Predictors of Problem Gambling Severity: Personality, Beliefs and Motivation

Final report to the Ontario Problem Gambling Research Centre

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Abstract
The present study explored the inter-relationships among impulsivity, gambling related cognitions, and gambling motivation in community and university student samples. All three factors differentiated non-problem and problem gamblers as defined by scores on the Problem Gambling Severity Index. The largest effect size was for gambling cognitions. Only two facets of impulsivity, positive urgency and negative urgency, were significant predictors of gambling severity. Monetary motivation exhibited the largest motivation effect size. A logistic regression analysis showed that the independent contributions of cognition and motivation were statistically significant but that the contribution of impulsivity was not statistically significant. A behavioural measure of gambling was obtained by asking participants to play an online game of roulette for a maximum of 15 minutes. Only outside bets were permitted whereby participants were to bet on the colour of the winning number. The critical behavioural finding served as an index of the gambler’s fallacy: the likelihood of betting on a change in the colour from the preceding winning number increased as the number of consecutive outcomes of the other colour increased. Gambling cognitions and motivation, but not impulsivity, were associated with adherence to the gambler’s fallacy. Tracing the sources of specific influences on gambling behaviour may benefit from a framework distinguishing the “hot” (emotional) and “cold” (non-emotional) supporting mechanisms.

Keywords: gambling severity; gambling specific cognitions; gambling motivation; impulsivity; gambler’s fallacy
Predictors of Problem Gambling Severity: Personality, Beliefs and Motivation

Introduction

Wiebe, Mun and Kauffman (2006) found that 63% of Ontario adults aged 18 years and older reported participating in at least one gambling event during the prior year. Among gamblers, 4.2% were categorized as having moderate gambling problems and 1.3% as having severe gambling problems. Although the problem gambling rates are low, in the context of the high participation rate, problem gambling poses significant challenges for individuals and society. Understanding the characteristics that promote and sustain problem gambling may lead to interventions that reduce the harm stemming from the activities that the large majority of gamblers enjoy recreationally without adverse consequences.

The epidemiologic triangle framework (Peller, LaPlante, & Shaffer, 2008) identifies three potential supports of problem gambling: the host (characteristics of the player such as cognitive processes); the agent (characteristics of the game such as the internet and audiovisual features); and the environment (the external context in which gambling occurs). In the current study the agent and environment are held constant so as to focus on the dispositional traits that may contribute to the genesis and maintenance of excessive gambling behaviour.

A critical feature of problem gambling is impaired control of time and money spent: “Problem gambling may be characterised by a loss of control over gambling, especially over the scope and frequency of gambling, the level of wagering and the amount of leisure time devoted to gambling, and the negative consequences deriving from this loss of control” (Productivity Commission, 1999, Summary, p. 12). From a clinical perspective, Blaszczynski and Nower (2002) noted “repeated unsuccessful attempts to resist the urge in the context of a genuine desire to cease, as the central, diagnostic and foundational feature of pathological gambling” (p. 488). Dickerson and O’Connor (2006) argue that self-control over the initiation and limitation of gambling may be considered as a continuous quantitative dimension. Psychological scales of control, reflecting different theories of the pathways to excessive gambling (see Clarke, Tse, Abbot, Townsend, Kingi, & Manaia, 2007, for a review), diverge in terms of whether they assess general dispositional traits (e.g., Tangney, Baumeister & Boone, 2004) or beliefs specific to the gambling situation (Raylu & Oie, 2004).

In a test of 23 individual difference predictors of problem gambling severity, Chiu and Storm (2010) found that trait impulsivity was the strongest predictor. Whereas Chiu and Storm treated impulsivity as a single continuous construct, Cyders, Smith, Spillane, Fischer, Anius, and Peterson (2007) extended an earlier model of impulsivity (Whiteside & Lynam, 2001) to identify five distinct components of impulsivity, a theoretical advance that has sparked renewed interest in the role of impulsivity as a predictor of excessive gambling (MacLaren, Fugelsang, Harrigan, & Dixon, 2011; Michalczuk, Bowden-James, Verdejo-Garcia, & Clark, 2011; Torres et al., 2013).

Cyders et al. (2007) defined the components of impulsivity as follows: lack of planning involves a failure to plan ahead; lack of perseverance involves a failure to maintain vigilant attention on a task; sensation seeking is the tendency to pursue novel or thrilling experiences; negative urgency is the tendency to act rashly when upset; and, positive urgency is the tendency to act rashly when experiencing an unusually positive mood. Michalczuk et al. (2011) found that the greatest differences between a clinical sample of pathological gamblers and healthy controls occurred on the negative and positive urgency components. The groups also differed significantly on lack of planning and lack of perseverance, but not on sensation seeking.
A scale to measure beliefs specific to the gambling situation was developed by Raylu and Oie (2004). The Gambling Related Cognition Scale (GRCS) identifies five factors related to control while gambling: expectancies (e.g., “gambling makes the future brighter”); illusion of control (e.g., “specific numbers and colours can help increase my chances of winning”); predictive control (e.g., “losses when gambling are bound to be followed by a series of wins”); inability to stop (e.g., “I can’t function without gambling”); and, interpretive bias (e.g., “relating my losses to probability makes me continue gambling”). Scores on the GRCS are positively related to scores on standardized measures of gambling involvement (Emond & Marmurek, 2010). A potential limitation in interpreting the relationship between gambling related cognitions and gambling severity is that the cognitions may be secondary to rather than precursors of the onset of problem gambling.

Given the strong relationship between gambling related cognitions and gambling severity (Emond & Marmurek, 2010), Michalczuk et al. (2011) tested the distinctive patterns of gambling related cognitions and impulsivity among pathological gamblers. Although both positive urgency and negative urgency were directly correlated with illusion of control, only positive urgency was significantly correlated with the overall gambling related cognition score. No other facets of impulsivity were significantly correlated with gambling related cognitions. Michalczuk et al. tested the relationships of the impulsivity scale and the gambling related cognitions scale to another purported measure of impulsivity: discounting of delayed rewards. Whereas each sub-scale of gambling related cognitions was significantly associated with a preference for relatively small immediate rewards over relatively large delayed rewards, positive urgency and negative urgency were not significantly associated with that preference. Lack of planning and lack of perseverance, however, were significantly associated with a preference for immediate rewards. The healthy controls also exhibited an association between gambling related cognitions and delay discounting, but did not show any significant associations between facets of impulsivity and delay discounting. The overall pattern of results suggests that gambling related cognitions and facets of impulsivity contribute differentially to pathological gambling.

Michalczuk et al. (2011) noted as a limitation of their study that it focused on a sample (n= 30) of treatment-seeking gamblers. One goal of the present study was to analyze the distinctive relationship between gambling, impulsivity and gambling related cognitions across a broader spectrum of gamblers in the community and among university students. Moreover, rather than rely on a self-reported preference measure to index control (or lack thereof) over monetary decisions, the samples in the present study were observed gambling on an online roulette game. It was reasoned that this task bore stronger ecological validity than the self-report discounting paradigm. The betting pattern during roulette play was examined for its association with the cognitive and impulsivity predictors.

The betting pattern measured in the present study tested adherence to the gambler’s fallacy. The gambler’s fallacy predicts that in a finite series of equally probable events (e.g., heads and tails on a fair coin toss), there should be an equal number of instances of each event (e.g., as many heads as there are tails) in a sequence of the events. Oskarsson, Van Boven, McClelland, and Hastie (2009) have provided a comprehensive review of the subjective biases and formal probabilistic models underlying the prediction of a series of binary events. Two critical empirical studies central to that review (Croson & Sundali, 2005; Sundali and Croson, 2006) analyzed the security videotapes of roulette bets provided by executives at a Reno Nevada casino. Among the key findings was a pattern whereby gamblers were more likely to bet on a reversal in the colour of the winning number as the number of preceding outcomes of a particular
colour increased. That is, whereas the likelihood of betting on a black number was approximately 50% following a single red colour, that likelihood increased to 65% following a sequence of five red numbers. The reversal betting pattern indexes the gambler’s fallacy. In their studies, Croson and Sundali did not have access to data on the characteristics of gamblers that might correlate with behavioural endorsement of the gambler’s fallacy. The present study measured whether gambling related cognitions and impulsivity predict roulette game betting patterns. Specifically, the study examined whether those correlates of gambling severity served as predictors of sensitivity to the recent history of outcomes in a game involving a series of two equally likely events (i.e., the outcome is either a red or a black coloured number).

Another precursor of gambling severity is the motivation for gambling (e.g., Clarke et al., 2007; Lee, Chae, Lee, & Kim, 2007; Neighbors, Lostutter, Cronce, & Larimer, 2002; Thomas, Allen, & Phillips, 2009; Wood & Griffiths, 2007). The main gambling motivators include excitement, money, avoidance (escape from problems), socialization, and, amusement. Thomas et al. did not test monetary motivation but found that escape from problems was strongly correlated with problem gambling severity. Lee et al. found that only the monetary factor was directly related to problem gambling severity. Measures of gambling motivation were included in the present study to determine their contributions to gambling severity relative to those of impulsivity and gambling related cognitions, as well as to examine their role in adherence to the gambler’s fallacy.

**Research Questions/Hypotheses**

The current study was designed to explore the diversity of relationships among gambling severity, impulsivity, gambling related cognitions, and gambling motivation. In addition, the associations between the self-reported individual difference measures and patterns of gambling during roulette play were assessed. The gambler’s fallacy may be indexed by betting based on the history of winning colours (Croson & Sundali, 2005). The critical question is whether the influence of the history of colour outcomes on betting patterns is related to the dispositional, cognitive, and motivational predictors of problem gambling.

**Research Question 1:** What is the constellation of personality, cognitive, and motivational characteristics that differentiates non-problem and problem gamblers?

Hypothesis 1: Gambling severity is characterized by high positive and negative urgency, gambling related cognitions, and monetary motivation.

**Research Question 2:** Are predictors of gambling severity associated with roulette betting behaviours?

Hypothesis 2: The likelihood of betting on an alternation in colour of the winning number will increase as the length of the sequence of the other winning colour increases. The behavioural endorsement of the gambler’s fallacy will be predicted by gambling related cognitions but not by impulsivity.

**Ancillary Research Questions:**

This study is the first to explore simultaneously the relations among facets of impulsivity, gambling related cognitions, motivation, and gambling severity. Two demographic variables were also included in the analyses: gender; and, community vs. student participants. The literature on the relationship between precursors to gambling severity and gender has yielded mixed results (Ko, C., Yen, J., Chen, C., Chen, S., & Yen, C., 2005; LaPlante, Nelson, LaBrie & Shaffer, 2006; Wenzel & Dahl, 2009). In Michalczuk et al. (2011) there were 28 males in each group of 30 pathological gamblers and healthy controls thus limiting the possibility of analyses for gender differences. The
present study tested larger and more equally represented samples to explore gender-based differences among the predictors of gambling severity. University students have higher rates of gambling severity than occurs in the general population (Blinn-Pike, Worthy, & Jonkman, 2007). Barnes, Welte, Hoffman, and Tidwell (2010) reported that 75% of university students engaged in some form of gambling in a year, and that 18% reported gambling more than once a week. University students provide an ideal population to study early stages of legalized gambling, and in particular the influence of their emerging personality dispositions on gambling severity. The present study explored whether the influence of gambling severity predictors differed among university students and community gamblers. Finally, there is evidence that gambling involvement (i.e., the range of gambling games that one engages in rather than any specific type of game) is a critical predictor of gambling severity (LaPlante, Nelson, LaBrie, & Shaffer, 2011). The effects of gambling involvement were compared to those of impulsivity, cognitions, and motivation.

**Method**

**Participants**

Two groups of participants were recruited. The community sample comprised regular gamblers from a database available at the Problem Gambling Research Laboratory at the University of Guelph. These gamblers had participated in prior unrelated studies and had indicated a willingness to participate in future studies. The database was sampled randomly during the period of testing (January through March, 2012). The university student sample comprised students over the age of 19 (age was verified by a legal picture document such as a driver’s licence) who were registered in an introductory psychology course. The students’ participation partially satisfied a research requirement of the course. Recruitment messages (by phone or posting on the psychology course research website) stated that “The purpose of the study is to examine characteristics of gamblers. For example, we are interested in how motivations to gamble differ among people who enjoy various gambling activities.” Participants were informed that they would receive $30 for their participation, and that they might earn additional compensation contingent on their gambling performance. A demographic questionnaire revealed that there were 53 males and 65 females in the community sample. In the university student sample there were 72 males and 70 females. It should be noted that the distribution of males and females in the university student sample is not representative of the gender distribution in the courses where typically 66% of students are female. However, the sample distribution may more closely approximate the gender distribution of university student gamblers. The demographic survey also showed that median age range (10 categories beginning at 19 with a 5-year range per category) for the community sample was 45-54 years; for the university student sample, 98% were in the 19-24 age range.

**Measurement instruments**

Participants completed a survey consisting of demographic questions about gender and age, the types of gambling in which participants had engaged during the past 12 months, and a series of standardized scales that measure problem gambling severity, gambling related cognitions, impulsivity, and gambling motivation. The survey was presented electronically or in paper format according to the preference of the participant. The items for the standardized scales are presented in the Appendix.

**Problem Gambling Severity Index (PGSI).** The PGSI (Ferris & Wynne, 2001) is a nine item subset of the Canadian Problem Gambling Inventory (see Appendix A). McMillen and Wenzel (2006) endorsed the PGSI as superior to the Victorian Gambling Screen and the South Oaks Gambling Screen. Holtgraves (2009) endorsed the use of the PGSI to index the
progression of gambling severity in non-clinical samples. Respondents are asked to think about the past year and indicate the frequency for each item using a 4-point scale: 0 = never; 1 = sometimes; 2 = most of the time; 3 = almost always. Classification into gambling subtypes is based on the sum of the responses across the nine items: 0 = non-problem gambler; 1-2 = low risk gambler; 3-7 = moderate risk gambler; 8 or more = problem gambler. In Section 3.6 of their report, Ferris and Wynne state that non-problem gamblers and low risk gamblers will not have experienced any adverse consequences from gambling. Whereas Ferris and Wynne describe the moderate risk group with some uncertainty about whether they may or may not have experienced adverse consequences from gambling, the problem gamblers are described as having experienced adverse consequences from gambling. In the present study, Cronbach’s alpha for the PGSI was 0.85.

Gambling Related Cognitions Scale (GRC). Raylu and Oie (2004) developed the GRC as comprising 23 statements that screen for overall cognitions and five separate dimensions (see Appendix B). Participants indicate their level of agreement with each statement on a 7-point scale (1 = strongly disagree; 7 = strongly agree). In the present study, the Cronbach’s alpha value for the total scale was 0.93. The alpha values for the subscales were as follows: expectancies, 0.82; illusion of control, 0.77; predictive control, 0.77; inability to stop, 0.87; interpretive bias, 0.85.

Impulsivity. The Impulsivity scale (Cyders et al., 2007) contains 59 items to which respondents indicate their level of agreement using a 4-point scale from 1 = agree strongly to 4 = disagree strongly (see Appendix C). The Cronbach’s alpha indices of internal consistency for the separate factors in the current study were: lack of deliberation, .87; lack of persistence, .85; sensation seeking, .91; positive urgency, .96; and, negative urgency, .90. An overall impulsivity score was obtained by adding the scores on the separate factors. Cronbach’s alpha for the overall scale was .83.

Gambling Motivation. The Lee et al. (2007) five-factor gambling motivation scale was adapted to a 27 item scale on which respondents indicated their level of agreement using a 5-point scale where 1 = strongly disagree, 3 = neutral, and 5 = strongly agree (see Appendix D). The overall motivation score in the present study yielded Cronbach’s alpha of 0.89. The Cronbach’s alpha for the five separate factors in the present study were: excitement, 0.91; monetary, 0.75; avoidance, 0.87; socialization, .81; and, amusement, .72.

Procedure

Participants were tested in groups of up to four participants. Each participant was tested in a separate cubicle in the laboratory. A testing session consisted of three stages of events. In the first stage, participants completed a consent form which outlined the general purpose and method of the study. Participants were informed that they were free to withdraw at any time without penalty (i.e., they would receive $30 compensation even if they did not complete all phases of the study). Then the participants were asked to complete a survey that included a demographic questionnaire and a series of scales including the Problem Gambling Severity Index (Ferris & Wynne, 2001), the gambling-related cognitions scale (Raylu & Oei, 2004), the five factor impulsivity scale (Cyders et al., 2007), and, the five-factor motivation scale (Lee et al., 2007). Participants also listed the forms of gambling in which they had participated in the last 12 months. The survey was completed online or in paper and pencil format according to the preference of the participant.

In the final stage of the session, participants were asked to play a simulated roulette game at www.rouletterus.com. The American version was selected. The game was set in the free play mode and the player started with a $1000 stake. Participants were asked to play to a maximum of 15
minutes at which time the researcher would inform them that the time was up. They were permitted to stop earlier or when their funds were exhausted. Participants were incentivized to maximize their winnings by informing them that the top 10 scorers would receive a $50 MasterCard gift card. Betting was restricted to the outside bets on colour. Participants were instructed to bet on either a red or black outcome which yields a 1 to 1 payout. The maximum bet permitted on a spin was $100. The colour and number of the winning numbers on each of the prior 8 spins was continuously updated as was the amount of money available to the player. The researcher recorded the colour selected by the player and the colour of the winning number on each bet.

The critical dependent variable in the roulette game was the likelihood of selecting a colour for a given spin that was different than the winning colour on the previous spin. The expected probability of an outcome on any spin is equal for red and black numbers. The gambler’s fallacy leads to the expectation that the number of red and black outcomes should be equal within a series of outcomes. Accordingly, participants should be more likely to bet on an alternation of colour than on a repetition of colour outcome for a given spin. Croson and Sundali (2005) showed that the likelihood of an alternation bet increased as the number of consecutive outcomes of a given colour increased. The question addressed here was whether that betting pattern was associated with predictors of problem gambling severity.

**Results**

**PGSI Categories**

Table 1 presents the distribution of participants by gender and sample source (students vs. community) across the four PGSI categories defined by Ferris and Wynne (2001). The distribution of participants across the gambling severity categories was: non-problem, 36%; low risk, 33%; moderate risk, 23%; and problem, 8%. Chi-square analyses showed that the distribution of gambling severity categories was independent of gender, $\chi^2(3) = 2.94, p = .40$, and of sample, $\chi^2(3) = 0.52, p = .91$.

Statistical analyses that focus on comparisons of gambling severity categories are typically based on identifying a cut-off for pooling categories into two groups (e.g., Currie, Hodgins, Wang, El-Guebaly, Wynne, & Chen, 2006; LaPlante et al., 2011; Williams & Wood, 2007). For example, Williams and Wood stated that 4.8% of gamblers in Ontario are problem gamblers who account for 36% of Ontario gambling revenue. Both moderate risk and problem gamblers as identified by the PGSI were treated as “problem gamblers” in that study. Accordingly, the analyses in the present study pooled non-problem and low risk categories as “non-problem,” a procedure supported by the description for those groups as not having experienced adverse consequences of gambling (Ferris & Wynne, 2001). Moreover, the healthy controls in Michalczuk et al. (2011) scored a maximum of 2 on the PGSI which is consistent with the present pooling of the non-problem and low risk categories. Note, however, that in the current study problem gamblers should not be regarded as directly comparable to the treatment seeking pathological gamblers studied by Michalczuk et al. In the present study, the mean PGSI score for the non-problem group was 0.66 ($SD = 0.76$) and was 6.01 ($SD = 3.54$) for the problem gambling group. Not surprisingly, the difference in PGSI between the two groups was statistically significant, $t(81) = 13.3, p < .001$, Cohen’s $d = 2.09$. Note that $df = 81$ rather than $df = 258$ is due to correcting for the inequality in variances. Similar comparisons between the groups were conducted for each item on the PGSI and all nine comparisons were statistically significant, $p < .001$. 


Gambling Involvement

Across all participants, the most popular forms of gambling in the past 12 months were scratch cards (63%) and lottery tickets (56%). The ordering of participation in the other gambling activities was slot machines (41%), cards (22%), sports other than horse racing (21%), casino table games (20%), horse racing (17%), bingo (15%), and internet gambling (4%). Chi-square analyses tested whether the sample source (students vs. community), gender, and gambling severity category were associated with the type of game. The community sample had a higher percentage of participation in the following types of gambling: lotteries, 72% vs. 44%, $\chi^2(1) = 21.34, p < .001$; slots, 62% vs. 23%, $\chi^2(1) = 40.91, p < .001$; casino games, 31% vs. 11%, $\chi^2(1) = 14.76, p < .001$; horse racing, 23% vs. 13%, $\chi^2(1) = 4.75, p = .03$; and, internet gambling, 8% vs. 1%, $\chi^2(1) = 7.36, p = .007$. There were no statistically significant gender differences among individual gaming types. Problem gamblers were more likely than non-problem gamblers to engage in three types of gambling: cards, 32% vs. 18%, $\chi^2(1) = 6.86, p = .00; horse racing, 24% vs. 14%, $\chi^2(1) = 4.10, p = .04$; and, internet, 9% vs. 2%, $\chi^2(1) = 4.65, p = .03$.

The total number of types of gambling was calculated for each participant and the means were subjected to a 2 x 2 x 2 (PGSI Group [non-problem, problem] x Sample [community, student] x Gender [male, female]) between-groups analysis of variance (ANOVA). All three main effects were statistically significant: problem gamblers engaged in more types of gambles ($M = 3.32, SD = 2.48$) than did non-problem gamblers ($M = 2.66, SD = 1.74$), $F(1, 252) = 11.59, p = .001$, Cohen’s $d = .31$; community gamblers ($M = 3.64, SD = 2.25$) played more types of games than did university students ($M = 2.21, SD = 1.54$), $F(1, 252) = 46.75, p < .001$, Cohen’s $d = .74$; and, females played more types of games ($M = 3.08, SD = 2.27$) than did males ($M = 2.61, SD = 1.67$), $F(1, 252) = 7.47, p = .007$, Cohen’s $d = .24$.

Table 2 presents the means that entered into significant interactions. The PGSI group difference depended on the sample, $F(1, 252) = 8.30, p = .004$ and on gender, $F(1, 252) = 4.34, p = .04$. Separate $t$-tests showed that the PGSI group effect was statistically significant for the community sample, $t(116) = 3.43, p = .001$, Cohen’s $d = .63$, but not for the student sample, $t(140) = 0.29, p = .77$, $d = .06$; and, the PGSI group effect was statistically significant for females, $t(133) = 2.86, p = .005$, $d = .49$, but not for males, $t(123) = 0.77, p = .44$, $d = .14$.

Group Differences in Gambling Related Cognitions (GRC)

Table 3 presents the mean and standard deviation values on the subscales and total score of the GRC for the non-problem and problem gambling groups. A 2 x 2 x 2 (PGSI Group [non-problem, problem] x Sample [community, student] x Gender [male, female]) multivariate analysis of variance of the means showed that the only statistically significant main effect was for PGSI Group, Pillai’s trace = 0.285, $F(5, 248) = 19.76, p < .001$, $\eta^2_p = 0.29$. None of the interactions were statistically significant for alpha = .05. The effect of PGSI Group was tested separately for each subscale. Table 2 presents the separate $F$ values showing that the present study replicates the finding that the problem group had significantly higher scores on the GRC scales than did the non-problem group (Emond & Marmurek, 2010; Michalczuk et al., 2011).

Group Differences in Impulsivity

Table 4 presents the mean and standard deviation values on the subscales and total score of the Impulsivity measure (Cyders et al., 2007) for the non-problem and problem gambling groups. A 2 x 2 x 2 (PGSI Group [non-problem, problem] x Sample [community, student] x Gender [male, female]) multivariate analysis of variance of the means showed two statistically significant main effects: for PGSI Group, Pillai’s trace = 0.07, $F(5, 248) = 3.57, p = .004$, $\eta^2_p = 0.07$; for Sample,
Pillai’s trace = 0.05, $F (5, 248) = 2.45$, $p = .03$, $\eta^2_p = 0.05$. None of the interactions were statistically significant for alpha $= .05$. The effect of PGSI Group was tested separately for each subscale and the total score. Table 4 presents the separate $F$ values showing that in the present study the problem group had significantly higher scores on Positive Urgency, Negative Urgency, and the total score. This effect replicates the findings of Michalczuk et al. (2011). However, the present study did not replicate the smaller significant effects reported by Michalczuk et al. for Planning and Perseverance. Sensation Seeking was not a significant source of difference between gambling severity groups in both the present study and in Michalczuk et al. The effect of Sample was tested for each subscale and was significant only for Sensation Seeking. The student sample ($M = 33.99$, $SD = 7.77$) scored higher on Sensation Seeking than did the community sample ($M = 31.55$, $SD = 7.43$), $F (1, 252) = 8.12$, $p = .005$, $\eta^2_p = 0.03$.

**Group Differences in Motivation**

Table 5 presents the mean and standard deviation values on the subscales of the Motivation measure (Lee et al., 2007) for the non-problem and problem gambling groups. A 2 x 2 x 2 (PGSI Group [non-problem, problem] x Sample [community, student] x Gender [male, female]) multivariate analysis of variance of the means revealed that only the PGSI Group main effect was statistically significant, Pillai’s trace $= 0.21$, $F (5, 248) = 12.97$, $p < .001$, $\eta^2_p = 0.21$. None of the interactions were statistically significant for alpha $= .05$. The effect of PGSI Group was tested separately for each subscale. Table 5 presents the separate $F$ values showing that in the present study the problem group had significantly higher scores on all scales except for socialization. The largest effect was for monetary motivation, replicating the pattern found by Lee et al. (2007).

**Correlations among Impulsivity, Cognition, and Motivation Sub-scales**

Table 6 displays the correlations among the sub-scales of the impulsivity and gambling cognition scales. Planning and perseverance were not significantly correlated with any cognition sub-scale. Sensation seeking showed a significant but small correlation with illusion of control and medium correlations with interpretative bias and inability to stop. Positive urgency and negative urgency showed an overall pattern of statistically significant medium sized correlations with all the cognition sub-scales.

Table 7 displays the correlations among the sub-scales of the impulsivity and motivation scales. Planning and perseverance were not correlated with any motivation sub-scale. Sensation seeking showed a significant medium correlation with excitement motivation and significant small correlations with the monetary, socialization and amusement motivations. Positive urgency showed a general pattern of significant medium correlations with each motivation sub-scale; the weakest correlation was for socialization. Negative urgency showed a similar pattern to that of positive urgency except that the small correlation with socialization was not statistically significant.

Table 8 displays the correlations among the sub-scales of the cognition and motivation scales. All of the correlations were statistically significant. The smallest effects occurred for the socialization motive. The largest effects were for the correlations between excitement motivation and the expectancies, predictive control, and interpretative biases sub-scales of cognition.

**Logistic Regression of Predictors on PGSI Classification**

The upper portion of Table 9 presents the correlation coefficients for the total scores of the predictors of gambling severity and PGSI classification. All the correlations between the predictors and PGSI classification were statistically significant. The effect sizes were small to medium for gambling involvement and impulsivity; the effect sizes for motivation and gambling
cognitions were medium and large, respectively. Gambling involvement was correlated neither with impulsivity nor with motivation, and was marginally correlated with gambling cognitions. Impulsivity showed a medium effect size correlation with both motivation and gambling cognitions. The effect size for the correlation between motivation and gambling cognitions was large.

The lower portion of Table 9 summarizes the results of a logistic regression analysis in which gambling involvement, impulsivity, motivation, and gambling cognitions were the predictors and PGSI classification as non-problem or problem gambler was the dependent variable. The Wald criterion indicates that only impulsivity was not a significant predictor of gambling severity category. The Exp (B) values show that gambling involvement, motivation, and gambling cognitions had equivalent effects on the odds ratio of a gambler being classified as a problem gambler.

Analyzes of Betting on Colour Alternation: Endorsement of the Gambler’s Fallacy

Table 10 displays the means and standard deviations for the number of occurrences of a run of consecutive outcomes of a given colour during the roulette game for run lengths 1, 2, and 3. The median number of occurrences of longer runs was very low (2 for a run of 4; 1 for a run of 5; and, 0 for a run of 6) so that inclusion of those runs in analyses of gambler characteristic effects would compromise power due to the loss of participants. A one-way repeated measures ANOVA for run lengths 1 to 6 showed a statistically significant inverse relationship between run length and the likelihood of experiencing that run length during the roulette game, $F(5, 1150) = 941.61, p < .001, \eta_p^2 = 0.78$. A second one-way repeated measures ANOVA for run lengths 1, 2 and 3 confirmed the inverse relationship between run length and frequency of occurrence, $F(2, 460) = 891.76, p < .001, \eta_p^2 = 0.77$.

Table 10 also presents the mean probability of betting on an alternation in the colour of the winning number following a run of a given colour. A one-way repeated measures ANOVA showed that the likelihood of betting on an alternation in colour increased as the run length of the previous colour increased, $F(2, 460) = 33.74, p < .001, \eta_p^2 = 0.13$. The linear trend was statistically significant, $F(1, 230) = 54.79, p < .001, \eta_p^2 = 0.19$; the quadratic trend was not statistically significant, $F(1, 230) = 0.10, p = .76$.

The top portion of Table 11 displays the correlations between the probability of betting on an alternation in colour for runs of 1, 2 and 3 with the overall scores for impulsivity, motivation, gambling cognitions and gambling involvement. There were two significant correlations and both were for the probability of betting on an alternate colour of a run of 3: for motivation, $r(248) = .15, p = .02$; and, for gambling cognitions, $r(248) = .22, p = .001$. A multiple regression analysis with motivation and gambling cognitions as predictors of betting on an alternate colour following a run of 3 consecutive outcomes of a colour is summarized in the bottom portion of Table 11. The overall regression model was statistically significant, $F(2, 243) = 6.01, p = .003$. However, the standardized coefficient was significant only for gambling cognitions, $\beta = .20, t = 2.47, p = .01$

Limitations

Among the limitations in the study are the potential effects of repeatedly testing the participants from the community database. However, none had ever played online roulette in the laboratory or completed the impulsivity scale. Moreover, the analysis of endorsement of the gambler’s fallacy as indexed by the influence of the history of outcomes on betting choices was novel. Repeated testing on the PGSI provides an index of reliability for our prevalence estimates, and comparison of effects with the newly-recruited university students provides an
index of generalization. Other limitations include the fact that participants did not play with their own money, and that the gambling occurred in a laboratory setting. However, by taking part in the gambling tasks participants did risk a sure gain (compensation for completing the self-report measures) against potential larger gains that were dependent on the outcomes of their gambles.

Another limitation is that participants were restricted to a maximum of 15 minutes of play while gambling. Although that time frame may be at variance with what players might select in a session within a true gambling environment, significant effects have been found in prior studies using a short period of time (e.g., Monaghan & Blaszczynski, 2010). Thus, although many important features of a casino were not represented in the laboratory (e.g., unlimited play time, unlimited betting amounts, opportunities for diversions such as refreshments and entertainment), it is possible to capture essential characteristics of gamblers in a controlled laboratory environment. The most compelling evidence that the comparatively sterile laboratory environment evoked representative gambling behaviour is that, although the gamblers had the option to take $30 and not play at all, every one of them chose to play despite the restrictions that may not have been representative of their non-laboratory gambling. More generally, the artificiality of the laboratory setting most likely minimizes the sensitivity to detect effects, so that any patterns that do emerge are sure to be more powerful in a real-life setting. It remains an empirical question as to whether any generalizations would extend to gambling of forms other than betting on the colour of the winning number prior to a spin of the roulette wheel.

Discussion

One goal of the present study was to explore the personality, cognitive, and motivational characteristics of problem gamblers. Analyses of multi-factor measures of the predictors confirmed that problem gambling severity is associated with impulsivity, gambling related cognitions, and motivation. Only two facets of impulsivity, positive urgency and negative urgency, were significant predictors of gambling severity. All of the cognitive factors were significant predictors of gambling severity, and all of the motivation sub-scales with the exception of socialization were associated with gambling severity. Monetary motivation exhibited the largest motivation effect size. Gambling involvement (number of types of gambling events) was also associated with gambling severity and was not correlated with any of the global measures of the other predictors. The impulsivity, cognition, and motivation sub-scales were significantly correlated with the exception of the planning and perseverance scales of impulsivity. A logistic regression analysis of the categorization to non-problem and problem gamblers showed that the independent contributions of involvement, cognition, and motivation were all statistically significant. The contribution of impulsivity was not statistically significant.

The finding that the association between gambling severity and impulsivity was weaker than that between gambling severity and gambling related cognitions replicates the pattern reported by Michalczuk et al. (2011). In their study comparing pathological gamblers and healthy controls, the mean effect size (Cohen’s d) for impulsivity was 0.96; for gambling related cognitions the mean effect size was 1.45. In the present study of community gamblers and university students, the mean impulsivity and cognition effects sizes for differences between non-problem and problem gamblers were 0.23 and 0.95, respectively. In both studies, gambling related cognitions were a stronger predictor of problem gambling severity than was impulsivity.

One difficulty in interpreting the association between gambling severity and impulsivity is determining the directionality of the association. Impulsivity, measured as a trait, is more likely a precursor of gambling severity rather than a consequence. However, Torres et al. (2013) questioned whether self-reported impulsivity is immune from a personal history of
gambling: “gambling exposure can gradually boost impulsive traits” (p. 1). Therefore, disentangling the direction of the association may be difficult when examining functional relations between cognitive and personality correlates of problem gambling.

In both Michalczuk et al. (2011) and the present study, the strongest impulsivity discriminators of gambling severity were positive urgency and negative urgency. Whereas Michalczuk et al. found that gambling severity differences were significant on four impulsivity scales, in the present study positive urgency and negative urgency were the only two significant discriminating factors. One critical difference between the studies that may contribute to the discrepancy in impulsivity effects is that whereas Michalczuk et al. (2011) compared pathological gamblers seeking treatment with healthy controls, the present study contrasted groups defined by a cutoff 3-plus score on the PGSI. However, a recent study of pathological gamblers found yet a different pattern of impulsivity effects.

Torres et al. (2013) tested 21 pathological gamblers in rehabilitation, 20 cocaine-dependent individuals in rehabilitation, and 23 controls. Negative urgency and lack of premeditation were the only significant predictors of clinical status (i.e., in rehabilitation vs. control). No measures of impulsivity differentiated the cocaine and gambling groups. Severity of gambling was indexed for the gamblers with interviews that asked about the number of months they had gambled and the amount of money spent on gambling per month. Only negative urgency was related to gambling severity. It is not clear why positive urgency, a significant predictor of problem gambling in the present study and in Michalczuk et al. (2011), had no predictive significance in Torres et al. Detailed information about the clinical samples might provide some basis for determining the individual characteristics that foster the influence of positive urgency.

Other discrepant results reported by Michalczuk et al. (2011) and Torres et al. (2013) emerged in the delay discounting task. The studies used different measures of delay discounting (a discounting parameter in Michalczuk et al. vs. the number of immediate reward choices in Torres et al.). Although both studies found that pathological gamblers exhibited a greater preference for immediate rewards than did the controls, Michalczuk et al. showed that effect of reward size on discounting was similar for pathological gamblers and healthy controls. More critically, whereas the discounting parameter in Michalczuk et al. was related to the lack of planning and lack of perseverance impulsivity sub-scales, the number of immediate reward choices in Torres et al. was related to only negative urgency. It is not apparent whether those contradictory outcomes reflect the computational differences in indexing the preference for immediate rewards.

Michalczuk et al. (2011) showed further that the discounting parameter was more strongly associated with gambling related cognitions than with self-reported impulsivity. That result suggests caution in interpreting results of the discounting paradigm as a direct reflection of trait impulsivity. Torres et al. reported that gambling severity (in terms of amounts bet and history of gambling) was not predictive of delay discounting. Negative urgency, then, was the only aspect of impulsivity that was associated with both gambling severity and reward delay discounting in Torres et al. Hirsh, Guindon, Morisano, and Peterson (2010) have shown that discounting by university students is negatively related to general cognitive ability and positively related to extraversion. However, the personality effect interacted with state emotion. It may be that similar interactions of personality and emotional state would limit the impact of self-reported impulsivity on discounting by gamblers. In addition, as Torres et al. caution, the
directionality pattern among those functional relationships is difficult to determine in cross-sectional studies.

An innovative feature of the current study was the examination of the relation between predictors of gambling severity and performance on a behavioural test of endorsement of the gambler’s fallacy—the tendency to believe that long term probabilistic patterns will occur in the short term. Questions on standardized self-report tests of the beliefs held by problem gamblers typically include an item assessing the gambler’s fallacy. Observation of roulette betting may provide more valid measures of gamblers’ behaviour than does the delay discounting paradigm. The roulette game afforded participants the possibility of winning real monetary rewards in contrast to the discounting task that presents hypothetical examples having no direct impact on the participant. Thus, the roulette task is more likely to elicit the emotions that govern gambling behaviour. Providing participants with an opportunity to observe directly the probabilistic patterns of outcomes in a roulette game may provide a context for changing gamblers’ cognitions.

Prior attempts have indicated the limitations of instruction about probabilities on gambling behaviour. Williams and Connolly (2006) showed that an intervention of explicit instruction on gambling-specific probabilities improved knowledge of gambling odds, but did not affect reports of time spent and money spent on gambling. Similarly, Floyd, Whalen, and Meyers (2006) found that presenting warning messages (e.g., “the result of any spin has nothing to do with previous spins” and “if you bet more to make up for your losses, you are likely to lose even more money”) during an electronic roulette game did change gambling beliefs but did not reduce the number of spins or the amount wagered per spin. The negative impact of information in those studies was not investigated for levels of problem gambling severity.

More recently, Monaghan and Blaszczynski (2010) reported a study in which they varied the content of pop-up messages during an electronic gambling game. Self-appraisal messages (e.g., “do you know how long you have been playing?”) led gamblers to estimate that, in future play, such messages were more likely to influence gambling session length and awareness of time than were probability information messages (e.g., “all outcomes are randomly determined by chance”). However, the information messages were superior in conveying the chances of winning the maximum prize. It should be noted that gambling behaviour was not observed directly in those studies.

The restricted impact of didactic information alone on gambling behaviour was demonstrated by Hertwig, Barron, Weber, and Erev (2004) who presented university students with choices between two risky gambles that varied slightly in expected value. For example, in one gamble, the players were to choose either an option where there was an 80% chance of winning 4 points or an option where there was a 100% chance of winning 3 points. The expected value of the first option is $0.8 \times 4 = 3.2$, and the expected value of the second option is $1 \times 3 = 3$ points. Players were paid according to the number of points accumulated at the end of play. Knowledge of the options was presented either by showing the numbers on a screen or by having participants repeatedly spin a dial to experience the probabilities of the outcomes. Hertwig et al. found that whereas 36% of participants in the numerical display group selected the higher expected utility choice, 88% of participants in the experience group selected the higher expected value choice. That is, although never explicitly informed of the different probabilities, the experience group enjoyed the higher payouts.

In the present study, adherence to the gambler’s fallacy was tested by requiring participants to bet on whether a roulette spin would yield a red or black winning number. The
critical measure was the probability of betting on a change in colour from the previous winning number (an alternation bet) as a function of the number of prior consecutive spins on which that colour was the winning number (run length). The probability of an alternation bet increased with run length and was correlated with overall gambling motivation and cognitions. A regression analysis on alternation probability at run length 3 showed that only gambling cognitions significantly predicted the probability of an alternation.

Croson and Sundali (2005) reported that the increase in proportion of alternation bets was significant for runs of 5 and greater. In the present study, the effect emerged at a run length of 3. There are at least two possible sources of this discrepancy. The gamblers studied by Croson and Sundali were free to make any type of roulette bet (including betting on specific numbers). In the present study, only the colour bet was permitted. Also, in Croson and Sundali, the history of recent winning colours was not displayed. In the present study, the history of the eight most recent winning colours was displayed. Both of these features may have sensitized the participants in the present study to attend to the history of winning colours. It should be noted, however, that participants were not told explicitly to monitor the history of winning colours. Future studies might explore whether explicit instructions would impact adherence to the gambler’s fallacy.

Hahn and Warren (2009) have argued that the gambler’s fallacy is supported by “either direct reflections of statistical properties of the experienced environment or the result of reasonable inferences from that experience” (p. 459). For example, in both Croson and Sundali (2005) and in the present study, the likelihood of experiencing a given run length decreased with the length of the run. In the present study, participants encountered a run of 1 approximately 25 times and a run of 3 approximately 6 times. That is, the finite experience of outcomes leads to the expectation that long runs are unlikely. Sun and Wang (2010) have reviewed the influence of both the frequency of sequences and the waiting time for sequences on estimations of event outcomes. Oliwola and Oppenheimer (2008) argued that attempts at corrective feedback about the misperceptions of randomness may fail because of limited memory processes. None of those studies, however, compared the perceptions and memories of participants varying in gambling severity. Extensions of those paradigms to gambling populations may reveal distinctive cognitive patterns to target with interventions. It may be that overcoming the cognitive biases would be facilitated by providing direct experiences of the independence of the frequency of sequence patterns and the likelihood of winning by any strategy on individual betting events. Addressing those biases may generalize beyond games such as roulette where the probability of winning is explicit to types of gambling where odds are generally unknown (e.g., slot machines).

Nonetheless, interventions reliant on a rational reconstruction of gamblers’ attitudes or practices are unlikely to succeed as the normative thinking mode for these problem gamblers is not strongly rational (Emond & Marmurek, 2010). Interventionists should recognize that the assumption that problem gamblers are less likely than non-problem gamblers to be familiar with knowledge of winning probabilities is false (Lambos & Delfabbro, 2007). Central to the excitement of gambling may be the hope of defeating the odds against winning. Successful interventions, then, may need to balance the focus on gambling specific cognitions with a focus on gambling motivations to arrive at techniques that improve decision making (Milkman, Chugh, & Bazerman, 2009).

In addition to the cognitive and motivational bases of problem gambling, the current study also examined the contribution of trait impulsivity. The impulsivity measure generated weaker effects than did the cognitive and motivational predictors. It should be noted that the
items on the cognitive and motivational scales make direct reference to the gambling situation. The impulsivity scale tests a generic characteristic. An impulsivity scale that is directed to a gambling context may give rise to stronger effects. The impulsivity factors that differentiated the gambling categories were positive urgency and negative urgency. Items testing those factors allude to emotional states which serve as referents for several items on the cognitive and motivational scales. Torres et al. (2013), finding that only negative urgency was predictive of gambling severity, speculated that negative emotions fuel pathological gambling. In the present study of a broader sample of gamblers, both positive urgency and negative urgency were associated with problem gambling. Distinguishing between “cold” (non-emotional) and “hot” (emotional) pathways to problem gambling may promote interventions tailored to the diversity of the supporting mechanisms.
References


Table 1

*Distribution of Participants by Gender and Sample across PGSI Categories*

<table>
<thead>
<tr>
<th>PGSI score</th>
<th>Non-Problem</th>
<th>Low Risk</th>
<th>Moderate Risk</th>
<th>Problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>41</td>
<td>40</td>
<td>32</td>
<td>12</td>
</tr>
<tr>
<td>1-2</td>
<td>40</td>
<td>32</td>
<td>27</td>
<td>8</td>
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<tr>
<td>3-7</td>
<td>53</td>
<td>47</td>
<td>27</td>
<td>8</td>
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<tr>
<td>&gt;8</td>
<td>45</td>
<td>39</td>
<td>26</td>
<td>8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gender</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students</td>
<td>49</td>
<td>33</td>
</tr>
<tr>
<td>Community</td>
<td>45</td>
<td>26</td>
</tr>
</tbody>
</table>
Table 2

*Means and Standard Deviations of Number of Types of Games Played in the Past 12 Months*

<table>
<thead>
<tr>
<th>PGSI Subtype</th>
<th>Non-problem (n = 181; PGSI = 0 - 2)</th>
<th>Problem (N = 79; PGSI &gt; 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td>Sample</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students</td>
<td>2.18</td>
<td>1.59</td>
</tr>
<tr>
<td>Community</td>
<td>3.20</td>
<td>1.76</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>2.53</td>
<td>1.68</td>
</tr>
<tr>
<td>Female</td>
<td>2.76</td>
<td>1.79</td>
</tr>
</tbody>
</table>
Table 3

*Means and Standard Deviations on Gambling Related Cognition (GRC) Scales*

<table>
<thead>
<tr>
<th>Scale</th>
<th>Non-problem (n = 181; PGSI = 0 - 2)</th>
<th>Problem (N = 79; PGSI &gt; 2)</th>
<th>F</th>
<th>Cohen’s d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expectancies</td>
<td>9.09 4.30</td>
<td>14.99 5.11</td>
<td>71.54</td>
<td>1.25</td>
</tr>
<tr>
<td>Illusion of Control</td>
<td>6.87 4.10</td>
<td>10.06 4.70</td>
<td>24.41</td>
<td>0.72</td>
</tr>
<tr>
<td>Predictive Control</td>
<td>13.08 6.26</td>
<td>18.46 6.55</td>
<td>36.34</td>
<td>0.84</td>
</tr>
<tr>
<td>Inability to Stop</td>
<td>6.34 2.82</td>
<td>11.19 6.30</td>
<td>70.12</td>
<td>0.99</td>
</tr>
<tr>
<td>Interpretive Bias</td>
<td>9.28 5.15</td>
<td>14.37 5.54</td>
<td>46.21</td>
<td>0.95</td>
</tr>
<tr>
<td>Total Score</td>
<td>44.66 18.12</td>
<td>68.34 22.95</td>
<td>74.14</td>
<td>1.15</td>
</tr>
</tbody>
</table>

Note: For all F (1, 252) values, p < .001.
Table 4

*Means and Standard Deviations on Impulsivity Scales*

<table>
<thead>
<tr>
<th>Scale</th>
<th>Non-problem (n = 181; PGSI = 0 - 2)</th>
<th>Problem (N = 79; PGSI &gt; 2)</th>
<th>F</th>
<th>Cohen’s d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative Urgency</td>
<td>27.23 6.74</td>
<td>30.51 6.14</td>
<td>11.97**</td>
<td>0.51</td>
</tr>
<tr>
<td>Positive Urgency</td>
<td>26.62 7.86</td>
<td>30.54 8.01</td>
<td>11.81**</td>
<td>0.49</td>
</tr>
<tr>
<td>(Lack of) Planning</td>
<td>31.51 5.49</td>
<td>31.42 3.71</td>
<td>0.01</td>
<td>0.02</td>
</tr>
<tr>
<td>(Lack of) Perseverance</td>
<td>26.75 5.40</td>
<td>26.90 4.10</td>
<td>0.01</td>
<td>0.03</td>
</tr>
<tr>
<td>Sensation Seeking</td>
<td>33.02 8.16</td>
<td>32.37 6.54</td>
<td>0.59</td>
<td>0.09</td>
</tr>
<tr>
<td>Total Score</td>
<td>145.14 20.54</td>
<td>151.95 13.78</td>
<td>5.84*</td>
<td>0.39</td>
</tr>
</tbody>
</table>

* F (1, 252) p = .02.
** F (1, 252) p < .001.
Table 5

Means and Standard Deviations on Motivation Scales

<table>
<thead>
<tr>
<th>Scale</th>
<th>Non-problem (n = 181; PGSI = 0 - 2)</th>
<th>Problem (N = 79; PGSI &gt; 2)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td>F</td>
</tr>
<tr>
<td>Excitement</td>
<td>27.85</td>
<td>6.82</td>
<td>30.09</td>
<td>5.53</td>
<td>4.30*</td>
</tr>
<tr>
<td>Socialization</td>
<td>9.88</td>
<td>2.69</td>
<td>10.54</td>
<td>2.86</td>
<td>2.06</td>
</tr>
<tr>
<td>Avoidance</td>
<td>12.55</td>
<td>4.95</td>
<td>16.47</td>
<td>5.54</td>
<td>32.21**</td>
</tr>
<tr>
<td>Monetary</td>
<td>14.21</td>
<td>4.32</td>
<td>18.15</td>
<td>3.49</td>
<td>47.18**</td>
</tr>
<tr>
<td>Amusement</td>
<td>13.16</td>
<td>3.41</td>
<td>15.27</td>
<td>2.75</td>
<td>20.21**</td>
</tr>
<tr>
<td>Total Score</td>
<td>78.44</td>
<td>16.84</td>
<td>90.81</td>
<td>12.57</td>
<td>29.69**</td>
</tr>
</tbody>
</table>

* $F (1, 252) p < .05$
** $F (1, 252) p < .001$. 
### Table 6

**Bivariate Correlations for Impulsivity and Cognition Sub-scales**

<table>
<thead>
<tr>
<th>Impulsivity</th>
<th>Expectancy</th>
<th>Illusion of Control</th>
<th>Predictive Control</th>
<th>Inability to Stop</th>
<th>Interpretive Bias</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning</td>
<td>.05</td>
<td>.03</td>
<td>.05</td>
<td>.06</td>
<td>.07</td>
</tr>
<tr>
<td>Perseverance</td>
<td>.06</td>
<td>.06</td>
<td>.02</td>
<td>.04</td>
<td>.02</td>
</tr>
<tr>
<td>Sensation seeking</td>
<td>.08</td>
<td>.15*</td>
<td>.28***</td>
<td>.09</td>
<td>.28***</td>
</tr>
<tr>
<td>Positive urgency</td>
<td>.36***</td>
<td>.33***</td>
<td>.39***</td>
<td>.30***</td>
<td>.38***</td>
</tr>
<tr>
<td>Negative urgency</td>
<td>.33***</td>
<td>.27***</td>
<td>.29***</td>
<td>.22***</td>
<td>.36***</td>
</tr>
</tbody>
</table>

* p < .05; ** p < .01; *** p < .001
Table 7

*Bivariate Correlations for Impulsivity and Motivation Sub-scales*

<table>
<thead>
<tr>
<th>Impulsivity</th>
<th>Motivation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Excitement</td>
</tr>
<tr>
<td>Planning</td>
<td>.02</td>
</tr>
<tr>
<td>Perseverance</td>
<td>.04</td>
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<tr>
<td>Sensation seeking</td>
<td>.36***</td>
</tr>
<tr>
<td>Positive urgency</td>
<td>.34***</td>
</tr>
<tr>
<td>Negative urgency</td>
<td>.37***</td>
</tr>
</tbody>
</table>

* p < .05; ** p < .01; *** p < .001
Table 8

*Bivariate Correlations for Motivation and Cognition Sub-scales*

<table>
<thead>
<tr>
<th>Motivation</th>
<th>Expectancy</th>
<th>Illusion of Control</th>
<th>Predictive Control</th>
<th>Inability to Stop</th>
<th>Interpretive Bias</th>
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</thead>
<tbody>
<tr>
<td>Excitement</td>
<td>.50***</td>
<td>.38***</td>
<td>.53***</td>
<td>.29***</td>
<td>.53***</td>
</tr>
<tr>
<td>Monetary</td>
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<td>.30***</td>
<td>.44***</td>
<td>.40***</td>
<td>.44***</td>
</tr>
<tr>
<td>Avoidance</td>
<td>.31***</td>
<td>.35***</td>
<td>.33***</td>
<td>.38***</td>
<td>.32***</td>
</tr>
<tr>
<td>Socialization</td>
<td>.24***</td>
<td>.23***</td>
<td>.30***</td>
<td>.19**</td>
<td>.32***</td>
</tr>
<tr>
<td>Amusement</td>
<td>.40***</td>
<td>.35***</td>
<td>.44***</td>
<td>.33***</td>
<td>.44***</td>
</tr>
</tbody>
</table>

* p < .05; ** p < .01; *** p < .001
Table 9

*Bivariate Correlations (a) and Summary of Logistic Regression on PGSI Category (b)*

<table>
<thead>
<tr>
<th>(a) Measure</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<td>1. Involvement</td>
<td>-</td>
<td>-0.08</td>
<td>-0.04</td>
<td>0.12</td>
<td>0.15*</td>
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<td>.37***</td>
<td>0.17**</td>
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<td>3. Motivation</td>
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<td>0.62***</td>
<td>0.36***</td>
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<td></td>
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<tr>
<td>4. Cognitions</td>
<td>-</td>
<td>0.49***</td>
<td></td>
<td></td>
<td></td>
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<td>5. PGSI Category</td>
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* * p < .05; ** p < .01; *** p < .001

(b) Logistic Regression Summary

<table>
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<tr>
<th>Variable</th>
<th>B</th>
<th>S.E.</th>
<th>Wald</th>
<th>df</th>
<th>p</th>
<th>Exp (B)</th>
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<td>Involvement</td>
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<td>.079</td>
<td>4.156</td>
<td>1</td>
<td>.04</td>
<td>1.175</td>
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<tr>
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<td>.010</td>
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<td>.010</td>
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<td>.001</td>
<td>1.041</td>
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<tr>
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<td>13.368</td>
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Table 10

*Mean Run Length Frequency and Probability of Betting on a Subsequent Alternation*

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<thead>
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<th>Run Length</th>
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<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
</tr>
<tr>
<td>Frequency of outcome</td>
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<td></td>
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<tr>
<td></td>
<td>24.97</td>
<td>12.64</td>
<td>11.62</td>
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<tr>
<td>Probability of alternation</td>
<td>.47</td>
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<td>.54</td>
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Table 11

Correlations for Total Scale Scores and Probability of an Alternation Bet (a) and Summary of Regression of Scale Scores on Probability of Alternation (b)

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<th>Scale</th>
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<td>.08</td>
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<tr>
<td>Motivation</td>
<td>.03</td>
<td>.04</td>
<td>.15*</td>
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<tr>
<td>Cognitions</td>
<td>.04</td>
<td>.06</td>
<td>.22***</td>
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<td>Gambling involvement</td>
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<td>.05</td>
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</table>

* p = .02; *** p = .001

(b) Summary of Regression on Alternation for Run Length 3

<table>
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<th>Scale</th>
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<th>t</th>
<th>p</th>
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<tr>
<td>Motivation</td>
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<td>.71</td>
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<td>Cognitions</td>
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<td>.62</td>
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<tr>
<td>Constant: B = .36</td>
<td>SE = .10</td>
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Appendix A

Problem Gambling Severity Index

1. How often have you bet more than you could really afford to lose?

2. How often have you needed to gamble with larger amounts of money to get the same feeling of excitement?

3. How often have you gone back another day to try and win back the money you lost?

4. How often have you borrowed money or sold anything to get money to gamble?

5. How often have you felt that you might have a problem with gambling?

6. How often has gambling caused you any health problems, including stress or anxiety?

7. Have people criticized your betting or told you that you had a gambling problem, regardless of whether or not you thought it was true?

8. Has your gambling caused any financial problems for you or your household?

9. Have you felt guilty about the way you gamble or what happens when you gamble?
Appendix B

Gambling Related Cognitions (GRC)

1. Gambling makes me happier.
2. I can’t function without gambling.
3. Praying helps me win.
4. Losses when gambling are bound to be followed by a series of wins.
5. Relating my winning to my skill and ability makes me continue gambling.
6. Gambling makes things seem better.
7. It is difficult to stop gambling as I am so out of control.
8. Specific numbers and colours can help increase my chances of winning.
9. A series of losses will provide me with a learning experience that will help me win later.
10. Relating my losses to bad luck and bad circumstances makes me continue gambling.
11. Gambling makes the future brighter.
12. My desire to gamble is so overpowering.
13. I collect specific objects that help increase my chances of winning.
14. When I have a win once, I will definitely win again.
15. Relating my losses to probability makes me continue gambling.
16. Having a gamble helps reduce tension and stress.
17. I’m not strong enough to stop gambling.
18. I have specific rituals and behaviours that increase my chances of winning.
19. There are times that I fell lucky and thus gamble those times only.
20. Remembering how much money I won last time makes me continue gambling.
21. I will never be able to stop gambling.
22. I have some control over predicting my gambling wins.
23. If I keep changing my numbers, I have less chances of winning.

Expectancies (1, 6, 11, 16)
Illusion of control (3, 8, 13, 18)
Predictive control (4, 9, 14, 19, 22, 23)
Inability to stop (2, 7, 12, 17, 21)
Interpretative bias (5, 10, 15, 20)
Appendix C

Impulsivity Scale

Planning
I have a reserved and cautious attitude toward life.
My thinking is usually careful and purposeful.
I am not one of those people who blurt out things without thinking.
I like to stop and think things over before I do them.
I don’t like to start a project until I know exactly how to proceed.
I tend to value and follow a rational, “sensible” approach to things.
I usually make up my mind through careful reasoning.
I am a cautious person.
Before I get into a new situation I like to find out what to expect from it.
I usually think carefully before doing anything.
Before making up my mind, I consider all the advantages and disadvantages.

Perseverance
I generally like to see things through to the end.
I tend to give up easily.
Unfinished tasks really bother me.
Once I get going on something, I hate to stop.
I concentrate easily.
I finish what I start.
I’m pretty good about pacing myself so as to get things done on time.
I am a productive person who always gets the job done.
Once I start a project, I almost always finish it.
There are so many little jobs that need to be done that I sometimes just ignore them all.

Sensation-seeking
I generally seek new and exciting experiences and sensations.
I’ll try anything once.
I like sports and games in which you have to choose your next move very quickly.
I would enjoy water skiing.
I quite enjoy taking risks.
I would enjoy parachute jumping.
I welcome new and exciting experiences and sensations, even if they are a little frightening and unconventional.
I would like to learn to fly an airplane.
I sometime like doing things that are a bit frightening.
I would enjoy the sensation of skiing very fast down a high mountain slope.
I would like to go scuba diving.
I would enjoy fast driving.
Positive Urgency
When I am very happy, I can’t seem to stop myself from doing things that can have bad consequences.
When I am in a great mood, I tend to get into situations that could cause me problems.
When I am very happy, I tend to do things that may cause problems in my life.
I tend to lose control when I am in a great mood.
When I am really ecstatic, I tend to get out of control.
Others would say I make bad choices when I am extremely happy about something.
Others are shocked or worried about the things I do when I am feeling very excited.
When I get really happy about something, I tend to do things that can have bad consequences.
When overjoyed, I feel like I can’t stop myself from going overboard.
When I am really excited, I tend not to think of the consequences of my actions.
I tend to act without thinking when I am really excited.
When I am really happy, I often find myself in situations that I normally wouldn’t be comfortable with.
When I am very happy, I feel like it is OK to give in to cravings or overindulge.
I am surprised at the things I do while in a great mood.

Negative Urgency
I have trouble controlling my impulses.
I have trouble resisting cravings.
When I feel bad, I will often do things I later regret I order to make myself feel better now.
When I am upset, I often act without thinking.
When I feel rejected, I will often say things that I later regret.
It is hard for me to resist acting on my feelings.
I often make matters worse because I act without thinking when I am upset.
In the heat of an argument, I will often say things that I later regret.
Sometimes I do things on impulse that I later regret.
Appendix D

Motivation to Gamble Scale

When I gamble, I..

Enjoy the thrilling experience in risk.
Have fun in risk taking.
Have fun in competing with others.
Enjoy intense feelings.
Want to enjoy uncertainty.
Have fun in guessing the results.
Want to experience excitement and pleasure.
Want to feel triumph when winning.
Want to win money easily.
Need money.
May win big money.
Have a financial difficulty.
Feel troubled.
Feel lonely.
I feel depressed.
I feel angry.
I feel tense.
I forget about stressful reality.
I socialize with others.
I meet new people.
I please my friends.
I change my mood.
I escape from routine.
I enjoy leisure time.
Executive Summary

Although a small percentage (<5%) of Ontario gamblers aged 19 years and older experience gambling problems, the high participation rate (>60%) in gambling activities in the province highlights the significant challenges that problem gambling poses for individuals and society. Understanding the characteristics that foster the initiation and perpetuation of problem gambling may lead to interventions that reduce the harm stemming from the activities that the large majority of gamblers enjoy recreationally without adverse consequences.

Impulsivity, gambling related cognitions, and gambling motivation are characteristics that distinguish non-problem and problem gamblers. Analytical advances have identified the multi-factor structure of those constructs. The components of impulsivity are as follows: lack of planning involves a failure to plan ahead; lack of perseverance involves a failure to maintain vigilant attention on a task; sensation seeking is the tendency to pursue novel or thrilling experiences; negative urgency is the tendency to act rashly when upset; and, positive urgency is the tendency to act rashly when experiencing an unusually positive mood. Gambling related cognitions cluster among the following five factors: expectancies (e.g., “gambling makes the future brighter”); illusion of control (e.g., “specific numbers and colours can help increase my chances of winning”); predictive control (e.g., “losses when gambling are bound to be followed by a series of wins”); inability to stop (e.g., “I can’t function without gambling”); and, interpretive bias (e.g., “relating my losses to probability makes me continue gambling”). The main gambling motivators include excitement, money, avoidance (escape from problems), socialization, and, amusement.

The current study was designed to explore the diversity of relationships among gambling severity, impulsivity, gambling related cognitions, and gambling motivation. In addition, the associations between those self-reported individual difference measures and patterns of gambling during roulette play were assessed. Of particular interest during roulette play was adherence to the gambler’s fallacy in which participants rely on the history of outcomes to predict future outcomes in a game where each outcome is independent of prior outcomes. The critical question addressed was whether the influence of the history of colour outcomes on betting patterns is related to the dispositional, cognitive, and motivational predictors of problem gambling.

Community gamblers and university students completed standardized measures of gambling severity, trait impulsivity, gambling related cognitions, and gambling motivation. In a subsequent game of online roulette, participants were restricted to placing outside bets on the colour (red or black) of the winning number. Participants were incentivized by informing them that the players who had the top 10 scores at the end of play would receive a $50 gift card. The crucial measure in the roulette game was the likelihood of betting on a colour that was different from the colour on the previous spin (i.e., an alternation bet). The alternation colour bets were tabulated as a function of the number of consecutive trials on which a given colour had won. For example, the likelihood of betting on red was examined as a function of whether there had been 1, 2, or 3 consecutive black winning numbers prior to the current spin.

Analyses of the multi-factor measures of the predictors confirmed that problem gambling severity is associated with impulsivity, gambling related cognitions, and
motivation. Only two facets of impulsivity, positive urgency and negative urgency, were significant predictors of gambling severity. All of the cognitive factors were significant predictors of gambling severity with excitement yielding the largest effect size. All of the motivation sub-scales with the exception of socialization were associated with gambling severity. Monetary motivation exhibited the largest motivation effect size. The impulsivity, cognition, and motivation sub-scales were significantly correlated with the exception of the planning and perseverance scales of impulsivity. A logistic regression analysis of the categorization to non-problem and problem gamblers showed that the independent contributions of cognition and motivation were statistically significant. The contribution of impulsivity was not statistically significant.

An innovative feature of the current study was the examination of the relation between predictors of gambling severity and performance on a behavioural test of endorsement of the gambler’s fallacy---the tendency to believe that long term probabilistic patterns will occur in the short term. The roulette game afforded participants the possibility of winning real monetary rewards such that it was likely to elicit the emotions that govern normative gambling behaviour. Adherence to the gambler’s fallacy was tested by requiring participants to bet on whether a roulette spin would yield a red or black winning number. The critical measure was the probability of betting on a change in colour from the previous winning number (an alternation bet) as a function of the number of prior consecutive spins on which that colour was the winning number (run length). The probability of an alternation bet increased with run length and was correlated with overall gambling motivation and cognitions. A regression analysis on alternation probability at run length 3 showed that only gambling cognitions significantly predicted the probability of an alternation. Interventions that involve providing participants with an opportunity to observe directly the probabilistic patterns of outcomes in a roulette game may provide a context for changing gamblers’ cognitions.

However, interventions exclusively reliant on a rational reconstruction of gamblers’ attitudes or practices are unlikely to succeed as the normative thinking mode for these problem gamblers is not strongly rational. Interventionists should recognize that central to the excitement of gambling may be the hope of defeating the odds against winning. Successful interventions, then, may need to balance the focus on gambling specific cognitions with a focus on gambling motivations to arrive at techniques that improve decision making. The significant contributions of positive urgency and negative urgency to gambling severity suggest further that cognitive and motivational interventions must promote a balanced understanding of the “hot” (emotional) and “cold” (non-emotional) mechanisms that support problem gambling.