Published in final edited form as:

Psychiatry Res. 2008 September 30; 160(3): 300–307. doi:10.1016/j.psychres.2007.08.007.

The association of cognitive distortions with problem and pathological gambling in adult male twins

Hong Xian, PhD^{a,b,*}, Kamini R. Shah, MHS^{a,b}, Sharon M. Phillips, MS, RD^{a,b}, Jeffrey F. Scherrer, PhD^{a,c}, Rachel Volberg, PhD^d, and Seth A Eisen, MD, MSc^{a,b,e}

^aResearch Service, St. Louis Veterans Affairs Medical Center, 915 North Grand Boulevard, St. Louis, MO 63106, United States

^bDepartment of Internal Medicine, Division of General Medical Sciences, Washington University School of Medicine, 660 South Euclid, St. Louis, MO 63108, United States

^cDepartment of Psychiatry, Midwest Alcoholism Research Center, Washington University School of Medicine, 660 South Euclid, St. Louis, MO, 63110, United States

^dGemini Research Ltd., P. O. Box 1390, Northampton, MA 01061, United States

^eMedical Service, St. Louis Veterans Affairs Medical Center; 915 North Grand Boulevard, St. Louis, MO, 63106, United States

Abstract

Treatment studies suggest that gambling-related irrational beliefs and attitudes (i.e., cognitive distortions (CDs)) contribute to risk for problem gambling behavior. In a community sample of men, we investigated the associations among lifetime gambling-related CDs, psychiatric disorders other than pathological gambling, and problem gambling severity. Subjects were 1,354 members of the Vietnam Era Twin Registry. Problem gambling and gambling-related CDs were derived from a 2002 interview using the National Opinion Research Center DSM-IV Screen for Gambling Problems (NODS). Exploratory factor analysis was performed with the 12 CD items to identify an underlying construct. Generalized linear models were computed to test for associations among CDs, psychiatric disorders other than pathological gambling, and gambling problem severity. Co-twin control analyses of monozygotic twin pairs discordant for problem gambling severity adjusted for genetic and shared environmental influences. Twelve CD items related to one underlying CD construct (Cronbach's alpha = 0.89). After adjusting for lifetime psychiatric disorders, pathological gambling symptoms were positively associated with higher CD scores. Pathological gambling symptoms remained significantly associated with CD scores after controlling for genetic and shared environmental influence. These results provide empirical support for an association between gambling-related CDs and gambling problem severity, even after controlling for genetic and shared environmental influences and non-pathological gambling psychiatric disorders. Public health messages and therapeutic interventions that reinforce the randomness of gambling and draw attention to distorted thinking may prevent the development of problem gambling and improve treatment outcomes.

* Address for correspondence: Hong Xian, Ph.D., St. Louis Veterans Affairs Medical Center, Research Service 151-JC, 915 North Grand Blvd., St. Louis, MO 63106, Voice (314) 289-6466, FAX (314) 289-7604, E-mail address: hongx@epiresearch-stl.org

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Keywords

Cognitive distortion; veterans; twins; behavior genetics; pathological gambling

1. Introduction

Problem and pathological gambling have a large negative economic and psychological impact on individuals and families (Gerstein et al., 1999). Pathological gambling has been associated with a variety of psychiatric and substance use disorders (Cunningham-Williams et al., 1998; Lesieur et al., 1986; Ramirez et al., 1983; Slutske et al., 2000; Slutske et al., 2001). Despite negative consequences of P & PG, the course of the disorder is chronic with waxing and waning of symptoms (Abbott et al., 2004; Sartor et al., in press; Slutske et al., 2003). Persistence of problem and pathological gambling appears to be partly due to the disordered beliefs about the likelihood of success in outcomes held by problem gamblers (Joukhador et al., 2003).

Ladouceur and Walker (1996) suggest that an erroneous perception of randomness is the fundamental mistake made by gamblers. Gamblers attempt to control and predict events that are objectively random and uncontrollable by developing an illusion of control and superstitious beliefs that motivate them to develop strategies and skills to increase their winnings. Other cognitive biases associated with gambling include selectively remembering wins while not giving equal weight to the multitudes of losses experienced, overestimating the odds, superstitious behaviors, and the “gambler’s fallacy” (i.e., the belief that a future win or loss is related to past payoffs, when, in fact, each gambling event is discrete). These concepts are presumed to contribute to gambling problems by affecting the gamblers’ interpretations of their chances of winning, their subjective feeling of control over outcomes, their attributions for failure, their justifications for continuing, and their estimations of their skills or abilities (Breen et al., 2001; Tonatto, 1999).

Distorted thinking is associated with persistence in gambling. When actively gambling, habitual gamblers produce significantly more irrational statements than less frequent gamblers (Gilovich, 1983). A series of small wins can prompt illusions of control over chance outcomes, and there is a relationship between irrationality and increased size of bets among non-problem gamblers (Delfabbro and Winefield, 2000). However, studies such as these leave much to be learned about the relationship between CDs and problem and pathological gambling, and none have demonstrated a quantitative relationship between ranges of cognitive distortions (CD) severity and problem and pathological gambling severity.

For problem and pathological gamblers who enter treatment, cognitive therapy has been used in an attempt to increase awareness of the CD assumptions underlying gambling beliefs and behaviors by subjecting these beliefs to critical evaluation (Toneatto and Ladouceur, 2003). Yet these authors acknowledge that increased awareness of problem gambling, and not just challenges to CD may be the mechanisms of positive change. Nonetheless, changing gamblers’ erroneous cognitions including illusions of control, superstitions about chance and fate, selective recall of winnings, and belief in special skills may lead to a reduction in problematic gambling behaviors (Walker, 2005).

The present study expands on the literature by investigating the association between severity of CDs and severity of problem gambling. Based on previous work by Toce-Gerstein and colleagues (2003), we created gambling severity groups defined as low risk (0 symptoms), at risk (1-2 symptoms), problem (3-4 symptoms) and pathological (5 or more symptoms). The analysis of data derived from twins is a particular strength because it permits adjusting for potential confounding from genetic and environmental influences on the association between

problem and pathological gambling and CDs. (1) test gambling-related CDs for an association with non-pathological gambling psychiatric disorders; (2) test for an association between severity of gambling problems and gambling-related CDs; and (3) determine if the relationship between gambling-related CDs and pathological gambling remains after controlling for lifetime history of non-pathological gambling psychiatric disorders, and genetic and shared environmental influences.

2. Methods

2.1. Vietnam Era Twin (VET) Registry

Participants for the present study were solicited from the VET Registry, a non-clinical cohort of approximately 7,400 male-male monozygotic (MZ) and dizygotic (DZ) twin pairs born between 1939 and 1955 in which both siblings served on active military duty during the Vietnam era (1965-1975). The characteristics of the VET Registry and method of zygosity determination have been reported elsewhere (Eisen et al., 1987; Eisen et al., 1989; Henderson et al., 1990).

In 1992 and in 2002, participating VET Registry members completed comprehensive computer-assisted telephone interviews (CATI) about their lifetime gambling and other behaviors. Surveys were administered by trained, experienced staff from the Institute for Survey Research, Temple University. Interviewers contacted the twins and began interviewing after verbal informed consent was obtained, a method approved by the Institutional Review Boards at participating institutions.

2.2. 1992 Sample and Interview

In 1992, 10,300 VET Registry members (5,150 pairs) were solicited to participate in a telephone interview to assess the genetic and environmental contributions to a variety of psychiatric disorders; 8,169 individuals (79.3% of living Registry members) were interviewed. Registry members were administered the Diagnostic Interview Schedule Version III, Revised (DIS-III-R) (Robins et al., 1988) to obtain data which allowed derivation of DSM-III-R criteria (APA, 1987) lifetime diagnosis of the following disorders: alcohol abuse and dependence, illicit drug abuse and dependence, nicotine dependence, major depression, dysthymia, post-traumatic stress disorder (PTSD), generalized anxiety disorder (GAD), panic disorder, conduct disorder, antisocial personality disorder (ASPD) and pathological gambling.

2.3 2002 Sample and Interview

In 2002, 2,400 (1,200 twin pairs) respondents to the 1992 study were invited to participate in a survey of gambling behaviors and problems. The target sample for the 2002 study included 418 twin pairs who were concordant or discordant for one or more DSM-III-R pathological gambling symptoms in 1992. The remaining 790 twin pairs were randomly selected from the cohort of twin pairs in which neither twin sibling endorsed any DSM-III-R pathological gambling symptoms in 1992. Structured, diagnostic interviews were completed for 1,675 twins (response rate, 70%). Four categories of lifetime gamblers were identified according to the National Opinion Research Center DSM-IV Screen for Gambling Problems (NODS) (Gerstein et al., 1999): “low risk” (i.e., 0 symptoms, 85% of the sample), “at risk” (i.e., 1 to 2 symptoms, 9% of the sample), “problem” (i.e., 3 to 4 symptoms, 4% of the sample), and “pathological” (i.e., 5 or more symptoms, 2% of the sample). We utilized these groupings because previous research has found differences in diagnostic characteristics among persons at risk compared to those with problem gambling (Toce-Gerstein et al., 2003).

During the interview, subjects were asked 12 questions about lifetime gambling-related CDs (e.g., superstitions, illusions of control over luck) to assess thought processes involved in

making a bet (Table 1). The questions were derived from review of the literature on cognitive beliefs of gamblers (Steenbergh et al., 2002; Toneatto, 1999). Subjects were asked to reply on a 5-level Likert scale: never = 1, rarely = 2, sometimes = 3, often = 4, always = 5.

Data for the current analysis were obtained from 1,354 twins (200 DZ pairs, 278 MZ pairs, 398 singletons) who endorsed gambling at least 25 times in their lifetimes in the 2002 survey and were; therefore, asked about gambling-related CDs. On average, subjects in this study were 53 years of age (range 45 to 60 years); 90% were Caucasian; 6% were African-American and the remainder were Native American, Asian, Hispanic or not specified; 97% had at least a high school education; 78% were married; 86% were employed full or part time; and 60% had an annual household income between \$35,000 and \$100,000.

2.4. Analyses

We began by first testing if the 12 CD items could be reduced to a composite variable (i.e. 1 factor) reflecting both severity and number of endorsed CDs. Cronbach's coefficient alpha was calculated (Cronbach, 1951). Cronbach's alpha is a measure of the proportion of a scale's total variance that is attributable to a common source such as the true score of a latent variable. If the latent variable causes the individual items comprising a scale to vary jointly (i.e., the items are correlated with each other), alpha will be large, suggesting that the items can be combined into one scale. Next, an exploratory factor analysis was conducted to determine if one or more underlying constructs represent the 12 gambling-related CDs. The resulting factor loadings were used to compute a composite variable (the CD factor score) from the 12 original survey items, which was used in all further analyses. A higher CD factor score represented a higher overall level of gambling-related CDs.

Generalized linear models were used to investigate the association of gambling-related CDs with the respondent's lifetime history of non-gambling related psychiatric diagnoses (as measured in 1992) and 2002 self-reported gambling problem severity (i.e, NODS categories). In addition, a Pearson correlation coefficient was calculated to determine the strength of the association between the CD factor score and the number of DSM-IV pathological gambling symptoms endorsed. Confidence intervals and standard errors were estimated using the Huber-White robust variance estimator to account for clustered data. In the present study, data were clustered because they were obtained from twin pairs.

Linear regression was applied to a discordant MZ co-twin control design to determine if the relationship between gambling problem severity and gambling-related CDs remains after controlling for genetic and shared environmental influences. Because MZ twins share 100% of their genetic and shared environment, the co-twin control accounts for genetic factors and numerous unmeasured environmental influences (e.g. shared sociodemographic factors, common parenting, shared friends, etc). Therefore, differences observed using the discordant MZ co-twin design are attributable to unique (i.e. non-familial) environmental experiences. To implement this design, the CD factor score of the 91 twins in a less severe NODS problem gambling category was subtracted from the CD factor score of their co-twins in a more severe gambling category.

2.5. Sampling Weights

This study intentionally over-sampled from the 1992 cohort for MZ and DZ pairs in which one or both twin siblings reported a lifetime history of one or more DSM-III-R gambling symptoms. To correct for the effect of oversampling on statistical estimates, we developed sampling weights calculated as the cohort sampling fraction divided by the target sample fraction from six strata defined by level of zygosity and pairwise gambling status (concordant affected,

discordant and concordant unaffected). The sampling weights were applied to all subsequent descriptive and inferential analyses. Thus, all results are adjusted to the 1992 source population.

Because data obtained from twin siblings are not statistically independent, standard errors are underestimated. Appropriate error estimates were generated based on Huber's robust variance estimator using the STATA software package (STATA Corporation, 1997).

3. Results

Cronbach's coefficient alpha for the 12 gambling-related CD survey items was 0.89. The exploratory factor analysis identified a single factor solution for CD indicated by a solution with only one eigenvalue greater than one (i.e. eigenvalue=4.79, next largest eigenvalue=0.51). Standardized scoring coefficients (Table 1) were then calculated from the single factor model. The standardized scoring coefficient ranged from 0.06 for the question '...bet because you valued certain numbers or colors...' to 0.15 for two items querying bets made because of a loss or a win on a previous bet. This indicated that each item significantly contributed to the CD construct, and higher scoring coefficients are relatively stronger indicators of the CDs. The CD factor score was calculated by linear summation of the 12 CD items with each of their scoring coefficients and reflected both the number of CD items endorsed and the degree of positive endorsement along the Likert scale.

Sociodemographic characteristics (e.g., marital status, education, employment, annual household income) were not related to the CD score, with the exception of race. African Americans had a higher mean CD factor score (mean = 1.42; S.D. = 0.12) than did Caucasians (mean = 0.96; S.D. = 0.03) and members of other racial groups (combined category of Native American, Asian, Hispanic and not specified) (mean = 1.25; S.D. = 0.20) ($p < 0.01$).

As shown in Table 2, a higher mean CD score in 2002 was associated with having a lifetime history in 1992 of alcohol abuse/dependence, nicotine dependence, depression and or dysthymia, illicit drug abuse/dependence, PTSD and ASPD. The average CD score increased with the number of lifetime non-pathological gambling psychiatric disorders. Respondents with 3 or 4+ non-pathological gambling psychiatric disorders had significantly higher CD factor scores than respondents with 0, 1, or 2 non-pathological gambling psychiatric disorders ($p < 0.05$). Which suggests the CD factor has good construct validity.

After adjusting for lifetime psychiatric disorders, a higher mean CD score was significantly associated with increased gambling severity as indicated by the NODS gambling groups (Table 3). The mean CD score for each NODS category was significantly different than the mean CD score for all other NODS categories. Higher mean CD scores were observed in groups with more gambling symptoms.

Figure 1 further demonstrates that as the NODS gambling symptoms increased, the proportion of the cohort with higher CD scores increased. For example, 91% of the "low risk" group (i.e., 0 symptoms) had a CD score ≤ 2 compared with 17% of the "pathological gamblers" (i.e., 5+ symptoms), and the percentage of respondents with a CD factor score greater than 4.00 increased across NODS groups (0.04%, 2%, 3% and 9% for the "low risk", "at risk", "problem gambling" and "pathological gambling" groups, respectively).

The MZ co-twin CD discordant analyses (Table 4) demonstrate that twins with 0, 1-2, 3-4 and 5 or more gambling problems had higher CD factor scores than their co-twins with less severe gambling problems. Thus the association between CD and pathological gambling symptoms remained even after controlling for genetic and shared environmental influences.

4. Discussion

This study identified a single CD factor that summarized 12 gambling related cognitive distortions reported by gamblers. A history of non-gambling related comorbid psychiatric disorders were associated with higher mean CD scores, and increasing numbers of non-gambling related psychiatric disorders in 1992 were associated with higher mean CD scores in 2002. In addition, our analyses demonstrated that mean CD scores increased as the number of pathological gambling symptoms increased. This association remained after adjusting for comorbid psychiatric disorders and genetic and shared environmental influences.

Twins who gambled and who had lifetime co-occurring non-pathological gambling psychiatric disorders had elevated mean CD scores compared to those without co-occurring disorders. Elevated rates of CD in those with substance use disorders, depression, PTSD and ASPD may be partly explained by the high comorbidity between problem and pathological gambling and other psychiatric disorders (Blaszczynski et al., 1989; Cunningham-Williams et al., 1998; Lesieur et al., 1986; Lesieur & Blume, 1991; Linden et al., 1986; Ramirez et al., 1983; Slutske et al., 2000; Slutske et al., 2001;). An alternative explanation may be the presence of illusions of control in persons with other addictions or in persons with mood and personality disorders. The illusions associated with comorbid psychiatric disorders may be expressed by gamblers during gaming activities (Goudriaan et al., 2005; McCusker, 2001; Miller et al., 2005).

Our discordant MZ co-twin control analysis demonstrated that the relationship between gambling-related CDs and problem gambling severity remained after controlling for familial influences (i.e., genes and shared environment) that may contribute to this association. Our observation that the association is not accounted for by familial factors supports the utility of therapeutic attempts to modify distorted thinking in order to influence gambling behavior.

4.1. Limitations

The factor analyses does not validate the CDs, but was useful in reducing the items to a continuous measure. Thus the CD factor score may not be generalized to other populations of gamblers and the factor does not capture all potential dimensions of beliefs about chance in gambling. Generalization of our results may be limited because the twins are middle-aged males. Results may differ in much older or younger age groups and in women. Because, the CD factor score is a measure of gambling-related CDs, our results may not apply to a more general conceptualization of CDs that are unrelated to placing a bet during gambling. Because our measures of CDs and gambling problems reflected the gambler's experiences over his lifetime, it was not possible to determine whether these cognitions were involved in the development or maintenance of the gambler's behaviors. Though we asked respondents to report thoughts made during gambling, the cross-sectional designs does not permit establishing a temporal relationship. Others have reported CDs contribute to maintenance of problem and pathological gambling (Ladouceur & Walker, 1996; Toneatto, 1999).

It was beyond the scope of our study to measure cognitive beliefs associated with a specific type of gambling activity (e.g. blackjack as compared to slot machines). Differences in the levels of chance inherent to different types of games may have affected the way in which respondents construed the questions and the context in which their answers should be interpreted.

4.2. Strengths

The standardized method of data collection, use of CATI interviews and structured instruments likely reduced potential bias and enhanced the validity of our measures of self reported CD, problem and pathological gambling and co-occurring psychiatric disorders. The sample does

not suffer from bias inherent to clinical populations that tend to be more severely affected. The use of a general population study and the co-twin analyses provide novel information to the extant literature. The majority of studies of CD and gambling have utilized volunteers and clinical populations, and we are not aware of previous studies that have controlled for familial influences to the association between CD and gambling.

5. Conclusions

Our findings are consistent with previous studies that have shown that CDs are associated with the maintenance of gambling and that problem and pathological gamblers experience more CDs than other gamblers. Our results provide empirical support for an increasing trend between the severity of gambling-related CDs and the severity of gambling problems using measures that incorporate a broad scope of gambling problems and CDs. Genetic, shared and non-shared environmental factors likely contribute to pathological gambling and CDs, however our data demonstrate that this relationship remains after controlling for the presence of other psychiatric disorders and familial vulnerability. Further research with women and younger gamblers is warranted. Longitudinal studies may help determine the role of CDs in the etiology and persistence of gambling problems.

While speculative, these results are congruent with behavioral therapies that challenge the thinking patterns of patients with problem and pathological gambling. Public health and intervention studies should test the utility of media messages that reinforce the randomness of gaming and draw attention to the distorted thinking common to problem gambling. Recent data suggests such warnings, when applied frequently, can reduce risky gambling behavior in controlled settings (Floyd et al. 2006).

Acknowledgements

The United States Department of Veterans Affairs has provided financial support for the development and maintenance of the Vietnam Era Twin (VET) Registry. Numerous organizations have provided invaluable assistance in the conduct of this study, including: Department of Defense; National Personnel Records Center, National Archives and Records Administration; the Internal Revenue Service; National Opinion Research Center; National Research Council, National Academy of Sciences; the Institute for Survey Research, Temple University. Most importantly, the authors gratefully acknowledge the continued cooperation and participation of the members of the VET Registry and their families. Without their contribution this research would not have been possible.

Funding Support: This study was supported by the Department of Veterans Affairs Health Services Research and Development Service and National Institute of Mental Health, Pathological Gambling: Courses, Consequences and Causes, MH60426.

References

- Abbott MW, Williams MM, Volberg RA. A prospective study of problem and regular nonproblem gamblers living in the community. *Substance Use and Misuse* 2004;39:855–884. [PubMed: 15217196]
- APA. *Diagnostic and Statistical Manual of Mental Disorders*. 3rd edn. American Psychiatric Association; Washington, D.C.: 1987. Revised
- Blaszczynski A, McConaghy N, Frankova A. Crime, antisocial personality and pathological gambling. *Journal of Gambling Behavior* 1989;5:137–152.
- Breen RB, Kruegelbach NG, Walker HI. Cognitive changes in pathological gamblers following a 28-day inpatient program. *Psychology of Addictive Behaviors* 2001;15:246–248. [PubMed: 11563802]
- Cronbach LJ. Coefficient alpha and the internal structure of tests. *Psychometrika* 1951;16:297–334.
- Cunningham-Williams RM, Cottler LB, Compton WM III, Spitznagel EL. Taking chances: problem gamblers and mental health disorders--results from the St. Louis Epidemiologic Catchment Area Study. *American Journal of Public Health* 1998;88:1093–1096. [PubMed: 9663161]

- Delfabbro PH, Winefield AH. Predictors of irrational thinking in regular slot machine gamblers. *Journal of Psychology* 2000;134:117–128. [PubMed: 10766103]
- Eisen S, Neuman R, Goldberg J, Rice J, True W. Determining zygosity in the Vietnam Era Twin Registry: an approach using questionnaires. *Clinical Genetics* 1989;35:423–432. [PubMed: 2736790]
- Eisen S, True W, Goldberg J, Henderson W, Robinette CD. The Vietnam Era Twin (VET) Registry: method of construction. *Acta Geneticae Medicae Gemellologiae* 1987;36:61–66.
- Floyd K, Whelan JP, Meyers AW. Use of warning messages to modify gambling beliefs and behavior in a laboratory investigation. *Psychology of Addictive Behaviors* 2006;20:69–74. [PubMed: 16536667]
- Gerstein, D.; Murphy, S.; Toce, M.; Hoffman, J.; Palmer, A.; Johnson, R.; Larison, C.; Chuchro, L.; Bard, A.; Engelman, L.; Hill, MA.; Buie, T.; Volberg, R.; Harwood, H.; Tucker, A.; Christiansen, E.; Cummings, W.; Sinclair, S. Gambling impact and behavior study: Report to the national gambling impact study commission. National Opinion Research Center; Chicago: 1999.
- Gilovich T. Biased evaluation and persistence in gambling. *Journal of Personality and Social Psychology* 1983;44:1110–1126. [PubMed: 6875803]
- Goudriaan AE, Oosterlaan J, de Beurs E, van den Brink W. Decision making in pathological gambling: a comparison between pathological gamblers, alcohol dependents, persons with Tourettes syndrome and normal controls. *Cognitive Brain Research* 2005;23:137–151. [PubMed: 15795140]
- Henderson WG, Eisen S, Goldberg J, True WR, Barnes JE, Vitek ME. The Vietnam Era Twin Registry: a resource for medical research. *Public Health Report* 1990;105:368–373.
- Joukhaad J, MacCallum F, Blaszczyński A. Differences in cognitive distortions between problem and social gamblers. *Psychological Reports* 2003;92:1203–1214. [PubMed: 12931940]
- Ladouceur, R.; Walker, M. A cognitive perspective on gambling. In: Salkovskis, PM., editor. *Trends in cognitive and behavioral therapies*. Wiley; New York: 1996. p. 89-120.
- Lesieur HR, Blume SB. Evaluation of patients treated for pathological gambling in a combined alcohol, substance abuse and pathological gambling treatment unit using the Addiction Severity Index. *British Journal of Addiction* 1991;86:1017–1028. [PubMed: 1912747]
- Lesieur HR, Blume SB, Zoppa RM. Alcoholism, drug abuse, and gambling. *Alcoholism Clinical and Experimental Research* 1986;10:33–38.
- Linden RD, Pope HG, Jonas JM. Pathological gambling in major affective disorder: preliminary findings. *Journal of Clinical Psychiatry* 1986;47:201–203. [PubMed: 3957881]
- Miller IW, Keitner GI, Ryan CE, Solomon DA, Cardemil EV, Beevers CG. Treatment matching in the posthospital care of depressed patients. *American Journal of Psychiatry* 2005;162:2131–2138. [PubMed: 16263854]
- McCusker CG. Cognitive biases and addiction: an evolution in theory and method. *Addiction* 2001;96:47–56. [PubMed: 11177519]
- Ramirez L, McCormick RA, Russo AM, Taber JI. Patterns of substance abuse in pathological gamblers undergoing treatment. *Addictive Behavior* 1983;8:425–428.
- Robins, L.; Helzer, J.; Cottler, L.; Goldring, E. NIMH Diagnostic Interview Schedule Version III Revised (DIS-III-R). Department of Psychiatry, Washington University Medical School; St. Louis, MO: 1998.
- Sartor CE, Scherrer JF, Shah K, Xian H, Volberg R, Eisen SA. Course of pathological gambling symptoms and reliability of the Lifetime Gambling History measure. *Psychiatry Research*. 2006in press
- Slutske WS, Eisen S, True WR, Lyons MJ, Goldberg J, Tsuang M. Common genetic vulnerability for pathological gambling and alcohol dependence in men. *Archives of General Psychiatry* 2000;57:666–673. [PubMed: 10891037]
- Slutske WS, Eisen S, Xian H, True WR, Lyons MJ, Goldberg J, Tsuang M. A twin study of the association between pathological gambling and antisocial personality disorder. *Journal of Abnormal Psychology* 2001;110:297–308. [PubMed: 11358024]
- Slutske WS, Jackson KM, Sher K. The natural history of problem gambling from age 18 to 29. *Journal of Abnormal Psychology* 2003;112:263–274. [PubMed: 12784836]
- Stata Corporation. Stata Statistical Software: Release 5.0. Stata Corporation; College Station, TX: 1997.
- Steenbergh TA, Meyers AW, May RK, Whelan JP. Development and validation of the Gamblers' Beliefs Questionnaire. *Psychology of Addictive Behaviors* 2002;16:143–149. [PubMed: 12079253]

- Toce-Gerstein M, Gerstein DR, Volberg RA. A hierarchy of gambling disorders in the general population. *Addiction* 2003;98:1661–1672. [PubMed: 14651495]
- Toneatto T. Cognitive psychopathology of problem gambling. *Substance Use and Misuse* 1999;34:1593–1604. [PubMed: 10468110]
- Toneatto T, Ladouceur R. Treatment of pathological gambling: a critical review of the literature. *Psychology of Addictive Behaviors* 2003;17:284–292. [PubMed: 14640824]
- Walker MB. Problems in measuring the effectiveness of cognitive therapy for pathological gambling. *Journal of Gambling Studies* 2005;21:81–92.

FIGURE 1.
Prevalence of Cognitive Distortion (CD) Factor Score by NODS Gambling Category (n = 1,354)

Table 1

Gambling-related cognitive distortion (CD)¹ questions administered to 1,354 male members of the Vietnam Era Twin Registry, their means, standard deviations, and standardized scoring coefficients

Please answer the following questions with one of these responses: (1) Never, (2) Rarely, (3) Sometimes, (4) Often, or (5) Always. Have you ever made a bet because:			
	Mean	Standard deviation	Standardized scoring coefficient ²
1. you had a hunch or gut feeling about a future event, or thought you could predict the outcome of a future event?	2.0	0.95	0.14
2. you had received a good luck sign or were feeling lucky?	1.8	0.91	0.13
3. you had established a winning streak?	1.9	1.01	0.14
4. you had identified a pattern in the way outcomes or events were happening?	1.8	0.99	0.13
5. you had a long shot opportunity?	1.7	0.92	0.09
6. you valued certain numbers or colors more than others because they were lucky or had personal significance such as your birth date or the color of your shirt?	1.9	1.07	0.06
7. you believed your thoughts, desires or prayers could control the outcome of a game, a toss of the dice, or a dealer's shuffle?	1.4	0.69	0.09
8. you thought you could influence the outcome of a game by touching a machine in a certain way, talking to a machine, rolling the dice in a certain way, shouting out the outcome you desired as you made a play, or some similar action?	1.4	0.78	0.09
9. you thought you could break a losing streak by interfering with or intervening in the way a game was being played, such as forcing a pause in play?	1.3	0.70	0.12
10. you thought your skill could overpower chance or random elements of the game?	1.5	0.85	0.11
11. you just missed winning on your previous bet?	1.8	0.95	0.15
12. you had a big win on your previous bet?	2.0	1.03	0.15

¹ CD score formula: $\text{sum Q1 to Q12 of } [(X) \times \text{SD}] / \text{scoring coefficient}$, where X = the value of 1 to 5 associated with the answer to each CD question.

² Estimated by regression

Table 2

Mean cognitive distortion (CD) factor score among participants with one or more lifetime non-pathological gambling psychiatric disorders who also gambled at least 25 times in their lifetime (N = 1,354)

Lifetime Psychiatric Disorder in 1992 ^{1,2}	Prevalence % (n) ³	Mean CD factor score in 2002	
		Disorder Absent (n)	Disorder Present (n)
Alcohol abuse / dependence	62 (1352)	0.99 (518)	1.17 (834) *
Nicotine dependence	51 (1354)	1.02 (663)	1.17 (691) *
Depression / dysthymia	12 (1354)	1.06 (1189)	1.34 (165) *
Drug abuse / dependence	12 (1351)	1.04 (1187)	1.49 (164) *
PTSD	10 (1348)	1.06 (1210)	1.39 (138) *
ASPD	3 (1354)	1.08 (1309)	1.54 (45) *
Generalized anxiety / panic	3 (1354)	1.09 (1314)	1.32 (40)

Number of non-pathological gambling psychiatric disorders in 1992	Prevalence % (n)	Mean CD Factor Score in 2002 ⁴
0	23 (315)	0.96 ^A
1	30 (400)	0.97 ^A
2	28 (385)	1.11 ^A
3	11 (154)	1.39 ^B
4+	7 (100)	1.50 ^B

* Mean differences significant (p<.05).

¹ DSM-III-R lifetime diagnosis in 1992.

² Psychiatric disorders are not pure, other psychiatric disorders may be present.

³ The n's for analyses vary due to missing data.

⁴ Groups with different letters are different from each other (p<0.05).

Table 3

Association between NODS¹ gambling severity categories and cognitive distortion (CD) factor score among participants who gambled at least 25 times in their lifetime (n = 1,354)

Number of NODS ¹ Pathological gambling symptoms	Percent (n) of Sample	Mean CD factor score	Adjusted mean CD factor score ^{2,3}
'Low risk' (0 symptoms)	80 (1078)	0.83 ^A	0.82 ^A
'At risk' (1 - 2 symptoms)	11 (159)	1.70 ^B	1.69 ^B
'Problem gambler' (3 - 4 symptoms)	5 (66)	2.15 ^C	2.13 ^C
'Pathological gambler' (5+ symptoms)	4 (51)	2.82 ^D	2.80 ^D

¹ National Opinion Research Center DSM-IV Screen for Gambling Problems (NODS)

² Adjusted for presence of any non-pathological gambling lifetime psychiatric disorder diagnosed in 1992 (alcohol dependence, nicotine dependence, depression/dysthymia, illicit drug abuse/dependence, PTSD, ASPD, generalized anxiety/panic disorder).

³ Groups with different letters are different from each other (p<0.001).

Table 4

Within twin pair mean differences in cognitive distortion (CD) factor scores among 91 MZ twin pairs in which both siblings gambled at least 25 times in their lifetime and who differed In DSM-IV pathological gambling (PG) symptomatology¹

Lifetime PG symptom discordance	Number of discordant pairs ²	Mean difference ³ In CD Score (95% CI)	p-value
Siblings differ in number of PG symptoms	91	0.52 (0.30, 0.74)	<.0001
0 PG symptoms vs. ≥ 1 PG symptom	73 ⁴	0.62 (0.39, 0.85)	<.0001
0 PG symptoms vs. 1-2 PG symptoms	48	0.58 (0.28, 0.88)	<.0001
0 PG symptoms vs. 3-4 PG symptoms	17	0.80 (0.25, 1.35)	0.0042
0 PG symptoms vs. 5+ PG symptoms	8	0.45 (0.01, 0.89)	<0.05

¹ Determined using the National Opinion Research Center DSM-IV Screen for Gambling Problems (NODS) in 2002.

² Maximum number of discordant pairs = 91.

³ CD factor score of the twin with less severe gambling problems was subtracted from the score of his co-twin with more severe gambling problems.

⁴ The difference between 73 and 91 represent the number of pairs in which both siblings reported at least one PG symptom *and* siblings differed in number of PG symptoms.