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COMMITMENT, CHOICE AND SELF-CONTROL[1]

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When offered a choice (Choice Y) between a small immediate reward (2-sec exposure to grain) and a large reward (4-sec exposure to grain) delayed by 4 sec, pigeons invariably preferred the small, immediate reward. However, when offered a choice (Choice X) between a delay of T seconds followed by Choice Y and a delay of T seconds followed by restriction to the large delayed reward only, the pigeon's choice depended on T. When T was small, the pigeons chose the alternative leading to Choice Y (and then chose the small, immediate reward). When T was large, the pigeons chose the alternative leading to the large delayed reward only. The reversal of preference as T increases is predicted by several recent models for choice between various amounts and delays of reward. The preference for the large delayed alternative with long durations of T parallels everyday instances of advance commitment to a given course of action. Such commitment may be seen as a prototype for self-control.

Commitment to a course of action is a form of self-control (Skinner, 1953) the utility of which depends on reversals of preference from time to time. Consider, for instance, a popular form of commitment, payroll savings. When a man signs a payroll savings agreement he prefers saving a certain portion of his paycheck to spending it. The utility of making this commitment rests on the fact that, when the man actually receives the money, he prefers to spend it rather than save it. Were it not for the reversal, there would be no reason to sign the payroll deduction agreement in the first place.

A similar reversal of preference underlies the effectiveness of a device invented by Azrin and Powell (1968) to limit chain smoking. The device consists of a cigarette case that locks for 2 hr when it is closed. When the user takes out one cigarette, the value of the next cigarette is minimal. It sinks below the value of limiting smoking and the case is cheerfully locked. Later, when the first cigarette is finished and the value of the next cigarette is greater than the value of limiting smoking, it is too late to have the cigarette. The availability of cigarettes from sources other than the locking case may limit the usefulness of the device, but if such a case were the only source of cigarettes and if the relative values of smoking and nonsmoking reversed, as hypothesized above, the method would be infallible.

Commitment, such as exhibited by the payroll saver or the user of the cigarette case, may be seen as an active process of self-control. A more parsimonious view, however, would see the commitment response as simple choice of a presently higher valued alternative. When the man signs the payroll savings agreement he is choosing to save his money. Not to sign the agreement would be to choose to spend his money. The apparent contingencies of the situation offer three alternatives:

(a) Make the commitment and save the money.
(b) Do not make the commitment and spend the money.
(c) Do not make the commitment but save the money anyway.

The third alternative, however, is not a real one. If it were, the commitment would not be necessary. In other words, the very fact that the commitment is made is evidence that the relative values of saving and spending reverse in time.

An account of choice that predicts reversals as a function of time is, thus, a prerequisite for the study of commitment. While it might seem

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that such reversals would be predicted only by complicated theories of human behavior, they are in fact predicted by several recent simple models, developed with animal subjects, for choice among various delays and amounts of reinforcement (Catania, 1963; Logan, 1965; Renner, 1967; Baum and Rachlin, 1969; Fantino, 1969; Herrnstein, 1970). Perhaps the simplest of these models is the one presented by Baum and Rachlin. They suggest a form of the matching law in which the ratio of the values of two reward alternatives differing in delay and amount is the product of the ratio of amounts and the inverse ratio of delays:

$$\frac{V_1}{V_2}=\frac{A_1}{A_2}\cdot\frac{D_2}{D_1}$$

Suppose A_1 was twice A_2, but was always delayed for 4 sec more than A_2. If D_1 was 4 sec and D_2 was 0 sec, the ratio, V_1/V_2, would be less than 1 ($A_1/A_2 = 2$; $D_2/D_1 = 0$). If, however, 10 sec are added to both delays, the ratio V_1/V_2 would be more than 1 ($A_1/A_2 = 2$; $D_2/D_1 = 10/14$). The change from a ratio less than one to a ratio more than one indicates a reversal of preferences as the two rewards are removed further from the choice point.

Figure 1A shows a set of contingencies by which such a reversal may produce commitment. Choice Y results in a preference for A_2 according to the matching formula ($A_1/A_2 = 2$; $D_2/D_1 = 0$). If A_2 is always chosen at Y, the choice at X is also between A_1 and A_2, but with longer delays involved than with the choice at Y. The upper branch alternative of A_1 is present, but not a factor at point X because it is never chosen. At point X, the matching formula predicts a choice of A_1 ($A_1/A_2 = 2$; $D_2/D_1 = 10/14$). A_1 can be obtained only by choosing the lower branch. The only difference between the situation of Figure 1A and a simple choice at X between A_1 with delay of 14 sec and A_2 with delay of 10 sec is the behavior at point Y of actually choosing A_2 instead of being forced to accept it. But there is ample evidence (Rachlin and Herrnstein, 1969) that choices such as at X are governed by the reward actually obtained and are independent of behavior *per se* between the choice and the reward. Therefore, there is good reason to believe that organisms at point Y will choose A_2 and at point X will choose A_1.

The choice of A_1 in Figure 1A is predicted only on the basis of simple preference data. The only assumptions involved are that organisms will choose according to the matching formula, and that choice depends on the reward obtained and is independent of the behavior by which it is obtained. Both these assumptions are supported by evidence from previous experiments. As long as the choice responses are within the repertoire of the organism, commitment will be exhibited. The situation of Figure 1A parallels that of the payroll saver. The apparent alternatives at X are:

(a) Choose the upper branch and A_2;
(b) Choose the lower branch and A_1;
(c) Choose the upper branch and A_1;

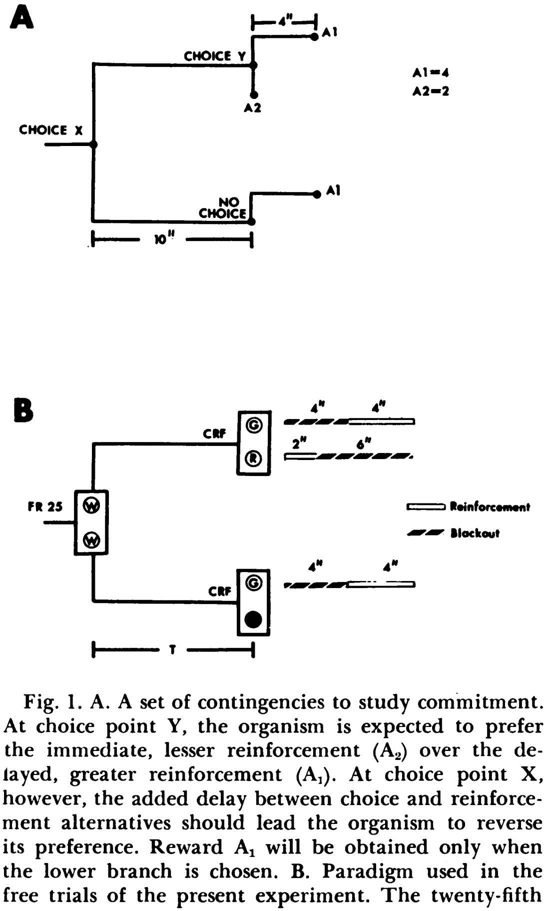

Fig. 1. A. A set of contingencies to study commitment. At choice point Y, the organism is expected to prefer the immediate, lesser reinforcement (A_2) over the delayed, greater reinforcement (A_1). At choice point X, however, the added delay between choice and reinforcement alternatives should lead the organism to reverse its preference. Reward A_1 will be obtained only when the lower branch is chosen. B. Paradigm used in the free trials of the present experiment. The twenty-fifth peck on the right key in the initial link leads to the upper branch which presents a choice between delayed, greater reinforcement (green key) *vs.* immediate, lesser reinforcement (red key). The twenty-fifth peck on the left key in the initial link leads to the lower branch, which presents the green key only (greater, delayed reinforcement), the other key being darkened. T represents the delay between the end of the initial link (twenty-fifth peck) and the presentation of the red and green (Choice) or green only (No Choice) keylights.

but, as with the payroll saver, alternative (c) is not a real one. While A_1 is preferred at X, A_2 will be preferred at Y. The only way to get A_1 is through commitment at X by choice of the lower branch.

The present experiment exposes pigeons to contingencies like those described by Figure 1A and varies the time (T) between Choice X and Choice Y. With A_1 fixed at twice A_2 and T at 10 sec, pigeons at X should prefer the lower arm to the upper (should prefer No Choice to Choice Y). But, as T is decreased, the matching formula predicts that the preference should reverse. This experiment is similar to one by George Ainslie (described in Rachlin, 1970, 186-188) except that here, T is varied and choices are between one response and another; in Ainslie's experiment, the alternatives were response *vs.* non-response.

METHOD

Subjects

Five male, adult, White Carneaux pigeons were maintained at about 80% of free-feeding weights. All five served as subjects in other experiments involving various delays and amounts of reward before the present experiment.

Apparatus

The experimental chamber contained two response keys, mounted 3.75 in. (8.9 cm) apart, which required a force of 0.15N to be operated, and a food hopper that could provide variable access to mixed grain. The chamber was illuminated by two 7-w white bulbs on the ceiling and the response keys could be transilluminated by lights of various colors. White masking noise was continuously present. Scheduling and recording were automatic, with standard relay equipment located in an adjacent room.

Procedure

Each daily session consisted of 50 trials, 10 forced trials followed by 40 free trials. Figure 1B is a diagram of the free-trial procedure. Each trial was a chain of events, some produced automatically and some contingent on responding by the subject. At the beginning of a trial (the initial link), both keys were transilluminated with white light. Passage to the next link was governed by a fixed-ratio (FR) of 25 pecks, which could be distributed in any way on the two keys. If the twenty-fifth peck was on the right key (the upper key in Figure 1B) both keys and the houselights darkened (blackout) for T seconds. After the blackout, the houselights and both keys were automatically reilluminated, one key with red light and the other key with green light. Which key was red and which green was determined randomly at each trial. A single peck on the red key (CRF) produced 2 sec of access to food, followed automatically by 6 sec of blackout. A single peck on the green key produced 4 sec of blackout, followed automatically by 4 sec of access to food. Thus, a peck on the red key produced a small immediate reinforcement while a peck on the green key produced a delayed but larger one. After the reinforcement or blackout, the keys were reilluminated with white light and a new trial began.

If, during the initial link, the twenty-fifth peck was on the left key (the lower key in Figure 1B) there was a blackout for T seconds followed by reillumination of only one of the keys (randomly determined at each trial) with green light. The other key remained dark. A single peck on the green key produced a 4-sec blackout followed by 4 sec of access to food. Then, a new trial began immediately with both keys illuminated with white light. Pecks on dark keys throughout the experiment had no scheduled consequences.

A forced-choice trial differed from a free-choice trial in only one respect; the twenty-fifth peck during the initial link was effective on only one key (determined randomly at each trial), although both keys were lit. Responding on the inactive key advanced the fixed-ratio counter, but could not produce the blackout and subsequent reinforcement. Thus, during the forced trials, more than 25 pecks could be made in the initial link, while during free trials, the twenty-fifth peck was always effective in advancing to the next link.

Pigeons responding on concurrent fixed-ratio schedules such as those in the initial link tend to distribute all or almost all of their pecks on the preferred key (Herrnstein, 1958). This is desirable in the present experiment because large variations of T, according to the matching formula, produce relatively small preferences for one alternative over the other. The concurrent fixed-ratio schedules tend to amplify preferences and make it easier to determine at what value of T preferences switch from one alternative to the other. A disadvantage of concurrent fixed-ratio schedules for these purposes, however, is that once preferences are formed they are likely to persist through large changes of the independent variables. The forced-choice procedure was designed to force the pigeons to sample both alternatives during each session and to weaken strong key preferences.

For the first five sessions, T was set at 10 sec and only the right-hand key was available during the initial link (only the upper arm of the diagram of Figure 1B was in effect). During these five sessions, each of the 50 trials was a form of forced trial, which differed from the forced trials described previously in that the inactive key was always the left key and its inactivity was signalled by darkening it.

After the first five sessions, both keys were lit and the 10 forced-trial and 40 free-trial sessions were instituted as described above. The value of T was constant during any single session but was varied between sessions for all pigeons. For 35 sessions, not counting the initial five training sessions, T was kept at 10 sec. Then, T was kept for 10 sessions at each of the following values in turn: 0.5, 1, 2, 4, 8, 16, 8, 4, 2, 1, and 0.5 sec.

RESULTS

When exposed to the red and green keys together, all pigeons, within a single session, came to peck the red key on virtually all trials. This exclusive preference for the small immediate reinforcement over the large delayed one appeared for all pigeons during the initial forced-choice session and persisted through the five preliminary forced-choice sessions, during the 10 forced-choice trials at the beginning of subsequent sessions, and during the 40 free-choice trials of those subsequent sessions. Of course, this preference could be measured only when the right-hand key (upper branch of Figure 1B) was chosen during the initial link. However, even during those sessions when the right key was chosen on only one or two of the 40 free-choice trials, the pigeons pecked the red key on those one or two trials. The percentage of responses on the red key during the CRF exposure to the red and green keys together was never less than 95% during a session for any pigeon after the first session. For most sessions, the red key was pecked whenever it appeared as an alternative.

With regard to behavior during the initial link, in the five preliminary forced-choice sessions with T = 10 sec, only the right key was available. At the sixth session, the left key was made available as well. Considering only behavior during the free-choice trials in the sixth session, two of the five pigeons pecked more on the left key and three pecked more on the right key. One of the pigeons that initially pecked more on the right key reversed its preference and came to peck more on the left key during the 35 sessions at T = 10. The other four pigeons showed no discernible changes in preference over the course of the 35 sessions.

Figure 2 shows, for each pigeon, median relative rate during the free-choice initial links (percentage of pecks on the left key) over the last five sessions at each value of T as T was increased from 0.5 sec to 16 sec and decreased again to 0.5 sec, the solid lines showing ascending, and the dotted lines, descending, values of T. Table 1 shows absolute rate of responding on left and right keys during those sessions

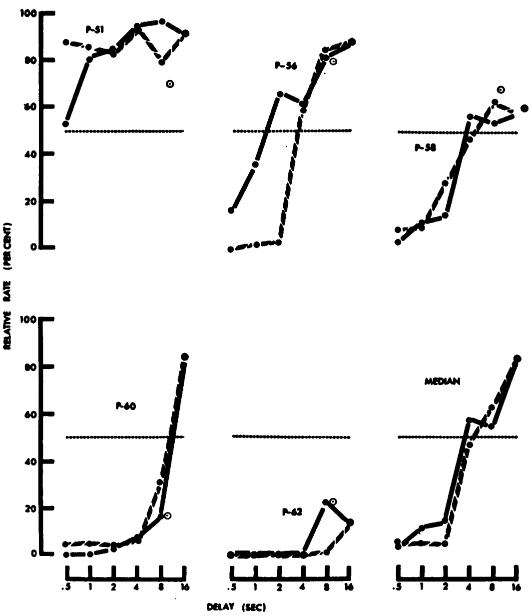

Fig. 2. Relative rate (percentage of pecks on the left key) during the initial link for each pigeon. The rates are medians from the last five sessions at each value of T during the 40 free-choice trials. Solid lines are for ascending values and dotted lines for descending values of T. Circled points are for the last five sessions at T = 10 sec. The lower right function is the median of the five individual functions.

shown in Figure 2. The circled points in Figure 2 are median relative rates for the last five of the initial 35 sessions at T = 10 sec. All of the curves increase as T increases, showing a tendency for pigeons to prefer the larger but longer delayed reinforcement over the smaller less-delayed one as the delay increases. The similarity between ascending and descending curves indicates that stability was reached during the sessions for which medians were taken. At T = 16 sec, four of the five pigeons pecked more on the left key, leading to the green key only (and the larger reinforcement). At T = 0.5 sec, four of the five pigeons pecked more on the right key, leading to a choice between the green key (larger reinforcement) and the red key (smaller reinforcement). Because the pigeons always pecked on the red key whenever both red and green keys appeared together, the only trials on which the larger reinforcement was obtained were those on which the left-hand key was pecked during the initial link.

The pigeons usually pecked on only one key during the initial link on the free-choice trials. However, when they switched, they switched more from the left to right keys than *vice-versa*. If relative entries from the left key to the next link were plotted in Figure 2, instead of relative pecks on the left key, the curves would be parallel to those shown but slightly lower. This would be expected from the matching formula because it predicts that as the time to reinforcement grows shorter (while the 25 pecks are being made) the right key (leading to the smaller, less-delayed reinforcement) should be preferred.

Figure 3 shows the total time (cumulated over the last 40 trials of each session) spent in the initial link as a function of T. As T increased and the delay of both small and large reinforcements increased, the pigeons tended to spend more time in the initial link. The figure shows the average time in the initial link for the five pigeons. Some pigeons paused considerably less and some considerably more than the mean, but all pigeons spent more time in the initial link as T increased. Most of the increase in time during the initial link represents a pause at the beginning of a trial. However, on occasion, the pigeons would pause, then peck a few times on one key, then pause again and complete the ratio on the same key or on the other key.

The scheduled delay T and the additional 4-sec delay after pecking the green key do not comprise the entire time between the end of the initial link and reinforcement. In addition, there is the reaction time after T between presentation of the green or red and green keys and the peck on the green or red key. Figure 4 shows that reaction time increased with T. The time for choosing between red and green was not greater than the time for pecking the green key when it was presented alone. In fact, while there were no significant differences, the average curves show longer reaction times with the lone green key. This may have been due to the fact that delay of reinforcement was greater for the green key than the red key. The reaction times were a significant fraction of total delay time for low values of T. For values of T less than 2 sec, the reaction time was greater than T. Even at T = 16

Table 1

Absolute rate of responding (per minute) on the left and right keys for sessions shown in Figure 2.

		T											
Pigeon	*Key*	*10*	*0.5*	*1*	*2*	*4*	*8*	*16*	*8*	*4*	*2*	*1*	*0.5*
51	Left	10.08	20.80	36.22	26.43	23.79	27.68	8.20	29.49	18.45	19.97	24.69	57.08
	Right	4.26	18.55	8.34	4.71	1.25	0.85	0.65	7.79	1.28	3.98	4.00	8.04
56	Left	40.58	9.14	10.24	41.84	34.08	42.42	45.50	44.80	30.48	4.77	2.83	0.00
	Right	10.03	48.76	18.49	21.11	20.57	8.94	6.21	8.22	21.13	113.49	120.02	143.98
58	Left	48.72	4.39	13.87	18.28	55.72	51.93	43.11	51.09	47.36	30.77	12.69	10.08
	Right	22.27	129.16	109.08	110.81	41.67	42.14	31.57	30.15	54.17	80.71	122.94	119.12
60	Left	6.27	0.69	0.47	2.83	5.76	8.30	41.98	9.94	4.57	2.90	2.90	3.27
	Right	32.18	100.10	159.01	112.12	68.88	42.99	7.87	22.04	66.46	64.71	58.89	74.55
62	Left	10.39	0.00	0.23	0.00	0.68	16.77	8.78	0.92	0.58	0.00	0.23	0.00
	Right	35.67	287.19	239.44	226.86	233.41	52.77	58.51	92.03	199.03	217.16	231.60	254.46

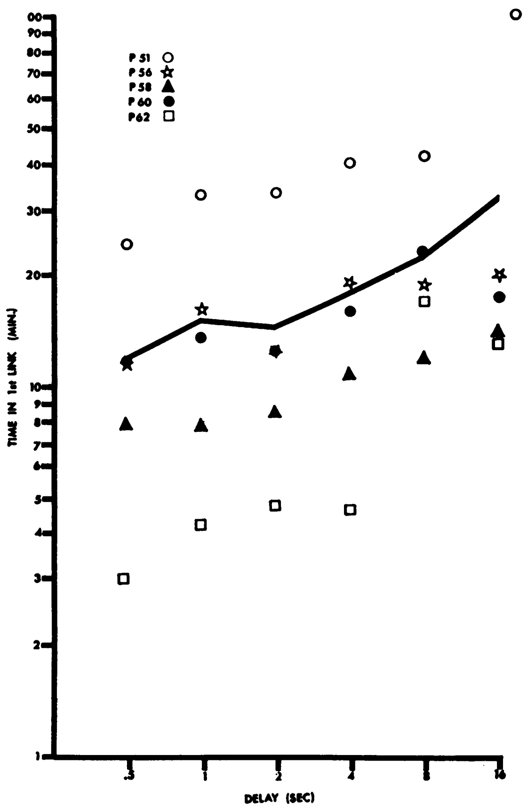

Fig. 3. Total time spent in initial link at each value of T. The figures are the average times for each pigeon in the last five sessions at each ascending T value, averaged with the last five sessions at each descending T value, during the 40 free-choice trials. The line is the average of the five points at each value of T.

sec, the reaction time comprised 17% of the delay between the initial link and the small reinforcement and 14% of the delay between the initial link and the large reinforcement.

DISCUSSION

As T increases, the matching formula predicts a shift in preference from the more immediate (smaller) to the more delayed (larger) reinforcement. The fact that all the functions of Figure 2 have upward slopes shows the tendency for preferences to shift in the predicted direction.

When the amounts and delays of the present experiment are substituted in the matching formula, an indifference point is predicted at $T = 4$ sec. But the nominal value of T is not the real value. In the case of the small reinforcement, for instance, the reaction time must be added to the nominal value of T to get the real delay between the twenty-fifth peck in the initial link and the reinforcement. A real delay of 4 sec would be experienced at about $T = 2.5$ sec since, in that region, the reaction time for both Choice (red and green keys) and No Choice (green key alone) is about 1.5 sec. The functions of Figure 2 should cross the horizontal line at about $T = 2.5$ sec. Only one of the five functions can be said to cross near that point (P-56). The average curve crosses closer to $T = 4$ sec. Functions showing relative entries rather than relative rate of response in the initial link would cross at a still higher value of T ($T = 5.5$ sec for the average curve).

Because the individual functions varied so widely in slope, no simple equation could account for the data. The average function would cross near the predicted value only if reaction time were ignored. It may be that the reaction time is somehow not effective as delay. Evidently, there are some additional determi-

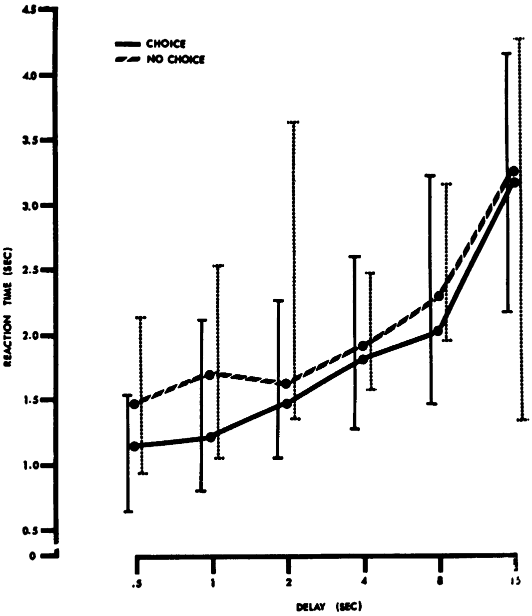

Fig. 4. Reaction time (time from end of initial link to peck on red or green key) at each value of T. Medians were determined for the last five sessions at each T value for each pigeon. Then, the ascending and descending medians at each T value were averaged. The solid line represents the reaction time for Choice trials (red and green keys) averaged across pigeons; the dotted line represents the reaction time for the No-Choice trials (green key only) averaged across pigeons. The vertical solid and dotted lines indicate the range of median reaction times.

nants of initial link behavior peculiar to individual pigeons which have not been accounted for. The FR schedules of the initial link generate strong key preferences that the forced-choice trials at the beginning of each session may not have counteracted. Furthermore, the amounts and delays as measured may not have equalled the amounts and delays actually in effect for each pigeon. For instance, a pigeon may start or stop eating at any time during the magazine presentation, even though the magazine is available for a fixed time. Chung (1965) found discontinuites in choice at short hopper times. In addition to the question of whether the obtained data could be accounted for by the proposed equation, there seems to be a more basic difficulty with the equation; it predicts that any immediate reinforcement ($D = 0$) no matter how small would be preferred to any delayed reinforcement, no matter how large. When $D = 0$, the value of a reinforcement would be infinite. This is not, however, a real difficulty because D can never be zero. The equation purports to deal with choice behavior. If an alternatve can be chosen it must also be capable of being rejected. Yet, an organism could not reject a reinforcement with no delay. To say $D = 0$ implies that the organism *has* the reinforcement. It is reasonable to consider preference to be infinite for a reinforcement already obtained. When the reinforcement is not yet obtained, when it still can be rejected, D can never be zero. Figure 3 implies a lower asymptote of about 1 sec for choice under the conditions of the present experiment.

It is worth noting that the proposed model for commitment is based on a reversal of preferences as the delay of alternatives changes. This reversal is a property of the particular matching equation of the introduction, but it is also a property of many other recently proposed quantitative accounts of choice (those cited in the introduction) as well as recent lexicographic models for choice (Coombs, 1964; Tversky, 1969). Thus, the model does not depend on a situation where the effective amounts and delays are expressible only in terms of hopper-time-up and hopper-time-down, as the proposed matching formula implies.

For the pigeons of the present experiment, commitment resulted in behavior often categorized as delay of gratification; the larger, more delayed reinforcement was obtained at the expense of the smaller, more immediate one. This raises the question of whether other instances of delay of gratification, and of self-control in general, rest on commitment.

In the illustrative examples of the introduction (the payroll saver and the user of the locking cigarette case) and for the pigeons of the present experiment, the commitment contingencies are overtly presented. That is, they are offered to the subject as strategies that he may take or leave. Payroll savings was invented by the bank, the cigarete case was invented by Azrin and Powell, and the electrical circuit that controlled the present experiment was built by the authors. For such situations, commitment would be predicted on the basis of reversal of preferences and presented contingencies. But commitment strategies may also be invented on the spot. When such commitment strategies are invented, rather than presented ready-made, we are more likely to regard the process as one of self-control. A recently cited classical example of self-control (Kanfer and Phillips, 1970) is Odysseus tying himself to the mast of a ship to avoid being tempted by the Sirens. Odysseus' behavior can be explained in terms of a reversal of values as the boat approached the Sirens. At a distance, the value of avoiding a crash on the rocks would be greater than whatever pleasure was to be gained by approaching the rocks. As Odysseus' boat approached closer to the rocks, these values would presumably reverse, with the value of approaching the Sirens rising above the value of avoiding a crash. The act of tying himself to the mast was a commitment similar in contingency to the choice of the lower arm of Figure 1A by the pigeons. The difference between Odysseus and the pigeons is that he invented his own commitment strategy, whereas they were presented with theirs. Another example of a commitment strategy a person might invent is putting his alarm clock out of easy reach of his bed so that when it rings he is forced to get up to turn it off. This strategy would work (if it does work) because before going to sleep the value of getting up in the morning is greater than that of sleeping later, whereas next morning these values reverse. When we label these behaviors as self-control the part that should be attributed to the self is the invention of the commitment strategy. Once this is done, subsequent behavior would be predicted by the matching formula and the contingencies.

We might speculate that even in instances where no overt commitment strategies are apparent, they nevertheless operate covertly. Mischel and Ebbeson (1970) report that children when faced with a choice between an immediate small reward and a delayed large reward "spent their time psychologically doing something (almost anything) other than waiting." Some children tried to sleep during the delay period and one child actually succeeded. The child who slept may well have been overtly putting into effect mechanisms that other children, and adults, learn to activate covertly. These mechanisms may serve effectively to commit us to a previously chosen alternative so that an ostensible choice, when it is offered, is not a real one. We may not "see" the immediate small alternative because we have committed ourselves in advance to ignore it. One thinks of "perceptual defense" and "gating" of sensory input. Such strategies of commitment may be the only explanation for our apparent self-control.

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