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TEMPORAL DISCOUNTING PREDICTS HOW PEOPLE GAMBLE ON A SLOT MACHINE

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The gambling research literature suggests that temporal discounting may be associated with problem gambling, but research has not demonstrated that rates of discounting predict differences in actual gambling behavior. Thirty eight individuals of different ages and backgrounds were recruited to complete several questionnaires, including a delay-discounting task. They were then given $10 in tokens with the opportunity to gamble on a slot machine. How steeply participants discounted the delayed (hypothetical) monetary rewards was a significant predictor of they gambled. Gender, age, and reported annual income were not significant predictors. To our knowledge, these data are the first to demonstrate that temporal discounting may predict differences in actual gambling behavior (vs. self reports). This predictive relationship has implications for both researchers and practitioners.

Keywords:Temporal Discounting, Gambling, Slot Machine

Petry (2005) outlined six risk factors for pathological gambling: substance abuse, sex, age, marital status, socioeconomic status, and ethnicity. Although these factors are known to be associated with pathological gambling, they are not necessarily causal factors. That is, none of the factors are necessary or sufficient for the presence of pathology.

Of the other factors that have been linked to pathological gambling, one of the more popular ones is temporal discounting. A number of studies have suggested that pathological gamblers discount delayed rewards more steeply than non-pathological gamblers (e.g., Dixon, Marley, & Jacobs, 2003; see Madden et al., 2007, or Petry, 2005, for reviews). In other words, when faced with the (hypothetical) decision of getting $900 today or getting $1,000 a week from today, pathological gamblers are more likely than non-pathological gamblers to prefer the $900 today. Delay discounting has also shown to be related to other risky behaviors such as drug use (e.g., Reynolds, 2006) and smoking (e.g., Reynolds, Richards, Horn, & Karraker, 2004).

The research results on gambling and discounting to date represent correlations found in pre-existing populations (i.e., pathological and non-pathological gamblers). Although it is possible that changes in discounting play a role in the emergence of pathological gambling, it is equally possible that the pathology leads to changes in the discounting process. A recent study from our laboratory (Weatherly, Derenne, & Chase, in press) highlights the murkiness of the issue. One hundred seventy eight undergraduate partici-

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pants completed a temporal-discounting task after providing information pertaining to the above risk factors (excluding drug use) and completing the South Oaks Gambling Screen (SOGS; Lesieur & Blume, 1987), the most widely used screening instrument for gambling behavior (Petry, 2005). Results showed that none of the risk factors or SOGS score were significant predictors of how individuals discounted delayed (hypothetical) monetary rewards. Given that each of these variables is related to pathological gambling, one might consider this result surprising.

It is unknown whether the risk factors for pathological gambling and/or rates of temporal discounting translate into differences in actual gambling behavior. The present study was designed as an initial step toward this determination. Participants of varying ages and socioeconomic backgrounds were recruited to complete a temporal-discounting task and were then given $10 in tokens to, if they chose, gamble on a slot machine. Given previous findings, we predicted that participants' gender, age, socioeconomic status, and rate of temporal discounting would be significant predictors of actual gambling behavior.

METHOD

Participants

Participants (N= 38) were recruited from the student body of the University of North Dakota and the surrounding Grand Forks, ND USA community. Participants ranged in age from 21-86 years old (M = 52.3 years old, SD = 26.26). Fifteen of the participants were students; 23 were not. Seventeen were male; 21 were female. Seventeen reported being single while 11, 3, and 7 reported being married, divorced, or widowed, respectively. Ten participants reported earning less than $10,000 (USD) per year while 10 participants reported earning more than $75,000 per year. The median reported income was $15,000 - $24,999 per year. All participants were Caucasian.

Materials

Participants completed several paper-and-pencil measures. The first was an informed-consent sheet as approved by the Institutional Review Board at the University of North Dakota. The second form was a demographic questionnaire that asked the respondent's sex, age, marital status, annual income, and ethnicity.

As a measure of substance use, the participants completed the Khavari Alcohol Test (KAT; Khavari & Farber, 1978). The KAT is a 12-item questionnaire that asks respondents about their consumption of beer, wine, and liquor. The answers to these categories are then translated into a measure of ounces of alcohol consumed per day. Kavari and Farber (1978) reported that the internal consistency of the KAT was $\alpha = .80$, with a test-retest reliability of $r = .92$. The KAT does not assess drug use other than alcohol.

Participants were asked to complete the SOGS (Lesieur & Blume, 1987). The SOGS is a 20-item survey designed to assess the respondent's experience gambling. A score of 5 or more is indicative of the potential presence of pathology. Participants scoring 5 or more on the SOGS were not allowed to participate in the gambling session. The internal consistency of the SOGS is good, with Lesieur and Blume (1987) reporting $\alpha = .97$ using the original norming sample. Stinchfield (2003) reported $\alpha = .81$ for a large, non-clinical sample. Test-retest reliability has been reported at $r = .71$ (Lesieur & Blume, 1987).

The temporal-discounting task was a list of 63 choices between two hypothetical options, a certain amount of money available immediately or $1,000 available after a delay. The amount of the money available immediately and the delay of the constant amount varied across choices. There were nine different immediate amounts, ranging from $1 to $1,000, and seven different delays to the constant $1,000, ranging from one week to 10 years. The order in which the options were

presented to the participants was determined randomly prior to the study and all participants received the series of choices in the same random order (on a total of three pages). Participants indicated their choice(s) by circling their preferred option.

Apparatus

Participants played a Red, White, and Blue (wild) slot machine (IGT Inc.) that allowed the player to bet between one and three coins per play. Outcomes of individual spins were not preset (i.e., predetermined). The overall payback percentage for the machine was set at 87%, meaning that over an indefinite period of time the machine would return 87 tokens for every 100 bet. The machine had an internal counter that measured the number of tokens inserted and the number of tokens dispensed (for wins). The machine had been altered so that all wins were paid in tokens so that the counter would accurately track the number of tokens won. The visual displays on the machine indicated that it took 25-cent coins. However, the machine had been reprogrammed to accept tokens which, in the present study, were assigned the value of 10 cents. Thus, the "25¢" displays were covered with "10¢" displays. The machine was one of three that were located in a windowless room measuring approximately 1.5 m X 5 m. The other two machines were not turned on during the gambling session.

Procedure

Participants were run individually. The researcher first checked the participant's identification to ensure that s/he was at least 21 years of age. This precaution was taken because participants would be gambling money and the laws in North Dakota (and most states in the United States) require an individual to be 21 years of age or older to legally gamble.[1] The researcher then obtained informed consent and then administered the paper-and-pencil measures described above. As the participant was completing the temporal-discounting task, the researcher scored the SOGS so as to determine whether the participant had scored 5 or above on this measure. No participant was dismissed because of her or his SOGS score.

Once the participant had completed the pencil-and-paper measures, the researcher guided her or him to the slot machine and read the following instructions:

> You will now be given the opportunity to play on a slot machine. You will be given 100 tokens worth 10 cents each. Thus, you are being given 10 dollars to play with. You may bet as many credits per play as the machine allows. Your goal should be to end the session with as many tokens as you can. You may end the session at anytime by informing the researcher that you would like to end the session. The session will end when a) you quit playing, b) you run out of tokens, or c) 15 minutes has elapsed. At the end of the experiment you will be paid in cash for the number of tokens you have left or have accumulated. Do you have any questions?

If the participant had questions, the researcher answered by repeating the above instructions. The researcher then gave the participant 100 tokens.

The participants played the slot machine until one of the three criteria for terminating the session was met. The researcher then debriefed the participant and paid the participant for the number of tokens that remained or had accumulated. Student participants also received extra-course credit for their participa-

[1] The state laws of North Dakota, USA allow for researchers to possess modern gambling equipment under certain conditions and to have participants risk actual money. To our knowledge, North Dakota is the only state in the United States that currently allows such a procedure to be legally executed. Researchers attempting to replicate the present procedure (or some variation of it) should contact their local, state, and/or national officials to determine whether they can legally do so before conducting their research.

tion while non-student participants were paid an additional $5 for their participation. The researcher then dismissed the participant.

Analyses

The paper-and-pencil measures were scored by hand (according to the published scoring criteria when applicable). The degree to which participants discounted delayed (hypothetical) monetary rewards was determined in the following way. At each delay, the researcher determined the point at which the participant switched from preferring the delayed $1,000 to preferring the immediately available amount of money. The highest immediately available amount prior to the switch was used as the subjective value of the delayed reward at that particular delay. Because participants were asked to make choices about all nine amounts at each delay (in random order), it was possible for participants to display multiple switchover points at a particular delay (i.e., display inconsistencies in their preferences at a particular delay). When such instances occurred, the subjective value of the delayed reward at that particular delay was determined by the first switch point observed using the procedure described above.

A hyperbolic function was then fit to each participant's discounting data (e.g., Mazur, 1987):

$$V = A / (1 + kD) \quad \text{(Equation 1)}$$

In Equation 1, V is the subjective value of the delayed monetary reward, A is the amount of the monetary reward, *k* is a free parameter that describes the steepness at which discounting occurs, and D is the delay. The parameter *k* was calculated for each participant, with larger values of *k* representing steeper rates of delay discounting than smaller values. This equation was used because it is generally consistent with research results on temporal discounting across a variety of procedures, including those that have investigated discounting with gamblers (e.g., Dixon et al., 2003; Dixon, Jacobs, & Sanders, 2006).

The main dependent measure in the present study was the amount participants gambled on the slot machine as measured by the number of tokens participants inserted into the machine during the session. To test the main hypotheses of the study, a stepwise linear regression was conducted with number of tokens gambled as the dependent measure and gender, age, socioeconomic states (measured by annual income endorsed as a categorical variable), and *k* as predictor variables. Results from this analysis, and all other analyses, were considered significant at $p<.05$.

RESULTS

With one exception, all participants gambled the money they were staked. The mean number of tokens played per session across participants was 102.81 (SD = 86.06). The mean number of tokens won per session was 189.25 (SD = 215.71). This latter number was skewed by one participant who won a 1,199-token jackpot (and finished the session with 1,078 tokens). Of the 37 participants who played the slot machine, 19 ended the session with more than 100 tokens (i.e., they won), one broke even, and 17 ended the session with less than 100 tokens (i.e., they lost). None of the gambling sessions ended because participants had lost all 100 tokens they had been staked.

Table 1 presents the data from the linear regression. Only *k* was a significant predictor of the number of tokens bet ($F(1, 37) = 9.403$, $p<.01$, with $R^2 = .222$.[2] Overall, the more steeply participants discounted the delayed hypothetical monetary reward, the more they gambled when playing the slot machine.

[2] The large coefficient value for *k* in Table 1 is correct. It represents the change in the dependent variable as a function of one unit of *k*. Values of *k* are extremely small relative to the number of tokens bet in a session, so a large change in *k* would be expected to correspond to a very large change in the number of tokens bet.

Table 1
Results from the regression analysis

Factor	Coefficient	Beta Weight	*t*	Significance	Semi-Partial R^2
Gender		-.062	-.398	.693	-.070
Age		.197	1.292	.206	.223
Income		.194	1.273	.212	.220
k	10241.563	.471	3.066	.004	.471

Results from the correlation analyses resulted in relatively few significant correlations. Interestingly, number of tokens won during the session was not significantly correlated with any measure, including number of tokens bet during the session.[3] Gender was significantly correlated with income, r = -.383, p=.018[4], indicating that men in the present study tended to report higher incomes than women. Age was significantly related to marital status, r = .754, p<.001, indicating that older participants were more likely than younger ones to be married, divorced, or widowed. Age was also positively correlated with reported income, r = .718, p<.001. Participants' score on the SOGS did not correlate significantly with how they gambled or with their *k* value. Participants' score on the KAT was not significantly with how much they gambled, their score on the SOGS, or with their *k* value.

DISCUSSION

The present study was undertaken because several factors have been shown to be associated with problem and/or pathological gambling, but few if any studies have demonstrated a direct link between these factors and actual behavior. The present study attempted to determine whether gender, age, income, and/or how steeply participants temporally discounted hypothetical monetary rewards would predict how they gambled when playing a slot machine for money. Gender, age, and income were not significant predictors of gambling behavior. Delay discounting, on the other hand, was a significant predictor.

To our knowledge, the present study is the first to demonstrate that individuals who differ in how they discount delayed monetary rewards actually gamble differently. Furthermore, the present study demonstrated that this predictive relationship exists in a sample of non-pathological gamblers. As such, the present results may have implications for both gambling researchers and treatment providers. For researchers, they would appear to validate further study of differences in delay discounting in pre-existing populations. The present results should certainly be replicated before one concludes that temporal discounting is a reliable predictor of gambling behavior. However, the present finding supports the claims of some that discounting plays a role in gambling behavior and gambling problems (e.g., Madden et al., 2007; Weatherly & Dixon, 2007). Future studies might investigate whether rates of temporal discounting in general are predictive of gambling behavior or only when they involve monetary outcomes.
For treatment providers, the present results suggest that efforts to decrease gambling behavior may be accomplished by altering how

[3] Although interesting, finding that how much money people bet was not significantly correlated with how much money they won is not necessarily surprising. Numerous studies from our laboratory have reported that participants' gambling behavior is largely insensitive to how well or poorly the slot machine pays off (Weatherly & Brandt, 2004; Weatherly, Thompson, Hodny, & Meier, in press; Gillis, McDonald, & Weatherly, 2008).

[4] This correlation represents a point-biserial correlation due to the dichotomous nature of gender as a variable (see Howell, 2002).

individuals perceive delayed monetary consequences. For instance, teaching clients to devalue the consequence, money in this case, should lessen the rate at which they discount the delayed reward (e.g., Estle, Green, Myerson, & Holt, 2006). The importance of changing how clients temporally discount is bolstered by the finding that, with drug treatment programs, discounting is predictive of success in the program (e.g., Bickel & Marsch, 2001). Thus, if discounting is indeed a part of the process that leads to disordered gambling, then addressing how the client frames future events may ultimately be more successful than addressing the gambling behavior directly, especially given that discounting is related to a number of different behavioral disorders.

These implications, however, need to be couched in the understanding that the present study had a number of limitations. The sample size used in the present study, 38 participants, was not extremely large. Next, only one form of gambling (i.e., on a slot machine) was measured over a single session of relatively brief duration when participants played with staked money. These factors may have contributed to why gender, age, and socioeconomic income were not significant predictors of gambling behavior. It is also the case that the participants played an actual slot machine and not a simulation that would have allowed all the participants to experience the identical sequence of outcomes when gambling. The present procedure should be replicated under such a controlled situation. It was also the case the participants' scores on the SOGS and KAT were not correlated with their gambling behavior or with their *k* values and it is not immediately clear why such correlations did not exist.

In closing, the fact that the predictive relationship between discounting and gambling in the present study was found in a non-pathological sample is worthy of note. This finding suggests that steeply discounting delayed monetary consequences may not be a sufficient characteristic for the observance of pathological gambling. Further, the present data are silent as to whether displaying a steep discounting curve is predictive of becoming a pathological gambler. To make this determination, one would need to conduct a longitudinal study that monitors for pathology (and/or changes in discounting) across time. If steep discounting was a significant predictor of gambling in such a procedure, then its importance to researchers and therapists would be even further increased.

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