycle. During the experiment, all pigeons were maintained at 85% of their free-feeding body weight and were cared for in accordance with the University of Kentucky's Animal Care Guidelines.

Apparatus

The experiment took place in a BRS/LVE (Laurel, MD, USA) standard sound-attenuating operant test chamber measuring 34 cm high, 30 cm wide, and 35 cm across the response panel. Three circular response keys (2.54 cm diameter) were horizontally aligned on the response panel (spaced 6.0 cm apart from edge to edge) and were located 25 cm from the floor. A 12-stimulus in-line projector (Industrial Electronics Engineering, Van Nuys, CA, USA) with 28-V, 0.1-A lamps (GE 1820) was mounted behind each of the three response keys to project white on the center key. The side keys projected red, yellow, blue, and green hues, as well as a white vertical line, and a white horizontal line on a black background. Reinforcement consisted of 1.5-s access to mixed grain (Purina Pro Grains, a mixture of corn, wheat, peas, kefir, and vetch) that was provided from a food hopper. A 28-V, 0.04-A lamp illuminated the hopper when reinforcement was delivered. A house-light (28-V, 0.04-A lamp) was mounted on the center of the ceiling of the chamber. Experimental events were controlled by a microcomputer and interface located in an adjacent room.

Procedure

Pretraining The pigeons were trained to peck the white stimulus on the center key and the other six stimuli on both side keys. Initially, one peck was required for reinforcement.

The schedule of reinforcement for responding to the four colors was then changed to fixed interval 5 s (FI 5 s, the first response after 5 s provided reinforcement). Once the pigeons were responding reliably, the pigeons began training on the chained schedules. To ensure that the pigeon was oriented between the two side keys at the start of each trial, all trials began with the white orienting stimulus on the center key. One peck to the white center key turned it off and turned on one of the side keys with either a vertical or a horizontal line (randomly in blocks of four trials without replacement). If the vertical line was presented, a single peck turned off the line and replaced it with a blue hue. Completion of an FI 5-s schedule (the first peck after 5 s) turned off the blue hue and replaced it with a yellow hue. Completion of an FI 5-s schedule turned off the yellow hue and provided the pigeon with reinforcement. If the horizontal line appeared, a single peck turned off the line and replaced it with a green hue. Completion of an FI 5-s schedule turned off the green hue and replaced it with a red hue. Completion of an FI 5-s schedule turned off the red hue and provided the pigeon with reinforcement. Each session consisted of 30 vertical-blue-yellow trials and 30 horizontal-green-red trials.

Training Once the pigeons were able to complete a session in 25 min or less, they were assigned randomly to two groups. For one counterbalancing group ($n = 6$), the FI schedule associated with the yellow stimulus and the green stimulus was increased to fixed time (FT) 10 s for one session and then increased to FT 15 s (on a FT schedule pecking is not required). In the same session, the schedule associated with the blue and red stimuli was shortened to FT 2 s. For the other counterbalancing group ($n = 6$), the FI schedule associated with the blue and red stimuli was increased to FT 10 s for one session and then to FT 15 s. In the same session, the schedule associated with the yellow and green stimuli was shortened to FT 2 s. In addition, a gap was inserted between the two colored stimuli on each trial. The gap was initially 1 s and was gradually increased to 4 s over the next four training sessions. The design of the experiment appears in Fig. 2. Each of 30 training sessions involved 30 vertical line trials and 30 horizontal line trials. During training, the lines and the colors that followed did not change sides from trial to trial.

Testing

On testing trials, a peck to the center white stimulus presented both line orientation stimuli, one on each side

Fig. 2 Design of Experiment 1: Choice of the left alternative presents a signaled short (2-s) interval, followed by a dark (4-s) gap, followed by a signaled long (15-s) interval, followed by reinforcement. Choice of the right alternative presents a signaled long (15-s) interval, followed by a dark (4-s) gap, followed by a signaled short (2-s) interval, followed by reinforcement

key. Each testing session consisted of 40 training trials (20 vertical-blue-gap-yellow and 20 horizontal-green-gap-red trials) and 20 testing trials. The training and testing trials were randomly presented in blocks of six trials (two of each type of training trial and two test trials). On testing trials, choice of either line extinguished the other line stimulus and resulted in the hue stimuli that followed that line during training. During testing, the lines and the colors that followed did not change sides from trial to trial. There were 25 testing sessions.

Data analysis

Choice data, pooled over the last five sessions of testing, were analyzed using a single-sample *t* test against chance (50%). Pecking rate to the four hues was also analyzed with a two-factor, repeated-measures analysis of variance with initial-link versus terminal-link and gap early versus gap late as factors. Because the schedules associated with the color stimuli were FT (no pecking was required), large individual difference in pecking were expected. To reduce the effect of those individual differences, for purposes of analysis we used the proportion of total pecks/s for each subject for each color.

Results

Choice

Acquisition of the choice preference as a function of training session appears in Fig. 3. Mean preference for the late gap was 73.9%. The preference was significantly different from chance (50%), $t(11) = 2.35$, $p = .04$, Cohen's $d = 1.37$.

Pecking

The proportion of total pecks/s for each of the links (initial link long, initial link short, terminal link long, terminal link short) appears in Fig. 4. Each of the pigeons pecked at each of the colors on at least some of the trials. The pigeons did not peck during the gap as the keys were dark and there was no houselight.

Analysis of the pecking data indicated that there was a significant difference between the proportion of pecks to the initial link stimuli (mean = .14) and pecks to the terminal-link stimuli (mean = .36), $F(1,11) = 18.07$, $p = .001$, Cohen's $d = 2.56$. But there was no significant difference in the proportion of pecking when the gap was early (mean = .24) versus late (mean = .26), $F < 1$, and there was no significant Initial-Terminal Link $\times$ Early-Late Gap interaction, $F(1,11) = 2.89$, $p = .12$, Cohen's $d = 1.03$. The initial-terminal link effect indicates that the pigeons pecked more at the terminal links than at the initial links. The absence of a significant interaction was surprising, however; pecking during the short terminal link was quite variable given that it was only 2-s long and it was preceded by a 4-s dark gap. Furthermore, the schedule did not require a response.

Fig. 3 Experiment 1: Choice of the late gap over the early gap over training sessions

Fig. 4 Experiment 1: Proportional peck rate to the four signaled intervals

Discussion

The results of Experiment 1 suggest that pigeons prefer to defer the potentially aversive 4-s gap. By an almost three to one margin, they preferred the long initial link followed by the gap and then the short terminal link prior to reinforcement over the short initial link followed by the gap and then the long terminal link and then reinforcement. The preference for the long initial link was almost 10% greater than that found by Zentall et al. (2018), who did not include a dark gap between the two signaled intervals. Although the rate of pecking the short terminal link stimulus was not significantly greater than the long terminal link stimulus, on average, the pigeons pecked it proportionally at almost twice the rate as the long terminal link.

The difference between the results of Experiment 1 and those of Zentall et al. (2018) was likely the insertion of a brief delay between the two links in each response chain; however, the difference in schedule between Zentall et al. (2018), FI, and the present Experiment 1, FT, may have contributed to the magnitude of the effect found.

In Experiment 1, the presumably aversive event that resulted in a preference to delay its occurrence was a dark gap. When individuals procrastinate, however, they delay engaging in behavior that requires some kind of response. One of the purposes of Experiment 2 was to include an operation that required subjects to make a response that could be made early or deferred to later.

Experiment 2

The present research, as well as earlier research (Zentall et al. 2018), was motivated by a paradoxical suboptimal finding with humans (Rosenbaum, Gong, & Potts, 2014). In the research with humans, subjects were asked to walk along a line

from a start line to an end line and pick up either one of two heavy buckets along the way. One bucket was about one-third of the way to the end line, the other bucket was about two-thirds of the way. Surprisingly, most subjects picked up the nearer bucket, which meant carrying the bucket further. The authors suggested that picking up the bucket represented a task subgoal and by picking up the nearer bucket, they could complete the subgoal sooner. They referred to this strategy as “precrastination.” Early subgoal completion may be an appropriate strategy, especially if the subgoal represents a cognitive memory load. For example, if one has several errands to run, it may be efficient to take care of the small ones early, especially if one may forget one of them. In the case of the bucket-carrying task, although forgetting to pick up the bucket is not likely, it may be that subgoal completion generalized from tasks in which forgetting *is* more likely.

The purpose of Experiment 2 was to use a procedure that combined some of the elements of Experiment 1 with some of the elements of the Rosenbaum et al. (2014) procedure. In Experiment 2, we had the pigeons walk between a start panel and a goal panel, but they had to peck a response key on one of two panels along the way (see Fig. 5 for a drawing of the apparatus). The question was would they prefer to peck the panel closer to the start panel (analogous to Rosenbaum et al.’s, 2014, human subjects) or to peck the panel closer to the goal as would be suggested by the pigeons in Experiment 1. According to delay reduction theory, pecking the response panel closer in time or distance to reinforcement should serve as a better conditioned reinforcer and therefore, should be preferred.

The experiment was conducted in three phases. In Phase 1, a single peck was required to the side panel key that was lit on each trial. In Phase 2, ten pecks were required to the key on the *near* panel but only one peck was required to the key on the *far* panel. The purpose of this change was to make the procedure more similar to that used by Rosenbaum et al. (2014) in which the effort required following a near choice was greater than the effort required following a far choice. In Phase 3, ten pecks were required regardless of which side panel was preferred. If the pigeons preferred to peck the far panel, it would suggest that the pigeons preferred to defer the key-pecking effort required. It would also suggest that the far panel side key response requirement might have served as a better conditioned reinforcer than the near panel side key response requirement.

Subjects

The subjects were six pigeons similar to those used in Experiment 1. All the pigeons had prior experience with simultaneous color discriminations. They were all cared for as described in Experiment 1.

Fig. 5 Design of the apparatus used in Experiment 2

Apparatus

The apparatus was a cage made from heavy-duty wire mesh. It was 3 m long x 1 m wide x 1 m high (see Fig. 5). Inside the cage were four three-key BRS/LVE (Laurel, MD, USA) response panels similar to those used in Experiment 1. One panel was centered at either end of the cage. One of the other panels was placed 1 m from one end of the cage on one side of the cage. The remaining panel was placed 1 m from the other end of the cage on the other side of the cage. Only the center key was used on the two side panels. Experimental events were controlled by a microcomputer and interface located in an adjacent room.

Procedure

Training The pigeons were trained to peck one of the side keys on one of the end panels, which lit a key on one of the side panels. A peck to the lit side key lit the center key on the far end panel and a peck to that key provided reinforcement. Once each pigeon had acquired the stimulus response chain, the end panel became the start panel for the next trial. Training continued until each pigeon was able to chain together 40 of these trials, constituting a training session. For half of the pigeons, the left key on the start panel (facing the panel) lit the key on the near panel (in both directions) and the right key on the start panel lit the key on the far panel. For the remaining pigeons, the right key on the start panel lit the key on the near panel and the left key on the start panel lit the key on the far panel. During training, the initial side key on the end panel that was lit was determined by a random permutation. Each pigeon received ten sessions of this forced-trial training.

Testing Testing sessions were similar to training sessions with the exception that in each block of four trials two of the trials were randomly chosen as choice trials. On choice trials, both side keys on the start panel were lit and the key that was chosen on the start panel determined the side panel on which

a key was lit. Each of the sessions consisted of 20 forced trials (ten near-panel and ten far-panel trials) and 20 choice trials.

In Phase 1 of testing, a single peck was required to the lit key that appeared on the side panel. Phase 1 consisted of ten testing sessions. In Phase 2 of testing, ten pecks were required to the lit key on the near side panel but only one peck was required to the lit key on the far side panel. Phase 2 consisted of ten testing sessions. In Phase 3 of testing, ten pecks were required to the lit key that appeared on whichever side panel was selected. Phase 3 consisted of 14 testing sessions.

Analysis

The mean choice of the far panel over the ten (or last ten) testing sessions was analyzed with a single sample *t*-test relative to chance (50%).

Results

In Phase 1, with a single peck required on the lit side key, the mean choice of the far panel, over the ten sessions of testing, was 46.6%. The preference for the far panel was not significantly different from chance, $t < 1$.

In Phase 2, with ten pecks required to the lit key on the near side panel but only one peck required to the lit key on the far side panel, the mean choice of the far panel, over the ten sessions of testing, was 79.3%. Acquisition of the preference for the far panel is presented in Fig. 6. The preference for the far panel was significantly greater than chance, $t(5) = 3.46$, $p = .018$, Cohen's $d = 3.09$.

In Phase 3, with ten pecks required to the lit key on either side panel, the mean choice of the far panel, over the last ten sessions of testing, was 74.2%. Maintained preference for the far panel appears in Fig. 7. The preference for the far panel was significantly greater than chance, $t(5) = 4.70$, $p = .005$, Cohen's $d = 4.20$, and not significantly different from the mean choice of the far panel in Phase 2, $t(5) = 1.43$, $p = .21$,

Fig. 6 Experiment 2: Phase 2. Percentage choice of the far panel over sessions. Pigeons could choose between the near panel, which they were required to peck ten times, and the far panel, which they were required to peck once

Cohen's $d = 1.28$. As can be seen in Fig. 7, there was little regular decline in the preference for the far panel over sessions.

Discussion

In Experiment 2, we tried to make the pigeons' task more similar to the task used by Rosenbaum et al. (2014) with humans by having pigeons walk from the start panel to the end panel after choosing which panel's response key they would be required to peck along the way, near or far from

Fig. 7 Experiment 2: Phase 3. Percentage choice of the far panel over sessions. Pigeons could choose between the near panel, which they were required to peck ten times, and the far panel, which they were required to peck ten times

the start. In Phase 1, when only a single peck was required, the pigeons appeared to be indifferent between the two response panels. In Phase 2, when the near panel required ten pecks, but the far panel required only one peck, the pigeons showed a clear preference for the far panel. In Phase 3, when both panels required ten pecks, the pigeons preferred the far panel.

The purpose of Phase 2 was to test the “precrastination” hypothesis (Rosenbaum et al., 2014) that pigeons would prefer to complete a subgoal early, even if it required additional effort. Nevertheless, a clear preference for the far panel was found. In Phase 3, when the response requirement to both the near and far panels was ten pecks, the pigeons still preferred the far panel. Although there may have been some carryover from the preference for the far panel in Phase 2 to Phase 3, the fact that there was no decline in preference over the testing sessions in Phase 3 suggests that the increase in response requirement to the far panel did not affect its preference. Thus, we confirmed that the pigeons showed a procrastination effect, as they did in Experiment 1 and in our earlier research (Zentall et al., 2018). The results of Phase 3 were also consistent with delay-reduction theory in showing that events (in this case pecking) closer to reinforcement were preferred over events further from reinforcement.

A perhaps important difference between the procedure used in Experiment 2 and that used by Rosenbaum et al. (2014) was that in the present procedure the pigeons had to commit to the near versus far panel at the start of the choice trial. The rationale for this procedure was to ensure that the pigeons were making a choice between the two intermediate panels. This was needed because during training, to give the pigeons equal experience with both of the intermediate panels, they were trained with only one of those panels available on each trial.

General discussion

The purpose of the present experiments was to investigate the relation between delay reduction theory, proposed by Fantino (1969) to describe the associative value of stimuli that predict reinforcement, and procrastination behavior, putting off the completion of a task that is somewhat aversive. When delay reduction theory is applied to procrastination, it views engaging in the task as a potential conditioned reinforcer because completion of the task should be reinforcing. And, when completion of the task comes shortly before the deadline, according to delay reduction theory it should become a better conditioned reinforcer and thus should be more reinforcing.

In Experiment 1 of the present research, we used a dark gap between the initial link and the terminal link as a mildly aversive event (see McDevitt et al., 1997) and found that the pigeons preferred to experience the dark gap later in the chain.

In Experiment 2, although the pigeons were indifferent between the near and far panels when only a single peck was required, they showed a clear preference for the far panel when ten pecks were required to the near panel (Phase 2), as well as when ten pecks were required to both the near or the far panels (Phase 3).

The results of both experiments are consistent with what one would call procrastination behavior in humans. Although the human motivation for engaging in the aversive activity has been proposed to be anxiety reduction (negative reinforcement), rather than the positive reinforcement that occurs for the pigeons, both would be expected to increase the motivation for task completion. Just as anxiety is expected to increase as the deadline approaches, and its reduction should be reinforcing, according to delay reduction theory, the value of the task (the conditioned reinforcer) should also increase as the reinforcement approaches. This raises a question about the mechanism responsible for human procrastination. Most people who procrastinate suggest that they would prefer to start on a task earlier but often they persist in procrastinating. From the perspective of delay reduction (basic learning) theory, what prevents procrastinators from showing better self-control may be the conditioned reinforcement that accompanies procrastination. According to this theory, working on the task, and especially completion of the task, just prior to the deadline becomes a stronger reinforcer than those same cues when they occur well before the deadline. These conditioned reinforcers may also account for the fact that procrastination may become a habitual behavior. If task completion that comes close to the deadline is additionally reinforcing, procrastination may be a habitual behavior that is especially difficult to modify.

Open Practices Statement All the data and materials are available from the first author at zentall@uky.edu

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