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SELF-CONTROL IN PIGEONS UNDER THE MISCHEL PARADIGM

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Walter Mischel studied self-control in preschool children in the following manner: if the child waited for an interval to end, he or she received the more preferred of two reinforcers; if the child responded to terminate the interval by ringing a bell, the less preferred reinforcer was given. We used an analogous procedure to study self-control in pigeons: if the bird waited for a trial to end, it received the more preferred reinforcer; if the bird terminated the trial by pecking a key, the less preferred reinforcer was given. We explored the effects on self-control of a number of variables analogous to those studied by Mischel and co-workers, e.g., presence versus absence of reinforcers, of alternative responses, and of stimuli during the wait interval; prior experience of the subjects; and test paradigm. The results obtained with pigeons paralleled the results obtained by Mischel with human children.

Key words: delayed reinforcement, reinforcers as stimuli, alternative response, delay of gratification, conditioned reinforcement, choice, key peck, pigeons

Experimental psychologists have often investigated simple units of animal behavior, such as the conditioned reflex (Pavlov, 1927) or the operant contingency (Skinner, 1938) and then combined these units in attempting to explain complex animal and human behaviors (e.g., Skinner, 1953). An alternative procedure for studying behavior, used originally by ethologists but increasingly by experimental psychologists, has been to start with complex human activity and seek direct analogues or homologues in animal behavior (e.g., Lorenz, 1974). For example, love was identified in rhesus monkeys (Harlow, 1971), and language in the chimpanzee (Premack, 1971; Gardner & Gardner, 1971), classes of behavior that had been thought by many to be unique to humans. The present experiment explores an animal model of self-control, another class of behavior often thought to be uniquely human (Klausner, 1965).

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Two major studies of self-control in pigeons evolved from the Skinner "simple unit" approach (Navarick & Fantino, 1976; Rachlin & Green, 1972). Self-control, exemplified by choosing a large delayed reinforcer rather than a small immediate one, was hypothesized to derive from basic principles of choice performance under concurrent schedules of reinforcement. These analyses emphasized reinforcement contingencies commonly studied with animals. The present series of experiments used the alternative, ethologically derived "analogue approach" in an attempt to parallel, with pigeons as subjects, an elegant series of experiments performed by Walter Mischel and co-workers on self-control in children (Mischel, 1974). In his basic procedure, Mischel gave children a choice between a more preferred reward, e.g., a pretzel, and a less preferred reward, e.g., animal crackers. The child received the preferred pretzel as reward at the end of a trial in which he or she sat quietly at a desk and waited for the experimenter to return to the room, this occurring after 15 minutes of absence from the room. The less preferred animal crackers were received if the child terminated the trial by ringing a small bell, causing the experimenter immediately to return. Mischel described important influences determining how long children could wait in this self-control task. To

parallel the Mischel procedure with pigeons as subjects, we replaced the bell with a lighted key which the pigeon could peck and replaced the pretzel and animal crackers with two food hoppers, one containing more preferred food and the other less preferred food. If the pigeon waited until a predetermined period elapsed, the more preferred food was given. As with the children, the pigeon could terminate the trial at any time by pecking the key, but as consequence it received the less preferred reward. The main questions were whether pigeon and human self-control are similar and whether both are influenced by similar variables.

GENERAL METHOD

Subjects

Eight White King pigeons (1, 2, 3, 4, B, D, Y14, and Y20) were maintained at 80% of their free-feeding weights by supplementary feeding of mixed pigeon grain after each experimental session. All had previous experience under a variety of reinforcement schedules. They were housed individually in 1-ft cubed compartments with water and grit always available.

Apparatus

The experimental chamber, 30 by 41 by 32 cm, contained a Gerbrands response key in the center of the front wall. The key could be transilluminated with a 7.5-W red light and required 30-g force (.3N) to be operated. Located below the key was a Gerbrands food hopper and 4 cm to the right of this hopper was a second identical hopper. Both hoppers had Plexiglas doors attached, so that when a pigeon placed its head in the hopper, a microswitch was operated. The center hopper could be illuminated with a 7.5-W blue light and the right hopper with a 7.5-W green light. The chamber was illuminated from above by two 7.5-W white bulbs. An outer box provided partial sound and light isolation, and an exhaust fan provided additional sound masking. Electromechanical equipment controlled the experiment from an adjoining room.

Procedure

Pilot study had shown that pigeons preferred mixed racing grain, normally used in operant conditioning experiments, to what will be referred to as "Kasha grain", consisting of 40% chicken starter, 40% crushed rat food, and 20% buckwheat groats. Preferences were tested initially and at intervals throughout the experiment by presenting two containers of food in the home cage, one containing mixed grain, the other Kasha grain. When given this choice, the pigeon almost invariably ate the mixed grain first. However, when presented with the Kasha grain alone, the pigeon would readily eat this too. The mixed grain was used as the more preferred reinforcer and the Kasha grain as the less preferred.

In the basic procedure, the pigeon was given a choice: if it pecked the illuminated key, it obtained immediate access to Kasha grain, the less preferred reinforcer; if the pigeon waited and did not peck the key, it eventually gained access to mixed grain, the more preferred reinforcer. A typical trial began with the simultaneous illumination of the red keylight and the white overhead lights. This signaled the beginning of a trial, during which a single peck to the key was immediately followed by a 1.5-sec access (timed from when the pigeon placed its head through the hopper door) to the Kasha grain delivered in the right hopper. A peck also darkened and inactivated the key and houselight. If the pigeon did not peck the key for a predetermined wait interval, generally 15 or 20 sec, the interval terminated with 3-sec of access (again timed from when the pigeon opened the Plexiglas hopper door) to mixed grain, presented in the center hopper. Again, the key and houselight were darkened and inactivated upon presentation of the reinforcer. Thus, the less preferred reinforcer was contingent upon a keypeck response and the more preferred reinforcer was contingent upon waiting and not responding. When either the more or less preferred reinforcer became available to the bird, a 1320-Hz, 80-dB tone was sounded. Following either reinforcer was a 20-sec intertrial interval during which the chamber was totally dark and after which a new trial began with illumination of key and overhead lights. A typical session consisted of 30 of these trials.

All subjects were trained under the following self-control contingencies prior to participating in the experiments to be described below. The pigeon was first allowed to peck the lighted key for Kasha grain reinforcement (without the possibility of receiving mixed grain). Once the pecking response was emitted consistently, a short wait interval of 1 to 2 sec

was introduced. If the pigeon did not peck during this interval, the more preferred reinforcer was given. After a subject experienced the more preferred reinforcer for waiting and the less preferred reinforcer for pecking, the wait interval was gradually lengthened to 15 sec.

EXPERIMENT 1

Mischel and Ebbesen (1970) asked whether permitting a child to see more and less preferred rewards would increase the length of time they could control themselves. Using the procedure described in the Introduction—where the child received a preferred reinforcer for waiting until the experimenter returned to the room or the less preferred reinforcer for ringing a bell and bringing the experimenter back—Mischel and Ebbesen compared two conditions. In one, the more and less preferred reinforcers—pretzels and animal crackers—were placed in a cake tin and left open for viewing in the experimental room where the child waited; in the other, the reinforcers were absent. Based on psychoanalytic and other theory, the authors hypothesized that the reinforcement-present condition would engender increased self-control, i.e., the children would wait longer. However, the opposite result was found. When both rewards were present, the children waited an average of only 2 min before ringing the bell; when the reinforcers were absent, they waited significantly longer, an average of approximately 12 min (out of a maximum of 15 min). The present experiment attempted to determine whether pigeons reacted as did children to the presence of reinforcers during a self-control task.

Method

Subjects

Pigeons 1, 2, 3, and 4 served.

Procedure

There were three phases: reinforcers present during the wait interval, reinforcers absent, and a return to reinforcers present. In the first phase, the pigeons were permitted to view both more and less preferred reinforcers: the more and less preferred hoppers were activated and illuminated throughout the wait interval. Although the pigeon could look at the reinforcers, eating was prohibited in the following way: if the hopper door was opened during the wait interval, the hopper was immediately inactivated and the 20-sec intertrial interval began. (In the Mischel and Ebbesen experiment, the children were not permitted to eat the reinforcers during the wait interval, and so doing terminated the trial.) The trial was then repeated until the pigeon either pecked and received less preferred reinforcement or waited and received more preferred reinforcement. To assist the birds to discriminate between periods of reinforcement present for view only and periods of reinforcement present for eating: (a) the 1320-Hz tone was present during the eating period but not during the wait period; (b) the key and houselight were dark during eating and lighted during waiting; and (c) only one hopper was operated during eating whereas both were operated during waiting. In the second, or reinforcement-absent phase, the procedure was identical to above except that the hoppers were not activated during the wait interval. The third phase was a return to the reinforcement-present condition.

Throughout the experiment, the length of the wait interval alternated between 5 sec and 15 sec so as to increase the probability that each subject would experience both immediate less preferred and delayed more preferred reinforcers during each session. In the pilot study it had been found that the birds generally waited for the more preferred reinforcer when the interval was 5 sec whereas they often pecked when the interval was 15 sec. The birds were exposed to each phase for 10 to 20 sessions, or until their behavior was stable. Each session consisted of 30 trials. The main dependent variable was the percentage of trials that the bird waited and received the more preferred reinforcer.

Results and Discussion

Two subjects did not complete the experiment and their data are not presented: Pigeon 4 was discontinued because it consistently failed to eat the less preferred reinforcer when offered in the experimental chamber; Pigeon 3 continually put its head in the activated hopper during the wait interval of the reinforcement present phases, thereby prohibiting measurement of pecking versus waiting. The other two birds also occasionally put their heads into

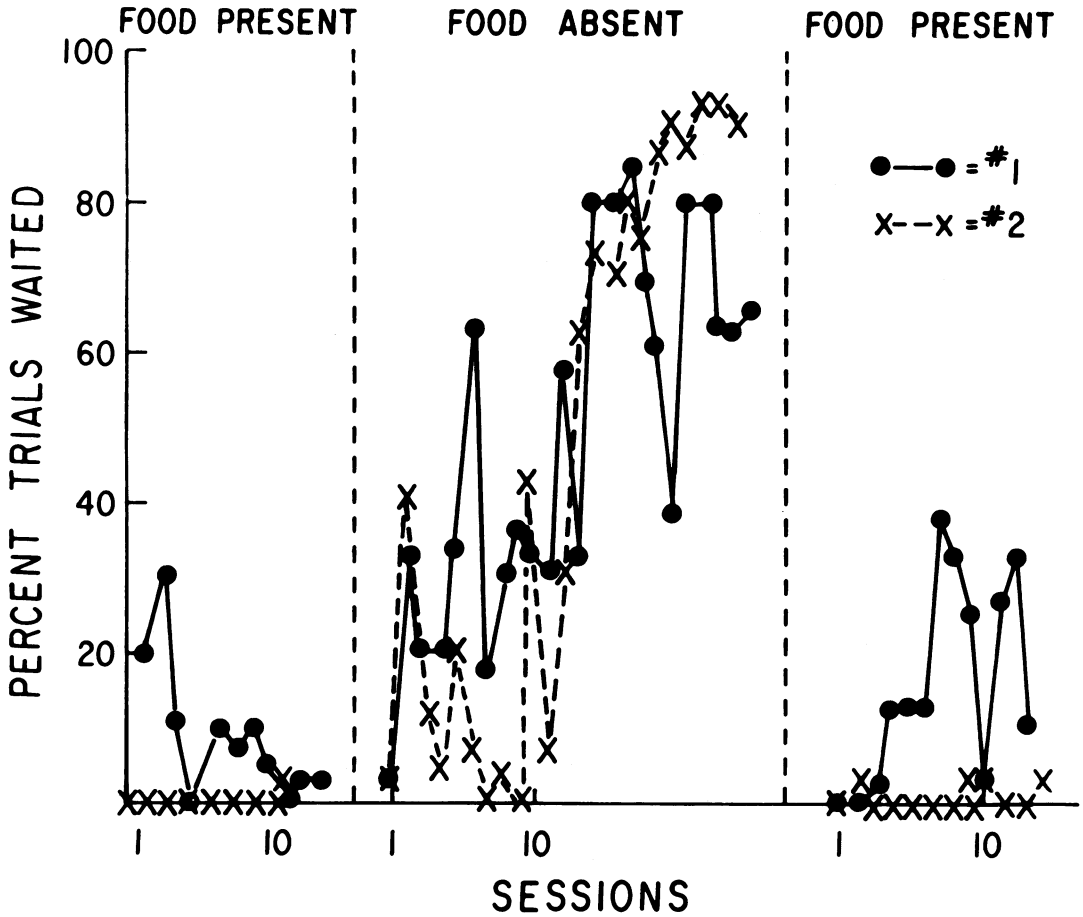

Fig. 1. Percentage of trials pigeons waited successfully and received the more preferred of two rewards. In the first and third conditions, rewards were present for view during the wait period; in the second condition, rewards were not present during the wait period.

the hopper during the reinforcement present phases, but relatively infrequently.

Pigeons 1 and 2 showed a clear effect of presence versus absence of reinforcement during the wait interval (Figure 1). The birds waited successfully an average of 6.6% of the trials during the last 3 sessions of both reinforcement present conditions whereas when reinforcement was absent, the birds waited successfully, over the last 3 sessions, during an average of 83.5% of the trials. These results are similar to the Mischel and Ebbesen results where none of the children waited successfully when both rewards were present and 75% waited successfully when rewards were absent.

One might have hypothesized that pigeons would wait longer, or show greater self-control, when reinforcers were present for viewing than when they were absent, because the reinforcers possibly would cause superstitious behavior to be directed near the hoppers (and consequently away from the response key) and thereby would increase the time before pecking. Indeed, the presence of the reinforcers during the wait interval often caused the birds to approach and look into the hoppers. But, except for the instances in which this behavior was followed by an attempt to eat the reinforcer (and, consequently, a termination of the trial), approach to the hopper was generally quickly followed by a peck to the key, thereby resulting in the decreased self-control similar to that found by Mischel and Ebbesen with children.

Mischel and Ebbesen discussed their findings in terms of frustrative nonreward theory (e.g., Amsel, 1962; Wagner, 1966), and their analysis can be applied to the present case. The wait

period is made relatively more aversive when the salience of the preferred, presently unobtainable reward is increased by presenting it for view during the wait interval.

> "In part, attending to the rewards in the waiting paradigm may be aversive, because it increases the frustration of anticipating the attainment of a blocked reward; in part it may be frustrative, because it enhances the aversiveness of the waiting situation and accentuates the ongoing decision conflict" (Mischel & Ebbesen, 1970, pp. 335-6).

An alternative interpretation derives from an analysis of the specific contingencies present in both Mischel and Ebbesen and the present case. If a bird put its head into the operated hopper, it thereby terminated the trial, produced a 20-sec intertrial timeout and, in effect, engendered the complete absence of reinforcement. By pecking the key, the bird avoided this last outcome and received immediate, albeit less preferred reinforcement. With Mischel and Ebbesen's children, too, the instructions prohibited eating the rewards during the wait interval, and when that rule was broken the subject was removed from the experiment (Mischel, Ebbesen, & Zeiss, 1972). In both cases, therefore, when reinforcers were present for viewing, the subjects may have pecked or pressed in part to avoid the possibly punishing consequence of trial termination and no reinforcement. A general conclusion is that both children and pigeons behaved counter to prediction, and behaved in precisely the same manner: both responded for an immediate albeit less preferred reinforcer much sooner when both preferred and less preferred reinforcers were present for view than when they were absent.

Although our results were analogous, one difference between the Mischel and Ebbesen and present paradigm should be noted. In the former, each child received only a single self-control trial, and performances of children in different groups—with reinforcers present versus absent—were compared. In the present case, each subject received more than 600 self-control trials. Since the presence of the reinforcers continued to adversely affect the birds' self-control performances, the results can be considered comparable, despite the methodological difference.

EXPERIMENT 2

Mischel, Ebbesen, and Zeiss (1972) hypothesized that if self-control is decreased when children attend to the reinforcers, as in Experiment 1, then drawing the children's attention away from the reinforcers might increase self-control. Using basically the same procedure as described above in the Mischel and Ebbesen (1970) study, Mischel et al. (1972) gave one group of children a slinky toy to play with during the wait interval whereas another group had no toy. Confirming the hypothesis, presence of the toy appreciably increased the children's self-control, i.e., they waited significantly longer and obtained more preferred reinforcers. The present study asked whether analogous results could be obtained with pigeons.

Method

Subjects

Pigeons 1 and 2 served.

Apparatus

Same as above with the addition of a Gerbrands 45-mg pellet dispenser and Gerbrands response key on the rear wall of the chamber (opposite the wall containing the self-control key and two hoppers). The pellet dispenser delivered Noyes pigeon pellets. The key, located 22 cm above the floor and occasionally transilluminated by a 7.5-W orange light, required pecks of at least 30-g force to be operated.

Procedure

The pigeons were trained to peck the rear key by the experimenter reinforcing with Noyes pellets successive approximations to the peck response. After conditioning, the schedule of reinforcement was increased to a fixed ratio 20 (FR 20) for about 75 reinforcements. When the birds were pecking the rear key consistently, the two front hoppers were activated and illuminated while the FR 20 on the rear key remained in effect for 25 additional reinforcements. Opening the doors resulted in the hoppers being inactivated.

The experimental condition then began and consisted of three procedures. Under the "no toy" procedure, the rear key was covered with black tape, pellets were never given in the rear, and the basic self-control procedure with reinforcers present described in Experiment 1 was

in effect. Throughout this experiment, both more and less preferred hoppers were activated during the wait interval. Under a second, or "toy plus FR 20" condition, the rear key was present and illuminated during the wait interval, and every 20th peck to the rear key was reinforced with a pellet. In all other respects, the procedure was identical to the "no toy" procedure. Thus, this procedure assessed self-control when an alternative response and alternative reinforcer were available during the wait interval. In the third, or "toy, no reinforcement" procedure, everything was identical to that in the "toy plus FR 20" condition except that pellets were never given contingent upon rear keypecks. The rear key was illuminated during the wait interval, pecks could occur to it, but the pecks were never reinforced. Here we assessed the effects on self-control of an alternative response when that response did not engender extrinsic reinforcement.

The two subjects experienced the procedures in different orders: Pigeon 1 received "toy plus FR 20", "no toy", "toy, no reinforcement" and a final phase of "no toy", in that order. Pigeon 2 received "no toy", "toy plus FR 20", "toy, no reinforcement" and, again, a final phase with "no toy." Five to 8 sessions were conducted under each procedure.

Results and Discussion

Figure 2 shows that the presence of an alternative response key during the delay period appreciably increased self-control in both birds, For purposes of presentation, the order in the figure is different from the order with which Pigeon 2 received the different procedures. When the alternative response key was absent, i.e. the "no toy" condition, both birds waited successfully during an average of only 4% of the trials and consequently rarely obtained the more preferred reinforcer. Self-control was dramatically improved when the rear key was

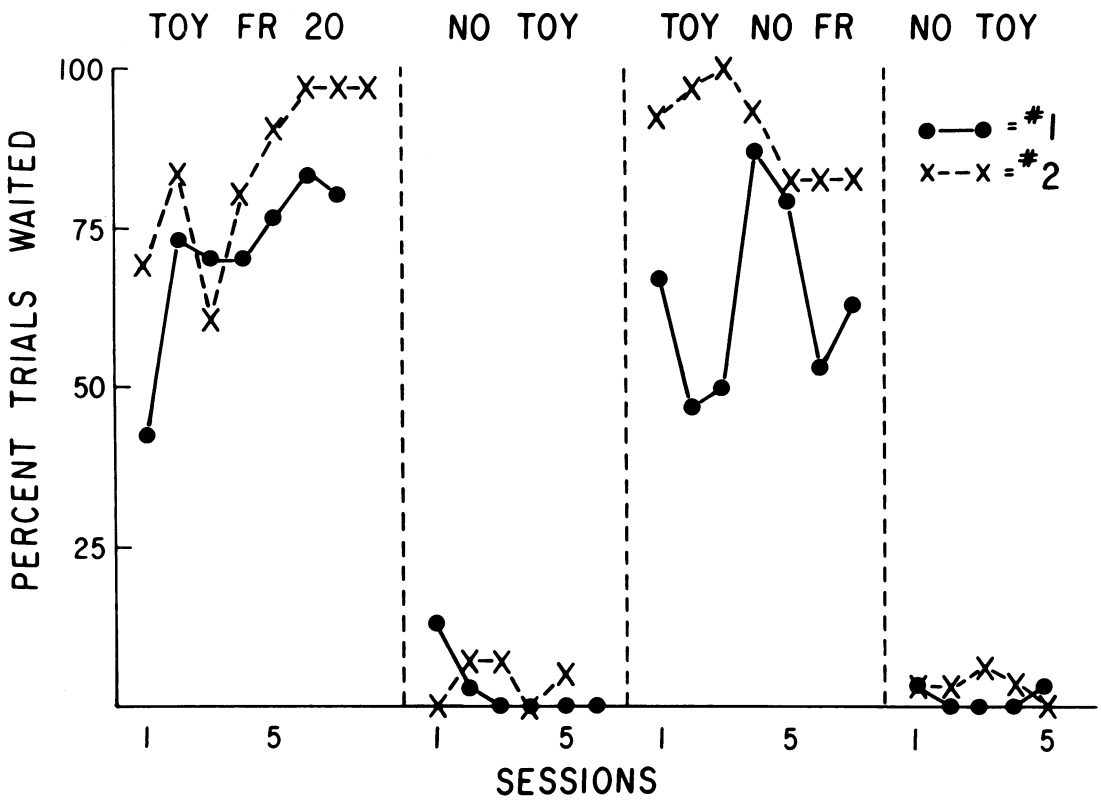

Fig. 2. Percentage of trials pigeons waited and received the more preferred reward as a function of availability of an alternative keypeck response. Under Toy FR 20, every 20th response to the alternative key was reinforced; under Toy No FR, the alternative keypecks were not reinforced; and under No Toy, the alternative key was not present.

available for pecking, and this improvement was similar whether or not pellets were contingent upon pecking the rear key. For the "toy plus FR 20" condition, the birds waited during an average of 78% of the trials; for the "toy, no reinforcement" condition they waited an average of 76% of the trials. Frequencies of responses to the rear key were similar in the FR 20 and no reinforcement conditions and, in both, they increased over sessions: an average of 362 responses per session were emitted to the rear key during the first three "toy plus FR 20" sessions and these increased to 403 responses per session during the last three sessions; and 468 responses per sessions were emitted during the first three "toy, no reinforcement" sessions and these increased to 567 responses per session over the last three sessions.

In other studies as well as the present, the availability of an alternative response increased the likelihood of reinforcement under schedules which require that the subject delay or withhold responses. Zuriff (1969) showed this under differential reinforcement of low rate schedules, Schwartz and Williams (1971) under discrete-trial spaced-responding schedules, and Williams and Williams (1969) under negative automaintenance schedules. In these cases, as in the present "toy, no reinforcement" condition, extrinsic reinforcement was not contingent upon emission of the alternative response. The increased probability of reinforcement engendered by responding on the alternative manipulandum presumably reinforced those responses.

EXPERIMENT 3

Most of Mischel's research emphasized the study of how cognitive variables influence self-control in children. In one study, Mischel, Ebbeson, and Zeiss (1972) instructed children to think about the more and less preferred rewards for which they were waiting, i.e., the children were told to "think of the marshmallow and pretzel (the more and less preferred rewards used in that experiment) for as long as you want." Telling the children to think about the rewards significantly decreased the waiting time when compared with a control condition in which there were no instructions to think. Thus "thinking" about the rewards had a detrimental effect similar to the actual presence of the rewards during the wait interval (see Experiment 1). The present experiment attempted to see if an analogous effect occurred in the pigeon. In place of the verbal directions to "think about" the rewards, we provided stimuli which had been correlated with the rewards, illumination of the food hoppers. The main question, then, is whether such conditioned stimuli, when presented during the wait interval, caused self-control to decrease in pigeons.

METHOD

Subjects

Pigeons 2, 3, D, and Y20 served.

Apparatus

Same as described in Experiment 1.

Procedure

The birds were first given 10 trials of initial "warm up": the self-control contingencies as described above were in effect but the wait interval varied randomly between 5 sec (an interval waited by the birds almost all of the time) and infinity (an interval impossible to wait). Thus, the subjects received the more and less preferred reinforcers approximately 50% of the time and made contact with both experimental contingencies.

Each bird was then exposed to a single session consisting of 30 self-control trials. On 7 of these trials, randomly interspersed, both the more and less preferred hoppers were illuminated with their appropriate hopper colors for the duration of the wait interval. Note that the hoppers were not activated and, unlike Experiment 1, food was not presented for view. The pigeon was allowed to look at the hopper but could not put its head into hopper since opening the hopper door resulted in the 20-sec intertrial period after which the trial was repeated. The remaining 23 trials were identical except that the hoppers were not illuminated during the wait period. The wait time required for more preferred reinforcement was a constant 20 sec for all trials, a time estimated to be one that subjects could wait on some but not all trials. The houselight was dark throughout the experiment (to make the hopper lights more salient), and the initiation of a trial was signaled only by red illumination of the key. In this and the following experiments, the main dependent variable was

changed to the average time per trial waited (rather than percentage success as in Experiment 1 and 2). The two variables are correlated, but time was found to be more sensitive. (Individual time data were not available in the first two experiments.)

Results and Discussion

Figure 3 shows time waited by each of the four birds under the two conditions—hoppers not lighted (points) and hoppers illuminated during the wait interval (X's). Each of the birds waited, on the average, less time when the hoppers were illuminated (overall average of 6.2 sec) than when they were dark (overall average of 10.7 sec). The average wait times in each of the two conditions for each of the four subjects were used in a paired t-test which showed a statistically significant difference between the two conditions ($t = 7.947$, df $= 3$, $p < .005$, 2-tailed).

These results are consistent with the Mischel et al. (1972) findings that instructing his subjects to "think about the rewards" caused a decrease in wait time by children, this decrease being similar to the decrease due to the presence of the rewards themselves. The hopper lights may have affected performance because the birds were "thinking" about the primary reinforcers. An alternative interpretation, similar to that given for the results of Experiment 1, is that if the birds opened the hopper doors during the wait interval, the trial immediately terminated and a 20-sec intertrial period followed. Since hopper illumination engendered attention to, approach towards, and occasional opening of the hopper doors, the illumination was correlated with timeout and no reinforcement. Thus, the hopper lights might have served as a cue for conflict—opening hopper door is sometimes followed by food and sometime by timeout—and the birds consequently responded to the key to escape from the cue.

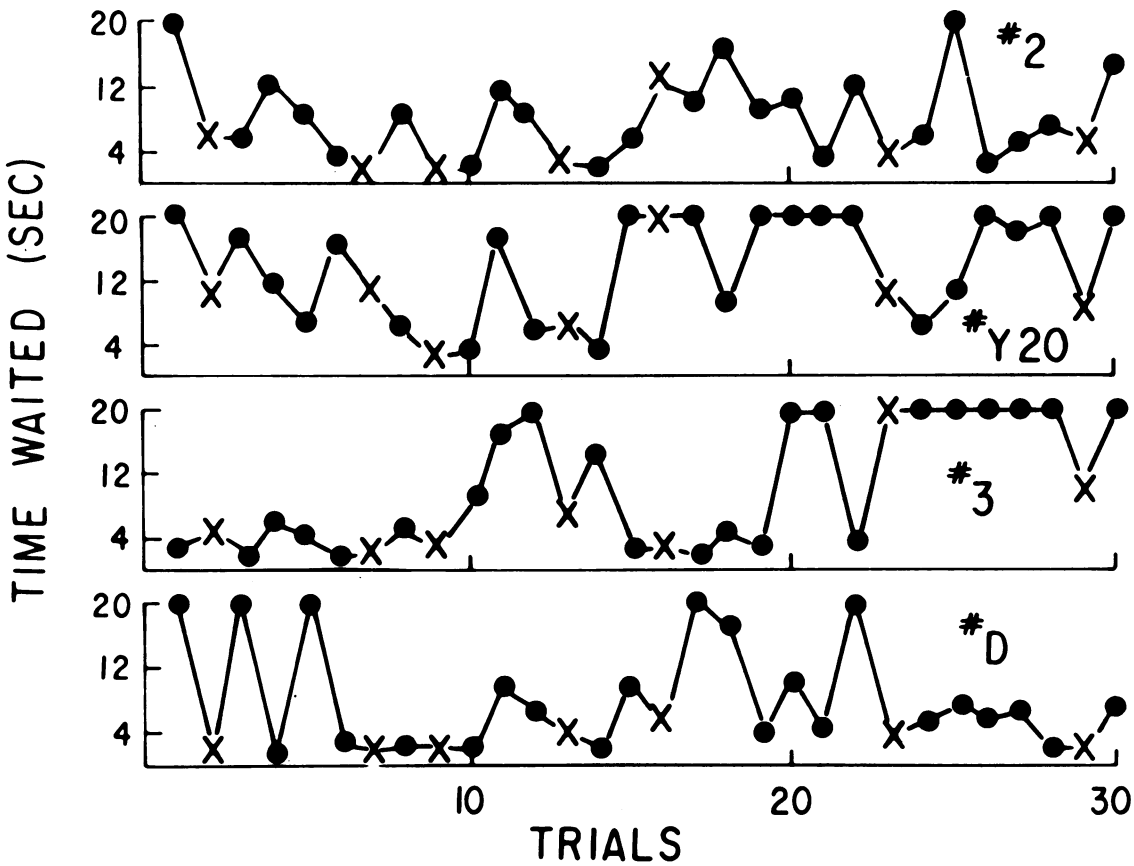

Fig. 3. Amount of time waited without pecking during each trial. On trials shown by dots, the hoppers were dark and inoperative during the wait interval. On trials shown by X's, hoppers were illuminated during the wait.

EXPERIMENT 4

The preceding experiment may have confounded two aspects of the hopper light cue: first, during reinforcement the hopper illumination preceded and was correlated with eating food, and the lights therefore served as a conditioned positive stimulus; however, because opening the hopper doors during the wait period engendered 20 sec of timeout, the same hopper lights might have served as a conditioned aversive stimulus. To separate these two possible effects, overhead lights not previously associated with the hoppers were employed, with one light being established as an unconfounded conditioned positive stimulus (S+) and the other as an unconfounded conditioned aversive stimulus (S−). The effects of presenting an S+ or S− stimulus on self-control performance were then separately assessed.

In a possibly analogous experiment (Mischel et al., 1972), one group of children was instructed to think about a "fun" event during a self-control trial; a second group was told to think about a "sad" event. With rewards presented for view during the delay period (as in Experiment 1), thinking sad thoughts increased self-control slightly whereas thinking fun thoughts increased self-control appreciably. There was a statistically significant difference between waiting times under the two conditions. We therefore predicted that the S+ stimulus, when presented to pigeons during the waiting period, would engender longer waiting than the S− stimulus.

Several procedural changes from the preceding experiments were required. The birds received preliminary experience with an overhead S+ stimulus which cued food reinforcement and a second overhead S− stimulus which cued timeout. The effects on self-control were assessed by occasionally presenting these stimuli during the wait interval of the self-control paradigm. Lockable hopper doors were constructed so that, during the wait intervals, the birds could look at the food; indeed, they could peck at or otherwise attempt to open the Plexiglas hopper doors, but the doors would not open until more or less preferred reinforcement was available following a successful wait or a peck to the key. Under these conditions, the S+ stimulus never preceded timeout, and the S− stimulus never preceded food. The main question was whether a stimulus correlated only with a positively reinforcing consequence would affect self-control differently than a stimulus correlated only with an aversive consequence.

METHOD

Subjects

Pigeons 1, 3, B, and Y20 served.

Apparatus

Same as above with two exceptions. First, eight orange 7.5-W bulbs were positioned above the chamber ceiling, four along the left wall and four along the right wall. Flashing one set of these lights was to serve as an S+ stimulus and flashing the other set as an S− stimulus. Second, the hoppers were modified so that an electromechanical device could automatically lock the door. When unlocked, the Plexiglas door was free to swing open, as in the previous experiments. The appropriate door was unlocked only during presentation of reinforcement.

Procedure

Subjects first received discrimination training in which, with the self-control key dark, 5 sec of flashing of the left overhead lights served as an S+ stimulus and 5 sec of flashing of the right lights served as S−. The S+ was followed by 3 sec of access to the more preferred food hopper and the S− was followed by 30 sec of timeout during which the chamber was totally dark. Both food reinforcer and timeout occurred independently of any behavior as did the onset of each of the stimuli. On the average of once each 30 sec, S+ or S− was presented, the order being random. The S+ and S− stimuli flashed at different rates: Pigeons B and Y20 were exposed to S+ stimuli which flashed at a rate of 10 flashes per sec and to S− stimuli which flashed one flash per sec. The order was reversed for Pigeons 1 and 3; i.e., the fast flashing light was correlated with S− and the slow flash with S+. Each subject was exposed to 10 sessions of this discrimination training, with each session containing 80 food presentations and 80 timeouts.

Following this preliminary training, each bird was given 5 sessions, each of which consisted of two phases: during the first phase, 40 S+ and 40 S− discrimination training trials were presented, as just described. During the

second phase of each session, there were 30 standard self-control trials where waiting resulted in access to the more preferred reinforcer and pecking the lighted key resulted in access to the less preferred reinforceer. To assess the influence of S+ and S− stimuli on self-control, on the average of once every three trials, either the S+ or S− stimulus was flashed for the duration of the wait interval (or until the bird pecked the key). Thus, during these wait periods, in addition to the response key being illuminated, the overhead lights (left or right) were flashing (rapidly or slowly). Reinforcement depended, however, solely on the behavior of the birds: if they waited successfully, more preferred reinforcement was given; if they pecked, they received less preferred reinforcement. The intervening trials were control trials during which there were no flashing lights. The wait interval was a constant 15 sec and the more and less preferred reinforcement hoppers were activated and illuminated throughout all wait intervals so as to maintain the parallel with the Mischel et al. (1972, Experiments 1 and 2) condition. However, unlike in the previous experiments, access to the rewards during this interval was prevented by the locked hopper doors. Each session consisted of 5 trials with S+ flashing, 5 trials with S−, and 20 control trials.

Results and Discussion

Figure 4 shows ratios for each bird during each session of the average time waited in S+ relative to time waited in control (S+ wait time divided by control wait time) and average time waited in S− relative to the same control time. There was a small and inconsistent effect of the S− stimulus on relative waiting, i.e., the ratios were approximately 1.0. However, all birds waited approximately twice as long during the first session when S+ was flashing than during the control trials; this ratio decreased across the five sessions. A paired t-test showed a highly significant difference in relative waiting time during S+ and S− stimuli in the first session ($t = 8.2405$, $df = 3$, $p < .005$, 2-tailed), but no significant differences in any of the ensuing sessions. During the S+ stimuli, birds occasionally oriented to the overhead flashing lights, but it was more common for them to wait quietly. During the S− stimuli, the birds appeared to be more agitated than during S+.

The results of this experiment appear to be inconsistent with the results of Experiment 3. There it was shown that when the hoppers were illuminated during the delay interval, a significant *decrease* in self-control occurred. Hopper illumination is, of course, a visual stimulus correlated with reinforcement. In the present case, when 5 sec of overhead illumination preceded reinforcement, the overhead illumination was found to *increase* self-control. The differences in results may partly be due to the specific contingencies involved. In Experiment 3, attention was drawn to the hoppers; furthermore, opening the hopper door resulted in a timeout period. In Experiment 4, attention was drawn away from the hopper, and opening the hopper door was impossible. Thus, whereas the S+ (hopper illumination) in Experiment 3 was sometimes followed by an aversive event (timeout) the S+ in Experiment 4 (overhead flashing lights) was never followed by an aversive event. By not pecking the key, the subjects in Experiment 4 maintained an unconfounded conditioned positive reinforcer. A similar analysis may be made for the human case.

An alternative interpretation, one more closely related to that offered by Mischel et al. 1972), is that since the flashing light in Experiment 4 was more distant from the food than was the hopper light in Experiment 3, the flashing S+ served a different function than the hopper light. Mischel et al. suggested that a stimulus may serve informative, or cue functions concerning the possibility of a forthcoming reinforcer, and that when it does, self-control in the presence of that stimulus may be increased. The overhead flashing light in Experiment 4 might have served just such an informative function. On the other hand, when a stimulus engenders attention to consummatory attributes of the reinforcer, it serves to decrease self-control (Mischel & Baker, 1975). In Experiment 3, hopper light might have served such a consummatory function. The next experiment attempted to test more directly whether increasing attention to consummatory behavior during the wait period would indeed decrease self-control, as predicted by the Mischel theory.

EXPERIMENT 5

In this experiment, attention to consumption was engendered by permitting birds to eat

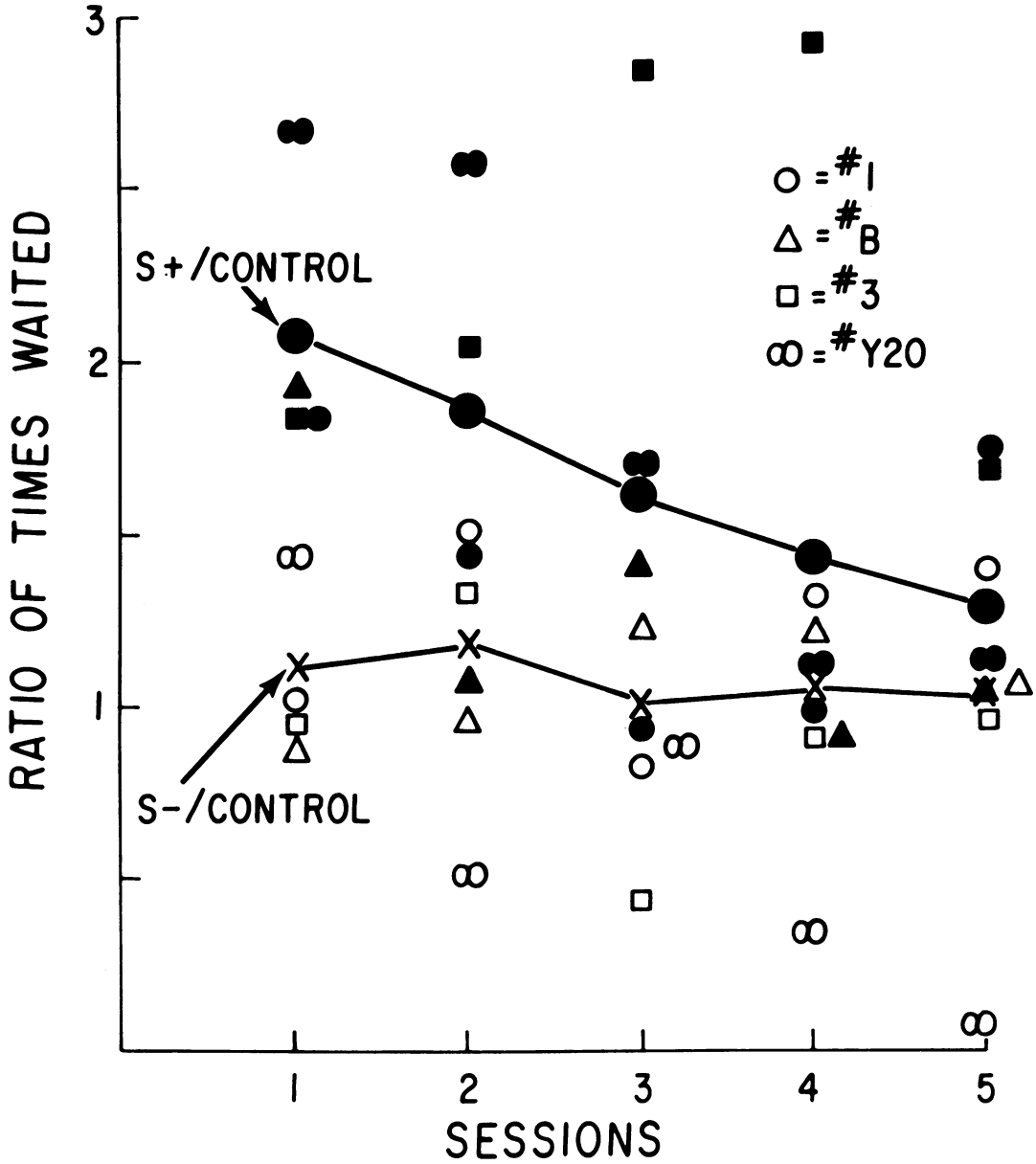

Fig. 4. Time waited in S+ trials relative to control trials (S+/control), as indicated by filled characters, and in S− trials relative to control (S−/control), as indicated by unfilled characters. Lines connect averages of the 4 birds.

grain immediately preceding a self-control trial. Two considerations suggest that this procedure would increase, rather than decrease, the birds' waiting during the delay interval: first, since they would have just eaten grain, their motivation for food would be decreased and consequently probability of pecking a key for food might be lowered; second, since the bird is given the preceding food noncontingently, "not pecking" is reinforced and this also should increase the probability of not pecking, or waiting, in the ensuing trial. However, according to the Mischel and Baker (1975) analysis, attention to eating, as presumably would be induced by eating itself, should *decrease* self-control.

Method

Subjects

Pigeons 1, 3, and D served.

Apparatus

The chamber was the same as in Experiment 3. Unlike Experiment 4, the hopper doors were not locked (since food was not present for view during the wait interval) and there were no overhead cues.

Procedure

The procedure was identical to that in Experiment 3 except that (a) the hoppers were neither lighted nor operated during the wait interval, and (b) during seven randomly selected trials the pigeon was permitted to eat the more or less preferred reinforcer prior to the beginning of the wait interval. This was accomplished by activating both more and less preferred hoppers and their accompanying hopper lights before the start of the wait period and allowing the pigeon to eat from either of the hoppers for 3 sec. Once the bird had eaten, the hoppers were inactivated and a standard self-control trial followed immediately.

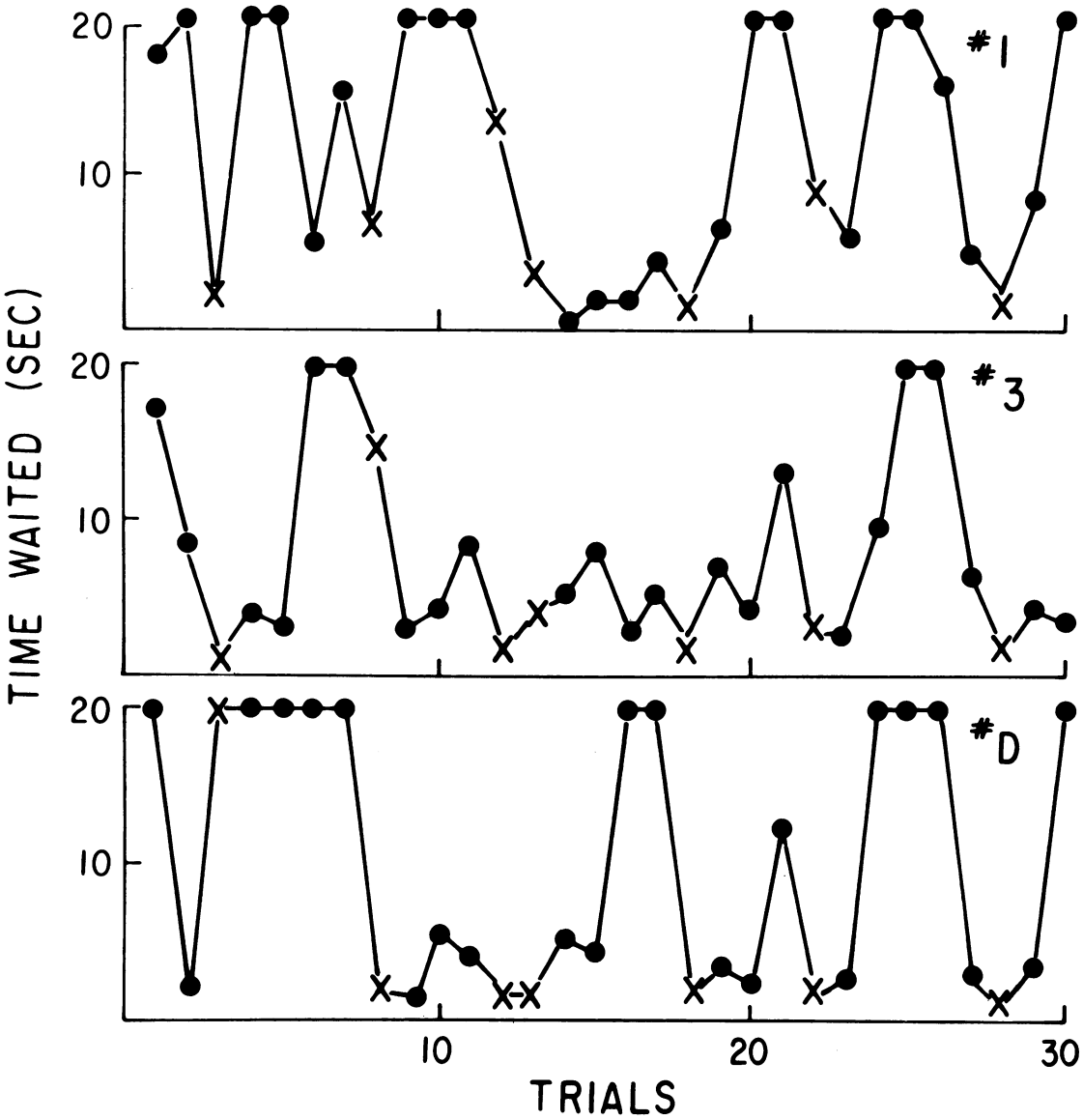

Fig. 5. Amount of time during each trial that pigeons waited without pecking. Access to 3 sec of food was given immediately prior to trials indicated by X's. No food was received prior to trials indicated by dots.

Results and Discussion

Figure 5 shows the time waited by each of the three birds under the two conditions, i.e. no food prior to self-control (points) and 3 sec of free food prior to self-control trials (X's). In all cases, the birds chose to eat the prefered grain when given free access to the two reinforcers. Each of the three birds waited, on the average, less time when free feed preceded a self-control trial than in the control condition. The average of the birds' waiting times when food preceded a trial was 4.3 sec; the average waiting time when there was no prior food was 11.4 sec. A paired t-test on the average wait times in the two conditions showed a significant difference ($t = 8.223$, $df = 2$, $p < .025$, 2-tailed). The results therefore confirmed the prediction derived from the Mischel and Baker (1975) study: self-control decreased when attention was focused on food consumption. And the results support the view that Experiments 1 and 3 may have engendered decreased wait times because sight of food or hopper lights were closely correlated with consumption.

EXPERIMENT 6

The previous experiments explored the influence on self-control of the presence versus absence of reinforcers and stimuli associated with reinforcers. In cognitive terminology, the experiments examined how thoughts about reinforcers influence self-control. Another type of cognitive influence studied by Mischel and Staub (1965) and, earlier, by Mahrer (1956) was expectancy of future rewards. In both studies, children were given either successful or unsuccessful preliminary experience with a problem and then tested under a self-control paradigm. For example, in the Mahrer experiment, one group of subjects was told that they would receive small toys the next day, and the toys were presented as promised. Thus waiting was followed by a reward. A second group was promised the same toys, but these subjects never received the promised items. In this case, waiting was not rewarded. When the children had received successful preliminary experiences (and therefore presumably had positive expectations) their ability to choose and wait for the delayed, more preferred reinforcer was significantly better than when they had unsuccessful preliminary experiences (with the concomitant negative expectations engendered). The present experiment attempted to determine whether prior experience similarly affected the self-control performance of pigeons. There were three conditions: in one, the birds received preliminary trials in which they obtained the more preferred reinforcer for waiting a relatively short duration (analogous to the positive expectation case); in this case waiting was always successfully followed by the preferred reinforcers. In a second condition, the wait interval was increased to infinity so that the bird could never receive the more preferred reinforcer and could receive only the less preferred reinforcer for pecking the key (negative expectation); in this case, waiting was never reinforced. In the third condition, the above two conditions were randomly intermixed. According to the Mischel and Staub (1965) and Mahrer (1956) studies, receiving more preferred reinforcement exclusively during preliminary training should lead to greatest self-control, receiving only less preferred reinforcement should lead to least self-control, and a mixture of the two might lead to an intermediate level of self-control.

Method

Subjects

Pigeons 2, 3, and Y20 served.

Apparatus

Same as in Experiment 5.

Procedure

The procedure was basically the same as that in Experiment 5 except that there were three separate conditions. In the infinity condition, the wait interval was made infinitely long, forcing the pigeon to respond for the less preferred reinforcer on every trial. Thirty consecutive trials of infinity wait interval were given, following which there were 30 standard self-control trials during which the wait interval was a constant 20 sec. In the 3-sec condition, the wait interval was 3 sec, a relatively short time, during the preliminary 30 trials. If the pigeons waited for 3 sec, they received the more preferred reinforcer, and this occurred for 30 consecutive trials. If the pigeon happened to peck the key during the wait interval (a rare occurrence) and consequently received the less preferred reinforcer, the train-

ing was restarted so that each bird had 30 consecutive successful trials prior to the experimental phase. Again, the latter consisted of 30 self-control trials with a constant 20-sec wait interval in effect. In the final condition, there was a random mixture of infinite-duration and 3-sec trials followed by the standard 30 self-control trials. Each subject received the three conditions in a different order. Pigeon 2 received 3-sec, infinite, and mixture, Pigeon 3 received mixture, 3-sec, and infinite, and Pigeon Y20 received infinite, mixture, and 3-sec.

Results and Discussion

Figure 6 shows the average time waited by each subject under each of the conditions. All birds waited the least amount of time (average of 3.9 sec) following experience with the infinite wait interval, waited the greatest amount of time (average of 14.6 sec) following experience with the easy 3-sec wait, and waited an intermediate amount of time (average of 8.6 sec) following experience with a mixture of the two. Analysis of variance, repeated measures, showed a statistically significant effect [$F(2,4) = 23.25$, $p < .01$]. Paired comparisons were made using Newman-Keuls method and showed that the infinite and 3-sec conditions differed at $p < .01$ and the mixture condition differed from the other two at $p < .05$.

As predicted, prior experience with a more preferred reinforcer for successful waiting led to significantly longer waiting than did prior experience in which, no matter how long the pigeon waited, more preferred reinforcement was impossible. Similiar results were interpreted by Mischel and Staub (1965) in terms of the expectancies of the children: when they received successful preliminary trials they were more likely to wait for a delayed, more preferred reinforcer than when they had received unsuccessful preliminary training. However, an alternative interpretation of the present

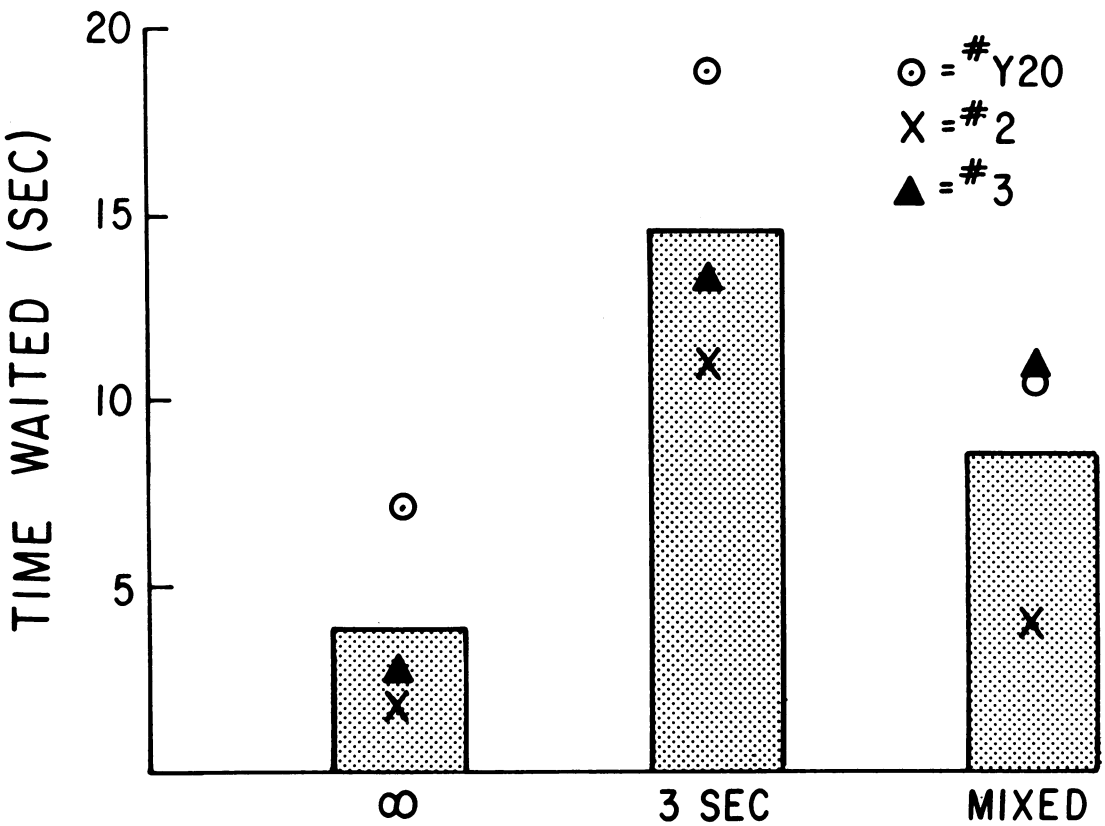

Fig. 6. Amount of time waited without pecking as a function of prior experience. In the infinity condition, birds first experienced wait intervals which were infinitely long, i.e., they were never reinforced for waiting; in the 3-sec condition, birds received prior experience with preferred reinforcement for waiting a short, 3-sec interval; in the mixed condition, 50% of the prior trials were infinitely long and 50% 3-sec long.

results can be given in terms of relative reinforcement for pecking versus waiting behavior. In the 3-sec wait condition, pecking was never reinforced and waiting for 3 sec was followed by more preferred reinforcement. Thus, probability of waiting increased, as demonstrated in the test phase which followed. In the infinite delay condition, waiting was never followed by food, i.e., was never reinforced, whereas pecking was reinforced, albeit with the less preferred reinforcer. The extinction of waiting and reinforcement of pecking led to an increased probability of pecking in the test phase (and, concomitantly, a decreased probability of waiting). Following training in which waiting and pecking were reinforced 50% of the time, the probabilities of each were intermediate. According to this analysis, to increase self-control, one must reinforce self-control behavior. In the Mahrer (1956) study, when a wait interval was followed by reinforcement, probabilities of later waiting increased.

EXPERIMENT 7

The experiments to this point used a delay of gratification paradigm: if the subject delayed immediate gratification by not pecking, it was provided with a more preferred, albeit delayed, reinforcer. The subject's task, then, was to withhold its response. The duration of time that the subject waited before responding, or success versus failure to wait the requisite interval, was used as a measure of self-control. However, as Mischel et al. (1972) point out, ". . . one obviously cannot generalize . . . to . . . forms of self-control other than the delay of gratification paradigm" (p. 216). The question confronted in the final experiment is whether another form of self-control varies in the same way as did the delay-of-gratification behavior. We attempted to assess the effects of reinforcers present versus absent (as in Experiment 1) on a task which required the subject to emit many responses rather than withhold responses. The paradigm was an attempt to model the "term-paper crunch" where a given amount of work is required (finished term-paper manuscript) within a given time period in order for a more preferred reinforcer (good grade) to be received at the end of the time period. Self-control here implies getting the work done in the time allotted. Note that the preferred reinforcer (good grade) is not obtained until the end of the time period (semester) no matter when the requisite work is completed. Also, a nonpreferred reinforcer (poor grade) is given at the end of this same period if less than the required amount of work had been emitted. The present experiment attempted to model this situation and assess the effects of reinforcers present for view versus reinforcement absent. In Experiment 1, reinforcers present had a strong detrimental effect on self-control as assessed by the delay-of-gratification paradigm, i.e., responses were much more likely in the presence of reinforcement than in its absence.

METHOD

Subjects

Pigeons 2 and Y14 served.

Apparatus

Same as in Experiment 6.

Procedure

Subjects were first trained to respond on a fixed ratio 100 (FR 100) schedule of reinforcement, where 100 responses were required to obtain 3 sec of access to the more preferred reinforcer. They were then given a modified conjunctive schedule under which a fixed number of responses had to be emitted within a fixed amount of time. For instance, both subjects were initially required to respond 30 times in 30 sec. Upon completion of the 30th response, the houselights and keylight were darkened until the end of the 30-sec interval at which time 3 sec of access to the more preferred reinforcer was given. If the subject failed to respond 30 times in the 30 sec, 1.5 sec of access to the less preferred reinforcer was delivered at the end of the interval. Note that either more or less preferred reinforcers were delivered at the end of 30 sec independently of a specific keypeck. Once either of the reinforcers had been obtained, the trial terminated and an intertrial period began (average of 20 sec) during which all lights in the chamber were dark; the next trial began with illumination of key and houselights. Both subjects were gradually required to emit a greater number of keypecks within a longer time period until the period reached 60 sec. The re-

quired number of responses was maintained at 75 for Pigeon Y14 and 100 for Pigeon 2, requirements which resulted in each bird experiencing both more and less preferred reinforcers within each experimental session.

There followed five test sessions for Pigeon 2 and seven sessions for Y14, each consisting of 20 trials: the hoppers were "up" for 10 trials and "down" for the other 10. During the 10 "hoppers up" trials, both hoppers were activated and illuminated for the duration of the 60-sec trial. Subjects were prevented from entering the hoppers by the locked hopper doors, as in Experiment 4. During the "hoppers down" trials, the hoppers were dark and inactivated, as is usually the case. Ten hopper up trials were given followed by 10 hopper down trials in one session; in the next session, the order was reversed, and so on.

Results and Discussion

In all but the first session for Pigeon Y14, more of the preferred reinforcers were obtained with the hoppers up than with hoppers down. The averages over all sessions are shown in Figure 7. Thus, having the reinforcers present for view *increased* self-control in the present experiment, i.e., increased the probability of emitting the required number of responses necessary to receive the more preferred reinforcers.

In the present experiment, as in Experiment 1 and Mischel and Ebbeson (1970), the presence of the reinforcers during the wait interval led to increased *responding*. Whereas in the former two cases, this increased responding engendered less self-control, i.e., less preferred reinforcement, the increased responding in the

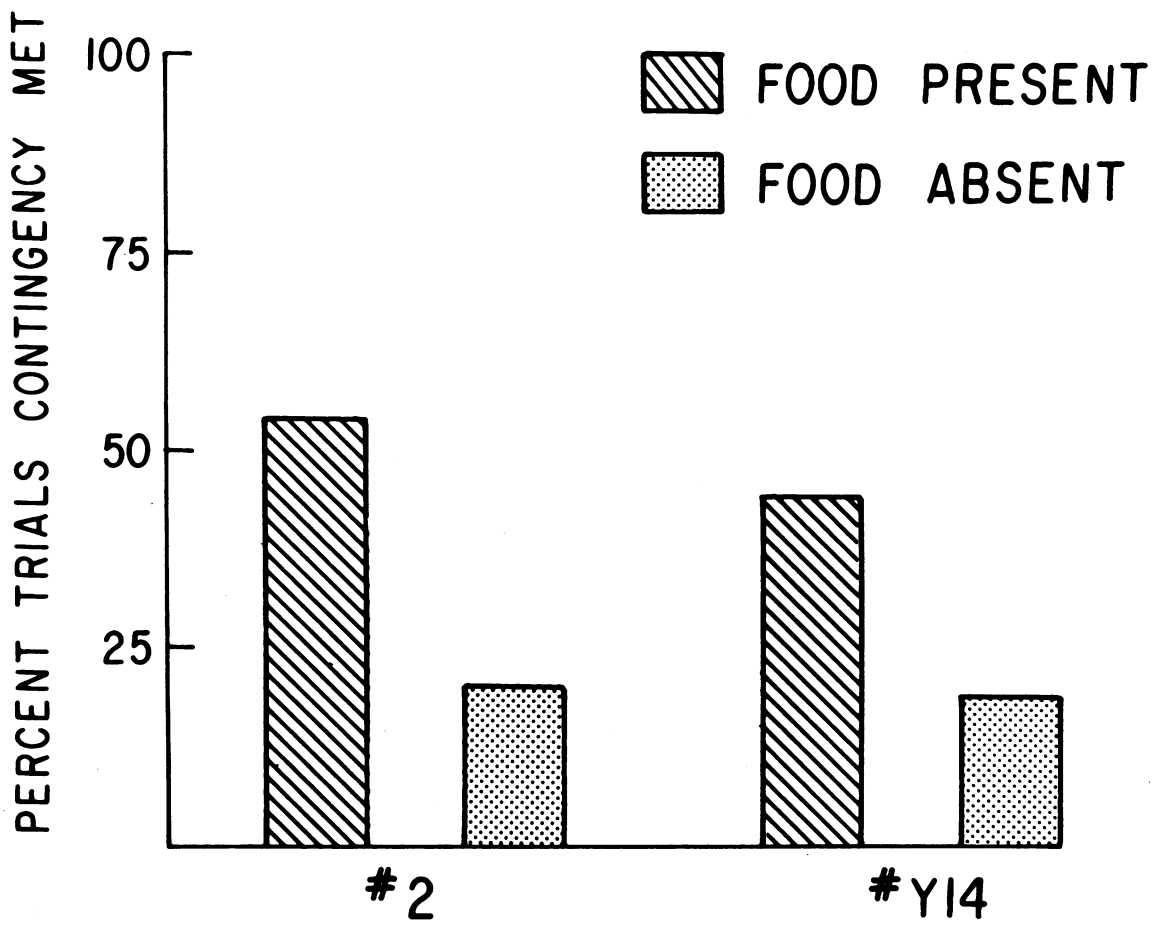

Fig. 7. Percentage of trials pigeons pecked sufficient numbers of times to receive the more preferred of two rewards. In the first condition, rewards were present for view during the interval; in the second condition, rewards were not present for view.

present case engendered more self control, i.e., more preferred reinforcement. Mischel's word of caution concerning the generality of his (and, by implication, the present) findings is well taken. "Satan get thee behind me," the advice given by Skinner (1948) in *Walden Two* to engender self-control, works in some cases (e.g., Experiment 1), but is counterproductive in others (e.g., the present experiment).

GENERAL DISCUSSION

The results of the present series of experiments paralleled, to a surprising degree, those obtained by Mischel and his coworkers with children. (1) When reinforcers were present for view, pigeons and children waited less time to obtain a more preferred reinforcer than when the reinforcers were not present. The decrease in wait time may have been related to (a) the conflict and frustration engendered by the presence of the reinforcers and/or (b) the punishment (in the form of timeout) contingent upon attempts to gain access to the reinforcers during the wait interval. (2) Adding an alternative response manipulandum to the chamber dramatically improved pigeons' self-control, just as adding a slinky toy improved children's self-control. In both cases, (a) the alternative response provided an escape from the frustrative or punishing cues of the self-control stimulus and/or (b) responding on the alternative manipulandum was reinforced by an increased probability of preferred reinforcement. (3) If the presence of reinforcers during the wait interval debilitated self-control, might thoughts about, or stimuli correlated with, these same reinforcers have similar effect? Mischel instructed children to think about the reinforcers while they waited; we presented hopper lights correlated with primary reinforcement. In both human and pigeon cases, self-control was significantly decreased. Interpretation of these results is similar to that for Experiment 1. (4) In Experiments 1 and 3, the stimuli present during the wait interval—the food reinforcers themselves in Experiment 1, and the hopper lights illuminating the food in Experiment 3—were correlated both with eating the more preferred reinforcer (when the pigeon waited successfully through the interval) and with a presumed punisher, i.e., timeout and no food (when the pigeon occasionally opened the hopper door inappropriately during the wait interval). The detrimental effects on self-control may thus have been due to the correlation of these stimuli with either positive or negative consequences. Experiment 4 attempted to separate these consequences by correlating food with an S+ stimulus and timeout with an S− stimulus, and by not having any confounding between the two. When S+ and S− stimuli were individually presented during the wait interval, it was found that the S+ engendered significantly longer waiting than did the S−, at least initially. The potency of these stimuli decreased with successive presentations. Mischel et al. (1972) also found that a stimulus exclusively correlated with a positive event (in this case, the verbal "think fun") engendered significantly longer self-control than a stimulus correlated with a negative event ("think sad"). Thus, again, results from pigeons paralleled those from children. (5) Mischel and Baker (1975) theorized that attending to consummatory attributes of the reinforcer while waiting might engender decreased self-control. We asked whether food presented just prior to each self-control trial would decrease waiting time, and the answer was clearly yes. The birds waited significantly longer when they had *not* just eaten as compared to when they had just eaten, again confirming the Mischel and Baker (1975) hypothesis. (6) Mischel and Staub (1965) hypothesized that long-term cognitions, in the form of expectancies, influenced the probability that children would wait for a delayed preferred reinforcer. In their experiment, some children received positive or confirmatory experiences prior to the self-control trial, while others received negative or disconfirmatory experiences. The "positives" exhibited significantly better self-control than the "negatives." Pigeons behaved similarly. When given prior experience in which waiting behavior was punished—negative experience—they exhibited significantly less self-control than when given prior experience in which waiting was followed by the preferred reinforcer—positive experience. A mixture of negative and positive prior experiences engendered intermediate self-control. (7) The final experiment confirmed the Mischel et al. (1972) suggestion that the way in which the variables discussed above affect self-control may depend upon the particular type of self-control examined. In all of the above cases, self-control was synonymous

with waiting. Another type of self-control entails emitting responses at high rates rather than withholding responses. The last experience found that presence versus absence of food during the self-control interval had the same *behavioral effects* but with opposite consequences as compared with Experiment 1. Presence of food led to increased responding here as in Experiment 1. But whereas the increased probability of response caused a decreased probability of more preferred reinforcement in Experiment 1—where withholding of response was required—the same increased response probability led to an *increased* probability of reinforcement in the present case—where rapid responding was necessary for more preferred reinforcement. In sum, there was a striking similarity between the results from Mischel's experiments on self-control in human children and results with pigeons under analogous procedures. Some of the pigeon procedures offered as parallels to the human case may be questioned. A verbal stimulus such as "think fun" may have consequences richer than, and different from, a conditioned reinforcing stimulus. The finding that both had analogous effects on self-control may be accidental, for we do not know whether pigeon and child were "doing" the same thing. But the overall similarity between the results of the two sets of experiments suggests that valuable predictions concerning pigeon self-control can be made on the basis of findings from the human, and vice versa.

For example, derived from the present series of pigeon studies were hypotheses possibly relevant to people. (1) Experiments 1 and 3 were interpreted to indicate that the decreased self-control caused by the reinforcers being present during the wait interval was partly due to subjects escaping from an aversive possible consequence—timeout and no reinforcement if an attempt were made to eat the food. It is hypothesized that in the human situation, too, the conflict between having the food readily accessible and the implicit or explicit instruction not to eat might have engendered responding to escape. (2) Experiment 4 presented analogous "think fun" (or S+) and "think sad" (or S−) stimuli a total of 25 times rather than the single time these instructions were given to the children in the Mischel et al. (1972) study. The initial pigeon results were the same as in the single human trial: the S+ stimulus engendered significantly longer waiting than did the S−. However, with continued presentation of the stimuli, the effects decreased. It is hypothesized that continued "think" instructions to the human subject would have decreasing effect, i.e., thinking fun is an effective self-control device only initially. (3) In Experiment 5, if pigeons ate food just prior to a self-control trial, they waited significantly less than if they did not eat. An analogous effect is hypothesized for the child. (4) Experiment 7 showed that when self-control is defined as the emission of a minimum number of responses, food present for view during the self-control interval increased self-control, rather than decreased it as in Experiment 1. It is hypothesized that, in the human case as well as the pigeon, the variables studied increase or decrease probability of responses rather than a more general "self-control." This can be tested in children with a procedure analogous to that in Experiment 7.

There are a number of relatively separate subdisciplines in psychology. The experimental analysis of animal behavior makes references only infrequently to human experimental psychology; the latter emphasizes cognitive factors in the control of behavior. It has been the norm of these subdisciplines to avoid using terminology and concepts from other subdisciplines. Operant conditioners are often trained not to use "mentalistic" terminology; cognitive psychologists find that "behavioral" terminology is inappropriate for the complex cognitive sphere. Rather than ignoring different languages, it might be most productive to demand translations between them. For example, both child and pigeon may expect the experimenter to be trustworthy, or both may have been differentially reinforced; both may play with a toy, or both emit alternative responses; and both may think about the reinforcer or both be presented with a conditioned reinforcing stimulus. An interaction between animal and human research areas may be fruitful precisely because of the ideas, biases, and jargon each brings to the other. In the present case, the series of experiments with pigeons derived explicitly from a series performed with children. The results from this research paralleled the human findings. We hope they will contribute to, and help explain, these findings.

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