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Uncommitted Commitment: Behavioral Strategy to Prevent Preference Reversals

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Abstract

When both smaller–sooner (SS) and larger–later (LL) rewards are temporally distal, individuals frequently prefer the LL. However, because both outcomes become proximal, individuals frequently switch to preferring the SS. These preference reversals are predicted by hyperbolic delay discounting, and may model the essential challenge of self-control. Using smokers, a population known to have high rates of delay discounting, and thus more vulnerable to preference reversals, this pilot study sought to examine *soft commitment* as a strategy that may prevent preference reversals. Eleven smokers were assigned to an experimental commitment condition, operationalized as 3 weeks of daily commitment trials indicating preference between an SS and LL. Ten smokers were assigned to a control commitment condition. These 3 weeks were followed by 8 days of daily choice trials indicating preference between an impending SS and LL, for both experimental and control conditions. Though no overall difference of preference was observed between groups during the choice trials, hierarchical linear modeling revealed a decrease in preference for the LL over time by the control group (e.g., increasing trend of preference reversals) but no changes by the experimental group. This pilot study provides an initial indication that soft commitment can facilitate choice persistence and prevent preference reversals.

Keywords Delay discounting · Preference reversal · Commitment · Intertemporal choice

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Introduction

The National Institute on Drug Abuse (2014), the American Society of Addiction Medicine (2011), the American Psychiatric Association (2017), and the most recent version of the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM-5*; American Psychiatric Association, DSM-5 Task Force, 2013) all characterize relapse or similar constructs as an essential characteristic of addiction and substance-use disorders. For example, a cigarette smoker may express a desire to quit smoking and may even initiate an attempt, but subsequently resume smoking at a later point. Assuming that drug abstinence results in delayed reinforcement (improved health and social outcomes) whereas drug use results in immediate reinforcement (e.g., euphoria, relief from withdrawal), this reversal of preference from a large, delayed reward to a small, more immediate reward has been characterized as a failure of self-control (Rachlin, 1995), and in the parlance of behavioral economics, is called a preference reversal.

Preference reversals are predicted by the hyperbolic (and similar) model of delay discounting (see Green & Myerson, 2004). Formalized in Mazur (1987) Eq. 1,

$$v_D = \frac{1}{1 + kD} \qquad (1)$$

the hyperbolic delay discounting equation identifies v_D as the discounted value of a delayed outcome, D as delay, and k as the index of discounting. Higher values of this parameter (k) indicate steeper discounting or a faster loss of subjective value as a function of delay.

Figure 1 offers a graphical representation of a preference reversal resulting from hyperbolic delay discounting. The x-axis indicates the passage of time going from right to left, and the y-axis represents the value of larger–later (LL) and smaller–sooner (SS)
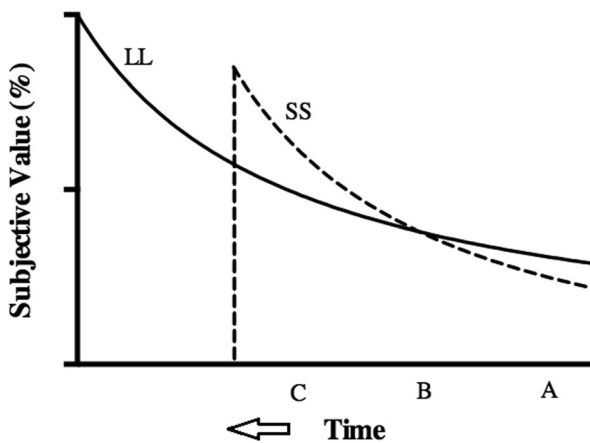

Fig. 1 The x-axis represents time, starting at the right and going left as time passes. SS ("smaller, sooner") represents a small reward that is available relatively sooner, and LL ("larger, later") represents a larger reward that is available relatively later. The y-axis indicates subjective value. At time point *A*, the LL has a higher discounted value, and is preferred. As time passes, at time point *B*, SS and LL have equal discounted value and are equally preferred. At time point *C*, the SS has a higher discounted value, and is preferred

rewards. Although the objective value of the LL outcome is greater than that of the SS outcome, the LL is paired with a longer delay. If an individual is choosing between LL and SS, it is predicted that preference will be towards the outcome that has higher subjective value (curved lines). The LL is predicted to be preferred at time point *A*, until both LL and SS are subjectively equivalent at time point *B*, followed by preference reversal to SS at time point *C*. A synthesis of previous research (e.g., Ainslie & Herrnstein, 1981; Green, Fisher, Perlow, & Sherman, 1981; Green & Estle, 2003; Green, Fristoe, & Myerson, 1994) supports this conceptualization of preference reversals: preference is typically for the LL when both options are temporally remote, but switches to the SS as time passes and both options become temporally proximal.

Hard commitment strategies can be effective in preventing preference reversals: Odysseus having himself tied to the mast of his ship so that he would not be lured by the sirens' song is the popular exemplar appearing in Homer's *Odyssey*. However, hard commitment strategies have the problematic characteristic of constraining choice (Rachlin & Green, 1972; Solnick, Kannenberg, Eckerman, & Waller, 1980). As an alternative, Rachlin (1995, 2000) has proposed *soft commitment*, which proposes that patterns of behavior have intrinsic value and a commitment to the LL can occur by allowing the development of a temporally extended pattern of choice (Seigel & Rachlin, 1995; Kudadjie-Gyamfi & Rachlin, 1996). If preference for LL is likely when both SS and LL options are temporally remote, then initiation and continuation of choice when both options are distal could result in the development and maintenance of preference for the LL past the point at which a preference reversal would occur under normal circumstances. Though soft commitment appears to be effective for pigeons (Siegel & Rachlin, 1995), where choice for LL was maintained when preceded by a fixed-ratio 31 schedule that could be met with any distribution of responses to the SS and LL keys, we are aware of no published studies examining this phenomenon with human participants. The present pilot study is an initial examination of this possibility in a small sample of individuals known to have high rates of delay discounting (see Reynolds, 2006; Yi, Mitchell, & Bickel, 2010) and likely to exhibit preference reversals (Yi, Matusiewicz, & Tyson, 2016): cigarette smokers.

Method

Participants

Eligible participants were cigarette smokers, at least 18 years of age, able to send/receive SMS text messages, did not report significant medical/psychiatric condition or SUD (excluding tobacco/cannabis), and met at least two of the following smoking criteria: 1) *DSM-5* criteria for at least mild tobacco SUD; 2) ≥ 5 on the Fagerstrom Tolerance Questionnaire (FTQ; Fagerstrom & Schneider, 1989); 3) smoked ≥ 10 daily cigarettes for the previous year. Smoking status was biochemically confirmed (carbon monoxide breath sample ≥ 6 ppm).

Of 39 qualified participants, 18 did not complete the study or failed to respond to ≥ 3 consecutive daily choice responses. Data from the remaining 21 participants were included in all analyses. Due to loss of demographic data for some participants, mean age and sex distribution could not be calculated for the sample.

Materials

Delay Discounting Task A computerized, binary-choice delay discounting task was administered for hypothetical money. Participants indicated preference on each trial between hypothetical $25 available after a specified delay and a smaller amount of money available immediately. Across a six-trial sequence, the immediate outcome was titrated (Du, Green, & Myerson, 2002) to determine a present, subjective value (indifference point) of the delayed $25. This sequence was completed at each of four delays (1 day, 1 week, 1 month, and 6 months) to determine four indifference points.

Text-Messaging Choices To calculate the individualized, immediate SS value that would be predicted to result in a preference reversal 1-week prior to the delivery of the SS and 2-weeks prior to the delivery of the LL ($25), we first determined each individual's 1-week discount rate (k) from the delay discounting task using Mazur (1987) hyperbolic equation (Eq. 1).

The discount function for the LL was set equal to that for the SS (Eq. 2),

$$\frac{SS}{1 + k(D_{SS})} = \frac{LL}{1 + k(D_{SS} + D_{LL})} \tag{2}$$

where k was the 1-week discount rate, D_{SS} was the delay to the SS, and D_{LL} was the additional delay to the LL; as the delay to the LL was planned as 1 week longer than the SS, D_{LL} was set to 7 days. Setting D_{SS} to 7 days resulted in Eq. 3,

$$\frac{SS}{1 + k(7)} = \frac{25}{1 + k(7 + 7)} \tag{3}$$

which allowed for the calculation of the individualized SS that was subjectively equivalent to $25 (LL) when the SS was available in 1 week and the LL was available in 2 weeks. This crossover point between the discounting functions for SS and LL was assumed to be the expected preference reversal point.

For the text-messaging portion of the study (see Fig. 2), participants were randomly assigned to either the Experimental or Control conditions for the 3-week Commitment Phase, followed by a 1-week Choice Phase. Note that the start of the Choice Phase represents the point at which a preference reversal was expected. The purpose of the experimental condition was to establish commitment to the LL alternative prior to the Choice Phase. The purpose of the control condition was to establish no commitment to the LL, while still requiring participants to indicate preference on a money-based binary choice task. Participants were informed that one of the choices made during the 4-week text messaging portion of the study would be selected at random at the follow-up session and paid.

Commitment Phase

Experimental Condition On day 1 of the Commitment Phase, the participant received a text-message asking them to indicate preference between the following outcomes: $25
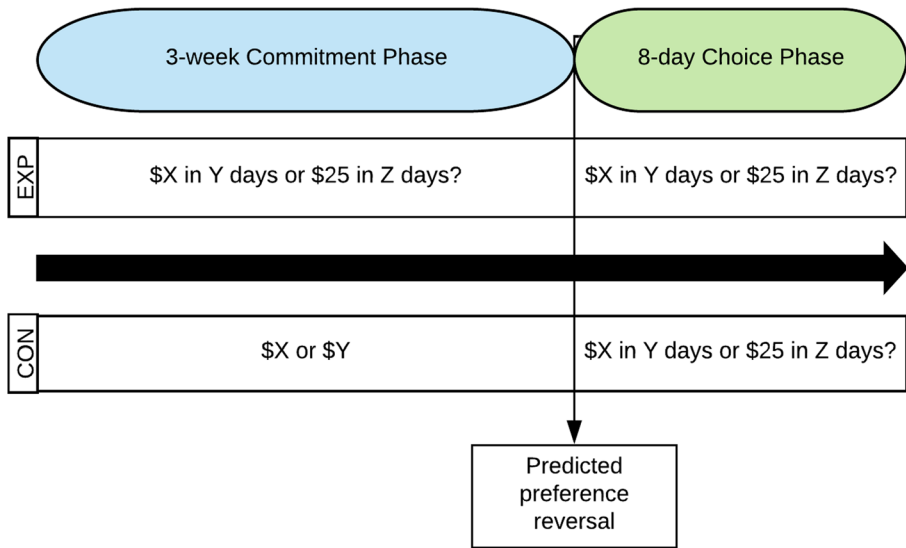
Fig. 2 This diagram represents the 21-day Commitment Phase and subsequent 8-day Choice Phase for participants in the Experimental (EXP) and Control (CON) conditions. Equation 3 was used to estimate the individualized value of the SS that would predict a preference reversal at the beginning of the Choice Phase

(LL) delayed by 35 days (5 weeks) versus the individualized SS delayed by 28 days (4 weeks, the end of text messaging). On day 2, the participant received the following outcomes: $25 delayed by 34 days versus the individualized SS delayed by 27 days. The number of days to both outcomes was reduced by 1 each day in this manner.

Control Condition Each day, the participant received a text message asking them to indicate preference between two sums of money with no associated delays. These values were arbitrarily selected from the SS and LL amounts used in the Experimental condition. For example, participants might be asked to indicate preference between $12 and $16.

Choice Phase

On day 1 of the Choice Phase, each participant in both conditions received a text message asking them to indicate preference between the following outcomes: $25 (LL) delayed by 14 days versus an individualized SS delayed by 7 days. Each day, the delays to both alternative were reduced by 1 day. For participants in the experimental condition, this was a continuation of choices started during the Commitment Phase.

Procedure

Following informed consent, screening, and confirmation of current alcohol sobriety (BAC = 0.0%), participants completed the computerized delay discounting task as well as secondary assessments not reported here. At the conclusion of the session, participants were given directions regarding the text-messaging portion of the study, and

scheduled for the follow-up session immediately following 4 weeks of text messaging (see Fig. 2). Each day thereafter, participants received one binary-choice text message that required a response. Text messages were sent during a convenient 4-hour time block specified by the participant, with response required within 2 hours. Participants were instructed to defer from responding during situations in which it was unsafe or inappropriate.

On the follow-up session day, participants responded to one additional text message before arriving for the session. BAC was assessed to ensure sobriety. Participants then completed the delay discounting task and other measures not reported here. Participants were then debriefed, compensated for participation, and paid one randomly selected choice during text messaging. In cases where the LL was selected, the participant returned 1 week later to receive the LL amount.

Result

Baseline and follow-up rates of delay discounting were determined by fitting the hyperbolic discounting model (Eq. 1; Mazur et al., 1987) to the indifference points using nonlinear regression. These values were natural logarithm-transformed (ln-k) and used in a 2 x 2 mixed analysis of variance with group condition (experimental/control) and time (baseline/follow-up) as factors. No significant main effects of group (F (1, 19) = .028, p = .72) nor time (F (1, 19) = .760, p = .394), nor interaction (F (1, 19) = 1.382, p = .254) were observed. Daily response rate for control condition participants during the Commitment and Choice phases were high (median = 95.2% and 85.7%, respectively). Daily response rate for experimental condition participants during the Commitment and Choice phases were also high (median = 95.2% and 100%, respectively).

To evaluate our procedure for estimating the individualized SS that would be associated with a preference reversal at the beginning of the Choice Phase, we scored preference for SS and LL as "0" and "1," respectively, and computed 2-day means for each participant in the experimental condition. For visualization purposes, individual 2-day means were computed (with the exceptions of the first days of the Commitment and Choice Phases) and the means of those values, which represent percentage of LL choice at the group level, are plotted as function of time in the text-messaging portion of the study (Fig. 3). Going from left to right, preference for LL was observed for most of the Commitment Phase, followed by a substantial drop in preference for the LL at the beginning of the Choice Phase, which then remains mostly constant for the remainder of that phase. Thus, although indicating that the experimental (i.e., soft commitment) condition did not prevent preference reversals amongst some participants, the sudden drop in preference for the LL at the beginning of the Choice Phase also provides good indication that the method of determining individualized preference reversal points in the present study was reasonably effective.

Regarding preference between conditions in the Choice Phase, percentage of preference for the LL in the control condition started at 60% and decreased to 20% on the last day, with a range of 20%–75% in-between. Percentage of preference for the LL in the experimental condition started at 50% and decreased to 40% on the last day, with a range of 40%–56% in-between. Despite these differences, comparison of overall amount of preference for the LL between conditions in the choice phase revealed no
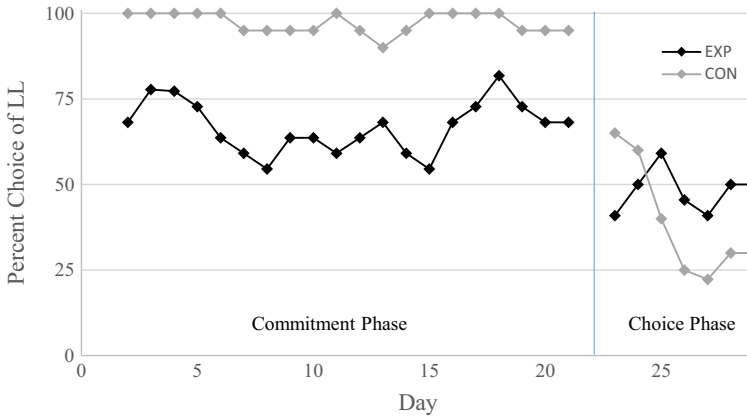
Fig. 3 Scoring preference for SS and LL as "0" and "1," respectively, 2-day means were computed for each participant in the experimental and control conditions. The means of these running means (y-axis, shown as percentage of LL preference) are plotted as a function of the days in the Commitment and Choice phases (x-axis)

significant difference (t (19) = .635, p = .533). However, as visual inspection indicated different trajectories over time, *within- and between-subject change* in responses over time during the choice phase was examined using hierarchical linear modeling (HLM; Raudenbush & Bryk, 2002), including the time × condition interaction. Results indicated that there was significant variability in participants' responses on the first day of the choice phase (B = 0.44, SE = 0.12, p < 0.001; see Table 1) although no significant differences existed between individuals across the two conditions (p = 0.40). A significant interaction between condition and time (B = 0.07, SE = 0.03, p = 0.042) indicated different patterns of response change between conditions: experimental condition participants did not exhibit change of preference over time (p = 0.87), whereas control condition participants decreased preference for the LL over the course of the choice phase (B = 0.06, SE = 0.03, p = 0.049).

Table 1 Change in responses during the choice phase

Fixed effects models	B	SE	t	p
Choice phase				
Intercept	0.435	0.117	1.814	**<0.001**
Intercept * Condition	-0.294	0.234	-0.870	0.395
Time	0.029	0.015	1.939	0.067
Time * Condition	0.065	0.030	2.186	**0.042**
Choice phase—experimental condition				
Intercept	0.533	0.145	3.685	**0.004**
Time	-0.002	0.013	-0/173	0.866
Choice phase—control condition				
Intercept	0.329	0.181	1.814	0.103
Time	0.063	0.028	2.276	**0.049**

Discussion

The present study provides initial evidence of soft commitment as a strategy that may promote choice persistence in humans. Though one study has examined soft commitment with animals (Siegel & Rachlin, 1995), we are aware of no published studies examining this phenomenon in humans. Given that observations of preference reversals are common (Green et al., 1994; Kirby & Herrnstein, 1995), behavioral strategies that reduce their occurrence while concurrently respecting individual freedom and not constraining available options may be preferable.

In the present study, though preference for the LL was modest amongst participants in the experimental (i.e., soft commitment) condition at the beginning of the Choice Phase (50%), preference for the LL remained fairly consistent for the duration of the phase (i.e., no preference reversals were not generally observed). In contrast, preference for the LL was higher in the control (i.e., no commitment) condition at the beginning of the Choice Phase (60%), but reduced to only 20% at the end of the phase (i.e., preference reversals were observed).

Moreover, the fact that a number of participants in the experimental condition appeared to exhibit a preference reversal right at the beginning of the Choice Phase provides good evidence that the procedure implemented in this study to define and identify the predicted preference reversal point was effective. It is noteworthy that no aspect of the study experience qualitatively changed for these participants between Commitment and Choice Phases—only the passage of time. As the control participants were not provided with intertemporal choice items during the Commitment Phase, we do not know their pattern of intertemporal choice prior to the Commitment Phase. However, as their percentage of choice for the LL dropped to 30% by day 4 of the Choice Phase and continued to drop to 20% by day 8, it is reasonable to conclude that the method implemented here was effective in predicting a reasonably accurate preference reversal point for participants in both experimental and control conditions.

Strengths of this pilot study include examination of this novel construct and an innovative approach. By individualizing the SS value based on the baseline delay discounting assessment, the present study allowed for the same study parameters across participants: each participant indicated preference across a 3-week Commitment Phase and an 8-day Choice Phase, between an LL = $25 and the individualized SS. Moreover, the strong control condition reduces the likelihood that the observed effects are attributable to a factor other than the Commitment Phase condition.

The primary limitation of this pilot study is the small sample size. Despite the significant differences in the trajectories of choice between experimental and control conditions during the Choice Phase, the small sample likely contributed to the absence of an overall difference between groups on preference for LL. As altering study parameters to allow for a longer choice phase could enhance overall difference between groups, replication of the observed effect with a larger sample and expanded study parameters is necessary to fully establish the robustness of the observed effect. A second limitation is the high number of participants that did not complete the study or comply with study requirements, though this is not surprising given the relatively high participant burden. Associated with this limitation is the possibility that the remaining sample are essentially self-selected. Given that loss of demographic data did not allow for a full characterization of this sample, the generalizability of these findings may be limited. Finally, although

these results are potentially valuable in modeling preference reversal, they do not capture the complexity of preference reversals observed in real-world exemplars of preference reversal. For example, a myriad of other transient factors independent of the passage of time are known to influence exemplars such as smoking relapse. Phasic changes in craving, withdrawal symptoms, exposure to smoking cues, stress, motivation (Allen, Bade, Hatusukami, & Center, 2008; Niaura et al., 1988; Slopen et al., 2013; Vangeli, Stapleton, Smit, Borland, & West, 2011; Zhou et al., 2009), and a variety of other factors predict and contribute to smoking relapse perhaps independently from rate of delay discounting. Soft commitment as a behavioral strategy may be unable to speak to these transient or oscillating causal mechanisms of smoking relapse.

Despite these limitations, this pilot study provides initial indications that soft commitment may help prevent preference reversals. By incorporating the construct of hyperbolic delay discounting into the understanding of preference reversals, identification of when a smoker attempting to quit is likely to become most vulnerable to relapse may be possible, which can then inform the timing and intensity of interventions designed to maintain abstinence and prevent relapse. Pending further evidence for soft commitment as a mechanism to prevent preference reversals, strategies to help in the development of behavioral inertia towards a future quit attempt could be implemented in established smoking cessation interventions to aid in the initiation and maintenance of quit attempts.

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