Value Transfer in a Simultaneous Discrimination Appears to Result From Within-Event Pavlovian Conditioning

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When pigeons acquire a simple simultaneous discrimination, some of the value acquired by the S+ transfers to the S−. The mechanism underlying this transfer of value was examined in three experiments. In Experiment 1, pigeons trained on two simultaneous discriminations (A+B− and C±D−) showed a preference for B over D. This preference was reduced, however, following the devaluation of A. In Experiment 2, when after the same original training, value was given to D, the pigeons’ preference for C did not significantly increase.

In Experiment 3, when both discriminations involved partial reinforcement (S±), A+C− training resulted in a preference for B over D, whereas B+D− training resulted in a preference for A over C. Thus, simultaneous discrimination training appears to result in bidirectional within-event conditioning involving the S+ and S−.

It has been proposed that when pigeons acquire a simultaneous discrimination, value accrues to the S+ directly through reinforced responding, whereas, although no value is acquired by the S− directly (because responses to it are never reinforced), value is acquired to the S− indirectly through its presentation with S+ (Fersen, Wynne, Delius, & Staddon, 1991). Recently, Zentall and Sherburne (1994) tested this theory (referred to by Fersen et al., as value transfer theory [VTT]) by establishing two S−s that were presented with stimuli that had different reinforcement histories. One S− was presented with an S+ (to which responding was always reinforced), and another S− was presented with an S± (to which responding was reinforced on only one half of the trials). The resulting two simultaneous discriminations were designated as A+B− and C±D−. According to VTT, although neither B nor D should have acquired any direct value (responses to both were never reinforced), B should have acquired more indirect value from A (to which responses were always reinforced) than D should have acquired from C (to which responses were reinforced on only one half of the trials). In support of VTT, when pigeons were given a choice between B and D on test trials, they showed a strong preference for B.

The purpose of the present research was to determine what mechanism underlies value transfer. Two relatively simple mechanisms are proposed, both of which are based on Pavlovian conditioning principles.

According to the first view, the association between the B− and the unconditioned stimulus (US) is direct and results from the fact that on approximately one half of the AB training trials the pigeon observes B prior to observing A, pecking A, and obtaining reward. Thus, in a procedure analogous to trace conditioning, on those trials observation of B is always followed (after a delay) by reward (see Figure 1).

The second proposed mechanism is based on Pavlovian higher order conditioning. According to this view, A+ represents the primary conditioned stimulus (CS1), to which responses are followed by reinforcement (the US), and B− represents CS2, a stimulus that is paired with, or signals, CS1. Although the A+ and B− are presented simultaneously, pigeons are likely to develop patterns of stimulus observing that place themselves in front of one of the two response keys at the start of each trial (Wright & Sands, 1981). On one half of the trials, A is presented on this key and the pigeon pecks it. On the remaining trials, B is presented on this key. Initially the pigeon learns to peck A and not to peck B. Later, the pigeon learns that observation of B signals the presence of A on the other key.

The distinction between direct conditioning and conditioning through a second CS is one that has been made by Rescorla (1980). Rescorla suggested that one way to distinguish between these two mechanisms is to devalue the CS1 and test for conditioning of CS2. If, after devaluation, there is little evidence for conditioning of CS2, it suggests that CS2 derived its association with the US through CS1. If, following the devaluation of CS1, one finds evidence for a CS2–US association, however, it suggests that a direct association between those two events was established during original training.

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Figure 1. Two possible bases for an association between S— and S+ in a simultaneous discrimination.

Experiment 1

In Experiment 1, the mechanism by which value transfers from A+ to B— was assessed by first training with the two simultaneous discriminations used by Zentall and Sherburne (1994), A+B— and C±D—, and then testing with B versus D. Subsequently A+ was devalued for one group and C± for another group, and then B versus D was tested again. The rationale for training with the C±D— discrimination was first to confirm that differential value would transfer to B and D (as evidenced by the B vs. D test) and then to assess the effects of devaluation on a retest. Devaluation was accomplished by presenting the A stimulus (for one group) or C stimulus (for the other group) by itself and extinguishing responses.

Method

Subjects

The subjects were 8 experimentally naive, mixed-sex White Carneaux pigeons (retired breeders, 5–8 years old) purchased from the Palmetto Pigeon Plant (Sumter, SC). The pigeons were housed in individual wire cages and were maintained at 80% of their free-feeding weights throughout the experiment. They also had free access to water and grit. The colony room in which the pigeons were housed was maintained on a 12:12 light-dark cycle.

Apparatus

The sound-attenuated test chamber in which the experiment was conducted measured 37 cm high, 34 cm across the response panel, and 30 cm from the response panel to the back wall. Mounted side by side on the response panel were three pecking keys (3.2 cm wide × 2.5 cm high and 0.5 cm apart). The bottom edges of the pecking keys were 16.0 cm from the wire mesh floor of the chamber. Only the left and right pecking keys were used in the present experiments. Behind each pecking key was a 12-stimulus in-line projector (Model 10, Industrial Electronics Engineering, Van Nuys, CA) with 28-V, 0.1-A lamps that projected one of four hues, red (R), green (G), yellow (Y), or blue (B; produced by Wratten filters, Nos. 26, 60, 9, and 38a, respectively) onto each of the response keys.

The opening to a rear-mounted grain feeder was centered on the response panel midway between the floor and the pecking keys. Reinforcement for correct responding consisted of timed access to Purina Pro Grains. A shielded houselight (GE 1820) located 7.6 cm above the center pecking key provided general chamber illumination. White noise at 72 dB and an exhaust fan mounted on the outside of the chamber provided sound masking. The experiment was controlled from an adjacent room by a microcomputer.

Procedure

Pretraining. All of the pigeons were trained to eat from the grain feeder and were then exposed to an autoshaping procedure, with each of the four hues (R, G, Y, B) randomly presented on each of the side pecking keys. Each stimulus was presented for 6 s followed by 3 s of reinforcement. The time between stimulus presentations was 15 s. If a peck occurred during a stimulus presentation, reinforcement was provided and the stimulus was turned off. A second autoshaping session was provided if pecking did not occur to any of the stimuli. Most pigeons pecked one of the stimuli during the first autoshaping sessions, and all of the pigeons pecked at least one of the stimuli within two autoshaping sessions. On the following day, a similar procedure was used, with the exception that each stimulus remained on until the pigeon pecked once, the interstimulus interval was shortened to 10 s, and the reinforcement duration was shortened to 2 s. During the following session, the number of pecks required for reinforcement was increased gradually to five.

Discrimination training. Simultaneous discrimination training began on the next day. The four pretrained stimuli were divided into two pairs, RY and GB. Each trial began with one pair of hues presented, one stimulus on the left key the other on the right key. Five pecks to either stimulus defined a response. Five pecks were required because it was found in earlier research that pigeons sometimes made a single short-latency peck that resulted in presentations of the stimulus pair that were too brief for adequate observation. The first peck to either stimulus resulted in the onset of the other stimulus. The unchosen stimulus was turned off after the first response to avoid the complex analysis of conditioning effects that might result if pigeons switched back and forth between the two stimuli. After four additional pecks to the initially chosen stimulus, that trial ended and the 10-s intertrial interval (ITI) began. For the stimulus pair designated AB, the fifth peck to A was always reinforced, whereas the fifth peck to B was never reinforced (A+B—). For the stimulus pair designated CD, the fifth peck to C was reinforced on one half of the trials and nonreinforced on the remaining trials, whereas the fifth peck to D was never reinforced (C±D—). Each training session consisted of 96 trials, with the AB and CD pairs randomly occurring within balanced blocks of 8 trials (each stimulus appeared equally often on the left and right pecking keys). The pigeons were randomly assigned to four groups (n = 2, each) in training, identified by which of the four stimuli (R, Y, G, B) was designated as A. Thus, although in training R and Y always appeared as a pair (and likewise G and B), each hue appeared equally often as A, B, C, and D. The design of this experiment is presented in Table 1.

Table 1

<table>
<thead>
<tr>
<th>Group</th>
<th>Training</th>
<th>Test 1</th>
<th>Devaluation</th>
<th>Test 2</th>
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<tbody>
<tr>
<td>A—</td>
<td>A+B— and C±D—</td>
<td>B vs. D</td>
<td>A—</td>
<td>B vs. D</td>
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<tr>
<td>C—</td>
<td>A+B— and C±D—</td>
<td>B vs. D</td>
<td>C—</td>
<td>B vs. D</td>
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Note. The hues, red, green, yellow, and blue served equally often as A, B, C, and D.
Each pigeon was trained on the two discriminations until it reached criterion (43 correct responses—i.e., choices of A+ or C±—out of 48 trials) on each discrimination for two consecutive sessions.

**Test 1.** On the following day, a single test session was conducted. The test session consisted of 32 A+B− trials, 32 C±D− trials, and 32 B versus D test trials, presented in random order. Reinforcement was provided for choice of either stimulus on a random half of the BD test trials. On the remaining BD test trials, reinforcement was not provided for either choice. This initial test was included to replicate the value transfer effect found by Zentall and Sherburne (1994) and to serve as a baseline against which to assess the effects of devaluation training.

**Retraining.** In the session following Test 1, all of the pigeons were retrained for one 96-trial session on the AB and CD discriminations, and the two pigeons in each training group were randomly assigned to one of two devaluation groups, A− and C−.

**Devaluation training.** During the session following retraining, devaluation training involving either A (for one half of the pigeons) or C (for the remaining pigeons) occurred. Devaluation trials consisted of the presentation of either A or C for 6 s. Responses to the singly presented stimulus were recorded, but they had no programmed consequence. Stimulus presentations were separated by a 10-s ITI. The stimulus was presented equally often on the left key and on the right key. Devaluation training continued to a criterion of no responses on 9 out of 10 successive trials.

**Test 2.** Immediately after devaluation training (approximately 20 s), a single test session was conducted. This test was identical to Test 1, with the exception that the 32 test trials were intermixed with 64 further devaluation trials (A− or C−) rather than training trials.

**Results and Discussion**

In all of the statistical analyses, the .05 level of significance was adopted.

**Acquisition**

Pigeons acquired the A+B− discrimination in an average of 3.1 sessions and the C±D− discrimination in an average of 3.8 sessions. This difference was not statistically reliable, \( F(1, 7) = 1.87 \). Although 4 of the pigeons took longer to acquire the C±D− discrimination, 1 pigeon took longer to acquire the A+B− discrimination, and 3 pigeons acquired the discriminations in the same number of sessions.

**Test 1**

In Test 1, pigeons showed a strong preference for the B stimulus (86.7%). A repeated measures analysis of variance (ANOVA) performed on the data indicated that this difference was significant, \( F(1, 7) = 41.16 \).

**Test 2**

In Test 2, pigeons in the A− devaluation group showed a slight preference for D over B (they responded to B on an average of 46.9% of the trials), whereas pigeons in the C− devaluation group showed a strong preference for B over D (they responded to B on an average of 92.7% of the trials). Although this difference was quite large, it did not reach statistical significance, \( F(1, 6) = 5.00 \). More important than the difference in preference on Test 2 is the change in preference between Test 1 and Test 2. A two-way mixed ANOVA performed on the data from the two tests indicated a significant Group × Test interaction, \( F(1, 6) = 6.52 \). Thus, the devaluation treatment had a significant differential effect on the two groups. The Test 1 and Test 2 data from Experiment 1 are presented in Figure 2.

The results of Experiment 1 indicate that if following simultaneous discrimination training the S+ is presented in isolation and responses extinguished, that devaluation does in fact change the relative preference for the S−. The results suggest that the mechanism underlying the apparent transfer of value from S+ to S− is the higher order conditioning of S− through S+. Although there was a strong preference shown for B over D in Test 1, that preference was significantly reduced following the devaluation of A (relative to the devaluation of C).

Another way of looking at this process is to propose that although the presentation of stimuli is nominally simultaneous, the pigeons actually observe them successively (first one stimulus and then the other, depending on where they are in the chamber at the start of the trial; see Wright & Sands, 1981). If this is the case, then during discrimination training, not only do pigeons learn to respond to A and not to respond to B, but they may also learn that B is a good predictor of A. Thus, B is preferred because on those trials in which it is seen first, it signals the presence of A, a highly preferred stimulus. D, on the other hand, is less preferred because, when it is seen first, it signals the presence of the less preferred C.

**Experiment 2**

In an alternative account of value transfer, as well as in the results of the devaluation manipulation found in Experiment 2.
Experiment 1, associations between the two discriminative stimuli are viewed as bidirectional. This might be the case if training with a simultaneous discrimination resulted in a form of what Rescorla and Durlach (1981) have referred to as within-event conditioning. According to this view, simultaneous discrimination training involves not only the development of direct associations between the S+ (A) and the food outcome but also the development of associations between the S− (B) and A, and between A and B. When A is devalued, not only does such training alter the relation between A and food but it also alters the relation between A and B, and between B and A.

The mechanisms underlying higher order conditioning and within-event conditioning are somewhat different. In the case of higher order conditioning, one would expect a directional association to form between B and A. Although “seeing B” might become a signal to “look for A,” “seeing A” should not become a signal to “look for B.” In the case of within-event conditioning, however, one would expect A and B to serve symmetrical roles. A should be as strongly associated with B as B is associated with A.

One way to distinguish between these two theories is to ask if alterations in the value of B (or of D), following original training, has an effect on the preference for A over C. Because neither B nor D acquires any direct value in training (by way of reinforced pecking), the appropriate value manipulation is to selectively give value to either B or to D in a single-stimulus training phase. According to a within-event conditioning account, giving value to D should result in value transfer from D to C, resulting, in turn, in a reduction in preference for A (relative to baseline). On the other hand, giving value to B should increase the preference for A over C. Because A may be chosen over C on virtually all baseline trials, however, an increased preference for A might not be detectable. As in Experiment 1, the critical dependent measure is the change in relative preference for A over C resulting from the valuation of B (vs. the valuation of D). The design of Experiment 2 appears in Table 2.

### Procedure

Pretraining and discrimination training were the same as for pigeons in Experiment 1. As each pigeon attained the discrimination criterion, it was tested (Test 1) the next day with a single session in which 32 of the 96 trials involved presentation of A and C, with choices of either stimulus reinforced on a random 50% of the trials. The remaining 64 trials were additional training trials.

**Retraining.** In the session following Test 1, the pigeons were retrained on the AB and CD discriminations for one session and were randomly assigned to either the B+ or D+ group.

**Valuation training.** During valuation training trials, a single stimulus was presented on one of the side keys and five pecks to it were reinforced. The stimulus was presented equally often on the left key and on the right key. Stimulus presentations were separated by a 10-s ITI. Valuation training consisted of a single 96-trial session.

**Test 2.** Immediately following valuation training, a single test session was conducted, identical to Test 1, with the exception that the 32 test trials were intermixed with 64 valuation trials (B+ or D+).

### Results and Discussion

**Test 1**

The pigeons showed a significant preference for A over C (87.1%) on Test 1, as indicated by a repeated measures ANOVA, F(1, 7) = 93.04.

**Test 2**

The pigeons also showed a significant preference for A over C (77.3%) on Test 2, F(1, 7) = 25.00, but there was little difference in preference for A by pigeons for which value had been given to B (78.1%) as compared with pigeons for which value had been given to D (76.6%). The data from Experiment 2 are presented in Figure 3.

### Method

**Subjects and Apparatus**

The subjects were 8 experimentally naive pigeons, similar to those used in Experiment 1. They were housed as were the pigeons in Experiment 1. The apparatus was the same as that used in Experiment 1.

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<thead>
<tr>
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<tbody>
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<td>B+</td>
<td>A+B− and C±D−</td>
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<td>B+</td>
<td>A vs. C</td>
</tr>
<tr>
<td>D+</td>
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<td>A vs. C</td>
<td>D+</td>
<td>A vs. C</td>
</tr>
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</table>

**Note.** The hues, red, green, yellow, and blue served equally often as A, B, C, and D.

**Figure 3.** Preference for A (the S+ from original training) over C (the S− from original training) prior to valuation (Test 1) and following valuation (Test 2) of either B (the S− paired in original training with S+) or D (the S− paired in original training with S−). The absence of a preference is indicated by the horizontal line at 50% of A.
A two-way mixed ANOVA performed on the test data, with Group (B vs. D) and Test (1 vs. 2) as factors, yielded a significant effect of test, \( F(1, 6) = 7.35 \) (the preference for A over C was significantly less on Test 2 than on Test 1), but neither the effect of Group nor the Group \( \times \) Test was significant, \( F < 1 \) and \( F(1, 6) = 1.99 \), respectively. The absence of a significant interaction further suggests that the valuation manipulation was ineffective in producing a differential change in preference for the A stimulus.

The results of Experiment 2 suggest that changes in the value of individual discriminative stimuli do not invariably affect preferences involving the alternative discriminative stimulus. In other words, giving value to D does not appear to improve the value of C relative to A. Instead, the results of Experiment 2 suggest that, in original training, B becomes a predictor of the presence of A, and D becomes a predictor of C. This interpretation is supported because changes in the value of A and C affect the relative preference for B over D, whereas changes in the value of B and D appear to have little effect on the relative preference for A over C.

It could be argued, however, that differences in the results found in Experiments 1 and 2 could be related to differences in the source of initial preferences found in Test 1. In Experiment 1, B was preferred over D, in spite of similar conditioning histories. The source of preference of B over D was presumably the differential transfer of value from A to B as compared with the transfer of value from C to D. On the other hand, in Experiment 2, A was preferred over C because of differences in their reinforcement histories (i.e., continuous vs. partial reinforcement). It may not be reasonable to expect that the differential transfer of value resulting from the valuation of B versus D would be sufficient to overcome the direct difference in value between A and C acquired during original training.

**Experiment 3**

The purpose of Experiment 3 was to use a more sensitive design that might allow for additional value to accrue to A following discrimination training. The design used in Experiment 3 accomplished this in two ways. First, it established both the A and C stimuli in a context of partial reinforcement. This was done to allow for more sensitivity in the detection of the effects of later experience on the preference for A over C (or for B over D). Second, it presented the devaluation and valuation of stimuli in a context of discrimination training (rather than single-stimulus training used in Experiments 1 and 2), a context that was more similar to the context of original training. Because the original training and test contexts used in Experiments 1 and 2 both involved the simultaneous choice between two stimuli, it is possible that the single-stimulus manipulation of value was not as effective as it could have been.

In Experiment 3, the effects of devaluation and valuation were examined in a design in which devaluation and valuation occurred in the context of a simultaneous discrimination. To accomplish this, Experiment 3 involved two groups of pigeons. Pigeons in Group A+C- were initially trained on two simultaneous discriminations, A±B- and C±D-.

In Phase 2, they were trained on a single simultaneous discrimination, A+C-, and then were tested with B versus D. The logic of the Phase 2 manipulation for Group A+C- was as follows: In original training, although responses to both B and D were nonreinforced, both should come to signal the presence of a stimulus sometimes associated with reinforced responding, A and C, respectively. In Phase 2, C is now devalued through its consistent association with nonreward. The pigeons are then given a choice between B and D. The question of interest is whether B, because it now signals the presence of A (a stimulus that in Phase 2 was consistently associated with rewarded responding) should be preferred over D, which now signals the presence of C (a stimulus that in Phase 2 was consistently associated with nonrewarded responding).

The second group in Experiment 3, Group B+D-, was trained on the same pair of simultaneous discriminations as Group A+C-, A±B- and C±D-. In Phase 2, however, pigeons in Group B+D- were trained on a B+D- discrimination, and were then tested with A versus C. The logic of the Phase 2 manipulation for Group B+D- was as follows: In Phase 2, B should be valued through its consistent association with rewarded responding. To the extent that the valuation of B transfers to A, A should be preferred over C in test.

**Method**

**Subjects and Apparatus**

The subjects were 8 experimentally naive pigeons, similar to those used in Experiments 1 and 2. They were housed as were the pigeons in Experiment 1. The apparatus was the same as that used in the two previous experiments.

**Procedure**

**Pretraining and training.** Pretraining was the same as for pigeons in Experiments 1 and 2. All of the pigeons were trained on two simultaneous discriminations, A±B- and C±D-, in which responses (5 pecks) to A or C were reinforced on one half of the trials and were not reinforced on the remaining trials, and responses to B and D were never reinforced. Each training session consisted of 48 randomly alternating trials with each discrimination. As each pigeon attained the acquisition criterion (two consecutive sessions at or above 43 of 48 trials correct on each discrimination), it was randomly assigned to Group A+C- or to Group B+D-.

**Phase 2 training.** In Phase 2, pigeons in Group A+C- were exposed to a simultaneous discrimination, A±C-, and pigeons in Group B+D- were exposed to a B+D- discrimination. Phase 2 sessions consisted of 96 trials, all with the new simultaneous discrimination. In Phase 2, all of the pigeons were trained to a criterion of one session with a discrimination accuracy of 90% correct or better.

**Test.** All of the pigeons were tested on two consecutive sessions, with 64 Phase 2 trials and 32 test trials on each session. The test trials were B versus D for pigeons in Group A+C-, and they
were A versus C for pigeons in Group B+D-. On test trials, reinforcement was provided for a response to either stimulus on a random half of the trials. The design of Experiment 3 appears in Table 3.

Results and Discussion

Acquisition and Phase 2 Training

Pigeons acquired the two simultaneous discriminations in an average of 5.6 sessions. In Phase 2, they acquired the new discrimination in an average of 1.9 sessions.

Test

The pigeons in Group A+C− showed a large preference for B over D on both the first and second test sessions, 71.8% and 86.0%, respectively. Similarly, the pigeons in Group B+D− showed a preference for A over C on both the first and second test sessions, 61.2% and 69.2%.

A three-way mixed ANOVA performed on the data, with test stimulus preference (B vs. D for Group A+C− and A vs. C for Group B+D−), test session (1 or 2), and group (A+C− vs. B+D−) as factors, indicated that the only significant effect was for test stimulus preference, $F(1, 6) = 21.65$. Thus, the effects of devaluation and valuation in Phase 2 were consistent with value transfer theory. The effect of group was not significant, $F(1, 6) = 2.11$, and although there appeared to be an effect of session, it too was not significant, $F(1, 6) = 5.67$. Of more importance for purposes of the present experiment, the Preference $\times$ Group interaction was also not significant, $F(1, 6) = 2.11$.

Because data from the two groups represent theoretically different questions, these data were also analyzed separately. For Group A+C−, although the preference for B over D was not statistically significant on the first test session, $F(1, 3) = 9.09$, the overall preference for B by pigeons in Group A+C− was significant when data from the two test sessions were combined, $F(1, 3) = 14.06$.

The pattern of results was a bit different for Group B+D−, although the overall conclusion was quite similar. Although the preference for A over C by pigeons in Group B+D− was significant on the first test session, $F(1, 3) = 15.70$, the overall preference did not quite reach statistical significance when data from the first and second test sessions were combined, $F(1, 3) = 7.96$. The test data from Experiment 3 are presented in Figure 4.

Thus, the results of Experiment 3 suggest that both devaluation (of a former S±) and valuation (of a former S−) of stimuli that appeared in a simultaneous discrimination can retroactively affect the value of stimuli that appeared with them. These results suggest that stimuli that appear in a simultaneous discrimination not only develop direct associations with reward and nonreward through instrumental responding, but they also develop within-event associations that can be detected through the devaluation and valuation of individual components of the discrimination.

There are at least three reasons for why the valuation manipulation was apparently effective in Experiment 3, whereas it appeared to have had little effect on test stimulus preference in Experiment 2. First, the valuation context in Experiment 3 was a simultaneous discrimination—a context similar to both training and test. Second, the baseline value of the positive stimulus in training was probably lower in Experiment 3 (because training involved partial reinforcement) than in Experiment 2 (in which training involved continuous reinforcement). And third, at the end of training the direct values of the two positive stimuli in Experiment 3 (A± and C±) were comparable, whereas the direct values of those stimuli (A+ and C+) were clearly quite different in Experiment 2. Thus, the design of Experiment 3 is likely to have been more sensitive to the effects of the valuation manipulation.

General Discussion

The results of the present experiments suggest that Pavlovian processes affect the relation between S+ and S− in a simultaneous discrimination. Although an animal may learn to approach and respond to one of those stimuli (the S+) and avoid the other (S−), associations also develop between the two stimuli. Evidence for the development of these associations was demonstrated in three ways in the present research. First, it was shown that the S− takes on
some of the value of the S+ with which it appears (Experiments 1 and 2; Test 1; Zentall & Sherburne, 1994). Second, it was found that following discrimination training, the devaluation of the S+ retroactively affects the value of the S− (Experiment 1. Test 2). Third, the valuation of S− was shown to increase the preference for an S± that accompanied it during discrimination training, whereas the devaluation of S± was shown to decrease the preference for an S− that accompanied it during discrimination training (Experiment 3).

Note that the devaluation procedures used in Experiment 1 might have affected the within-event conditioning that had been established in training, not only by retroactively altering the value that transferred between the simultaneously presented stimuli, but also by decoupling those stimuli. Extinguishing responses to A should not only alter the value of A, but because it also involves presenting A in the absence of B, it should weaken any association between them. Decoupling A from B could result in a reduced preference for B if during devaluation training the pigeons learn that A typically occurs in the absence of B. Thus, D is still a good predictor of C, but B is no longer a good predictor of A.

The design of Experiment 2 should have allowed one to distinguish between these two theories because the valuation of D should have increased the value that transferred to C, thus reducing the preference for A over C in test. Unfortunately, as was mentioned earlier, the differential direct values acquired by A and C in training in Experiment 2 may have precluded observation of potential differential value transfer effects produced by the later valuation of B or D.

The results of Experiment 3, however, suggest that devaluation (and valuation) does, in fact, affect the retroactive transfer of value from the altered-value stimulus to the stimulus with which it was originally paired. In Experiment 3, for Group A+C−, if A+C− training in Phase 2 decouples A from B and C from D, those effects on B and D should be comparable because A and C had similar value in original training. A similar argument can be made for Group B+D−.

Of course, the results of Experiment 3 do not rule out a contribution of decoupling to the devaluation effects found in Experiment 1. They merely indicate that the retroactive transfer of value can occur in the absence of differential effects of decoupling.

The within-event conditioning effects found in the present research with simultaneous discrimination training differ in two important ways from within-event conditioning effects reported earlier (see Rescorla & Durlach, 1981). First, in the present research, the two simultaneously presented stimuli were presented on separate response keys, more than 4 cm apart. In much of the Pavlovian conditioning research, the compound stimuli are presented at the same location (e.g., a compound CS consisting of smell and taste, Durlach & Rescorla, 1980; or consisting of two tastes, Rescorla & Cunningham, 1978), or when they are visual stimuli, at least they are typically presented in very close proximity (e.g., Rescorla & Durlach, 1981).

Second, in the present research, training occurs in an instrumental conditioning context in which responses to the S+ are selectively reinforced and responses to the S− are extinguished. In the typical within-event conditioning experiment, compound training occurs in a Pavlovian context in which responses to the two CSs are not differentiated.

The implication of the present research is that these within-event associations are strong enough to overcome the spatial separation between S+ and S− as well as the differential contingencies associated with responding to the two discriminative stimuli.

One issue that has not been clearly resolved is the functional temporal relation between the two stimuli presented in a simultaneous discrimination. On the one hand, it has been hypothesized that the processing of these stimuli might be considered successive (see Wright & Sands, 1981). On the other hand, the bidirectional effects found in Experiment 3 have been interpreted in terms of within-event conditioning, and such conditioning effects are assumed to involve the simultaneous occurrence of stimuli. It is possible, of course, that within-event conditioning can occur in this context when two stimuli are presented successively. Adequate resolution of this question does not appear to be possible without further research.

The present research also suggests that the acquisition of a simultaneous discrimination may provide a useful model for studying various Pavlovian conditioning phenomena, such as potentiation. In potentiation, a CS, such as odor, that by itself would result in only weak conditioning when paired with illness, results in strong conditioning when the odor is presented in compound with a taste CS.

The associations produced during simultaneous discrimination training can be viewed as follows: A weak association is developed between S− (CSa) and food (US) by extinguishing responses to S− and reinforcing responses to S+ in the presence of S−. A strong association is developed between S+ (CSb) and food (US) by reinforcing responses to S+. Finally, a strong association is developed between S− (CSa) and S+ (CSb) because the S− serves as a signal for S+.

The conditions needed to produce potentiation can be similarly defined: Because of natural predispositions in this case, weak associability exists between, for example, an odor (CSa) and illness (US); strong associability exists between a taste (CSb) and illness; and strong associability exists between odor (CSa) and taste (CSb).

Because simultaneous discrimination training allows one to manipulate the relation between arbitrary stimuli and reinforcers, this instrumental paradigm might be useful in modeling other Pavlovian conditioning phenomena, such as overshadowing, blocking, and latent inhibition.

Notions of the transfer of value between components of a simultaneous discrimination may also be applicable to other instrumental conditioning phenomena. For example, the finding that the reversal of a simultaneous discrimination is facilitated by overtraining the original discrimination (i.e., the overtraining reversal effect) has been variously attributed to increased dimensional attention (Mackintosh, 1965), increased discrimination of the reversal phase (Guttman, 1963), and the relatively greater impact of frustration due to
nonreward (Amsel, 1962). The present value transfer experiments suggest an alternative account. Although overtraining may not appreciably increase the value of S+ , it may increase the amount of value that transfers to the S-. If it does, it should make the S- less inhibitory and, thus, make it easier to convert the overtrained S- into an S+. This hypothesis is not unlike a suggestion made by Biederman (1968). Biederman suggested that during overtraining there is likely to be little responding to S-. Thus, the consequences of responding to S- are more likely to be forgotten. Biederman trained rats on two simultaneous discriminations, one of which involved 3 times as many training trials as the other. Following acquisition, when the rats were given a choice between the two S-s, a strong preference was shown for the S- from the overtrained discrimination. According to the notion of value transfer, overtraining allowed more value to transfer from S+ to S-, resulting in the preference for the overtrained S-.

This discussion suggests that within-event conditioning in simultaneous discrimination training may provide a useful model for understanding and integrating a number of instrumental and Pavlovian conditioning phenomena.

References


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