In the present paper, we explore a novel preparation for the study of animal choice behaviour designed to capture some aspects of naturally occurring patch exploitation. Although one can cast the problem of patch exploitation as a binary choice, naturally occurring patch-leaving decisions are inevitably asymmetric. We asked whether captive blue jays, Cyanocitta cristata, treat leaving and staying in the same way. To do this we factorially varied the delays associated with leaving and staying in a food patch. In addition, we manipulated our subject’s level of motivation (e.g. hunger) using prefeeding treatments. We found that hungry subjects came closest to our prediction of treating leaving and staying in the same way, but that less motivated subjects showed a pronounced and surprising bias in favour of leaving. We discuss the implications of results for experimental and theoretical studies and choice behaviour. We suggest that students of choice behaviour need to understand the sources of such biases because naturally occurring choice situations are seldom perfectly symmetrical.

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Behavioral ecologists often formulate hypotheses about the fitness consequences of choice. They might hypothesize, for example, that a male frog should prefer to call in the centre of a pond because this option will produce more matings. A basic premise of this approach is that the fitness consequences associated with alternative actions should control choice. Yet, one of the most striking results in studies of human choice behaviour is that context and situation matter, even when two choice situations offer economically equivalent alternatives. In studies of human choice behaviour these are often called framing effects (Tversky & Kahneman 1992; Kahneman & Tversky 2000), because they suggest that choice behaviour depends on how the investigator ‘frames’ the choice problem. Animals in nature must face situations that are ‘framed’ by their habitats and social environments in many different ways. Yet, we know relatively little about ‘framing’ effects for nonhuman animals, and the importance of context is just beginning to attract the attention of behavioural ecologists (see for example Marsh & Kacelnik 2002).

In this paper, we explore the properties of a novel choice situation that we designed to resemble the natural foraging problem of patch exploitation (Stephens & Anderson 2001). To understand the rationale behind our patch choice problem, we must first review more conventional approaches to the study of choice. Figure 1a shows a conventional binary, mutually exclusive choice situation (‘self-control’). In this situation, the subject waits for an interval \( t \) (called the intertrial interval), and then the apparatus presents a choice (e.g. between a red key and a green key). The animal indicates its choice, for example, by pecking one of the keys. In the most common situation, one choice leads to small amount of food after a short delay (the smaller-sooner option), and the other leads to larger amount after a somewhat longer delay (the larger-later option). Investigators frequently use this choice situation to study impulsivity or ‘self-control’, because an animal that chooses to wait for the larger option is said to show ‘self-control’ (Madden & Bickel 2001). Results for experimental and theoretical studies and choice behaviour. We suggest that students of choice behaviour need to understand the sources of such biases because naturally occurring choice situations are seldom perfectly symmetrical.

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At this point, the subject can choose whether to leave the patch the animal must wait time $\tau$ before obtaining a food delivery of size $a_2$. The reader will note many differences between our patch situation and the conventional binary choice situation, but the key similarity is that in both situations the animal chooses between options where the smaller time commitment yields less food. Our laboratory has compared the patch and self-control situations in several experimental studies (Stephens & Anderson 2001; Stephens & McLinn 2003; Stephens & Dunlap 2009). These studies consistently show that subjects (captive blue jays) perform better in the patch situation. Specifically, they obtain higher overall rates of food intake in the patch situation, while, in contrast, their impulsivity reduces their achieved intake rate in the more conventional binary, mutually exclusive choice situation (in several papers, our group has developed the connection between this result and animal impulsivity (Stephens & Anderson 2001; Stephens et al. 2004)). Figure 2 shows a simple way to recast the patch situation in terms of binary choice and compare it to conventional ‘self-control’ style studies of binary choice. Figure 2 standardizes our choice diagrams by starting and ending at the choice point (marked with a large X in Fig. 2), and shows the conventional self-control situation (a) and the alternative patch situation (b). In self-control the animal chooses between two options at the point indicated with the large X. One option, as we explained above, leads to a small amount of food after a short delay and the other option leads to larger amount of food after a longer delay. After selecting an option the animal experiences a common delay (the intertrial interval), and then the apparatus offers the same choice again at the second large X. Figure 2b shows the patch situation in the same format. The animal chooses between ‘leave’ and ‘stay’ at the large X, leaving leads to amount $a_1$ after a delay of $T_1$ and this brings the animal to the next choice point; if, however, the animal chooses to stay, it obtains amount $a_2$ after delay $T_2$ and then it obtains a second food delivery of $a_2$ after a further delay of $T_2$ before it returns to the choice point. This second food delivery arises because, as in natural patch exploitation, an animal that chooses to stay must ultimately leave to find a new patch.

One can draw several conclusions from this comparison of the patch and self-control preparations as binary choice problems. For example, we see that even though one can think of the patch situation as ‘binary’, it is a strongly asymmetric binary choice situation, with one option leading to two food deliveries and the other producing only one. In addition, one option is part of the
other. That is, the structure of the patch situation (and natural patch exploitation) imposes an asymmetry between the ‘leaves’ and ‘stays’ options. Here, we explore these asymmetries by directly comparing the effects of identical changes in delay in the leave and stay options in Fig. 2b. We tested the hypothesis that changes in leave and stay delays affect choice in the same way. This hypothesis might seem implausible given that the stay option leads to two food deliveries, while the leave option leads to only one. In the binary choice situation, however, evidence suggests that events after the first food delivery have little or even no effect on choice behaviour (Rachlin & Green 1972; Bateson & Kacelnik 1996).

Figure 2c, d shows this idea. According to this hypothesis, animals behave as if they only care about things that happen before the first food delivery so that they treat the situation in Fig. 2a as if it is the simpler situation in Fig. 2c, and so they should treat the more complicated situation in Fig. 2b (our patch situation) as if it is the simpler situation in Fig. 2d.

Our experiment uses two treatment conditions to test this hypothesis. In the ‘leave varies’ treatment, we hold the ‘stay delay’ constant (at 40 s) and vary the leave delay (testing four levels of delay), while in the ‘stay varies’ treatment, we do the reverse: holding the ‘leave delay’ constant (at 40 s) and varying the stay delay. Collectively, we call these ‘varied option’ treatments. To simplify the situation, subjects obtained the same amount of food regardless of whether they chose the leave or stay option ($a_1 = a_2$). This simplification means that subjects should choose the option with the smaller delay.

Hunger, Deprivation and Patch Exploitation

In addition to our ‘leave varies’ and ‘stay varies’ treatments, we varied our subject’s hunger level (via prefeeding manipulations). Our rationale for this manipulation was as follows. Although everyone recognizes that hunger can profoundly influence feeding behaviour, the effects of hunger on choice in the self-control situation vary widely (Logue & Pena-Correal 1985; Bradshaw & Szabadi 1992; Kirk & Logue 1997). Behavioural ecologists have commonly conceived of hunger as a measure of habitat richness (Charnov 1976; Stephens & Krebs 1986). Animals in rich habitats will be less hungry on average than animals in lean habitats. In the patch situation, however, the ‘leave’ component should affect the animal’s experience of hunger more strongly than the ‘stay’ component; because the forager experiences the consequences of the leave option in every cycle of patch exploitation (or in every trial, in experimental jargon). In contrast, the forager only experiences the consequences of ‘stay’ when it in fact stays. We might expect, therefore, a three-way interaction between delay, varied component and hunger.

Overall, then, our experiment followed a 2 x 2 x 4 factorial design: two levels of motivation (high and low); two levels of varied option (leave and stay); and four levels of delay (10, 25, 55 or 75 s).

METHODS

Subjects and Apparatus

Seven blue jays, Cyanocitta cristata, of unknown gender and mixed experimental histories (band numbers 14, 92, 51, 223, 21, 11 and 21) served as subjects. During testing and training we housed each subject in its own Skinner box. Figure 3 shows an overhead

Figure 2. Standardized diagrams of the (a) patch situation and (b) self-control situation (i.e. binary, mutually exclusive choice). The figure ‘standardizes’ the two situations by starting and ending at the choice point rather than at the beginning of the ‘trial’ as determined by the experimenter. We offer an interpretation of this standardization in the text. Results from the self-control preparation suggest that animals are often short-sighted in the sense that they ‘do not care’ about events after the first food delivery. This hypothesis is shown diagrammatically in (c) and (d), and holds that subjects ‘see’ the self-control situation (c) instead of the more accurate representation in (a).
view of the apparatus. We equipped each box with three perch levers, and we positioned a stimulus light above each perch. A microswitch attached to each perch reported the bird’s presence or absence to the central computer controlling the experiment. A computer program written in the MED-PC language (Med Associates, Burlington, VT, U.S.A.) recorded the birds’ behaviour and controlled the stimulus lights and food dispenser. We housed subjects in their experimental boxes 23 h per day.

**Treatments and Treatment Order**

In overview, the experiment followed a factorial design with 16 treatments: two levels of varied option (‘leave varied’ versus ‘stay varied’), two levels of ‘motivation’ (high and low feed-up) and four levels of delay (10, 25, 55 and 70 s). We used the following randomization scheme to determine the order of treatments. (1) We randomly selected half of the birds to experience the ‘low feed-up’ condition first, and the other half experienced ‘high feed-up’ first. Within each of these groups, we selected half of the birds to experience the ‘leave varies’ treatments first and half to experience the ‘stay varies’ treatments first. Within each of these groups, we randomized the order of the four delay treatments without restriction.

Subjects completed all of their high or low feed-up treatments before proceeding to the next level of feed-up treatments. To reduce weight changes during treatments we began each feed-up treatment with a neutral (leave delay = stay delay = 40 s) baseline treatment that we ran for 4 days before starting the real treatments for a given feed-up level. In each treatment (i.e. each combination of feed-up, delay and varied option) we tested each subjects for 600 free-choice trials. For the purpose of analyses, we divided these 600 trials into three blocks of 200 trials. In the Results section we report measurements for only the final 200 trials in each treatment, effectively allowing the subjects’ 400 trials to adjust to each new treatment.

**High- and low-motivation treatments**

To control our subject’s level of motivation, we controlled the amount of food they obtained each day. We calculated the amount of food required to maintain a body weight equal to 90% of their free-feeding or ad libitum body weights. We consider this to be a healthy normal body weight, because free-feeding birds in captivity are typically heavier than wild-caught birds. We use X00 to represent the ration that maintains a given individual at its 90% weight. In our high-motivation treatments we restricted each subject’s daily intake to 80% of X00; while in our low-motivation treatments we provided each subject with 120% of X00; that is RHIGH-mot = 0.80 X00 and RLOW-mot = 1.2 X00. Where RHIGH-mot and RLOW-mot are high- and low-motivation rations.

Clearly, food deprivation of any type can produce stress, and yet hunger and the motivation to feed are necessarily central topics in the study of foraging choices. Accordingly, we took several steps to minimize the stress and health risks associated with our food deprivation treatments. We designed these treatments based on our previous experience working with captive jays, and in consultation with our veterinarian. In addition, we assessed the health of our subjects once each day. During these daily checks we weighed each bird, assessed its body condition by palpation, and scored its behaviour for signs of food stress. These assessments showed that our subjects were healthy and active during these studies.

**Trials**

We tested subjects in the patch situation (described above; see Fig. 1b). We use \( T_1 = (\delta + \theta) \) to denote the delay associated with the ‘leave option’ (which includes the travel time, \( \theta \), and initial delay, \( \delta \)). We arranged trials so the travel time \( \theta \) and the initial delay \( \delta \) were both one-half of the experimentally determined ‘leave delay’ (i.e. \( \delta = \theta = T_1/2 \)). Thus, an animal choosing the leave option waited on the back perch for \( T_1/2 \) s; after this delay the apparatus presented the patch stimulus, and bird hopped forward to ‘enter’ the patch, it then waited for an \( T_1/2 \) s in ‘the patch’ before receiving food. As in Fig. 1b, \( T_2 \) denotes the delay associated with the ‘stay’ option; so, if the subject chose to stay in the patch (remain on the front perch), it received food after a further delay of \( T_2 \).

We arranged trials into blocks of 32 trials. The first eight trials in each block were forced-choice trials, in which the apparatus did not respond to certain options. For example, in a forced ‘leave trial’, the ‘stay’ option was not available, so the apparatus only responded to a ‘leave’ response. Four types of forced trials could occur: ‘forced stay on left’, ‘forced stay on right’, ‘forced leave on left’ and ‘forced leave on right’. The eight forced trials in each block presented each of these trial types twice in a randomly determined order. Subjects could choose freely in the remaining 24 trials of each block. Forced-choice trials (sometimes called no-choice trials) are a standard component of experiments like ours. Investigators use forced trials to ensure that subjects have the opportunity to learn about all the alternatives in a choice study.

**Daily sessions**

Typically, experimental contingencies were in force during 0700–1100 hours and during 1200–1600 hours, with the proviso that we stopped the experiment each day when a subject had acquired 90% of its ‘high motivation’ ration (RHIGH-mot); we then provided the remainder of the animal’s assigned ration in a separate dish. This procedure ensured that the subjects had the experience of being ‘fed-up’ in both the high- and low-motivation treatments.

**Within trial events**

At the beginning of each trial, the apparatus repeatedly flashed the rear light. Once the subject hopped on the rear perch, the stimulus light stopped flashing and burned steadily. After an intertrial interval of \( T_1/2 \) s, the apparatus presented a single ‘patch’ stimulus by flashing one of the front lights, randomly selecting whether to use the right or left light. A proviso here is that the experimental program would not present the ‘patch’ stimulus unless the subject occupied the rear perch. If the subject was elsewhere, the program flashed the rear light and waited for the subject to return to the rear perch. Once the subject hopped on the front perch, the front stimulus light stopped flashing and burned steadily. The subject then waited for an additional \( T_1/2 \) s, after which the apparatus flashed the magazine light and dispensed one food pellet. At this point the subject had to choose to leave or stay, the choice that was the central focus of this experiment. To indicate this choice, the front stimulus began flashing in a colour that differed from the patch encounter colour (which we call the ‘stay’ colour) while the apparatus flashed the rear (or leave) light. If the subject hopped to the rear light, indicating a decision to ‘leave’, then the rear light stopped flashing and burned steadily while the apparatus switched off the front light. If, instead, the subject remained on the front perch, the front light stopped flashing and burned steadily, indicating a decision to ‘stay’. The rear light continued to flash if the subject chose to stay, because (by analogy with natural patch use) the subject could leave the patch at any time. If the subject chose to stay, then the apparatus dispensed a single food pellet after a delay of \( T_2 \) s, flashing the magazine light (a small light positioned above the food cup; Fig. 3) as the pellet dispenser operated. After the second food delivery, the front lights were extinguished while the rear light continued to flash, and the subject typically returned to the rear perch to start a new trial.
RESULTS

Figure 4 shows the averaged choice data for all 16 treatment conditions. The figure shows proportional choice of the option that we varied experimentally (denoted by P(Varied)) for subjects in the high feed-up conditions (i.e. low-motivation condition; Fig. 4a) and the low feed-up conditions (high-motivation condition; Fig. 4b). The high-motivation treatments showed a very clear-cut response to increasing delay. As we increased delay, subjects shifted preference away from the varied option regardless of whether we varied the ‘leave’ or ‘stay’ option of our patch choice preparation. In contrast, the two situations produced strikingly different results in the low-motivation situation. When the jays had little motivation to feed they were convincingly biased in favour of the ‘leave’ alternative. Notice, finally, that although the two cases (high and low motivation) were quite different, jays tended to choose the varied branch more frequently when we varied the ‘leave’ branch, suggesting a bias towards leaving that varies with motivation intensity.

Formal Analysis

A repeated measures ANOVA of these data (Fig. 4) showed a significant interaction between motivation and delay ($F_{3,1} = 12.4, P = 0.0001$). When the birds were highly motivated (low feed up), they showed a classical sigmoid transition from preferring the varied alternative to avoiding it. In the less motivated treatments, however, they responded to increasing delay, but the response was more gradual and less sigmoid. The analysis also confirmed that the jays’ response to the leave and stay alternatives varied with their motivation (motivation by varied option interaction: $F_{1,6} = 44.85, P = 0.0005$). When the jays were highly motivated they treated the leave and stay branch similarly (as economic models predict); when they were less motivated, however, they showed a bias in favour of the ‘leave’ alternative. In addition, our ANOVA showed significant main effects of delay ($F_{3,18} = 78.92, P < 10^{-6}$; increasing delay reduced preference), and a main effect of varied branch ($F_{1,6} = 29.23, P = 0.002$; jays chose the ‘leave’ option more frequently in economically analogous situations). Interestingly, the effect of motivation showed up only in interactions with other variables, since we found no main effect of our ‘feed up’ variable. However, we did not observe the three-way interaction between varied option, delay and motivation that we expected ($F_{3,18} = 1.78, P = 0.19$).

Latency to Leave

If an animal chooses to leave, clearly it should leave immediately; because staying beyond the decision point can only waste time. So, we would like to ask how closely our subjects approximated this prediction. However, we cannot reasonably expect subjects to make instantaneous decisions. Indeed, one can imagine a decision mechanism in which departure rates determine choice: the mechanism sets a high departure rate to favour ‘leaving’ and a low departure rate to favour ‘staying.’ If this is true, we might expect that latencies to leave will track choice probabilities. So, we should see longer latencies when animals typically stay and shorter latencies when they typically leave. To test these ideas, we conducted a repeated measures ANOVA on latencies to leave. In doing this, we considered only trials in which the subject chose to leave (i.e. we excluded ‘stay’ trials), and then calculated the mean latency to leave for each subject in each treatment.

Overall, subjects left relatively quickly when they did leave, achieving an average ± SE latency of 5.0 ± 0.3 s. In addition, in high-motivation treatments, subjects achieved even lower latencies consistently below the overall mean of 5 s. In contrast, when subjects were less motivated, latencies were higher and more variable (low feed-up: 3.62 ± 1.36 s; high feed-up: 6.39 ± 3.78 s). We log-transformed the latency data before conducting our repeated measures ANOVA to reduce the effects of this difference in

![Figure 4. Overview of results. Proportional choice by blue jays when options were experimentally varied (P(Varied)) as a function of the delay associated with each option: (a) high-motivation condition; (b) low-motivation condition. Error bars show 95% confidence limits.](image-url)
variability. This ANOVA showed a significant interaction between delay and varied option ($F_{3,18} = 9.55, P = 0.0005$), and a significant main effect of motivation ($F_6 = 7.95, P = 0.03$; more motivated animals showed lower latencies). The ANOVA did not detect any other significant effects. Figure 5 shows the significant interaction between delay and varied option. Overall the pattern for latencies was similar to the pattern for the choice data. Highly motivated subjects came closest to the economical ideal of immediate leaving (i.e. zero latency). Overall, however, their latencies tracked their choice behaviour, with longer latencies in treatments where they tended to stay more. This provides some support for a ‘leaving rate’ model of choice (see Shapiro et al. 2008 for a related idea).

**DISCUSSION**

While it is certainly true that we can frame many aspects of animal behaviour as ‘choice’ (e.g. choosing mates, choosing habitats, choosing to escalate a conflict), it does not necessarily follow that we can apply results from studies of binary, mutually exclusive choice to this diverse set of phenomena. Our study takes a small step to address this concern, by investigating choice in a laboratory situation that mimics naturally occurring patch exploitation. In our experimental patch situation, we found that highly motivated subjects closely followed economic predictions (derived from studies of binary choice), in that our subjects treated the consequences of the ‘leave’ and ‘stay’ options in the same way. Yet, subjects, overall, showed a surprising bias towards leaving, and unmotivated subjects showed this effect most strongly.

The observation that animals achieve nearly optimal feeding behaviour when they need to is, of course, not surprising. But, our results extend this commonsense finding to the more realistic patch choice situation. The observed bias towards leaving is more surprising, because we might expect a bias towards staying for several reasons. For example, subjects may be more likely to stay in the patch situation because the ‘stay’ option leads to two food deliveries, while the ‘leave’ option leads to only one. In addition, since leaving requires an active change in behaviour, while staying only requires staying put, we might expect that behavioural inertia would favour staying. Our results in combination with earlier results from our laboratory (Stephens & Dunlap 2009) seem to contradict both of these ideas. An alternative account that is consistent with our results is that subjects favour leaving because it is the more familiar option, since they experience the ‘leave’ option on every trial. The leaving bias observed here raises a more general point: students of binary choice usually strive to eliminate all sources of bias, for example, ensuring that the subject has equal experience with all options, or counterbalancing the spatial position of alternatives. The patch situation, like choices in nature, has some fundamental asymmetries that may lead to biases in choice. Seen in this light, our study suggests that a full understanding of choice behaviour may require that we move beyond experiments that ‘eliminate’ biases to those that seek to understand how biases and predispositions interact with the economic determinants of choice behaviour. Pre-existing biases probably reflect rules of thumb (e.g. avoid open areas, stay with conspecifics) that have fitness value for animals in the wild. If so, then understanding these biases and how they influence choice behaviour is clearly a basic problem.

Students of human decision making have emphasized the importance of so-called framing effects (Kahneman & Tversky 2000). The classical example would be Tversky & Kahneman’s (1981) well-known observation that human subjects treat loss and gains differently even though there is no economic rationale to do so. According to Kahneman & Tversky’s prospect theory (Kahneman & Tversky 1979; Tversky & Kahneman 1992), this occurs (in theory) because a reference point derived from the subject’s current wealth frames the decision. The research described here is related to the idea of framing, because we focus on a novel way to frame a smaller-sooner versus larger-later choice. Our rationale is different, however, because it flows from a naturally occurring type of decision. Our research on the patch situation suggests that framing influences outcomes (subjects acquire more food in the patch situation than in the binary choice situation), yet this study suggests that subjects may, in fact, use similar choice rules in both patch and binary choice situations.

The Patch Situation versus Natural Patch Exploitation

Our study develops a critique of the choice literature derived from the common natural problem of patch exploitation. In doing so, our study shows how ideas from behavioural ecology and animal behaviour can be brought to bear on the interdisciplinary field of decision making that includes neuroscientists, economists and psychologists. While this is significant, we feel that our study is also relevant to naturally occurring patch exploitation. Animals exploiting natural patches must choose between leaving and staying just as our experimental subjects had to; and, in nature, the leave and stay alternatives are strongly asymmetric as in our experiment. To take the simplest example, the animal must initiate quite different motor patterns when it chooses to stay or leave. While we would be reluctant to conclude that our results necessarily apply to naturally occurring patch exploitation behaviour, they do suggest hypotheses for further experimentation and exploration.

Impulsivity and Ecological Rationality

A key result of binary choice studies is that animals often choose impulsively. That is, they favour smaller-sooner options even when choosing the larger-later option produces a higher food intake over the long term. Impulsivity attracts considerable attention from a wide range of investigators, including psychologists, neurobiologists, economists and clinicians, interested in addiction and mental health (Madden & Bickel 2010). Impulsive choice seems

![Figure 5. Significant interaction ($F_{3,18} = 9.55, P = 0.0005$) between delay and varied option. The panel shows latencies for trials in which subjects chose the ‘leave’ option. The plot shows averages across subjects (means ± 95% confidence limits). Note that the confidence limits shown here assume each condition is independent, while the repeated measures ANOVA allows for a ‘subject effect’. (Explaining why the ANOVA can detect a significant effect even though the error bars overlap considerably.)](image-url)
maladaptive, but it is only maladaptive if impulsive choice is costly to foraging animals in natural situations. We developed the patch situation to ask whether animals make costly mistakes in a more natural choice situation. Our working hypothesis has been that animals use impulsive rules of choice, because these rules work well in situations like patch exploitation, even though the same rule leads to seemingly costly mistakes in binary, mutually exclusive choice (Stephens & Anderson 2001; Stephens et al. 2004). One implication of this hypothesis is that natural selection might favour impulsive choice mechanisms because they are ‘ecologically rational’: impulsive mechanisms perform well in natural ‘patch-like’ choice problems, and selection favours them, but they perform poorly in arbitrary choice test in the laboratory (see Todd & Gigerenzer 2000 for a general discussion of ecological rationality).

Even though we did not directly compare the patch and binary choice situations in our present study (for direct comparisons see Stephens & Anderson 2001; Stephens & McLinn 2003; Stephens & Dunlap 2009), the present study addresses a key claim of the ecological rationality idea by asking whether animals treat the leave and stay components of patch choice as co-equal alternatives. We found that this was approximately true when our subjects were highly motivated, but we observed a bias in favour of leaving when our subjects were not highly motivated. At some level, this is neither surprising nor disconcerting, since most studies of choice use highly motivated subjects. Yet, the finding that the effect of asymmetries (e.g. the differences between stay and leave) may depend on motivation suggests that further exploration of the interaction between choice context and motivation may be illuminating.

Limitations and Further Questions

The relative simplicity of our patch situation represents an important limitation of our results. Specifically, if we hope to apply our results to naturally occurring patch exploitation behaviour, we must recognize that our experimental ‘patch’ is an incredibly simple one. Natural patches vary in many ways (number of items available, stochasticity in timing and amount, etc.). Again, only further studies with more complex situations can tell us whether our results generalize to more realistic situations. In combinations with other studies from our laboratory, this study suggests that the conventional choice models based on time and amount (e.g. the short-term rate rule, the hyperbolic discounting model) cannot account for the unique features of the patch situation, specifically the bias in favour of the ‘leave’ option reported here. So, we need new models of choice. Models that consider choice as a competition between alternative actions offer some intriguing possibilities because these suggest a natural difference between the patch and self-control situations (Freidin et al. 2009).

Summary

We studied choice in a simple, experimental patch exploitation situation. This choice problem differs from conventional approaches because the animal could make an active choice to leave, or a more passive choice to ‘do nothing’ and stay. By factoring manipulating the delays associated with the leave and stay options, we asked whether animals treat these two options in the same way. Hungry animals showed similar patterns of choice in response to changes in the ‘leave’ and ‘stay’ delays. Less motivated animals, however, favoured leaving. This observation raises significant questions for general models of choice behaviour. Where do these biases in preference come from, and how can models of choice accommodate them?

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