J Gambl Stud (2012) 28:139–154
DOI 10.1007/s10899-011-9249-x

ORIGINAL PAPER

Gambling-Related Cognitive Biases and Pathological Gambling Among Youths, Young Adults, and Mature Adults in Chinese Societies

Catherine So-kum Tang · Anise M. S. Wu

Published online: 10 May 2011

Abstract This study investigated the extent to which gambling-related cognitive biases would associate with various levels of gambling pathology among 2,835 youths, 934 young adults, and 162 mature adults in Chinese societies. Results showed that gambling cognitive biases, especially biases in perceived inability to stop gambling and positive gambling expectancy, were salient correlates of pathological gambling across the three age cohorts. Analyses of variances on total cognitive biases also showed a gambling pathology main effect and an age cohort $\times$ gambling pathology 2-way interaction effect. It was noted that the probable pathological gambling group had greater cognitive biases than the probable problem gambling group, which in turn had greater cognitive biases than the non-problem gambling group. In the non-problem gambling group, mature adults had greater cognitive biases than youths and young adults, but this pattern was reversed in the probable problem gambling group. In the probable pathological gambling group, youths had greater cognitive biases than young and mature adults. Specific categories of cognitive biases also varied according to gender and gambling pathology. While men as compared to women in the non-problem and probable problem gambling groups reported a greater bias in their perceived inability to stop gambling, no significant gender difference in this bias was found in the probable pathological gambling group. Men generally had greater perceived gambling expectancy bias than women.

Keywords Chinese gambling cognitions · Chinese pathological gambling · Chinese youth gambling

C. S. Tang (✉)
Department of Psychology, National University of Singapore, AS4, Level 2, 9 Arts Link, Singapore, Singapore
e-mail: tang.catherine@nus.edu.sg

A. M. S. Wu
Department of Psychology, University of Macau, Macau, People's Republic of China

Introduction

Conceptual models of pathological gambling often implicate cognitive biases as a precipitating and perpetuating factor (Blaszczynski and Nower 2002; Sharpe 2002; Sharpe and Tarrier 1993). Research has also documented associations between gambling cognitions and pathological gambling (Ladouceur 2004a; Oei et al. 2008; Raylu and Oei 2004a; Steenbergh et al. 2002; Toneatto 1999). Interventions that target at correcting erroneous gambling cognitions through behavior and cognitive behavior therapies have been found to be effective in reducing disruptive gambling (Oei et al. 2010; Toneatto and Ladouceur 2003; Toneatto and Millar 2004). However, the gambling literature has focused on adults from the United States, Canada, and Australia. Limited research has been conducted on the role of gambling cognitions in the onset and maintenance of pathological gambling among youths (Derevensky and Gupta 2005) and non-Caucasian populations (Loo et al. 2008; Raylu and Oei 2002). The present study represented the first study to investigate the extent to which gambling-related cognitive biases would associate with various levels of gambling pathology among youths, young adults, and mature adults in Chinese societies.

Gambling Cognitive Heuristics/Biases

The cognitive approach stipulates that pathological gambling results from erroneous decision-making based on faulty information processing (Ladouceur and Walker 1996; Sharpe 2002; Sharpe and Tarrier 1993). An understanding of individual's cognitive heuristics/biases in gambling would provide a contextual paradigm to examine disruptive gambling. Common gambling cognitive heuristics/biases include hindsight bias in believing gambling outcomes can be predicted, attribution bias in assigning credit to own skills in winning and blaming external influence in losses, and availability bias in making probability judgments based on experiences easily recalled from memory (Ladouceur et al. 1988; Langer 1975; Wagenaar 1988). Another three broad categories of irrational gambling cognitions proposed by Ladouceur (2004a) include misperceptions about the independence of gambling events (i.e., not accepting the randomness of each gambling event), illusions of control, and superstitions.

More recent research on gambling cognitions has focused on deriving and validating measurement scales based on various categorizations of cognitive heuristics/biases. For example, a 21-item self-report scale was devised to measure gamblers' cognitive biases along the luck/perseverance and illusion of control dimensions (Steenbergh et al. 2002). These two dimensions refer respectively to core beliefs that lead gamblers to overestimate their chance of winning and their control over gambling outcomes (Ladouceur and Walker 1996; Walker 1992). The 23-item self-report scale devised and validated by Raylu and Oei (2004a) includes five subscales in order to capture more detail categorization of gambling cognitions. The first three subscales are similar to the three broad categories of cognitive biases as proposed by Toneatto (1999). Illusion of control refers to assuming one's control over gambling outcomes, predictive control refers to believing one's skill in making accurate prediction about gambling outcomes, and interpretative bias refers to reframing gambling outcomes that would encourage continued gambling despite losses. Two cognitions commonly reported by substance abusers were also added to the scale. They include perceived inability to stop gambling and expectation of positive gambling outcomes (Oei et al. 1998).

Biases in gambling cognitions are not exclusive to gamblers. Non-gamblers have also been found to employ many cognitive distortions when gambling in laboratory settings.

Experimental studies showed that cognitive biases became more prevalent and persistent as non-gamblers increased their gambling involvement (Ladouceur 2004b; Ladouceur and Walker 1996). Individuals under stress were susceptible to illusion of control and exhibited poor knowledge about contingencies of choices when they engaged in gambling activities (Friedland et al. 1992; Preston et al. 2007). Based on gamblers' self-reports, biases in gambling cognitions were related to their motivation and persistence in disruptive gambling (Raylu and Oei 2002, 2004a; Oei et al. 2008; Steenbergh et al. 2002). Compared to non-problem gamblers, problem and pathological gamblers reported greater cognitive biases along the luck/perseverance and illusion of control dimensions (Myrseth et al. 2010; Steenbergh et al. 2002; Wohl et al. 2007) as well as higher total and subscale scores on the gambling cognitions scale devised by Raylu and Oei (2004a) and Oei et al. (2008). Problem and social gamblers tended to adopt different cognitive heuristics, with the greatest differences in heuristics of laws of randomness (Baboushkin et al. 2001). Moreover, gambling cognitions were found to moderate the relationship between risky gambling practices and gambling intensity, with the relationship being stronger when gamblers also reported high levels of irrational gambling cognitions (Miller and Currie 2008). Intervention studies have documented that biases in gambling cognitions could be modified by behavior and cognitive behavior therapies, which were in turn related to a reduction in pathological gambling (Oei et al. 2010; Toneatto and Ladouceur 2003; Toneatto and Millar 2004). In sum, there are empirical evidences to support the important role of gambling cognitive biases in the development and maintenance of disruptive gambling.

Knowledge and Research Gaps in Gambling Cognitions

Despite almost three decades of research on gambling cognitions, there are still many knowledge gaps. First, the majority of gambling research has focused on the underlying erroneous cognitions used by adults. Limited information is available on gambling cognitive biases among teenagers and adolescents, despite high prevalence of gambling behaviors among youths (Derevensky and Gupta 2005; Shaffer and Hall 1996). According to Piaget's (1950) theory of cognitive development, it could be expected that gambling cognitions, including gambling biases, would become more similar with those of adults as children grown older, move from pre- to formal operational cognitive stages, and transit to adolescence and young adulthood. Indeed, in a study on lottery ticket selection conducted with teenagers aged 7–14 (Herman et al. 1998), it was found that the use of cognitive heuristics/biases underlying the concept of randomness and control increased as teenagers got older. Other studies also noted that younger as compared to older teenagers/adolescents had more rational cognitions about gambling (Derevensky et al. 1996; Herman et al. 1998; Gupta and Derevensky 1998). Younger adolescents believed that successful performance in blackjack, roulette, slots, or lottery ticket selection was related more to luck than skill. In contrast, older adolescents believed that greater levels of skill and less luck were related to success in these same games of chance. However, there is not yet any study that compares gambling cognitive heuristics/biases between adults and adolescents, as well as examines the extent to which gambling cognitive heuristics/biases would associate with varying levels of gambling pathology among youths. It thus remains unclear whether the pattern of association found in adults would be applicable to youths.

Secondly, relatively few research has examined cultural similarities/differences in gambling cognitions in non-Caucasian populations (Loo et al. 2008; Raylu and Oei 2002, 2004b). Individuals from different cultural background espouse unique cultural values and belief systems to account for life events, and may exhibit distinct cognitions about gambling. For example, superstitious thinking has been more commonly reported by Chinese people as part of their cultural beliefs as compared to Caucasian populations (Tsang 2004). It was also suggested that beliefs regarding fate and illusion of control among Chinese gamblers might be more insidious and profound than Caucasian gamblers (Papineau 2005). Indeed, a recent study found that among recreational gamblers residing in Australia, Chinese as compared to Caucasians demonstrated a higher illusion of control and a more elevated perceived inability to stop gambling (Oei et al. 2008). Another study also showed that compared to Caucasian gamblers in the United Kingdom, Chinese gamblers in Hong Kong exhibited less probabilistic thinking and made riskier gambling decisions (Lau and Ranyard 2005). Given that there is a paucity of gambling research conducted with non-Caucasian populations, it is unclear whether gambling cognitions and their association with disruptive gambling would be similar or different among various cultural and ethnic groups.

Thirdly, prevailing brain research has noted gender differences in structural and functional organization of the brain (Cosgrove et al. 2007). This may impact on cognition and behavior between men and women, who may have differences in responsiveness of the reward system, information processing, and cognitive strategies utilized in problem-solving (Pogun 2001). The gambling literature has been equivocal regarding gender similarities/differences in gambling cognitions, which may also vary in various cultural and ethnic groups. For example, Raylu and Oei (2004a) found that Australian men as compared to women had significantly higher scores on various gambling cognitive biases, with the exception of illusion of control. Research on Chinese samples also found that Chinese men had significantly greater gambling cognitive biases than women (Hong and Chiu 1988; Oei et al. 2007), but the greatest gender difference was found in illusion of control (Hong and Chiu 1988). With a small sample of problem gamblers in Canada, no significant gender difference was found in gambling-related cognitive distortions (Toneatto et al. 1997). In view of these mixed findings, it is difficult to determine whether gender disparity in the prevalence of pathological gambling, preference of gambling activities, and progression toward social dysfunction (Ibanez et al. 2003; Tang et al. 2007) would be attributable to differences in gambling cognitions between men and women.

Purposes of the Present Study

This study attempted to fill various knowledge gaps in gambling cognitions. It represented the first study to investigate the extent to which gambling cognitive biases would associate with various level of gambling pathology among youths, young adults, and mature adults in Chinese societies. Understanding gambling cognitive biases at different developmental and life stages in various cultural groups would provide valuable information to determine the ideal age for gambling prevention programs as well as to design age appropriate and culturally relevant intervention for disruptive gambling.

Based on available gambling literature, it was hypothesized that biases in gambling cognitions would associate with pathological gambling. It was further speculated that cognitive biases would differ according to the level of gambling pathology, age cohort, and gender. In particular, the pathological gambling group would report greater cognitive biases than the problem gambling group, which in turn would report greater biases than the non-problem gambling group. Mature adults would exhibit greater gambling cognitive biases than young adults, who in turn would exhibit greater biases than youths. Men as compared to women would report greater biases in gambling cognitions. Furthermore, interaction effects among gambling pathology, age cohort, and gender on gambling cognitive biases would also be explored.

Method

Recruitment and Characteristics of Participants

The present study was part of a larger study on gambling behavior in Chinese societies. Its focus was on the association between gambling cognitions and disruptive gambling across age cohort and gambling pathology. For this study, three convenience samples of Chinese were recruited to represent three age cohorts: youths (high school students aged 11–17), young adults (college students aged 18–25), and mature adults (community adults aged 26 and above). Recruitment procedures varied slightly among the three samples due to administrative and practical constraints. Participation in the study was voluntary and without monetary reward. Confidentiality and anonymity of responses on the questionnaire was ensured. Participants were told that they would withdraw from the study at anytime. The questionnaire took about 20–30 min to complete. After the questionnaires were collected by research assistants, information on pathological gambling and local counseling centers for disruptive gambling were distributed to participants. Approval to conduct the study was given by the ethics review committee of the Chinese University of Hong Kong.

For the high school sample, permission to recruit students to participate in the study was obtained from eight school administrators and/or principals. A total of 3,000 questionnaires were distributed after classes or assemblies by research assistants, who were also available at the site to answer any questions that students might have about the questionnaire. 5% of the collected questionnaires were discarded due to students missing more than half of the information. As a result, this sample included 2,835 high school students (1,596 boys, 1,233 girls, 6 unidentified gender). Participants' age ranged from 11 to 17 years old, with a mean age of 14.41 ($SD = 1.54$).

For the college sample, invitations to undergraduate students to participate in this study were distributed through notices and posters in university campuses, dormitories, libraries, and student unions. A total of 1,500 questionnaires were distributed, and 979 completed questionnaires were collected, yielding a response rate of 65%. 45 questionnaires had more than half of the information missing and were discarded for subsequent analyses. Hence, this sample included 934 undergraduate students (456 men, 466 women, 12 unidentified gender) from different faculties of various universities in Hong Kong and Macau. Participants' age ranged from 18 to 25 years old, with the average age being 20.63 ($SD = 1.50$).

The community adult sample was recruited through various sources including notices and posters in public libraries, community centers, gambling treatment centers, and personal network. In order to be included in the study, participants were to be of aged 26 years or above and had engaged in at least one type of gambling activity in their lifetime. Four out of ten invited individuals agreed to take part in the study, yielding a response rate of about 40%. The major reason for declining was not having enough time and interest in the study. This sample included 162 individuals (128 men, 33 women, 1 unidentified gender).

Table 1 Demographic and gambling characteristics of participants

	High school students ($N = 2{,}835$) %	College students ($N = 934$) %	Community adults ($N = 162$) %
Gender			
Male	56.3	48.8	79.0
Female	43.5	49.9	20.4
Missing data	.2	1.3	.6
Age			
17 or below	100	–	–
18–25	–	100	–
26–29	–	–	7.4
30–39	–	–	36.4
40–49	–	–	33.3
50 or above	–	–	22.9
Marital status			
Single	100	99.8	25.3
Married	–	.2	61.7
Others	–	–	13.0
Ever engaged in gambling activities	50	85	100
Year of gambling			
0–5	83.5	44.0	16.7
6–10	2.5	22.0	14.2
11–20	–	10.1	37.6
More than 20	–	–	29.6
Missing data	14.0	23.9	1.9
Amount of gambling debt			
Nil	84.1	94.0	45.1
Under US$1,200 (10 K)	1.3	2.9	13.6
US$1,200–2,500 (20 K)	.7	1.0	8.0
US$2,501–3,800 (30 K)	–	–	7.4
US$3,801–5,100 (40 K)	–	–	8.0
Above US$5,100	–	–	14.2
Missing data	13.8	2.0	3.7
Major gambling activities			
Casino	–	25.6	53.7
Horse racing	2.5	8.3	62.3
Soccer betting	6.9	21.8	50.6
Mahjong	19.4	68.3	66.0
Internet gambling	20.1	–	–

The majority of participants aged between 30 and 49 years old. Regarding educational attainment of participants, 15% completed grade schools, 77% completed high school education, and 8% completed universities.

Table 1 summarizes demographic and gambling characteristics of the three samples, including age, gender, marital status, major gambling activities, years of gambling, and amount of gambling debt.

Instrument

Gambling Heuristics/Biases

The 23-item Gambling Related Cognitions Scale was used to assess gambling-related cognitive heuristics and biases of participants (GRCS: Raylu and Oei 2004a). This scale has five subscales, including inability to stop gambling (GRCS-IS), interpretive bias (GRCS-IB), illusion of control (GRCS-IC), positive gambling expectancy (GRCS-GE), and predictive control (GRCS-PC). The Cronbach's alpha coefficients of the GRCS were satisfactory for the overall scale and its subscales. This scale was able to distinguish between non-gamblers and gamblers (Raylu and Oei 2004a; Oei et al. 2008). The Chinese version of the scale was available, and the 5-factor structure was confirmed using Chinese samples from Australia and Taiwan (Oei et al. 2007). Participants responded with a 7-point Likert scale to indicate the extent to which they agreed with each item, with 1 as "strongly disagree" and 7 as "strongly agree". High scores indicate high levels of erroneous gambling-related cognitions.

Pathological Gambling

The DSM-IV diagnostic criteria items for pathological gambling include 10 common symptoms reported by pathological gamblers (American Psychiatric Association 1994). Examples of these symptoms are "preoccupied with gambling" and "repeated unsuccessful efforts to control, cut back, or stop gambling." These symptoms were presented as a checklist, with "yes" and "no" responses. The items showed satisfactory reliability, validity, and classification accuracy (Stinchfield et al. 2005). The Chinese version of the DSM-IV diagnostic criteria was available and has also been used to determine the prevalence of pathological gambling in Hong Kong (Wong and So 2003). For the present study, participants used the lifetime time frame in their responses to the items. Affirmative items were summed to form a pathological gambling score.

Gambling Activities

Participants were asked to indicate whether they had engaged in various gambling activities, such as gambling in casinos (internet gambling for high school students), betting on soccer games and horse races, buying lottery, and playing mahjong, cards, and slot machines.

Demographics

Participants provided information on their age and gender.

Results

Factor Structure and Internal Reliability of the GRCS

Given that the GRCS had not been used with youths and Chinese samples from China and Hong Kong, its factor structure was first conducted to determine whether the five-factor model proposed by Raylu and Oei (2004a) would be applicable. A confirmatory factor analysis (CFA) with maximum likelihood estimation was performed on the three samples separately using EQS 6.1. No cross-loadings were postulated and all factor correlations were free. The model was first evaluated with the high school sample. Though the χ^2 statistic was significant, χ^2 (220) = 4,635.59, $P < .05$, all three fit indices were satisfactory (CFI = .93; IFI = .93; RMSEA = .087). All factors were also significantly inter-correlated ($P < .05$). Hence, the inter-correlated five-factor model was acceptably fit for the high school sample. For the college sample, CFA results also indicated that the postulated model was satisfactorily fit, with all three fit indices being satisfactory (CFI = .93; IFI = .93; RMSEA = .077), despite the χ^2 statistic was significant, χ^2 (220) = 1,394.06, $P < .05$. The five factors were significantly correlated with each other ($P < .05$). For the community adult sample, results of another CFA showed that the χ^2 statistic was significant, χ^2 (220) = 525.27, $P < .05$, and the fit indexes were close to the accepted value (CFI = .86; IFI = .86; RMSEA = .097). As expected, all factors were also significantly inter-correlated ($P < .05$). In addition, no parameter was suggested to be either deleted or added by the Wald test and LM test in order to further improve the goodness-of-fit of the model. With the consideration of the relatively small sample size of the community adult sample, the five-factor model was regarded as a marginally good fit of the data. In conclusion, the five-factor model of the GRCS was found to generally fit the data across high school, college, and community adult samples. This factor structure consistency enabled direct comparisons of subscale scores among the three samples in subsequent analyses.

The Cronbach's alpha values for the overall scale were high across high school, college, and community adult samples ($\alpha = .98$, .97, and .94, respectively). Moderate to high internal reliability coefficients were also found for each of the five GRCS subscales across the three samples: GRCS-GE ($\alpha = .88$, .83, and .83, respectively); GRCS-IS ($\alpha = .92$, .91, and .85, respectively); GRCS-IC ($\alpha = .88$, .85, and .67, respectively); GRCS-PC ($\alpha = .92$, .89, and .85, respectively); and GRCS-IB ($\alpha = .91$, .87, and .84, respectively).

Associations Between Gambling Cognitions and Pathological Gambling

Three separate multiple regression analyses were conducted to investigate the extent to which gambling cognitions would predict pathological gambling for high school, college, and community adult samples. Predictor variables included age, gender, and total GRCS scores, and the dependent variable was total scores for DSM-IV pathological gambling. Results as summarized in Table 2 indicated that total scores for GRCS were a salient correlate of pathological gambling across the three samples ($\beta = .36$, .30, .29, $P < .001$, respectively), with high levels of erroneous gambling cognitions being associated with high levels of pathological gambling. Gender was also found to be a significant correlate among high school and college students ($\beta = -.10$, $-.10$, $P < .001$, respectively), with male as compared to female students being more likely to report higher levels of pathological gambling.

Similar multiple regression analyses were conducted with five GRCS subscales, and results were also summarized in Table 2. In particular, perceived inability to stop gambling (GRCS_IS) was the most consistent correlate of pathological gambling across the three samples ($\beta = .22$, .28, .62, $P < .001$, respectively). Among high schools students, significant correlate of pathological gambling also included positive gambling expectancy bias (GRCS_GE) ($\beta = .16$, $P < .05$). Among community adults, positive expectancy bias (GRCS_GE), interpretative bias (GRCS_IB), and predictive control (GRCS_PC) were significant correlates ($\beta = .29$, .27; $P < .05$, respectively).

Table 2 Final models of multiple regression analyses in predicting pathological gambling

Predictors	High school students ($N = 2{,}835$)			College students ($N = 934$)			Community adults ($N = 162$)		
	β	t value	P value	β	t value	P value	β	t value	P value
Age	.03	1.85	.07	−.03	−.90	.37	−.12	−1.58	.12
Gender	−.10	−5.34	.00	−.10	−3.07	.00	−.13	−1.73	.09
Total gambling cognitions	.36	20.22	.00	.30	9.45	.00	.29	3.78	.00
R^2	.15			.11			.14		
Age	.04	1.97	.06	−.02	−.76	.45	−.08	−1.25	.21
Gender	−.09	−4.88	.00	−.08	−2.44	.02	−.08	−1.17	.24
Inability to stop gambling	.22	5.57	.00	.28	5.01	.00	.62	5.98	.00
Interpretive bias	.07	1.20	.23	.13	1.87	.06	.29	2.14	.03
Illusion of control	.04	.92	.36	.02	.33	.74	.07	.90	.37
Gambling expectancy	.16	3.64	.00	.02	.31	.76	.23	2.30	.02
Predictive control	.10	1.76	.08	.03	.34	.74	.27	2.26	.03
R^2	.16			.13			.36		

Gambling Cognitions Across Age Cohort, Gender, and Gambling Pathology

Levels of gambling pathology were classified according to the DSM-IV criteria items for pathological gambling, with 0 score as non-problem gambling, scores ranging from 1 to 4 as probable problem gambling (Loo et al. 2008), and scores 5 or more as probable pathological gambling (Stinchfield et al. 2005). Tables 3 and 4 respectively summarized the distribution of participants and mean scores of gambling cognitions as broken down by age cohort, gender, and level of gambling pathology. A 3 (Age cohort: high school students, college students, and community adults) × 3 (Gambling pathology group: non-problem gambling, probable problem gambling, probable pathological gambling) × 2 (Gender: male, female) univariate analysis of variance was first conducted on total GRCS scores. A significant main effect of gambling pathology was found ($F = 60.6$, $P < .001$), indicating that the probable pathological gambling group had significantly higher total GRCS scores

Table 3 Distribution of participants as broken down by age cohort, gender, and gambling pathology

	High school students ($N = 2{,}835$)			College students ($N = 934$)			Community adults ($N = 162$)		
	Male	Female	Sub-total	Male	Female	Sub-total	Male	Female	Sub-total
Non-problem gambling (DSM = 0)	1,316	1,115	2,431	377	428	805	34	22	56
Probable problem gambling (DSM = 1–4)	133	58	191	64	35	99	32	2	34
Probable pathological gambling (DSM 5 or above)	86	15	101	15	3	18	62	9	71
Subtotal	1,535	1,188	2,723	456	466	922	128	33	161
Missing information on gender & DSM scores			112			12			1

Table 4 Gambling cognitions as broken down by age cohort, gender, and gambling pathology

	High school students (N = 2,835)			College students (N = 934)			Community adults (N = 162)		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Total gambling cognitions	2.22 (1.30)	1.95 (1.11)	2.01 (1.22)	2.45 (1.19)	2.00 (.97)	2.23 (1.11)	3.37 (1.09)	2.72 (1.32)	3.23 (1.16)
Non-problem gambling	2.01 (1.16)	1.86 (1.06)	1.94 (1.12)	2.25 (1.14)	1.91 (.92)	2.07 (1.04)	3.20 (.95)	2.21 (1.02)	2.81 (1.09)
Probable problem gambling	3.13 (1.18)	3.10 (1.10)	3.12 (1.15)	3.38 (.92)	2.99 (.87)	3.25 (.92)	3.03 (1.00)	2.43 (.18)	3.00 (.98)
Probable pathological gambling	3.99 (1.41)	3.70 (1.29)	3.94 (1.39)	3.51 (1.07)	3.99 (.80)	3.59 (1.03)	3.62 (1.15)	4.03 (1.26)	3.67 (1.16)
Inability to stop									
Non-problem gambling	1.85 (1.16)	1.69 (1.02)	1.77 (1.10)	1.89 (1.18)	1.51 (.79)	1.68 (1.01)	2.78 (.95)	1.71 (.87)	2.36 (1.06)
Probable problem gambling	2.71 (1.35)	2.65 (1.31)	2.69 (1.33)	2.86 (1.11)	2.30 (.93)	2.66 (1.08)	2.75 (.98)	2.70 (1.56)	2.74 (.99)
Probable pathological gambling	3.83 (1.49)	3.69 (1.23)	3.82 (1.45)	3.44 (1.09)	4.33 (1.00)	3.59 (1.11)	3.90 (1.43)	4.44 (91.26)	3.97 (1.42)
Interpretive bias									
Non-problem gambling	2.05 (1.27)	1.92 (1.17)	1.99 (1.23)	2.42 (1.30)	2.02 (1.13)	2.21 (1.23)	3.60 (1.17)	2.39 (1.30)	3.13 (1.35)
Probable problem gambling	3.36 (1.36)	3.36 (1.32)	3.36 (1.34)	3.82 (1.21)	3.25 (1.31)	3.62 (1.27)	3.33 (1.38)	2.53 (1.77)	3.29 (1.34)
Probable pathological gambling	4.08 (1.51)	3.84 (1.44)	4.04 (1.49)	3.65 (1.11)	4.17 (.38)	3.74 (1.04)	4.23 (1.35)	4.73 (1.42)	4.33 (1.36)
Illusion of control									
Non-problem gambling	1.96 (1.21)	1.87 (1.12)	1.92 (1.17)	2.11 (1.24)	1.93 (1.09)	2.01 (1.16)	2.77 (1.00)	2.03 (.92)	2.48 (1.03)
Probable problem gambling	2.98 (1.32)	3.01 (1.30)	3.00 (1.31)	3.01 (1.16)	2.93 (1.26)	2.98 (1.19)	3.10 (2.21)	2.38 (1.23)	3.05 (2.16)
Probable pathological gambling	3.89 (1.54)	3.55 (1.19)	3.84 (1.49)	3.37 (1.24)	3.81 (1.38)	3.44 (1.23)	3.00 (1.28)	3.11 (1.49)	3.01 (1.30)
Gambling expectancy									
Non-problem gambling	2.10 (1.25)	1.86 (1.09)	1.99 (1.18)	2.53 (1.28)	2.07 (1.06)	2.29 (1.19)	3.38 (1.18)	2.61 (1.33)	3.08 (1.29)
Probable problem gambling	3.41 (1.41)	3.23 (1.26)	3.36 (1.37)	3.92 (1.02)	3.26 (1.08)	3.59 (1.08)	3.12 (1.19)	2.38 (.88)	3.08 (1.18)
Probable pathological gambling	4.10 (1.55)	3.79 (1.54)	4.06 (1.55)	3.57 (1.27)	2.67 (.95)	3.42 (1.24)	3.46 (1.43)	4.25 (1.75)	3.56 (1.49)
Predictive control									
Non-problem gambling	2.10 (1.26)	1.97 (1.17)	2.04 (1.22)	2.35 (1.26)	2.06 (1.09)	2.19 (1.18)	3.43 (1.11)	2.39 (1.20)	3.02 (1.25)
Probable problem gambling	3.20 (1.28)	3.25 (1.08)	3.22 (1.22)	3.41 (1.08)	3.28 (1.00)	3.37 (1.05)	2.96 (1.14)	2.17 (.24)	2.91 (1.12)
Probable pathological gambling	4.05 (1.46)	3.66 (1.29)	3.99 (1.44)	3.53 (1.04)	4.64 (.97)	3.72 (1.09)	3.48 (1.31)	3.77 (1.48)	3.51 (1.32)

Non-problem gambling (DSM = 0), probable problem gambling (DSM = 1–4), probable pathological gambling (DSM = 5 and above) than the probable problem gambling group, which in turn had significantly higher total GRCS scores than the non-problem gambling group. Results also showed a significant age cohort × gambling pathology 2-way interaction effect ($F = 2.03$, $P < .05$). Post-hoc tests indicated that in the non-problem gambling group, community adults had significantly higher total GRCS scores than high school and college students ($P < .05$); but this pattern was reversed in the probable problem gambling group ($P < .05$). In the probable pathological gambling group, high school students had significantly higher total GRCS scores than both college students and community adults ($P < .05$; Fig. 1). There was no significant main effect of age cohort and gender on total GRCS scores ($P > .05$).

A 3 (Age cohort) × 3 (Gambling pathology) × 2 (Gender) multivariate analysis of variance was also conducted on the five GRCS subscales. The multivariate model showed significant main effects for gambling pathology and gender ($F = 24.48$, 2.52, $P < .05$, respectively), as well as significant 2-way interaction effects between age cohort and gambling pathology ($F = 5.59$, $P < .001$), between age cohort and gender ($F = 3.10$, $P < .001$), and between gambling pathology and gender ($F = 2.62$, $P < .005$). Results of subsequent univariate analyses of variances on five GRSC subscales showed significant main effects of gambling pathology on all five subscales (F ranged from 34.73 to 95.66, $P < .001$), indicating that the probable pathological gambling group had significantly higher scores than the probable problem gambling group, which in turn had significantly higher scores than the non-problem gambling group. A main effect of gender was also found on GRCS_GE ($F = 6.49$, $P < .01$), with men reporting significantly higher gambling expectancy bias than women. The main effect of age cohort was non-significant ($P > .05$).

Univariate analyses results also showed significant age cohort × gambling pathology 2-way interaction effects on GRCS_GE ($F = 6.06$, $P < .001$), GRCS_PC ($F = 4.84$, $P < .001$), and GRCS_IC ($F = 3.74$, $P < .005$). These interaction effects were also presented in Fig. 1. Post-hoc tests showed that in the non-problem gambling group, community adults had significantly higher GRCS_GE, GRCS_PC, and GRCS_IC than high school and college students ($P < .05$). In the probable problem gambling group, high school and college students had significantly higher GRCS_GE and GRCS_PC than community adults ($P < .05$), but the three age cohorts did not differ on GRCS_IC ($P > .05$). In the probable pathological gambling group, high school students had significantly higher GRCS_PC and GRCS_IC than college students, who in turn had significantly higher scores on these two subscales than adult gamblers ($P < .05$). High school students in the probable pathological gambling group also had significantly higher GRCS_GE than both college students and community adults in the probable pathological gambling group ($P < .05$). Furthermore, a significant gender × gambling pathology interaction effect was also found on GRCS_IS ($F = 5.18$, $P < .01$). Post-hoc tests showed that in the non-problem and probable problem gambling groups, men as compared to women had significantly higher scores on inability to stop gambling ($P < .05$). However, there was no significant gender difference on this subscale in the probable pathological gambling group ($P > .05$).

Discussion

This study showed that gambling cognitive biases were core processes underlying various levels of gambling pathology among Chinese youths, young adults, and mature adults in Chinese societies. Results of regression analyses showed that gambling cognitive biases

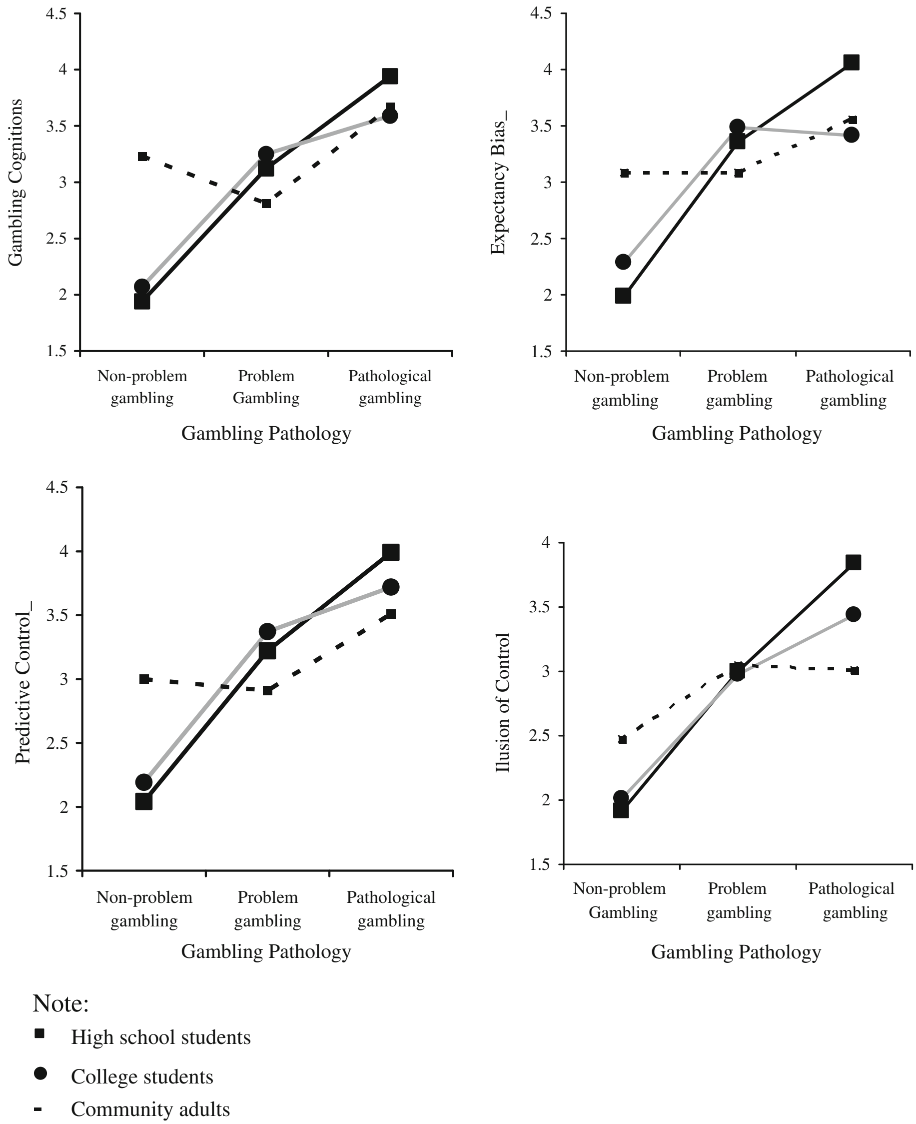

Fig. 1 Age cohort × gambling pathology interaction effects on gambling cognitions. *Square*, High school students; *circle*, college students; *dash*, community adults

were associated with pathological gambling in all three age cohorts. Previous research has also documented similar findings among Chinese adults in Australia and Taiwan (Oei et al. 2007, 2008) as well as among Caucasian adults in Western countries (Miller and Currie 2008; Myrseth et al. 2010; Oei et al. 2008; Raylu and Oei 2004a, b, Steenbergh et al. 2002; Wohl et al. 2007). Among the five categories of cognitive biases being examined in this study, perceived inability to stop gambling (GRCS_IS) and positive gambling expectancy bias (GRCS_GE) were the most salient correlates of pathological gambling. These two categories of biases were first identified among substance abusers (Oei et al. 1998) and later extended to problem gamblers (Raylu and Oei 2002). Subsequent research on biases in expectancy and efficacy beliefs have also shown consistent associations with disruptive gambling among Caucasian samples (Casey et al. 2008; May et al. 2003; Raylu and Oei 2004a; Oei et al. 2008; Steenbergh et al. 2002). These findings could be explained by the social cognitive theory (Bandura 1997), which stipulates that behavior is maintained by action-outcome expectancy and efficacy beliefs specific to the context.

Results of analyses of variances showed salient main effects of gambling pathology on total and specific categories of gambling cognitive biases in all three age cohorts. In general, probable pathological gamblers had greater cognitive biases than probable problem gamblers, who in turn had greater cognitive biases than non-problem gamblers. These results were in line with the prevailing literature on gambling cognitions (Baboushkin et al. 2001; Ladouceur 2004b; Oei et al. 2008; Myrseth et al. 2010; Raylu and Oei 2004a, 2004b; Steenbergh et al. 2002; Wohl et al. 2007).

The above main effects of gambling pathology should be interpreted with caution and in light of their interaction with age cohort. This study found significant interaction effects between age cohort and gambling pathology on total and specific gambling biases. Based on Piaget's theory of cognitive development (1950), it was hypothesized that gambling cognitions, including gambling bias, of children and adolescents would become similar with those of adults as the former grow older. The above hypothesis was only supported in the non-problem gambling group, where youths and young adults exhibited fewer gambling cognitive biases than mature adults. However, this pattern was reversed in the probable problem gambling group. In the probable pathological gambling group, youths had greater cognitive biases than the two adult groups, especially biases in expecting (GRCS_GE), predicting (GRCS_PC), and controlling (GRCS_IC) positive gambling outcomes. In other words, compared to young and mature adults, youths showed the greatest increases in gambling cognitive biases as gambling pathology worsened. This latter finding may be related to the nature of internet gambling, the most popular gambling activities among youths. Internet gambling typically offers intermittent outcomes every few seconds. Youths' gambling cognitive biases, especially biases related to expectancy and control, are thus being reinforced with random wins through an intermittent learning schedule at a much faster pace than non-internet gambling activities (Griffins and Woods 2005). In fact, there are global concerns that the easy access to internet gambling may present a specific danger for youths in developing disruptive gambling (Messerlain et al. 2004). Ladd and Petry (2002) also noted that compared to non-internet gamblers, internet gamblers tended to be younger and had higher prevalence in problem and pathological gambling.

The gambling literature is inconclusive regarding whether men and women differed in their gambling cognitive biases (Oei et al. 2007, 2008; Raylu and Oei 2004a; Toneatto et al. 1997). This study showed that gender differences in cognitive biases varied according to specific bias and level of gambling pathology. Similar to an earlier study on overall gambling distortions among Caucasian heavy gamblers (Toneatto et al. 1997), the present study did not find significant gender difference in total cognitive biases. However, men relative to women had a greater bias in own inability to stop gambling (GRCS_IS) in the non-problem and probable problem gambling groups, and no significant gender difference in this bias was found in the probable pathological gambling group. The latter finding should be interpreted with caution given the small number of women (14%) in the probable pathological gambling group, which is a common methodological shortcoming of research on pathological gambling (Raylu and Oei 2002; Toneatto et al. 1997). The only consistent gender difference across age cohort and level of gambling pathology was found on

GRCS_GE, with men relative to women having a greater bias in expecting positive gambling outcomes.

Limitations and Implications

This study has several limitations and its results should be interpreted with caution. First, three convenience samples were recruited using slightly different recruitment procedures that yielded different response rates. These variations were necessary in order to satisfy administrative requirements of participating schools, community centers, and voluntary organizations. It thus remains unclear the extent to which the present three samples represented their respective populations. In particular, the high prevalence rate of pathological gambling in community adults was likely the result of a self-selection bias. It is plausible that individuals who experienced severe gambling-related problems volunteered to participate in the study in order to obtain information about treatment. The high proportion of men in the community adult group may be related to greater social disapproval for women with gambling behavior than for men with similar behavior (Tang et al. 2007). As such, women may be less likely than men to admit gambling behavior and to participate in gambling research. Second, this study relied solely on self-reports of participants, without external verification of their gambling behavior and problems. Information collected from participants might thus be subject to recall and social desirability bias. Third, participants were asked to complete items on the DSM-IV criteria using a lifetime time frame. Hence, this study was not able to discriminate between participants with current disruptive gambling and those in remission. Some researchers have also cautioned that the DSM-IV criteria may represent a clinical definition of pathological gambling among adults rather than among youths (Ladouceur et al. 2005). Fourth, this study did not examine cognitive biases in relation to specific gambling activities, despite research has found people using different cognitive heuristics/biases in skill and chance gambling games (Baboushkin et al. 2001; Myrseth et al. 2010). Finally, the cross-sectional design only suggested associations between cognitive biases and gambling pathology. Thus it remains unclear whether greater cognitive biases lead to more severe disruptive gambling or gambling excessively causes an increase in cognitive distortions.

Despite the above limitations, this study provided pertinent information in planning gambling prevention and treatment programs in Chinese societies. Results of this study informed that core components of these programs should include: educating about the important role of gambling cognitive biases underlying disruptive gambling; increasing awareness and identification of cognitive biases, especially biases in positive gambling expectancy, inability to stop gambling, and control of gambling outcomes; substituting biases with objective laws of probabilities, randomness, and elements of chance that are characteristics of most gambling activities; and fostering a sense of self-efficacy by teaching strategies on how to cope with stress and resist/refuse gambling, etc. Furthermore, gambling prevention and treatment programs should tailor to specific needs of men and women in various developmental stage and level of gambling pathology. Of particular importance is to design and implement vigorous school-based gambling prevention programs for high school students, as their cognitive heuristics/biases in gambling are becoming more like adults and being reinforced by frequent intermittent learning schedule via internet gambling games. Further research should also be conducted to investigate how cognitive biases would interact with other risk factors in the development and maintenance of pathological gambling in various age groups.

References

American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders—Fourth edition*. Washington, DC: Author.

Baboushkin, H., Hardoon, K., Derevensky, J., & Gupta, R. (2001). Underlying cognitions in gambling behavior among university students. *Journal of Applied Social Psychology, 31*, 1409–1430.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: W.H. Freeman and Co.

Blaszczynski, A., & Nower, L. (2002). A pathway model of problem and pathological gambling. *Addiction, 97*, 487–499.

Casey, L. M., Oei, T. P. S., Melville, K. M., Bourke, E., & Newcombe, P. A. (2008). Measuring self-efficacy in gambling: The Gambling Refusal Self-Efficacy Questionnaire. *Journal of Gambling Studies, 24*, 229–246.

Cosgrove, K., Mazure, C., & Staley, J. (2007). Evolving knowledge of sex differences in brain structure, functions, and chemistry. *Biological Psychiatry, 62*, 847–855.

Derevensky, J., & Gupta, R. (2005). *Gambling problems in youth: Theoretical and applied perspective*. New York: Kluwer Academic/Plenum Publishers.

Derevensky, J., Gupta, R., & Della-Cioippa, G. (1996). A developmental perspective of gambling behavior in children and adolescents. *Journal of Gambling Studies, 12*, 49–66.

Friedland, N., Keinan, G., & Regev, Y. (1992). Controlling the uncontrollable: Effects of stress on illusory perceptions of controllability. *Journal of Personality and Social Psychology, 63*, 923–931.

Griffins, M., & Woods, R. (2005). Youth and technology: The case of gambling, video-game playing and the internet. In J. Derevensky & R. Gupta (Eds.), *Gambling problems in youth: Theoretical and applied perspectives* (pp. 101–120). New York: Springer.

Gupta, R., & Derevensky, J. (1998). Adolescent gambling behavior: A prevalence study and examination of the correlates associated with problem gambling. *Journal of Gambling Studies, 14*, 319–345.

Herman, J., Gupta, R., & Derevensky, J. (1998). Children's cognitive perceptions of 6/49 lottery tickets. *Journal of Gambling Studies, 14*, 227–244.

Hong, Y. Y., & Chiu, C. Y. (1988). Sex, locus of control, and illusion of control in Hong Kong as correlates of gambling involvement. *Journal of Social Psychology, 128*, 667–673.

Ibanez, A., Blanco, C., Moreryra, P., & Saiz-Ruiz, J. (2003). Gender differences in pathological gambling. *Journal of Clinical Psychiatry, 64*, 295–301.

Ladd, G. T., & Petry, N. M. (2002). Disordered gambling among university-based medical and dental patients: A focus on Internet gambling. *Psychology of Addictive Behaviors, 16*, 76–79.

Ladouceur, R. (2004a). Gambling: The hidden addiction. *Canadian Journal of Psychiatry, 49*, 501–503.

Ladouceur, R. (2004b). Perceptions among pathological and nonpathological gamblers. *Addictive Behaviors, 29*, 555–565.

Ladouceur, R., Ferland, F., Poulin, C., Vitaro, F., & Wiebe, J. (2005). Concordance between the SOGS-RA and the DSM-IV criteria for pathological gambling among youths. *Psychology of Addictive Behaviors, 19*, 271–276.

Ladouceur, R., Gaboury, A., Dumont, M., & Rochette, P. (1988). Gambling: Relationship between frequency of wins and irrational thinking. *Journal of Psychology, 122*, 409–414.

Ladouceur, R., & Walker, M. (1996). A cognitive perspective on gambling. In P. M. Salkoskvis (Ed.), *Trends in cognitive and behavioral therapies* (pp. 89–110). New York: Wiley.

Langer, E. J. (1975). The illusion of control. *Journal of Personality and Social Psychology, 32*, 311–328.

Lau, L., & Ranyard, R. (2005). Chinese and English probabilistic thinking and risk taking in gambling. *Journal of Cross-Cultural Psychology, 36*, 621–627.

Loo, J. M. Y., Raylu, N., & Oei, T. P. S. (2008). Gambling among the Chinese: A comprehensive review. *Clinical Psychology Review, 28*, 1152–1166.

May, R., Whelan, J., Steenbergh, T. A., & Meyers, A. (2003). The Gambling Self-Efficacy Questionnaire: An initial psychometric evaluation. *The Journal of Gambling Studies, 19*, 339–357.

Messerlain, C., Byrne, A., & Derevensky, J. (2004). Gambling, youth and the Internet: Should we be concerned? *The Canadian Child and Adolescent Psychiatry Review, 13*, 12–15.

Miller, N., & Currie, S. (2008). A Canadian population level analysis of the roles of irrational gambling cognitions and risky gambling practices as correlates of gambling intensity and pathological gambling. *Journal of Gambling Studies, 24*, 257–274.

Myrseth, H., Brunborg, G., & Eidem, M. (2010). Differences in cognitive distortions between pathological and non-pathological gamblers with preferences for chance or skill games. *Journal of Gambling Studies, 26*(4), 561–569.

Oei, T. P. S., Fergusson, S., & Lee, N. K. (1998). The differential role of alcohol expectancies and drinking refusal self-efficacy in problem and non-problem drinkers. *Journal of Studies on Alcohol, 59*, 704–711.

Oei, T. P. S., Lin, J., & Raylu, N. (2007). Validation of the Chinese version of the Gambling Related Cognitions Scale (GRCS-C). *Journal of Gambling Studies, 23*, 309–322.

Oei, T. P. S., Lin, J., & Raylu, N. (2008). Relationship between gambling cognitions, psychological states, and gambling: A cross-cultural study of Chinese and Caucasians in Australia. *Journal of Cross-cultural Psychology, 39*, 147–161.

Oei, T. P. S., Raylu, N., & Casey, L. (2010). Effectiveness of group and individual formats of a combined motivational interviewing and cognitive behavioral treatment program for problem gamblers: A randomized controlled trial. *Behavioral and Cognitive Psychotherapy, 38*, 233–238.

Papineau, E. (2005). Pathological gambling in Montreal's Chinese community: An anthropological perspective. *Journal of Gambling Studies, 21*, 157–178.

Piaget, J. (1950). *The psychology of intelligence*. London: Routledge & Kegan Paul.

Pogun, S. (2001). Sex differences, in brain and behavior: Emphasis on nicotine, nitric oxide and place learning. *International Journal of Psychophysiology, 42*, 195–208.

Preston, S. D., Buchanan, T. W., Stansfield, R. B., & Bechara, A. (2007). Effects of anticipatory stress on decision making in a gambling task. *Behavioral Neuroscience, 121*, 257–263.

Raylu, N., & Oei, T. P. S. (2002). Pathological gambling: A comprehensive review. *Clinical Psychology Review, 22*, 1009–1061.

Raylu, N., & Oei, T. P. S. (2004a). The Gambling Related Cognitions Scale (GRCS): Development, confirmatory factor validation and psychometric properties. *Addiction, 99*, 757–769.

Raylu, N., & Oei, T. P. S. (2004b). Role of culture in gambling and problem gambling. *Clinical Psychology Review, 23*, 1087–1114.

Shaffer, H., & Hall, M. (1996). Estimating the prevalence of adolescent gambling disorders: A quantitative synthesis and guide toward standard gambling nomenclature. *Journal of Gambling Studies, 12*, 193–214.

Sharpe, L. (2002). A reformulated cognitive-behavioral model of problem gambling: A biopsychosocial perspective. *Clinical Psychology Review, 22*, 1–25.

Sharpe, L., & Tarrier, N. (1993). Towards a cognitive-behavioral theory of problem gambling. *British Journal of Psychiatry, 162*, 407–412.

Steenbergh, T., Meyers, A., May, R., & Whelan, J. (2002). Development and validation of the Gamblers' Beliefs Questionnaire. *Psychology of Addictive Behaviors, 16*, 143–149.

Stinchfield, R., Govoni, R., & Frisch, G. R. (2005). DSM-IV diagnostic criteria for pathological gambling: Reliability, validity, and classification accuracy. *The American Journal on Addictions, 14*, 73–82.

Tang, C., Wu, A., & Tang, J. (2007). Gender differences in characteristics of Chinese treatment-seeking problem gamblers. *Journal of Gambling Studies, 23*, 145–156.

Toneatto, T. (1999). Cognitive psychopathology of problem gambling. *Substance Use and Misuse, 34*, 1593–1604.

Toneatto, T., Blitz-Miller, T., Calderwood, K., Dragonetti, R., & Tsanos, A. (1997). Cognitive distortions in heavy gambling. *Journal of Gambling Studies, 13*, 253–266.

Toneatto, T., & Ladouceur, R. (2003). Treatment of pathological gambling: A critical review of the literature. *Psychology of Addictive Behaviors, 42*, 92–99.

Toneatto, T., & Millar, G. (2004). The assessment and treatment of problem gambling: Empirical status and promising trends. *Canadian Journal of Psychiatry, 49*, 173–181.

Tsang, E. (2004). Toward a scientific inquiry into superstitious business decision-making. *Organizational Studies, 25*, 923–946.

Wagenaar, W. (1988). *Paradoxes of gambling behavior*. London, UK: Lawrence Erlbaum.

Walker, M. B. (1992). *The psychology of gambling*. Oxford, England: Pergamon Press.

Wohl, M., Young, M., & Hart, E. (2007). Self-perceptions of dispositional luck: Relationship to DSM gambling symptoms, subjective enjoyment of gambling and treatment readiness. *Substance Use and Misuse, 42*, 43–63.

Wong, L. K., & So, M. T. (2003). Prevalence estimates of problem and pathological gambling in Hong Kong. *American Journal of Psychiatry, 160*, 1353–1354.