JOURNAL OF APPLIED BEHAVIOR ANALYSIS 2006, **39,** 413–422 NUMBER 4 (WINTER 2006)

CONTEXTUAL CONTROL OF DELAY DISCOUNTING BY PATHOLOGICAL GAMBLERS

MARK R. DIXON, ERIC A. JACOBS, AND SCOTT SANDERS

SOUTHERN ILLINOIS UNIVERSITY

The present study demonstrated the relative impact of gambling and nongambling contexts on the degree of delay discounting by pathological gamblers. We used a delay-discounting task with 20 pathological gamblers in and out of the natural context in which they regularly gambled. For 16 of the 20 participants, it appeared that the difference of context altered the subjective value of delayed rewards, thereby producing relative changes in delay-discounting rates that were generally consistent with a hyperbolic model of intertemporal choice. The current data suggest that empirically derived *k* values from delay-discounting tasks are context sensitive and are not constant across various settings for the individual. Implications for future transitional research on addictive disorders generally, and gambling specifically, are discussed.

DESCRIPTORS: choice, self-control, impulsivity, delay discounting, establishing operation, gambling

---

Recent estimates suggest that approximately 3% to 5% of the population gambles more than is financially responsible (National Gambling Impact Study Commission Report, 1999), which is up from estimates of 1% reported 20 years ago (Ladouceur, Boisvert, Pepin, Loranger, & Sylvain, 1994). Excessive or pathological gambling is considered a type of impulse control disorder by the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM-IV-TR*; American Psychiatric Association, 2000), whereby the gambler displays high levels of impulsivity. Behavioral conceptualizations of the construct of *impulsivity* have been noted as the individual's selecting an immediate smaller reinforcer over a larger delayed reinforcer (Critchfield & Kollins, 2001). Choosing the latter alternative is termed *self-control* (Rachlin & Green, 1972). Over the past decade, there has been a growing literature conceptualizing some maladaptive behavior as problems of intertemporal choice (Bickel & Vuchinich, 2002; Critchfield & Kollins; Herrnstein & Prelec, 1992). Behaviors such as compulsive gambling and habitual substance abuse, for example, have been conceptualized as repeated choices between the relatively punctuated and proximal consequences of engaging in the behavior (i.e., intoxication or winning a jackpot) and the relatively diffuse and distal consequences of abstaining from the problem behavior (i.e., a healthier lifestyle or fiscal security). Consistent with this interpretation, a number of studies have demonstrated that these behavioral problems are often correlated with diminished sensitivity to the larger yet delayed outcomes (Dixon, Marley, & Jacobs, 2003; Madden, Petry, Badger, & Bickel, 1997; Petry & Casarella, 1999).

In these studies, researchers often compared the delay discounting of people diagnosed with impulse control disorders (i.e., substance dependence or compulsive gambling) to the discounting of matched control participants using a hypothetical choice task that was developed by Rachlin, Raineri, and Cross (1991). Using this task, participants are required to make repeated choices between

This study was completed in partial fulfillment of the MS degree in behavior analysis and therapy by the third author under the direction of the first and second authors and Brandon F. Greene. We thank the University Teletrack of Carbondale, Illinois, for allowing this research to take place.

Address all correspondence to Mark R. Dixon, Behavior Analysis and Therapy Program, Rehabilitation Institute, Southern Illinois University, Carbondale, Illinois 62901 (e-mail: mdixon@siu.edu).

doi: 10.1901/jaba.2006.173-05

immediate and delayed hypothetical consequences (e.g., hypothetical amounts of money or drugs). The delay to the deferred outcome is held constant within conditions but is varied across conditions. Within each delay condition, the amount of the immediate consequence is varied across choices to determine the point of subjective equivalence (i.e., an indifference point) between the immediate and delayed consequences.

The resulting indifference curves are generally consistent with the following hyperbolic model introduced by Mazur (1987):

$$V = A/(1 + kD). \quad (1)$$

In Equation 1, V is the subjective value of the delayed consequence (i.e., the indifference point), A is the nominal amount of delayed consequence, D is the delay to deferred consequence, and k is a free parameter that describes sensitivity to change in delay. The degree of discounting parameter, k, provides a convenient index of sensitivity to delayed consequences. Higher k values indicate lower sensitivity to delayed consequences. That is, for any given amount and delay, lower indifference points will yield higher derived k values.

Consistent with the interpretation that some maladaptive behavior may be functionally related to diminished sensitivity to delayed or diffuse consequences, derived k values for individuals with impulse control disorders tend to be higher than those for participants who do not display the maladaptive behavior. Opioid-dependent individuals, for example, discount delayed consequences more severely than do matched control participants (Madden et al., 1997). Likewise, self-identified heavy drinkers discount delayed consequences more severely than self-identified light drinkers (Vuchinich & Simpson, 1999), cigarette smokers discount more severely than nonsmokers (Odum, Madden, & Bickel, 2002), and pathological gamblers discount more severely than matched control participants (Dixon et al., 2003). Moreover, it appears that differences in delay discounting may also be correlated with the severity of the maladaptive behavior. Opioid-dependent individuals with comorbid gambling problems, for example, discount delayed consequences more severely than opioid-dependent individuals without the dual diagnosis (Petry & Casarella, 1999). Likewise, opioid-dependent individuals who express willingness to use a hypodermic needle after someone else has used it discount delayed monetary and heroin outcomes more severely than those who refuse to use the dirty needle (Odum, Madden, Badger, & Bickel, 2000). The converging pattern of evidence does much to support the contention that maladaptive impulse control disorders may be functionally related to a general deficit in sensitivity to delayed or diffuse consequences.

Although the aforementioned data greatly extend the external validity of the hypothetical choice task (Rachlin et al., 1991) and Mazur's (1987) hyperbolic model of temporal discounting, many questions remain regarding the origins of these individual differences in temporal discounting and the dynamics of temporal discounting. A number of reinforcement variables, for example, have been shown to influence delay discounting, including reinforcement magnitude, commodity type, schedule dynamics, and deprivation. In the hypothetical choice task, adults typically discount smaller money amounts more rapidly than they discount larger money amounts (Green, Myerson, & McFadden, 1997). Moreover, qualitatively different reinforcers are sometimes discounted to different degrees. Substance-dependent individuals, for example, tend to discount delayed drug reinforcers to a greater degree than a yoked amount of delayed money (Madden, Bickel, & Jacobs, 1999; Madden et al., 1997). Schedule manipulations have also been shown to affect delay discounting. Ostaszewski, Green, and Meyerson (1998), for example, demonstrated that currencies subject to rapid inflation are discounted more severely than yoked amounts of a more economically stable currency. Deprivation has also been shown to affect delay discounting. Giordano et al. (2002) studied the effects of drug deprivation on delay discounting in opioid-dependent outpatients receiving buprenorphine pharmacotherapy. Degree of deprivation was manipulated within participants by asking them to complete hypothetical choice assessments either before (i.e., while experiencing mild opioid withdrawal) or 2 hr following (i.e., while experiencing peak drug effects) buprenorphine administration. Participants discounted delayed monetary and drug reinforcers to a greater degree under the deprived conditions. Each of these reinforcement variables suggest an area of concern for those interested in developing interventions to treat impulse control disorders that may be related to delay discounting.

From a therapeutic perspective, understanding the effects of antecedent control of delay discounting may be of critical importance in developing effective interventions for impulse control disorders such as drug dependence or compulsive gambling. For someone struggling with these behavioral problems, merely encountering contexts that have been correlated with reinforcement of the problem behavior may be sufficient to induce relapse. For example, while in a weekly therapy session, a pathological gambler may have every intention of quitting gambling, and believes that his life will now change. However, after removal from the therapy setting, now on his way home passing a casino, quitting gambling seems much less possible. The propensity to relapse towards engaging in the maladaptive behavior may be indicated by varying degrees of discounting. What seems perplexing to researchers and treatment providers in the area of gambling addiction is that while claiming to want and need to stop gambling, the problem gambler often fails at doing so. Failed attempts by the pathological gambler may be considered the result of a disease, an impulsive personality, or lack of willpower. Yet, behaviorally, it may be the case that the pathological gambler discounts the delayed outcomes of terminating gambling, and the degree to which they do varies with the environmental arrangement in which he finds himself. Thus, while in the therapist's office or at home with a family member, the future consequences of quitting gambling are more psychologically present than while only footsteps from a casino.

In the present study we examined the effects of context on delay discounting of problem gamblers. Specifically, we performed within-participant comparisons of delay discounting in gambling (an off-track betting facility) and nongambling (e.g., a coffee shop) contexts to determine if delayed hypothetical money amounts were discounted to a higher degree in the gambling context.

METHOD

Participants and Setting

Twenty participants were recruited to participate (19 men and 1 woman, mean age = 37 years). Each participant completed the South Oaks Gambling Scale (SOGS), a 20-item questionnaire that assesses pathological gambling based on *DSM-IV-TR* (2000) criteria and has been shown to have acceptable psychometric properties (Lesieur & Blume, 1987). Scores on the SOGS range from 0 to 14, with a score of 4 or more indicative of potential pathological gambling. The mean SOGS score for the 20 participants in the present study was 6.6 (range, 5 to 12).

The gambling context in which sessions took place was an off-track betting facility. The facility housed two bars, a number of tables and chairs, and approximately 30 televisions broadcasting horse-racing events from all over the world. The nongambling contexts included coffee shops, restaurants, or a preferred business or public location where the participant would be able to perform the delay-discounting task.

Materials

A personal computer running a delay-discounting software program was used for data collection. This program was written in Visual Basic.NET by the first author (see Dixon & MacLin, 2003). All reward choices were made by the participant pointing directly at a hypothetical amount of money displayed on the computer screen. The time delays were 1 week, 2 weeks, 1 month, 6 months, 1 year, 3 years, and 10 years. The monetary reward amounts were $1,000, $990, $960, $920, $850, $800, $750, $700, $650, $600, $550, $500, $450, $400, $350, $300, $250, $200, $150, $100, $80, $60, $40, $20, and $10; these amounts have been used frequently in other studies (e.g., Bickel, Odum, & Madden, 1999; Critchfield & Kollins, 2001; Madden et al., 1999; Petry & Casarella, 1999; Rachlin et al., 1991).

Procedure

Each participant completed a preexperimental assessment using the SOGS in the gambling context and two experimental sessions of the delay-discounting task (one in the gambling context and one in the nongambling context), each lasting approximately15 to 25 min. At the onset of the preexperimental session, which took place in the gambling context where participants were recruited, the participant read a consent form and agreed to complete the study. The participants then were verbally administered the SOGS. The SOGS was then scored, and participants who did not score 4 or more (indicative of probable pathological gambling) were dismissed and excluded from the remainder of the study. Further questioning of the participants revealed that they were regular patrons of the betting facility, had never attended a Gamblers Anonymous meeting, and had never sought help for a gambling problem. Participants were randomly assigned to context order. Participants who were assigned to the gambling context first completed the delay-discounting task. Participants who were assigned to the nongambling context first were scheduled to meet the experimenter in such a context within the next few days to complete the delay-discounting task. After the completion of the first administration of the delay-discounting task, all participants rescheduled the next session with the experimenter to be completed in the other context within approximately 1 week.

At the beginning of the first experimental session, the researcher read to participants a script describing the delay-discounting computer program. In the program, participants were presented with multiple consecutive monetary choices. The participants was instructed to point to the hypothetical amount of money he or she would rather have: either a larger delayed reward or a smaller immediate reward. After the participant pointed to the desired selection on the screen, the response was recorded. This sequence continued for all hypothetical monetary rewards on the smaller immediate side. For example, the initial choice presented to the participant was between $1,000 available now or $1,000 available after 1 week. After a participant selected an amount, the next choice (i.e., $990 now or $1,000 after 1 week) was presented. The amount of money available continued to decrease to $10 along the values described earlier. The process was then repeated in ascending order (i.e., amounts increasing from $10 to $1,000 now vs. $1,000 1 week later). The ascending and descending sequences were then repeated at the next larger delay value (e.g., $1,000 available now vs. $1,000 available in 2 weeks).

RESULTS

The indifference points obtained at each of the seven delays are shown in Table 1 under gambling and nongambling conditions for each participant. Within each assessment, the indifference points usually decreased or remained the same across successive delay values. Each obtained indifference curve was evaluated according to the following criteria to determine consistency with delay discounting, broadly construed. The mean of the indifference points from the three shortest delay conditions had to

Table 1

Indifference Points, Derived *k* Values, Proportions of Variance Accounted for (R^2) by Equation 1, and Area Under the Curve (AUC) Measures for Each Participant Under Gambling (G) and Nongambling (NG) Conditions

		Delay (weeks)									
Participant	Condition	1	2	4	25	52	156	520	*k*	R^2	AUC
101	G	750	700	450	250	100	60	60	.2440	0.96	.087
	NG	1,000	850	850	550	350	150	150	.0349	0.97	.214
102	G	1,000	1,000	10	10	10	10	10	.2942	0.71	.016
	NG	1,000	1,000	1,000	500	400	175	10	.0307	0.98	.184
103	G	850	800	700	550	450	350	250	.0258	0.55	.347
	NG	920	850	800	700	550	400	300	.0127	0.75	.409
104	G	700	700	700	500	100	100	60	.1002	0.8	.121
	NG	800	800	775	650	200	100	100	.0454	0.87	.157
105	G	1,000	1,000	1,000	650	500	500	500	.0085	0.55	.521
	NG	1,000	1,000	1,000	700	550	500	500	.0070	0.61	.529
106	G	1,000	1,000	920	800	650	600	500	.0040	0.68	.590
	NG	800	800	700	700	500	400	400	.0137	0.16	.436
107	G	990	990	990	990	990	990	500	.0012	0.82	.819
	NG	920	1,000	920	850	800	650	550	.0025	0.71	.651
108	G	850	850	800	700	500	400	10	.0176	0.87	.302
	NG	800	750	700	650	600	500	500	.0150	−2.72	.526
109	G	920	850	800	750	550	10	10	.0236	0.89	.135
	NG	700	700	650	550	500	350	200	.0268	−0.18	.335
110	G	920	920	800	750	550	450	10	.0137	0.9	.333
	NG	920	920	850	800	700	400	100	.0101	0.95	.364
201	G	875	850	700	550	250	10	10	.0576	0.94	.085
	NG	920	920	920	750	550	10	10	.0220	0.93	.138
202	G	550	550	500	500	10	10	10	.3242	0.55	.047
	NG	960	920	1,000	500	500	500	10	.0186	0.86	.342
203	G	700	700	800	10	10	10	10	.1877	0.88	.032
	NG	1,000	1,000	500	600	10	10	10	.0799	0.83	.054
204	G	850	850	800	700	700	650	550	.0032	−1.47	.628
	NG	850	850	800	800	700	700	550	.0026	−1.09	.655
205	G	920	850	920	600	300	200	100	.0326	0.97	.216
	NG	850	850	990	770	700	300	100	.0128	0.92	.321
206	G	600	500	400	250	100	60	10	.4509	0.86	.067
	NG	920	750	500	300	100	40	10	.1665	0.97	.064
207	G	1,000	1,000	1,000	850	650	300	250	.0101	0.97	.371
	NG	1,000	1,000	920	800	600	400	250	.0099	0.97	.406
208	G	750	700	600	600	450	10	10	.0484	0.65	.110
	NG	920	850	750	700	650	10	10	.0223	0.85	.144
209	G	850	850	700	500	250	200	200	.0525	0.87	.235
	NG	500	400	400	200	200	200	200	.6232	−0.52	.206
210	G	1,000	1,000	1,000	500	300	10	10	.0398	0.96	.097
	NG	1,000	1,000	920	700	500	100	10	.0224	0.97	.170

exceed the mean of the indifference points from the three longest delay conditions, and indifference points could not increase across successive delays more than once. The obtained indifference curves for all participants under all conditions met these criteria.

Table 1 also contains the empirically derived discounting parameters (*k* values) and the individual proportions of variance (R^2) accounted for by the hyperbolic model for each participant under each condition. In general, the hyperbolic model provided an adequate description of the majority of the individual indifference curves. Across all participants and conditions, the median R^2 value was 0.86 and the interquartile range was 0.64 to 0.94. In 12 instances involving 9 participants, however, the proportion of variance accounted for by Equation 1 fell below 0.7. Such poor fits often occurred despite orderly indifference curves (e.g., see Participant 103 under the gambling condition). Thus, although Equation 1 ade-

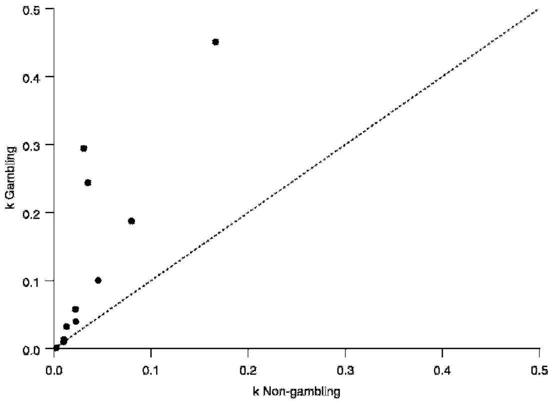

Figure 1. *k* values derived from data obtained in the gambling and nongambling contexts for select participants (see text for details). The dashed reference line depicts equality between the *k* values.

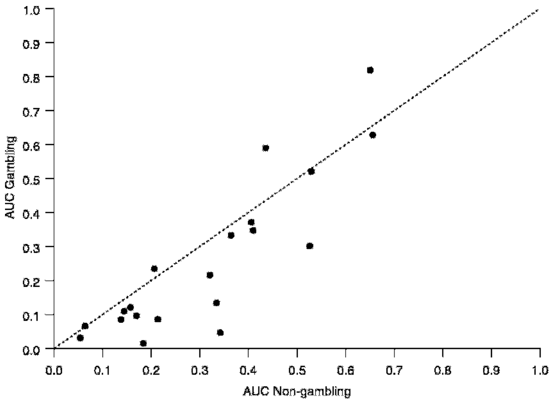

Figure 2. Area under the indifference curve obtained in the gambling and nongambling contexts for each participant. The dashed reference line depicts equality between the AUC measures.

quately described most of the individual indifference curves, a subset of the indifference curves may not have been formally consistent with the hyperbolic model.

Nonetheless, the *k* parameter provides a useful index of degree of discounting, as higher *k* values indicate greater sensitivity to delay to reinforcement. If the gambling context increases the degree of delay discounting, then the *k* parameters derived from data collected in the gambling context should exceed those derived from data collected in the nongambling context. Data from the 11 participants for whom Equation 1 provided an adequate description (i.e., $R^2 > 0.7$) of the indifference curves from both contexts are shown in Figure 1. For 10 of these 11 participants, the *k* value derived from data obtained in the gambling context exceeded that derived from data obtained in the nongambling context.

Area under the indifference curve (AUC), another measure of delay discounting, is also presented in Table 1 for each participant under both conditions. AUC is a theoretically neutral measure of delay discounting that requires no a priori assumptions regarding the form of the indifference curve (Myerson, Green, & Warusawitharana, 2001). As such, the AUC measure is applicable to a wider range of indifference curves than other quantitative models, such as those based on hyperbolic or exponential delay discounting, that make explicit assumptions regarding the form of the indifference curve. The AUC ranges from 0 (steep discounting) to 1 (little or no discounting).

If the gambling context exacerbates delay discounting, then the AUC obtained in the gambling context should be lower than the AUC obtained in the nongambling context. Indeed, for 16 of the 20 participants, the AUC was lower in the gambling context (see Figure 2). An analysis of variance was conducted to assess the effects of context and sequence of conditions on AUC. The effect of sequence was not statistically significant, $F(1, 18) = 2.4480$, $p = .14$, nor was the interaction between sequence and context, $F(1, 18) = 0.0220$, $p = .88$. However, the main effect of context on AUC was statistically significant, $F(1, 18) = 4.9788$, $p = .04$.

Figure 3 shows aggregate discounting curves for all participants in gambling and nongambling contexts. The data points represent the medians of the individual indifference points at each delay (see Table 1). Equation 1 provided a good description of the aggregate indifference curves. The proportions of variance accounted

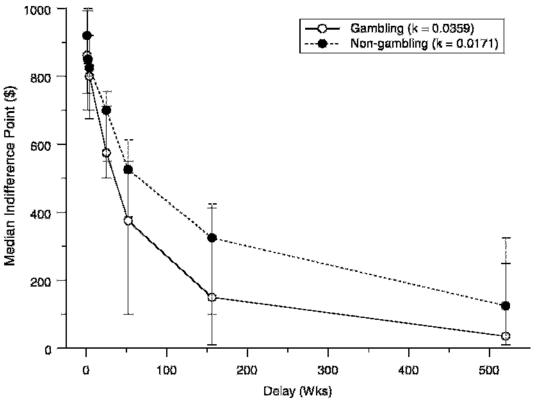

Figure 3. Aggregate indifference curves for participants in the gambling and nongambling contexts. Data points represent medians of the individual indifference points. Error bars represent the interquartile range of the individual indifference points at each delay. The solid line shows the best fit in the gambling context, and the dashed line shows the best fit in the nongambling context.

for by the hyperbolic model were 0.96 and 0.93 in the gambling and nongambling contexts, respectively. The derived k value for the aggregate data was higher for participants in the gambling context (k = .0358) than in the nongambling context (k = .0171). The area under the aggregate curve was also smaller in the gambling context (AUC = .1762) than in the nongambling context (AUC = .3118).

DISCUSSION

The current findings illustrate that most pathological gamblers discounted delayed rewards to a greater degree in a gambling context. For the majority of participants, k values derived from fitting Equation 1 to individual indifference curves were larger in the gambling context than in the nongambling context, indicating more severe discounting when gambling. It should be noted, however, that Equation 1 did not provide a good fit to the individual indifference curves for a number of participants, despite relatively orderly discounting data. Individual AUC measures were also smaller in the gambling context than in the nongambling context for the majority of participants, again demonstrating steeper temporal discounting when gambling. Aggregate data patterns were in accord with these individual patterns. However, the aggregate data were well described by Equation 1. Although previous research has demonstrated the utility of the hyperbolic model (Equation 1) to fit obtained discounting data (e.g., Kirby & Marakovic, 1995; Kirby, Petry, & Bickel, 1999; Madden et al., 1997; Mazur, 1987; Petry & Bickel, 1998; Rachlin et al., 1991; Raineri & Rachlin, 1993), our present findings revealed many instances in which this model provided a relatively poor fit to the obtained individual data. The difficulties we had with Equation 1 were similar to those reported by Dixon et al. (2003) in a comparison of delay discounting in pathological gamblers and matched controls and by Dixon et al. (2005) in a comparison of delay discounting in persons with acquired brain injuries and matched controls. As in these previous studies, AUC measures were deemed useful for data analysis. The strength of the AUC measure is that it is not tied to any particular theory about the form of the indifference curve (i.e., hyperbolic or exponential discounting). As such, it can be used to evaluate data that do not conform to existing quantitative models. One weakness of the AUC measure, however, is that similar areas may be obtained from very different discounting curves. Nonetheless, AUC analyses are gaining popularity for analyzing discounting data that may not fit hyperbolic decay functions (Dixon et al., 2003, 2005; Myerson et al., 2001), and future researchers may wish to compare the two metrics with various other clinical populations to further establish their concordance.

The present study also underscores the value of conducting within-participant analyses of variables that may affect intertemporal choice. Sixteen of our 20 participants showed greater degrees of delay discounting when assessed within a gambling environment compared to a nongambling environment. Although Figure 3 displays aggregate differences in discounting across contexts, the group analysis may obscure the magnitude and consistency of the effect. The individual data displayed in Table 1 and Figure 2 provide a more refined within-participant analysis of the subtle changes in discounting that occurred for each participant. For example, the interquartile ranges displayed in Figure 2 illustrate considerable overlap across contexts and could be considered an indication that the effect of context was not robust. However, it is the *relative* change that occurred within each individual participant's discounting pattern that should be considered our most important finding. Consider Participant 101, who displayed an AUC value of .08 in the gambling context and .21 in the nongambling context, and Participant 103, who displayed AUCs of .34 and .40 in those respective contexts. Both of Participant 101's AUCs were much higher than 103's (indicating generally greater discounting by 103), but the relative change within each participant was similar. This illustrates the true value of within-participant analysis. Although both participants had different degrees of delay discounting, each was relatively equally sensitive to the contextual manipulations of the present experiment.

The present findings add to a growing line of research on variables that affect delay discounting. Previous research has shown that severity of discounting can be affected by conditions of deprivation (Giordano et al., 2002), reinforcer magnitude (Green et al., 1997), reinforcer type (Bickel et al., 1999; Madden et al., 1997, 1999), and history (Bickel et al.). These findings are important because they suggest that such variables need to be controlled when conducting discounting assessments and they provide a rationale for conducting multiple assessments within individual participants.

The present data also further our understanding of the discounting behavior of pathological gamblers, who have been shown to discount to greater degrees than matched controls (Dixon et al., 2003; Petry & Casarella, 1999). Our data show that altering the context in which the delay-discounting task is completed can result in different degrees of discounting. To date, the impact of context on altering the behavior of pathological gamblers has only been speculative (Dixon et al., 2003); however, the current data demonstrate empirical support for this assertion.

The present study was conducted in a natural setting and, as such, suffers from some potential threats to internal validity that should be recognized. First, our sample may not have been representative of pathological gamblers in general. Participants were self-selected volunteers, and the method of identifying pathological gamblers relied on self-report rather than direct observation of relevant behavior. Although the SOGS is the primary screening instrument in the gambling literature, our sample may have been restricted to those pathological gamblers who responded accurately to the questionnaire. In addition, the sample may have included gamblers who underestimated the prevalence of their gambling. This sampling problem seems more likely in that many pathological gamblers may not wish to disclose the severity of their disorder to an unknown researcher. Furthermore, we used only pathological gamblers who were currently gambling and not seeking treatment for this disorder. Thus, our participants may actually represent the most severe type of pathological gambler, one who is currently gambling and not seeking treatment. Another potential confounding effect is that our current participants were free to consume alcohol within the gambling establishment, and drug use may have occurred prior to entering this establishment. Therefore, we are unaware of how substance use may have differentially affected our participants' responding across the two contexts. Richards, Zhang, Mitchell, and de Wit (1999) reported, however, that alcohol consumption did not affect responding on the hypothetical money choice task in a laboratory context. We were also not aware of, nor did we control for, the amount of time the participant was in the gambling establishment or the number of winning or losing wagers that had been made before completing our experiment. This latter point begs the question regarding the mechanism responsible for behavior change across contexts. Relevant variables in the gambling context might include the presence of others who are gambling, alcohol consumption, and the amount of money available to participants. It may have also been the case that the nongambling context was less natural or social in nature than the off-track betting facility. The specific variables that contributed to the between-context differences observed in the present study are unknown, but it seems safe to conclude that a gambling context contains critical variables that alter delay discounting, at least for pathological gamblers.

Future researchers may wish to further explore various additional parameters such as immediate financial instability, which may alter pathological gamblers' discounting. Pietras and Hackenberg (2001), for example, have demonstrated that income and budgetary constraints affect risky choice in humans in the laboratory. In translating the implications of their work to gambling, an experimenter might assess how moment-by-moment wins or losses alter the degree to which that person discounts delayed rewards prior to their initiation of the next wager. Brief discounting tasks could be completed between successive gambles, and comparisons could be made based on prior winning or losing wagers. Additional research might also attempt to evaluate the correspondence between discounting and the actual size of the next wager made by a pathological gambler in a gambling context. Finally, researchers might investigate the potential relations that may exist between gambling severity (as reported using metrics like the SOGS) and degrees of discounting. It may be possible that regression models that include factors such as SOGS score, context, age of onset of disorder, and current indebtedness may be predictive of delay discounting.

In summary, the present experiment illustrates a clear rationale for conducting translational research on delay discounting. The context in which the experimental procedures were conducted altered the choice patterns for many of the participants. There is a growing literature on temporal discounting in people with impulse control disorders. To the extent that insensitivity to delayed or diffuse consequences contributes to the provenance and maintenance of these behavioral problems, understanding the variables that control temporal discounting is of critical importance to the development of effective treatments (see, e.g., Petry, 2005). Identifying the conditions under which an individual is most sensitive to the long-term consequences of his or her behavior may enhance the likelihood that he or she will commit to a course of action that will bring behavior under control of those extended outcomes. Behavior analysts are uniquely poised to advance this research by examining environment-based controlling variables instead of accepting prescientific, organism-based explanations for these pervasive and socially significant behavioral problems.

REFERENCES

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th ed., text rev.). Washington, DC: Author.

Bickel, W. K., Odum, A. L., & Madden, G. L. (1999). Impulsivity and cigarette smoking: Delay discounting in current, never, and ex-smokers. *Psychopharmacology, 146*, 447–454.

Bickel, W. K., & Vuchinich, R. E. (Eds.). (2002). *Reframing health behavior change with behavioral economics*. Mahwah, NJ: Erlbaum.

Critchfield, T. S., & Kollins, S. H. (2001). Temporal discounting: Basic research and the analysis of socially important behavior. *Journal of Applied Behavior Analysis, 34*, 101–122.

Dixon, M. R., Jacobs, E. A., Sanders, S., Guercio, J., Soldner, J., & Parker-Singler, S., et al. (2005). Impulsivity, self-control, and delay discounting in persons with acquired brain injury. *Behavioral Interventions, 20*, 101–120.

Dixon, M. R., & MacLin, O. H. (2003). *Visual basic for behavioral psychologists*. Reno, NV: Context Press.

Dixon, M. R., Marley, J., & Jacobs, E. A. (2003). Delay discounting by pathological gamblers. *Journal of Applied Behavior Analysis*, *36*, 449–458.

Giordano, L. A., Bickel, W. K., Loewenstein, G., Jacobs, E. A., Marsch, L. A., & Badger, G. J. (2002). Mild opioid deprivation increases the degree that opioid-dependent outpatients discount delayed heroin and money. *Psychopharmacology*, *163*, 174–182.

Green, L., Myerson, J., & McFadden, E. (1997). Rate of temporal discounting decreases with amount of reward. *Memory & Cognition*, *25*, 715–723.

Herrnstein, R. J., & Prelec, D. (1992). A theory of addiction. In G. Loewenstein & J. Elster (Eds.), *Choice over time* (pp. 331–360). New York: Sage.

Kirby, K. N., & Marakovic, N. N. (1995). Modeling myopic decisions: Evidence for hyperbolic delay-discounting within subjects and amounts. *Organizational Behavior and Human Decision Processes*, *64*, 22–30.

Kirby, K. N., Petry, N. M., & Bickel, W. K. (1999). Heroin addicts have higher discount rates for delayed rewards than non-drug-using controls. *Journal of Experimental Psychology: General*, *128*, 78–87.

Ladouceur, R., Boisvert, J. M., Pepin, M., Loranger, M., & Sylvain, C. (1994). Social cost of pathological gambling. *Journal of Gambling Studies*, *10*, 399–409.

Lesieur, H. R., & Blume, S. B. (1987). The South Oaks Gambling Screen (SOGS): A new instrument for the identification of pathological gamblers. *American Journal of Psychiatry*, *144*, 1184–1188.

Madden, G. J., Bickel, W. K., & Jacobs, E. A. (1999). Discounting of delayed rewards in opioid-dependent outpatients: Exponential or hyperbolic discounting functions. *Experimental & Clinical Psychopharmacology*, *7*, 284–293.

Madden, G. J., Petry, N. M., Badger, G. J., & Bickel, W. K. (1997). Impulsive and self-control choices in opioid-dependent patients and non-drug-using control participants: Drug and monetary rewards. *Experimental and Clinical Psychopharmacology*, *5*, 256–262.

Mazur, J. E. (1987). An adjusting procedure for studying delayed reinforcement. In M. L. Commons, J. E. Mazur, J. A. Nevin, & H. Rachlin (Eds.), *Quantitative analyses of behavior: Vol. 5. The effect of delay and of intervening events on reinforcement value* (pp. 55–73). Hillsdale, NJ: Erlbaum.

Myerson, J., Green, L., & Warusawitharana, M. (2001). Area under the curve as a measure of discounting. *Journal of the Experimental Analysis of Behavior*, *76*, 235–243.

National Gambling Impact Study Commission. (1999). *Final report*. Retrieved June 6, 2006, from http://govinfo.library.unt.edu/ngisc/reports/fullrpt.html

Odum, A. L., Madden, G. J., Badger, G. J., & Bickel, W. K. (2000). Needle sharing in opioid-dependent outpatients: Psychological processes underlying risk. *Drug and Alcohol Dependence*, *60*, 259–266.

Odum, A. L., Madden, G. J., & Bickel, W. K. (2002). Discounting of delayed health gains and losses by current, never- and ex-smokers of cigarettes. *Nicotine & Tobacco Research*, *4*, 295–303.

Ostaszewski, P., Green, L., & Myerson, J. (1998). Effects of inflation on the subjective value of delayed and probabilistic rewards. *Psychonomic Bulletin & Review*, *5*, 324–333.

Petry, N. M. (2005). *Pathological gambling*. Washington, DC: APA Press.

Petry, N. M., & Bickel, W. K. (1998). Polydrug abuse in heroin addicts: A behavioral economic analysis. *Addiction*, *93*, 729–738.

Petry, N. M., & Casarella, T. (1999). Excessive discounting of delayed rewards in substance abusers with gambling problems. *Drug and Alcohol Dependence*, *56*, 25–32.

Pietras, C. J., & Hackenberg, T. D. (2001). Risk-sensitivity in humans as a function of earnings budget. *Journal of the Experimental Analysis of Behavior*, *76*, 1–19.

Rachlin, H., & Green, L. (1972). Commitment, choice and self-control. *Journal of the Experimental Analysis of Behavior*, *17*, 15–22.

Rachlin, H., Raineri, A., & Cross, D. (1991). Subjective probability and delay. *Journal of the Experimental Analysis of Behavior*, *55*, 233–244.

Raineri, A., & Rachlin, H. (1993). The effect of temporal constraints on the value of money and other commodities. *Journal of Behavioral Decision Making*, *6*, 77–94.

Richards, J. B., Zhang, L., Mitchell, S. H., & de Wit, H. (1999). Delay or probability discounting in a model of impulsive behavior: Effect of alcohol. *Journal of the Experimental Analysis of Behavior*, *71*, 121–143.

Vuchinich, R. E., & Simpson, C. A. (1999). Delayed-reward discounting in alcohol abuse. In F. J. Chaloupka, M. Grossman, W. K. Bickel, & H. Saffer (Eds.), *The economic analysis of substance use and abuse* (pp. 103–122). Chicago: The University of Chicago Press.

Received November 29, 2005
Final acceptance June 7, 2006
Action Editor, James E. Carr