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Pathological Gamblers Discount Probabilistic Rewards Less Steeply than Matched Controls

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Abstract

Nineteen treatment-seeking men meeting DSM-IV diagnostic criteria for pathological gambling and 19 demographic-matched controls participated. Participants provided demographic information, information about their recent drug-use and gambling activities, and biological samples (to confirm drug abstinence). They also completed the Eysenck Personality Questionnaire, the South Oaks Gambling Screen (SOGS), and two questionnaires designed to separately quantify probability and delay discounting. Pathological gamblers discounted probabilistic rewards significantly less steeply than matched controls. A significant correlation revealed that more shallow probability discounting was associated with higher SOGS scores. Across groups, there was no significant difference in delay discounting, although this difference approached significance when education and ethnicity were included as covariates. These findings, collected for the first time with pathological gamblers, are consistent with previous reports that problem-gambling college students discount probabilistic rewards less steeply than controls. The nature of the relation between probability discounting and severity of problem gambling is deserving of further study.

Keywords

probability discounting; pathological gambling; delay discounting; SOGS

Within a behavioral economic framework, *discounting* refers to the devaluation of an outcome when the outcome is either delayed (delay discounting) or obtained probabilistically (probability discounting). This tendency to discount delayed or probabilistic outcomes has been studied by examining the behavior of humans and animals as they choose between immediate and delayed or between certain and probabilistic real or hypothetical outcomes. In what might be viewed as a striking example of either homologous behavior or convergent evolution, a single equation well describes the choices of humans and animals in these experiments, and typically accounts for over 90% of the behavioral variance (see review by Green & Myerson, 2004). Applied to delay discounting, the equation holds that the subjective value (V) of an outcome of amount A , obtained following delay D , declines hyperbolically (Mazur, 1987):

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$$V = \frac{A}{1+kD} \quad (1)$$

and a similar equation (which substitutes the odds against winning, $\Theta = (1-p)/p$, for the delay) describes hyperbolically declining subjective values of probabilistic outcomes (Rachlin, Raineri, & Cross, 1991):

$$V = \frac{A}{1+h\Theta} \quad (2)$$

Equations 1 and 2 each contain a single free parameter which is straightforwardly interpreted as degree of delay (k) or probability (h) discounting. As the free-parameter value increases, the subjective value of the delayed or probabilistic outcome is more steeply discounted. Of these two behavioral processes, delay discounting has been more thoroughly investigated and Equation 1 has been shown to provide a better fit of human and animal choices than other equations with a single free parameter (e.g., an exponential equation favored for decades by economists; Green & Myerson, 2004).

The discounting literature has revealed a number of interesting inter-species and inter-strain differences between animal subjects (e.g., Anderson & Woolverton, 2005; Tobin, Logue, Chelonis, & Ackerman, 1996) as well as important individual differences among humans in the steepness of delay discounting. For example, a large body of literature reveals that individuals diagnosed with substance use disorders (Bickel & Marsch, 2001; Bickel et al., 2007) or pathological gambling (e.g., Petry, 2001; Petry & Madden, in press) discount delayed outcomes significantly more than matched controls. Recent evidence suggests steeper delay discounting is predictive of drug self-administration in nonhumans (e.g., Perry, Larson, German, Madden, & Carroll, 2005) and poorer outcomes in human substance abuse treatment trials (Dallery & Raiff, 2007; Yoon et al., 2007). Alessi and Petry (2003) reported that among pathological gamblers, degree of delay discounting accounted for more variance in gambling severity than frequently used personality measures of impulsivity. Building upon these findings, some researchers have suggested that Equation 1 predicts that steeper delay discounting renders decision making more likely to be influenced by probabilistic gambling-like rewarding outcomes (e.g., Madden, Ewan, & Lagorio, 2007; Rachlin, 1990).

The relation between probability discounting and drug addiction has been examined in a handful of studies (see review by Yi, Chase, & Bickel, 2007). Consistent with the contention that delay and probability discounting are different processes (e.g., Green & Myerson, 2004), no consistent difference in probability discounting has been observed between drug-dependent samples and matched controls (e.g., Mitchell, 1999). Thus far, only two studies have examined the relation between probability discounting and human gambling. Holt, Green, and Myerson (2003) reported significantly more shallow probability discounting functions in college student gamblers when compared with a matched group of non-gamblers. That is, gamblers placed a higher value on a probabilistic monetary outcome than non-gambling controls. More recently, Shead, Callan, and Hodgins (2008) found no significant correlation between degree of probability discounting and college-student gamblers' scores on the Canadian Problem Gambling Index (CPGI; Ferris & Wynne, 2001).

The present study was conducted to compare degree of probability and delay discounting in pathological gamblers and matched controls. To our knowledge, this is the first published comparison of probability discounting involving *pathological* gamblers. For these purposes,

we used the delay discounting questionnaire developed by Kirby and Maraković (1995) and modified it to create a second questionnaire assessing degree of probability discounting.

Method

Participants and Assessment Instruments

Nineteen men who met DSM-IV criteria for pathological gambling participated in this evaluation after providing written informed consent approved by the University of Connecticut's Institutional Review Board. Participation occurred in the context of an intake interview conducted after the men responded to advertisements for free and confidential gambling treatment. The 19 men whose behavior was examined in this study were drawn from a larger sample of treatment seekers so that average age, education, and income approximately matched that of the control group (see below). In addition, the pathological gamblers selected for inclusion in this study had no prior history of treatment for alcohol or illicit drug abuse. No other criteria were used or examined when selecting these participants.

The 19 control participants were recruited through advertisement for a study on personality characteristics (also in Connecticut). A telephone screen was used to exclude individuals reporting any current or past history of alcohol or illicit drug abuse or gambling problems. Control participants were compensated \$50 for traveling to the clinic and participating in the study.

Prior to the session, participants provided written informed consent and breath and urine samples which confirmed the absence of drug use on the testing day. Participants then completed a number of questionnaires including a demographics questionnaire, the Eysenck Personality Questionnaire (Eysenck & Eysenck, 1978), the Addiction Severity Index (ASI; McClellan et al., 1985) and the South Oaks Gambling Screen (SOGS; Lesieur & Blume, 1987). Using the TimeLine Follow-Back method (Sobell & Sobell, 1992; McCormick & Taber, 1991), participants indicated the number of days in which they had consumed alcohol in the last 30 days, and the gamblers also reported the number of days and dollars spent gambling in the preceding 3 months.

Delay Discounting Questionnaire

Participants completed the 27-item, paper-and-pencil delay-discounting questionnaire developed by Kirby and Maraković (1995). Each question asked them to choose between money delivered today and a larger amount of money delivered following delays ranging from 7 to 186 days; for a complete listing of these choice outcomes, see Kirby, Petry, and Bickel (1999). Participants were instructed to answer all questions by circling their preferred outcome. The questionnaire was used to estimate the degree to which delayed hypothetical rewards are discounted (k). Separate k -values are obtained at small- (\$25–35), medium- (\$50–60), and large-delayed rewards (\$75–85). Prior investigations using this questionnaire have shown that degree of delay discounting decreases as reward amount increases (e.g., Kirby et al.), a finding consistent with other methods of assessing the steepness of the delay discounting curve (see review by Green & Myerson, 2004). Scoring details for the delay discounting questionnaire are provided in Kirby et al. and mirror those described for the probability discounting questionnaire below.

Probability Discounting Questionnaire

Participants also completed a three-part paper-and-pencil probability-discounting questionnaire. In each part, participants were instructed to answer 10 questions by circling their preferred outcome. One outcome was always money delivered “for sure” and the other was a larger amount of money delivered probabilistically. For example, one item asked

participants to choose between “\$20 for sure” and “a 1-in-10 chance (10%) of winning \$80”. Table 2 shows the amounts and probabilities of winning arranged in the three different parts of the questionnaire. Within each part the probabilistic alternative on the first question had the lowest probability of winning and each subsequent question incremented this probability in the order shown in Table 2. Probabilities and amounts were selected to allow quantification of a wide range of h -values (see Table 2), and to assess for a possible magnitude effect on probability discounting. The order in which the parts of the questionnaire were presented was counterbalanced between subjects within each group.

The h -values shown in Table 2 reflect the degree of probability discounting at indifference between the two outcomes. At indifference the certain and probabilistic rewards are of equivalent subjective value. Therefore, degree of probability discounting is obtained by substituting the reward amounts at indifference in Equation 2, with the amount of the certain reward serving as V . To derive h -values reflective of individual participants' degree of probability discounting, one of two methods was used. The first was the most commonly used and was applied when a participant consistently selected the certain reward within each part of the questionnaire until the probability increased to a threshold value, after which he/she consistently selected the probabilistic outcome. The two questions across which the participant switched from selecting the certain to the probabilistic outcome provided the range of probabilities across which the participant was indifferent between the two outcomes. The mean of the boundary h -values shown in Table 2 was used in probability discounting analyses. If a participant always or never selected the probabilistic outcome (19% of the cases), their h -value was estimated at the lowest and highest value shown in Table 2, respectively.

The other method of deriving h -values was used when a participant's choices were not internally consistent within a part of the questionnaire (e.g., selecting a certain reward at a probability greater than that at which choices switched from certain to probabilistic). For this part, the h value most consistent with all of the subject's choices was determined. For example, if a participant preferred a 25% chance of winning \$80 over \$20 for sure (part 1), then this suggests that the degree of probability discounting (h) is less than 1.0 (the value of h if the participant had been indifferent between these outcomes). Given this choice, consistency scores of all h values <1.0 were incremented by one. This was repeated for every choice in each part until one h value had a higher consistency score than any other. This h value served as the best estimate of the degree of probability discounting when a participant's choices were internally inconsistent. Such inconsistent choices were observed in 3.4% and 1.7% of the gamblers' and controls' choices, respectively.

Data Analysis

Across-group differences in demographic characteristics were examined using χ^2 tests for categorical data, and t tests for continuous variables. When the latter data were not normally distributed, they were compared using a Mann-Whitney U test. Discounting parameter values (k and h) were natural log transformed because they were non-normally distributed. For h -values this transform did not normalize the distribution so Greenhouse-Geisser corrected degrees of freedom were used. Geometric mean k and h values are reported throughout because they provide the mean value of natural log transformed values into their original scale. For each discounting measure a 2×3 repeated measures ANOVA was conducted with group (pathological gamblers vs. controls) as the between-subjects variable and the three different parts of each questionnaire as the within-subjects variable. Where appropriate, Bonferroni t tests were used to compare degree of discounting between groups in the three different parts of the delay and probability discounting questionnaires. Correlations between delay and probability discounting, demographic characteristics, and

scores on the SOGS and the impulsivity subscale of the Eysenck were explored using *k*- and *h*-values, respectively, averaged across the three different parts of each questionnaire.

Results

As shown in Table 1, participant groups were matched on age, ethnicity, education, and income with no significant differences separating the pathological gamblers from non-gamblers on these characteristics. Although the differences in education and ethnic composition of the groups were not statistically significant, they were large enough to be included as covariates in supplemental tests of differences in discounting across pathological gamblers and controls. Both of these groups reported infrequent use of alcohol, with no significant difference across groups in either self-reported use in the last 30 days or ASI alcohol scores. Table 1 does not show ASI drug, cocaine, or opiate scores because all participants scored 0 on these scales. Pathological gamblers' average Eysenck impulsivity scores were somewhat higher than those of control participants, but the difference did not achieve conventional levels of significance. There was no overlap in SOGS scores across groups, with pathological gamblers scoring significantly higher than controls (see Table 1 for *p* values).

Delay Discounting

The upper panel of Figure 1 shows mean estimates of the degree to which delayed rewards were discounted by the pathological gamblers and controls (see Table 3 for exact values). Although the group-averaged *k*-values tended to be higher for the pathological gamblers, this difference was not statistically significant ($p = .22$). However, this difference approached significance when education and ethnicity were included as covariates in the ANOVA, ($F(1,34) = 3.84, p = .058, \eta_p^2 = 0.10$; where the effect size, η_p^2 , is the proportion variance in the dependent variable [$SS_{\text{effect}} + \text{error variance } SS_{\text{error}}$] attributable to the effect). A significant main effect of delayed reward amount on degree of delay discounting was observed ($F(2,72) = 25.3, p < .001, \eta_p^2 = 0.41$); discounting was less steep as the magnitude of the larger-later reward increased. No significant group by reward-amount interaction was detected ($p = .40$).

Across groups and delayed reward amounts, *k*-values were not significantly correlated with any of the demographic characteristic in Table 1; the strongest correlation was with education ($r = -.20, p = .23$). Degree of delay discounting was also not significantly correlated with scores on the Eysenck impulsivity subscale ($r = .16, p = .33$) or the SOGS ($r = .02, p = .89$). No significant difference in degree of delay discounting was observed across ethnic groups ($p = .49$).

Probability Discounting

The lower panel of Figure 1 illustrates the significant differences in degree of probability discounting across the pathological gamblers and matched controls ($F(1,36) = 11.5, p < .01, \eta_p^2 = 0.24$); a difference that remained significant when education and ethnicity were included as covariates ($F(1,34) = 7.8, p < .01, \eta_p^2 = 0.19$). Pathological gamblers discounted hypothetical probabilistic monetary rewards significantly less steeply than controls. For example, on average, pathological gamblers were willing to forgo a certain \$20 reward on a 27% chance of obtaining an \$80 reward. By contrast, the matched control participants were unwilling to forgo the \$20 sure thing until the odds of obtaining the \$80 reward were at least at chance (50%, on average).

No significant main effect of the three parts of the probability discounting questionnaire ($p = .13$) was detected and the group $\times$ part interaction was not significant ($p = .71$). Bonferroni

t tests revealed that pathological gamblers discounted the probabilistic alternative significant less than the control group in two of three parts of the questionnaire ($t > 2.8$, $p < .05$). The part of the questionnaire with the smallest difference in monetary amount between the certain (\$40) and probabilistic (\$60) outcomes did not yield a significant difference.

Across groups, degree of probability discounting was not significantly correlated with any of the demographic variables in Table 1, although the negative correlation with education approached significance ($r = -.29$, $p = .08$). Degree of probability discounting was significantly negatively correlated with SOGS scores ($r = -.46$, $p < .01$) but not with scores on the Eysenck impulsivity assessment ($r = -.12$, $p = .46$). No significant difference in probability discounting was detected across ethnic groups ($p = .48$). Finally, estimates of delay discounting were not significantly correlated with estimates of probability discounting ($r = .12$, $p = .46$).

Discussion

Individuals diagnosed with pathological gambling discounted hypothetical probabilistic monetary rewards significantly less steeply than matched control participants. A significant negative correlation between degree of probability discounting and scores on the SOGS was observed. However, unlike previous studies reported in the delay discounting literature (e.g., see review by Petry & Madden, in press), pathological gamblers did not discount delayed monetary rewards significantly more steeply than matched controls.

The primary findings reported here are in accordance with those of Holt et al. (2003) who found that college students with high SOGS scores (mean = 6.5) discounted hypothetical probabilistic monetary rewards less steeply than their peers with low SOGS scores (mean = 0.3). Our participants diagnosed with pathological gambling had much higher SOGS scores (range 7–20) than the student sample recruited by Holt et al., but the difference in degree of probability discounting separating gamblers from controls was qualitatively comparable. Quantitative comparisons cannot be made across studies because Holt et al. used much larger probabilistic reward amounts (\$1,000–\$50,000) than in the present study (\$25–\$85) and they did not report *h*-values. Unlike the Holt et al. study, we observed no differences in degree of probability discounting across probabilistic reward amounts. This may be due to the substantially smaller differences in reward amounts in the present study (at most a 3.4-fold difference) when compared to the Holt et al. study (a 50-fold difference). Comparing our findings with those of Shead et al. (2008, who also studied probability discounting in college-student gamblers) is more difficult because they did not include a sample of non-gambling controls. That they found no correlation between degree of probability discounting and scores on the Canadian Problem Gambling Index may owe to the high proportion of subjects classified as either low- or moderate-risk gamblers (81.4%) with smaller proportions of students classified as non-problem gamblers (8.5%) and problem gamblers (10.2%).

A second finding from the present study which is comparable to that reported by Holt et al. (2003) is that although the group-averaged degree of delay discounting in the present study was higher for the gambling than the control group, this difference was not statistically significant (although when education and ethnicity were included in the ANOVA as covariates, the difference approached significance, $p = .058$). The lack of a statistically significant effect of gambling status on degree of delay discounting is unusual in the delay discounting literature (Dixon, Marley, & Jacobs, 2003; MacKillop et al., 2006; Petry, 2001; Petry & Casarella, 1999). One difference between the present and past studies is that the sample size used here (38 participants combined) was small when compared to previous studies of delay discounting in pathological gamblers and matched controls (mean total

participants = 64.5, range 47–86). This sample size may have also been too small for an assessment of group differences using the questionnaire developed by Kirby and Maraković (1995). For example, Kirby and Petry (2004) found no significant group difference when the Kirby and Maraković questionnaire was completed by 33 alcohol-dependent and 44 control participants, although a number of studies, usually with larger samples, have found that alcohol-dependent individuals more steeply discount delayed rewards than controls (see review by Yi, Mitchell, & Bickel, in press).

A final similarity between the present findings and those reported by Holt et al. (2003) is that delay and probability discounting were not significantly correlated. This outcome is not unusual in the human delay/probability discounting literature. For example, Olson, Hooper, Collins, and Luciana (2007) found no correlation between these types of discounting in 62 adolescents (8% of the variance in one type of discounting was accounted for by variance in the other). Myerson, Green, Hanson, Holt, and Estle (2003) reported significant correlations between delay and probability discounting in two samples of 171 or 68 college students (the latter were data previously reported by Green, Myerson, & Ostaszewski, 1999), but no significant correlation with a separate sample of 101 students. In all of the cases summarized by Myerson et al., the correlations were modest at best (Pearson's r ranged from .032 to .373).

Myerson et al. (2003) note that when the correlation between delay and probability discounting is significant, the direction of that correlation is always positive. This would suggest a tendency for individuals that steeply discount delayed rewards to also heavily discount probabilistic rewards. As noted by Myerson et al., this positive correlation is counter-intuitive if one conceptualizes impulsivity as an inability to tolerate delays (steep delay discounting) and a propensity to take risks (shallow probability discounting). The extant delay discounting literature suggests that risk-taking pathological gamblers more steeply discount delayed rewards than controls, while the Holt et al. (2003) study and the present findings suggest gamblers show more shallow probability discounting than controls. This suggests a negative correlation between delay and probability discounting in pathological gamblers might be observed. When we separately assessed the correlation between delay and probability discounting in our gamblers and controls, we found neither correlation was significant (not surprising given $N = 19$), however, the direction of these nonsignificant relations were opposite in pathological gamblers ($r = -.06$) and controls ($r = .17$). Future research with larger samples of pathological gamblers should investigate the possibility of a negative relation between probability and delay discounting in this population.

Two weaknesses of the present study which have not already been discussed deserve comment. First, the probability discounting questionnaire employed has not been used in prior studies of discounting. The questionnaire used was based on the delay discounting questionnaire developed by Kirby and Maraković (1995) and intended to evaluate probability discounting along a similar range of reward magnitudes. Nonetheless, the probability discounting questionnaire had three more items than its delay discounting counterpart and was presented in blocks of choices with increasing win probabilities; whereas the delay discounting questionnaire was presented in a single block with a mixed sequence of delays. While these differences are potentially important, our participants' choices on the probability discounting questionnaire were internally consistent in almost all cases.

A second weakness is that control participants were compensated \$50 for transportation expenses while the pathological gamblers were not. While the gamblers received psychosocial treatment as a different form of compensation, the possibility remains that

seeding the controls with \$50 may have made them more risk prone. If this is so, then providing compensation may have decreased probability discounting, making them more like the pathological gamblers. Thus, the difference between these populations may have been bigger if this component of the procedure would have been held constant across groups.

Implications & Future Directions

Differences in the degree to which probabilistic rewards are discounted means either that the opportunity to gamble is subjectively worth more to pathological gamblers or that pathological gamblers display greater risk tolerance than controls. For example, given the rates of probability discounting obtained in this study, controls would be unwilling to forgo more than \$20 to flip a coin on the chance of winning \$80. However, our sample of pathological gamblers would be willing to forgo almost twice as much (\$38, on average) on the same probabilistic outcome. Unanswered by this study is if pathological gamblers' propensity for risky choice is confined to scenarios like those used here, or if it generalizes to other contexts. For example, are pathological gamblers more likely to forgo assured returns on an investment, preferring to take risks to obtain larger positive consequences such as stock market gains or improved health (e.g., through a surgical procedure that involves some risk)? Just as interesting is if more shallow probability discounting would be observed in pathological gamblers when the risky outcome involves probabilistic aversive events. Shead et al. (2008) reported a significant negative correlation between probability discounting of gains and losses in their sample of college gamblers. Thus, those who placed a higher value on a probabilistic win (shallow probability discounting) tended to steeply discount the negative value of probabilistic losses (taking a "nothing bad will happen to me" stance). Shallow probability discounting of gains suggests gambling for gains is a valuable alternative. Steep discounting of probabilistic losses means that the individual is willing to forgo very little (a certain payment) to avoid rolling the dice on a probabilistic loss. If this negative correlation is a general tendency across conditions and outcomes, pathological gamblers would, on average, be expected to more steeply discount the negative value of contracting a sexually transmitted disease by engaging in risky sexual practices. Petry (2000) noted that problem-gambling substance abusers engaged in significantly greater risky behaviors that spread HIV and contagious diseases than their non-problem gambling counterparts. Further study of probabilistic discounting and its impact on behavioral decision making in pathological gamblers is needed.

A second interesting question raised but not answered by the present research is if shallow probability discounting precedes and predicts pathological gambling. Some evidence obtained from nonhuman experiments suggests that degree of *delay* discounting is predictive of acquisition of cocaine self-administration and reinstatement of nicotine self-administration in rodents (see review by Carroll, Anker, Mach, Newman, & Perry, in press). Conducting a similar experiment by assessing probability discounting and then examining subsequent development of pathological gambling is hampered by at least two factors. First, conducting the required longitudinal research with humans may be impractical given the low incidence rate of pathological gambling (Petry, Stinson, & Grant 2005; Kessler et al., 2008). Second, although animal research has the advantage of controlling extraneous factors that may affect probability discounting and gambling, at present animal preparations have yet to adequately capture the functional characteristics of human gambling. For example, human gamblers wager, win, and lose, token reinforcers whereas animal studies have thus far been unsuccessful in establishing a surplus of token reinforcers which an animal might wager unless exchanging tokens for food is restricted by requiring the subject complete a large work requirement before tokens may be exchanged (Yankelevitz, Bullock, & Hackenberg, 2008). This is important because gambling losses which mirror gambling wins cannot be

arranged with food reinforcers which, once consumed, cannot be lost (see Madden, Ewan, & Lagorio, 2007).

In sum, the present data suggest that pathological gamblers discount probabilistic rewards significantly less steeply than controls. While a trend toward greater delay discounting was noted in the pathological gamblers, the between group differences were much more robust for probabilistic discounting. These results point to potentially unique aspects of decision making in pathological gamblers that may help explain the onset and/or progression of the disorder. Further research is needed to replicate and extend these findings, and to determine interventions that may assist in preventing individuals with shallow probabilistic discounting functions from developing gambling problems or in abating gambling problems among those who have developed the disorder.

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* $p < .01$

** Bonferroni t, $p < .05$

Figure 1.

Delay (top panel) and probability (bottom panel) discounting parameter estimates for pathological gamblers and controls (error bars correspond to SEM). Data are separated into the three different reward amounts (delay discounting) or three different parts of the probability discounting questionnaire. Overall corresponds to the main effect of group.

Table 1

Demographics and Drug Use Characteristics of Participants

Variable	Control Participants	Pathological Gamblers	<i>p</i>	
N	19	20		
Age	37.2 (2.2)	37.7 (2.4)	$t = 0.1$	0.89
Ethnicity (%)			$\chi^2 = 4.9$	0.09
Caucasian	47.4	80		
African American	36.8	10		
Other	15.8	10		
Education (years)	12.9 (0.3)	13.6 (0.4)	$t = 1.4$	0.16
Annual income (median & IQR)	16,200 (6,900-24,300)	18,000 (12,000-20,000)	$U = 161$	0.78
Eysenck Impulsivity	6.9 (1.0)	9.6 (1.2)	$t = 1.7$	0.1
South Oaks Gambling Screen score	0.8 (0.3)	13.3 (3.3)	$t = 15.6$	<.001
Days of alcohol use in past 30 days (median & IQR)	1 (0–3)	0 (0–4)	$U = 169$	0.73
ASI Alcohol (median & IQR)	0.01 (0–0.05)	0.01 (0–0.09)	$U = 128$	0.62
Years of gambling problems (median & IQR)		2.5 (0.5–10.7)		
Days gambled in last 3 months (median & IQR)		35 (25–43)		
Dollars gambled in last 3 months (median & IQR)		\$6,489 (\$2,910-\$15,732)		
Current gambling debt (median & IQR)		\$4,000 (\$0-\$20,000)		

Note: Values are means (and S.E.M.) unless otherwise indicated (IQR = inter-quartile range).

Table 2Probability Discounting Questionnaire and h -values Indicative of Indifference

	Certain Amount (\$)	Probability of Winning	Probabilistic Amount (\$)	h
Part 1	20	0.1	80	0.33
	20	0.13	80	0.45
	20	0.17	80	0.61
	20	0.2	80	0.75
	20	0.25	80	1
	20	0.33	80	1.48
	20	0.5	80	3
	20	0.67	80	6.09
	20	0.75	80	9
	20	0.83	80	14.65
Part 2	40	0.18	100	0.33
	40	0.22	100	0.42
	40	0.29	100	0.62
	40	0.33	100	0.74
	40	0.4	100	1
	40	0.5	100	1.5
	40	0.67	100	3.04
	40	0.8	100	6
	40	0.86	100	9.21
	40	0.91	100	15.17
Part 3	40	0.4	60	0.33
	40	0.46	60	0.43
	40	0.55	60	0.61
	40	0.6	60	0.75
	40	0.67	60	1.01
	40	0.75	60	1.5
	40	0.86	60	3.07
	40	0.92	60	5.75
	40	0.95	60	9.5
	40	0.97	60	16.17

Table 3

Estimated Measures of Delay and Probability Discounting for the Pathological-Gambler and Control Groups.

Discounting Estimate	Group	
	Control Participants	Pathological Gamblers
Delay – k (S.E.M.)		
Small	0.031 (0.015)	0.050 (0.013)
Medium	0.016 (0.016)	0.032 (0.013)
Large	0.013 (0.015)	0.018 (0.009)
Overall	0.019 (0.016)	0.031 (0.013)
Probability – h (S.E.M.)		
20 vs. 80	3.48 (1.19)	1.16 (0.19) **
40 vs. 100	2.98 (1.18)	1.44 (0.26) **
40 vs. 60	2.76 (1.54)	1.04 (0.82)
Overall	3.32 (1.20)	1.22 (0.34) *

*
 $p < .01$ **
Bonferroni t , $p < .05$