

EXTENSIVE TRAINING IS INSUFFICIENT TO PRODUCE THE WORK-ETHIC EFFECT IN PIGEONS

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Zentall and Singer (2007a) hypothesized that our failure to replicate the work-ethic effect in pigeons (Vasconcelos, Urquioli, & Lionello-DeNolf, 2007) was due to insufficient overtraining following acquisition of the high- and low-effort discriminations. We tested this hypothesis using the original work-ethic procedure (Experiment 1) and one similar to that used with starlings (Experiment 2) by providing at least 60 overtraining sessions. Despite this extensive overtraining, neither experiment revealed a significant preference for stimuli obtained after high effort. Together with other findings, these data support our contention that pigeons do not reliably show a work-ethic effect.

Key words: work ethic, effort, within-trial contrast, overtraining, key peck, pigeons

In the original demonstration of the work-ethic effect (Clement, Feltus, Kaiser, & Zentall, 2000), pigeons learned two simultaneous (S+ vs. S-) discriminations, one preceded by a fixed ratio (FR) 1 requirement to a center-key stimulus (low-effort trials) and the other preceded by an FR 20 requirement to the same stimulus (high-effort trials). After acquiring both discriminations to high levels of accuracy and 20 subsequent overtraining sessions, pigeons received periodic nondifferentially reinforced probe trials on which they had to choose between the high- and low-effort S+ stimuli and, on separate trials, the high- and low-effort S- stimuli. Clement et al. found a significant preference both for the high-effort S+ and the high-effort S-, the *work-ethic effect* (see also Kacelnik & Marsh, 2002; Friedrich & Zentall, 2004).

This result has been followed by a series of other findings from the Zentall lab showing that pigeons also prefer stimuli preceded by long over short delays (DiGian, Friedrich, & Zentall, 2004), by the absence versus presence of food (Friedrich, Clement, & Zentall, 2005), and by a relatively aversive reinforcement contingency (Singer, Berry, & Zentall, 2007). Zentall and Singer (2007b; see also Clement et al., 2000) propose that this pattern of results reflects

greater conditioned reinforcing value of the preferred stimuli arising from a larger contrast between the aversive states preceding them and the reinforcing effect that follows them.

Be that as it may, the original work-ethic effect has proved to be elusive. For example, we (Vasconcelos, Urquioli, & Lionello-DeNolf, 2007) were unable to replicate the effect in six separate experiments, and a similar failure-to-find was recently reported by Arantes and Grace (2008). Michael Colombo (personal communication, July 2, 2008) has also reported to us that his lab has been unable to replicate the effect with pigeons. Indeed, Zentall and Singer (2007a) mention an unpublished study by Klein and Zentall (2002) that was unable to reproduce the original (Clement et al., 2000) findings.

Zentall (2008) and Zentall and Singer (2007a) suggest that failures to replicate the work-ethic effect are probably due to insufficient overtraining and cite data from related studies in support of this (e.g., Friedrich & Zentall, 2004; Singer et al., 2007). Even though the original demonstration employed 20 overtraining sessions (the same number used by Vasconcelos et al., 2007), they argued that 2 or 3 times that number is probably required to reliably obtain preferences for high- over low-effort stimuli. According to them, the necessary within-trial contrast between prior events and the eventually preferred stimuli develops rather slowly.

In order to determine if this might indeed explain most of the discrepancies between pigeon studies of the work-ethic effect, the present paper tested the extensive-overtraining hypothesis in two different paradigms.

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Experiment 1 was conducted using the procedure described by Clement et al. (2000); Experiment 2 used an adaptation of Kacelnik and Marsh's (2002) procedure with European starlings. In both experiments, pigeons received at least 60 overtraining sessions before their preference tests. Neither experiment, however, returned data indicating that extensive overtraining yields a work-ethic effect like that originally reported by Clement et al. (2000).

EXPERIMENT 1

Pigeons were trained on two simultaneous discriminations, one preceded by a low-effort response requirement (FR 1) to one initial-link stimulus and the other preceded by a high-effort response requirement (FR 30) to a different initial-link stimulus. Signaling the different work requirements should enhance the probability of obtaining the work-ethic effect (cf. Zentall & Singer, 2007b). After pigeons acquired each discrimination to high levels of accuracy, they received 60 overtraining sessions and were then tested for their preferences for high- over low- effort stimuli.

METHOD

Subjects

Six experimentally naïve White Carneau pigeons obtained from the Palmetto Pigeon Plant (Sumter, SC) were used. All were retired breeders and had continuous access to Purina ProGrains upon arrival in the lab in order to determine their free-feeding body weights. Each pigeon's weight was then gradually reduced to and maintained at 80% of its free-feeding value by restricted feeding. During experimental participation, food was provided in the home cage only when food intake in a session was insufficient to maintain the 80% body weight and on days on which the experiment was not run.

Each pigeon was housed individually in stainless-steel, wire-mesh cages in a temperature- and humidity-controlled colony room on a 14:10 day-night cycle. The light portion of the cycle began at 07:00 hours. Grit and water were always available in the home cage.

Apparatus

A standard operant chamber consisting of a BRS/LVE (Laurel, MD) Model PIP-016 panel

inside a BRS/LVE Model SEC-002 enclosure was used in this experiment. On the panel were three horizontally aligned 25-mm-diameter response keys spaced 57 mm apart, center to center, and positioned 75 mm from the top of the panel. Inline projectors (BRS/LVE Model IC-901-IDD) located behind the left and right side keys were equipped with filters for displaying red, green, yellow, and blue hues. The projector behind the center key contained a film for displaying a small white dot and three white vertical or horizontal lines on black backgrounds (BRS/LVE Pattern No. 692). A rear-mounted food hopper containing Purina ProGrains was accessible through a 58-mm-square opening located 130 mm below the center key. When the food hopper was raised, a small miniature bulb (ESB-28) in the metal housing surrounding the hopper was lit. A partially covered GE #1829 bulb located 76 mm above the center key was used for chamber illumination; the opening in its metal cover directed light toward the ceiling. Ventilation and masking noise was provided by a constantly running blower fan attached to the chamber. All experimental events were controlled and recorded by an IBM-compatible computer connected to the chamber through an interface built in-house.

Procedure

The general procedure and procedural details were virtually identical to that for Group Line in Vasconcelos et al. (2007, Experiment 5), except that an FR 30 rather than an FR 40 requirement was used on high-effort trials. A condensed summary is provided below.

All pigeons were initially trained to eat reliably from the food hopper, after which their key peck response to a small white dot on the center key was shaped by the method of successive approximations. Over the next 12 preliminary training sessions, pigeons obtained food by pecking one center-key line stimulus on a continuous reinforcement (FR 1) schedule and the other line stimulus on a FR schedule whose parameter was raised from 2-30 across successive sessions. The line-schedule pairings were counterbalanced across birds, and the final multiple FR 1 FR 30 schedule was in effect for two sessions. Each 60-trial session contained an equal number of

randomized presentations of the vertical and horizontal lines.

Next, pigeons were trained on two concurrent simultaneous discriminations, one preceded by a single peck (FR 1) to either the vertical or horizontal lines on the center key (low-effort trials) and the other by 30 pecks (FR 30) to the alternative center-key lines (high-effort trials). Completion of the requirement on each trial turned off the line stimulus and immediately produced two hues (red and yellow, or blue and green) on the left and right side keys, with the positions of the hues in each set counterbalanced across trials. One set was presented on FR 1 trials (low-effort S+ and low-effort S-); the other set was presented on FR 30 trials (high-effort S+ and high-effort S-). A single peck to either hue within each set turned off the other and initiated a 6-s period that ended in food reinforcement if the S+ had been pecked or in nonreinforcement if the S- had been pecked. Reinforcer duration was constant within a session but varied from 2 s through 6 s across sessions, as needed, in order to maintain pigeons' body weights at 80% of their free-feeding values. The nonreinforcement (timeout) period following an S- choice was always equal to the reinforcer duration.

The two simultaneous discriminations were presented equally often in random order in each 96-trial training session, with the constraint that none of the four possible trial types (FR 1 vs. FR 30 x two left-right positions of the hue discriminative stimuli) occurred more than three times in a row. The houselight was only on during the 10-s intertrial interval that separated successive trials; it was turned off at the start of each trial and remained off until the end of the reinforcement or timeout period. Each pigeon was trained to a criterion of at least 90% correct on both discriminations within a single session. Sixty overtraining sessions then followed.

Five preference-test sessions followed overtraining. Each session included 36 test trials randomly intermixed among 60 baseline training trials. Half of the test trials involved a choice between the two S+ stimuli from training (low-effort S+ vs. high-effort S+) and the other half involved a choice between the two S- stimuli (low-effort S- vs. high-effort S-). Twelve test trials (6 with the two S+ stimuli and 6 with the two S- stimuli) were

preceded by completion of the FR 1 requirement to its corresponding center-key line stimulus, another 12 were preceded by completion of the FR 30 requirement to its corresponding line stimulus, and the remaining 12 involved the presentation of the two S+ or two S- stimuli without any center-key response requirement (i.e., at the end of the ITI). Choices on the test trials were nondifferentially reinforced 50% of the time. Type I error rate for all statistical tests reported here and in the following experiment was set at .05.

RESULTS AND DISCUSSION

Pigeons learned the two simultaneous discriminations in an average of 3.2 sessions. One pigeon was dropped from the experiment after 30 overtraining sessions because it repeatedly stopped for 3 hr or more at the onset of a high-effort (FR 30) trial. During overtraining, pigeons continued to perform accurately on both discriminations, averaging 99.4% and 99.3% correct on low- and high-effort trials, respectively, over the last five of these sessions, $F(1, 4) = 0.63$. Likewise, they performed accurately on both hue discriminations during testing, averaging 96.0% and 96.7% correct on low- and high-effort trials, respectively, on the first test session and 91.2% and 96.1% correct, respectively, over all five test sessions, $F(1, 4) = 1.00$ and 3.45, respectively, ns.

Figure 1 shows each pigeon's preference for the high-effort S+ and for the high-effort S- averaged across the five test sessions. The bottom right panel plots the corresponding preferences averaged across all pigeons. Preferences are broken down by initial-link requirement: no previous stimulus (nps), FR 1, and FR 30. The only indication of a consistent preference across pigeons was for the high-effort (FR 30) S+ on test trials initiated by a FR 30 to the initial-link stimulus, $t(4) = 2.91$, $p < .05$. There was no corresponding evidence of a consistent preference for that S+ on trials initiated by a FR 1 or trials that occurred with no previous (initial-link) stimulus, $t(4) = 0.19$ and -0.39 , respectively. On S- trials, 4 of the 5 pigeons preferred the FR 30 S- when test trials were initiated by an FR 1 to the initial-link stimulus; the remaining pigeon (S3) showed a strong preference in the opposite direction (i.e., for the FR 1 S-) on these trials. Overall, there was no evidence of a significant

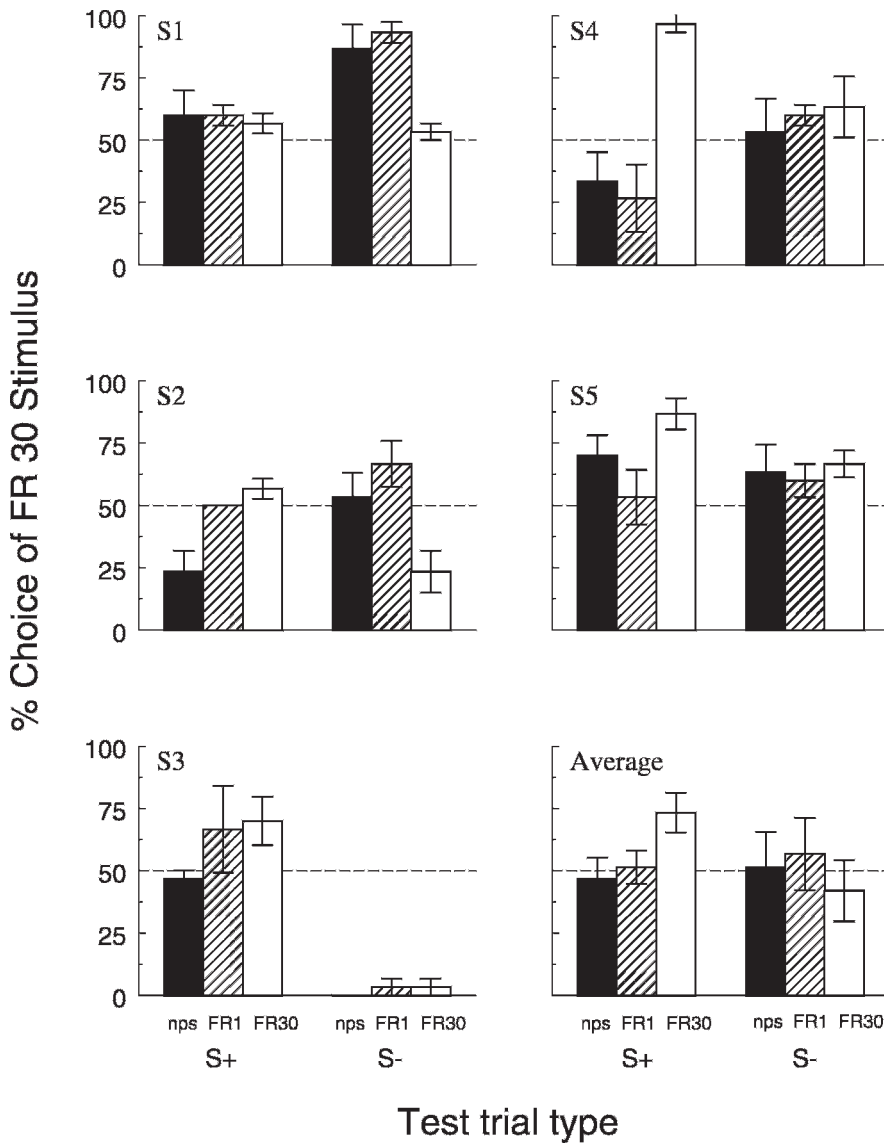


Fig. 1. Average percentage choices (\pm SEM) of the FR 30 stimuli during testing in Experiment 1 as a function of the initial work requirement in testing (none: filled bars; FR 1: hatched bars; FR 30: unfilled bars). Within each panel, the leftmost group of three bars shows percentage choices of the FR 30 S+ and the rightmost group shows choices of S-. Individual data are presented except in the bottom right panel which plots preferences averaged across all subjects and test sessions.

preference for the high-effort S- on trials initiated by an FR 1, FR 30, or no work requirement, $t(4) = 0.45, -0.65,$ and $0.09,$ respectively. In short, the variation in average preferences as a function of the initial-link work requirement in testing did not show a clearly discernible pattern other than a preponderance of "no preference" results.

Collapsed across initial-link requirements, pigeons chose, on average, the high-over low-effort S+ 57.1% of the time and the high-over low-effort S- 50% of the time. Neither preference deviated significantly from chance, $t(4) = 1.59$ and $0.00,$ respectively.

A repeated-measures analysis-of-variance (ANOVA) with trial type (S+ vs. S-) and

initial-link work requirement as factors was also run to evaluate trial-specific preferences. This ANOVA yielded no significant effects of trial type, $F(1, 4) = 0.26$, or initial-link work requirement, $F(2, 8) = 0.50$, but a significant interaction between the two, $F(2, 8) = 10.57$. This interaction likely reflects the significant preference for the high-effort S+ stimulus but not for the high-effort S- stimulus on trials initiated by an FR 30 initial-link requirement.

Visual inspection of Figure 1 indicates that the preference results from Pigeon S3 may have been atypical and, thus, masked an overall effect on the S- preference trials. However, even with this bird removed from the analyses, there was no significant overall preference for the high-effort S-, $t(3) = 1.92$. Excluding this bird also did not change the results of the repeated-measures ANOVA: no significant main effect of trial type, $F(1, 3) = 1.24$, or initial-link work requirement, $F(2, 6) = 1.36$, but a significant interaction between the two, $F(2, 6) = 15.05$. Again, this reflects the specificity of the high-effort S+ preference on test trials initiated by a FR 30 initial-link requirement.

ANOVA on the first-session test results (not shown) revealed no significant effect of trial type or initial-link requirement, $F(1, 4) = 0.31$ and $F(2, 8) = 3.17$, respectively, or of their interaction, $F(2, 8) = 0.51$. Pigeons preferred the high-effort S+ and the high-effort S- 62.2% and 55.6% of the time, respectively, on the first session. Neither preference differed significantly from chance, $t(4) = 1.54$ and 0.42, respectively. The results of these analyses were unchanged when the data from Pigeon S3 were excluded.

These results, once again, underscore the elusiveness of the work-ethic effect and demonstrate that extensive overtraining is insufficient to produce the effect even using a signaled-effort procedure to optimize the chances of observing preference for a high-effort stimulus.

EXPERIMENT 2

Given our repeated failures to find a work-ethic effect in pigeons using the procedure described by Clement et al. (2000), we decided to explore the issue further using a different effort manipulation. In particular, we adapted Kacelnik and Marsh's (2002) effort-based

procedure with starlings. In their experiment, starlings flew back and forth between two perches located 1 m apart either 4 times or 16 times. Food reinforcement was obtained by pecking one hue after 4 flights and by pecking another hue after 16 flights. Periodically, starlings received reinforced probe trials in which they chose between the two S+ stimuli encountered during training. Kacelnik and Marsh found a statistically significant preference for the S+ preceded by 16 flights over the S+ preceded by 4 flights.

In our version of this procedure, we used a "long box" containing two intelligence panels 930 mm apart. Pigeons had to walk from one panel to the other either 4 times (low-effort trials) or 16 times (high-effort trials) in order to obtain a discriminative stimulus that, when pecked, produced food. Different S+ stimuli followed the 4 and 16 runs. Pigeons were then probed for their S+ preferences after different amounts of overtraining. As in Experiment 1 and as in Kacelnik and Marsh's (2002) procedure, different stimuli signaled the different, forthcoming work requirements.

METHOD

Subjects

Four White Carneau pigeons obtained from the same supplier in Experiment 1 and housed and maintained as previously described served in this experiment. All had limited experience unrelated to the present contingencies.

Apparatus

A locally made operant chamber with a standard 3-key intelligence panel (BRS/LVE Model PIP-016) on each end was used. The pigeon's compartment (368 mm high \times 930 mm wide \times 343 mm deep) was equipped with an aluminum grid floor. Three clear plastic pecking keys, 25 mm in diameter and spaced 83 mm center-to-center, were about 250 mm above the floor on each panel. Each key had a BRS/LVE Model IC-901-IDD in-line projector mounted behind it for displaying visual stimuli. The center-key projectors could display a white vertical line and an open white triangle both on a black background (BRS/LVE Pattern No. 696). The side-key projectors could display red and green homogeneous colored fields. Partially covered GE #1829 bulbs located 57 mm above the center key on

each panel served as houselights. Purina ProGrains could be delivered in one of two magazines (one on each panel) which, when raised, were accompanied by lighting a small miniature bulb (ESB-28) in a metal housing that covered them. A 58-mm-square opening centered approximately 130 mm below the center key on each panel allowed access to the back-mounted magazine. Ventilation and masking noise were provided by two continuously running blower fans attached to the chamber. An IBM-compatible 386 computer located in an adjacent room controlled and recorded all experimental events via a locally made interface.

Procedure

Preliminary training. Pigeons were initially trained to obtain food by pecking at the red and green stimuli appearing on either side key of the right panel, with side randomly intermixed within a single session. Next, pigeons were trained to peck the vertical line and the triangle on the center key of both panels. In these 60-trial preliminary training sessions, a single peck to the stimulus on each trial turned it off and produced 3 s access to food on the same panel on which the stimulus appeared. The houselight was on during stimulus presentation and off during food reinforcement and the ensuing 10-s ITI. Only the houselight located on the panel on which the stimuli appeared was operative during these sessions.

Next, birds were taught to alternate (walk) between the two panels. All trials began and terminated on the right panel. At the beginning of each trial, the right houselight and the right-panel center key were lit. A single peck to the center-key stimulus turned it and the right houselight off and lit the houselight and the center key on the opposite (left) panel. Again, a single peck at the left center-key stimulus turned it and the left houselight off and lit the houselight and the center key of the right panel. This cycle was repeated until the required number of runs between the two panels was met. Completion of the requirement turned off the houselight and produced 2 to 6 s access to food, adjusted individually for each pigeon in each session so as to maintain its 80% body weight. There were 60 trials per session separated by a dark 10-s ITI. On half of these trials, the center-key stimulus was the

vertical line; on the remaining half, it was the open triangle. The number of runs required to complete a trial was gradually raised from 2 to 8 across four sessions.

Baseline training I. During baseline training, pigeons had to complete either 4 runs (low-effort trials) or 16 runs (high-effort trials) between the two panels. Each trial began with the onset of the right houselight and the illumination of either a vertical line or an open triangle on the right-panel center key. A single peck terminated this stimulus and the right houselight and lit the left houselight and the left-panel center key with the same stimulus. This cycle repeated up to the last run. On the final run, pecking the left-panel center-key stimulus turned it and the left houselight off and illuminated the right houselight and one of the right-panel side keys (counterbalanced across trials) with either red or green, depending on the running requirement. A single peck to red (or green) turned it and the right houselight off and produced 2 to 6 s access to food, adjusted individually for each pigeon in each session as before. A 10-s ITI with houselights off then commenced.

For half of the pigeons, the red hue appeared on high-effort trials and the green hue appeared on low-effort trials; for the remaining half, these contingencies were reversed. Likewise, for half of the birds, the vertical line appeared on the center keys on high-effort trials and the triangle appeared on the center keys on low-effort trials, and vice versa for the remaining half. The two trial types occurred in a random order with the constraints that each occurred 30 times per 60-trial session and that none occurred more than three times in a row.

Preference testing I. After 25, 50, and 60 baseline training sessions, pigeons received a test session in which they were probed for their preference for the high- versus low-effort S+. Each session included 12 probe-test trials randomly intermixed among 48 baseline training trials, with the constraints that each baseline trial type occurred at least once before the first test trial and that no two test trials occurred in a row. Four test trials were preceded by 4 runs, another four by 16 runs and, on the remaining four, the two S+ stimuli simply appeared on the side keys at the end of the ITI (i.e., no run requirement). On these trials, a single peck to either S+ immediately turned off both stimuli

and the right houselight and produced food with a .5 probability independently of the pigeon's choice. All other details were the same as in baseline training.

Baseline training II. Next, the baseline contingencies were reversed. Both the center-key stimulus and the S+ previously presented on high-effort trials were now assigned to the low-effort trials, and vice versa for the stimuli initially presented on low-effort trials. All other details for these 70 sessions were the same as in Baseline Training I.

Preference testing II. Pigeons were again tested in a single session for their preference between the two S+ stimuli after 20, 50, and 60 baseline training sessions. After 70 sessions, 5 test sessions were given. Details of these sessions were identical to Preference Testing I.

RESULTS AND DISCUSSION

The average latencies to peck the initial, center-key stimulus on low- and high-effort trials over the five training sessions prior to the first test session were 2.65 s and 21.13 s, respectively. This latency difference was significant, $F(1, 3) = 26.86$, as were the corresponding differences for the five training sessions preceding the other two prereversal sessions, $F_s(1, 3) = 56.40$ and 21.87 . After the baseline contingencies were reversed, the average difference in center-key-peck latencies prior to the first test session approached significance, $F(1, 3) = 8.66$, $p = .06$, and was significant for the baseline sessions preceding the remaining test sessions, smallest $F(1, 3) = 11.15$. Overall, these analyses confirm that pigeons could discriminate the forthcoming low- versus high-effort requirement upon seeing the center-key stimulus.

Figure 2 shows each pigeon's preference for the high-effort S+ during pre- and postreversal tests broken down according to the run requirement preceding the appearance of the high- versus low-effort S+ stimuli. We plot the data only from the tests following 25 and 60 (or 70) pre- and postreversal training sessions¹ because repeated-measures ANOVAs

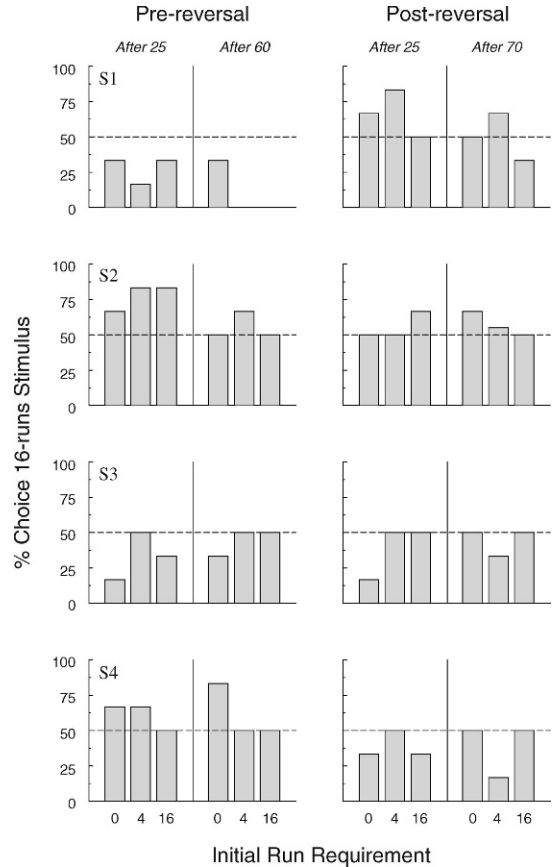


Fig. 2. Percentage choices of the high-effort (16-runs) stimulus for each bird during testing in Experiment 2 as a function of the initial work requirement. The left panel presents preferences after 25 and 60 prereversal training sessions. The right panel presents the data after 25 and 70 postreversal training sessions.

revealed no significant effect of test session, all $F_s < 1.00$ (see Vasconcelos & Uruioli, 2008, Figure 1, for the average results from the remaining test sessions).

The initiating run requirement had no significant effects on the preferences observed in any test, all $F_s(2, 6) < 1.00$. More importantly, there was no consistent between-subject pattern of preference in either the pre- or postreversal tests. Likewise, there was no consistent pattern of preference within subjects in their pre- versus postreversal tests. Throughout a total of 11 test sessions, none of the preferences for the high-effort stimulus deviated significantly from chance, all $t_s(3) \geq -1.57$ and ≤ 1.00 .

¹The data at 70 training sessions after reversal correspond to the first of the five test sessions that were given. A repeated-measures ANOVA with test session and initiating event as factors confirmed that neither had a significant influence on pigeons' choices, $F(4, 12) = 0.28$ and $F(2, 6) = 1.68$, respectively.

In short, extensive overtraining using an adaptation of Kacelnik and Marsh's (2002) procedure for pigeons did not produce significant preferences for a high-effort S+, contrary to Kacelnik and Marsh's findings with starlings. Given that we ran only 4 pigeons (compared to the 12 starlings used by Kacelnik and Marsh), a legitimate concern is that we had insufficient statistical power to detect a work-ethic effect. However, if the variability observed here is indicative of the variability we would have seen with other pigeons, the results would have been substantially the same.

Of course, the use of different species (starlings vs. pigeons) and different responses (fly vs. walk) makes comparisons between experiments complicated. It is known, for instance, that flying costs much more energy than walking for starlings (Bautista, Tinbergen, & Kacelnik, 2001). The issue, however, is how effortful (energetically costly) are different amounts of walking for pigeons and how these map onto different degrees of aversiveness (Zentall & Singer, 2007b). Our manipulation was not predicated on absolute costs but, rather, on the relative aversiveness of walking 16 times between panels in the context of the alternative 4 walks. Shapiro, Siller, and Kacelnik (2008), for example, have found that the latency to accept food sources that differ in amount and delay to reward is affected not only by the rate (amount/delay) associated with the present option, but also by the rate associated with the alternative option. Briefly, latencies to accept a currently presented option increased with higher alternative reward rates. The fact that pigeons were much slower to initiate a high-effort than a low-effort trial clearly indicates that they were sensitive to the different walking requirements. If those latency differences also reflect differential aversiveness, then within-trial contrast should have yielded preferences for the high-effort S+ (e.g., Zentall & Singer, 2007b). But no such preferences were observed.

GENERAL DISCUSSION

In two different paradigms, we examined the possibility that pigeons would show preferences for stimuli following high effort over stimuli following low effort if they received extensive overtraining after discrimination acquisition (Experiment 1) or extensive train-

ing with singly presented S+ stimuli (Experiment 2). Experiment 1 was closely modeled after Clement et al.'s (2000) procedure with two exceptions. First, work requirements were signaled. According to Zentall and Singer (2007b), this should increase the chances of observing such preferences. Second, an FR 30 instead of an FR 20 was used as the initial-link requirement on high-effort trials, increasing the disparity between the high- and low-effort trials. Experiment 2 used an effort-based manipulation that had previously proven effective in producing preferences for a high-effort S+ in starlings (Kacelnik & Marsh, 2002). Our version of their procedure required pigeons to walk from one end of a long box to the other end different numbers of times (again, signaled by different initial-link stimuli) in order to obtain the terminal-link S+ stimuli. The results of these two experiments were exactly the same: Pigeons did not exhibit an overall preference for the high-effort discriminative stimuli from training.

There was some variation in preference as a function of the initial-link requirement, but this was mostly inconsistent across pigeons. Indeed, the only statistically significant variation was found in Experiment 1 where pigeons preferred the high- over low-effort S+ when those stimuli appeared after the high-effort (FR 30) requirement. This suggests that training may have resulted in a conditional discrimination in which choice of a particular S+ was cued by the initial-link requirement that preceded it. But even here, the data are inconsistent given that there were no corresponding preferences for the low- over high-effort S+ when they appeared after the low-effort (FR 1) or no requirement. Preference variations as a function of initial-link requirements have been previously noted by us (Vasconcelos et al., 2007) and by Arantes and Grace (2008), but neither a consistent nor a single pattern emerges. Coupled with the lack of such variation in Clement et al. (2000), there does not appear to be a reliable effect here either, which should not be surprising given that successful baseline performances did not require a conditional discrimination.

One might surmise that our findings of no overall preference simply mean that what we call "low effort" and "high effort" are, in fact, not functionally different for pigeons. This concern can be answered in a number of ways.

First, if these schedules are not functionally different along the dimension(s) important for within-trial contrast (Zentall & Singer, 2007b), then this clearly supports our contention (Vasconcelos et al., 2007) that the original claim of a work-ethic effect in pigeons (Clement et al., 2000) was a Type I error. It would also bring into question the reliability of other, similar findings (e.g. Friedrich & Zentall, 2004). Second, number of pecks necessary to complete the high-effort (FR 30) requirement in Experiment 1 was 50% greater than the number of pecks necessary to complete the high-effort (FR 20) requirement in Clement et al. (2000) and our attempted replications of that study (Vasconcelos et al., 2007, Experiments 1 through 4). This increase should enhance the probability that the two initial-link schedule requirements would be functionally different. Third, the literature indicates that a large FR requirement has aversive qualities for pigeons, especially when alternated within a session with a smaller FR requirement (Flory, 1969; see also Azrin, 1961, and Thompson, 1965). In view of this, it would be rather surprising if there were no differential aversiveness associated with a 30:1 difference in signaled initial-link work requirements. Moreover, we observed that the pigeons in Experiment 1 often paused for very lengthy periods of time on FR 30 trials (indeed, one pigeon had to be dropped from the experiment because it routinely stopped responding altogether on these trials), indicating a clear difference between this schedule and the FR 1 schedule.

Questions about functional differences, or lack thereof, may be even more apropos to Experiment 2. Here, our manipulation was predicated on the assumption that walking back and forth between the ends of a long box 4 versus 16 times for pigeons was akin to flying back and forth 4 versus 16 times between perches for starlings (Kacelnik & Marsh, 2002). The two types of responding may be vastly different in energetic consequences, as we previously acknowledged, but we can rest assured that the work requirement difference for pigeons was large enough to have a major effect on their behavior: They took eight times longer, on average, to initiate walking on the high-effort trials than on the low-effort trials. Indeed, this measure allows us to avoid the circularity of postulating differential aversive-

ness on the basis of the very preference results that those differences are meant to explain. Of course, we did not obtain the predicted preference for a high-effort S+ (Zentall & Singer, 2007b) despite pigeons' long-latency reactions to the initial-link stimulus that signaled it.

Both sets of results are consistent with previous findings (Arantes & Grace, 2008; Vasconcelos et al., 2007) and indicate that contrary to Zentall and Singer's hypothesis (2007a), insufficient overtraining is not responsible for failures to replicate the work-ethic effect in pigeons. Zentall (2008) has recently argued that previous experience with lean schedules of reinforcement may be another factor contributing to the null findings that we and others have reported. Again, both experiments reported here speak against this argument given that our pigeons had either no prior experimental history (Experiment 1) or had experience with matching-to-sample (Experiment 2) which, at asymptote, involves nearly continuous reinforcement.

At least three different sets of researchers have now reported a failure to replicate the work-ethic effect in pigeons: ourselves (Vasconcelos et al., 2007; the present experiments), Arantes and Grace (2008) and Colombo (personal communication, July 2, 2008). In closing, we should point out that the natural reaction of wondering why the effect is found by some (e.g., Clement et al., 2000) but not by others presupposes that there is an effect to be found. However, if the original work-ethic demonstration was indeed a Type I error, there is no effect to be found and no conflict exists other than that occurring by chance.

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