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Gambling, Risk-Taking, and Antisocial Behavior: A Replication Study Supporting the Generality of Deviance

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Abstract Research suggests that high frequency gambling is a component of the "generality of deviance", which describes the observation that various forms of risky and antisocial behavior tend to co-occur among individuals. Furthermore, risky and antisocial behaviors have been associated with such personality traits as low self-control, and impulsivity, and sensation-seeking. We conducted a replication (and extension) of two previous studies examining whether high frequency gambling is part of the generality of deviance using a large and diverse community sample ($n = 328$). This study was conducted as a response to calls for more replication studies in the behavioral and psychological sciences (recent systematic efforts suggest that a significant proportion of psychology studies do not replicate). The results of the present study largely replicate those previously found, and in many cases, we observed stronger associations among measures of gambling, risk-taking, and antisocial behavior in this diverse sample. Together, this study provides evidence for the generality of deviance inclusive of gambling (and, some evidence for the replicability of research relating to gambling and individual differences).

Keywords Gambling · Risk-taking · Antisocial behavior · Deviance · Personality · Attitudes · Replication

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Introduction

The "generality of deviance" framework suggests that various forms of antisocial risk-taking tend to co-occur among individuals (reviewed in Gottfredson and Hirschi 1990; Hirschi and Gottfredson 1994; Jones and Quisenberry 2004). In support of this hypothesis, substantial empirical evidence demonstrates that some people persistently engage in such diverse forms of antisocial behavior as violent and property crime, dangerous driving, problem gambling, and illicit substance use/abuse, among others (Arneklev et al. 1993; Donovan and Jessor 1985; Farrington 1995; Grasmick et al. 1993; Hirschi and Gottfredson 1994; Jones and Quisenberry 2004; Mishra et al. 2010a, Mishra et al. 2011a; Moffitt et al. 2002; Osgood et al. 1988; reviewed in Mishra 2014; Mishra and Lalumière 2009; Mishra et al., in press; Toneatto and Nguyen 2007; Zuckerman 2007). These behaviors represent antisocial forms of risk-taking because they involve actual or risk of harm to oneself or others. These behaviors also involve high payoff or outcome variance, which is the canonical definition of risk in the behavioral sciences (reviewed in Mishra 2014).

Those who exhibit "generality of deviance" appear to possess stable individual differences associated with poor impulse control (e.g., impulsivity, low self-control), and sensation-seeking (Grasmick et al. 1993; Jones and Quisenberry 2004; Junger and Tremblay 1999; Mishra et al. 2010a, 2011a; reviewed in Gottfredson and Hirschi 1990; Lalumière et al. 2005; Moffitt et al. 2002; Zuckerman 2007). Associations between analogues of these traits and behavioral risk-taking has even been identified among non-human animals, suggesting that a trait approach to risk-propensity is broadly relevant across taxa and not unique to humans (reviewed in Mishra et al. 2011b).

Two recent studies highlight the association of these stable individual differences with behavioral risk-taking, gambling, and antisocial behavior. Mishra et al. (2010a) provided evidence that gambling represents a general manifestation of "taste for risk". Both a higher level of general gambling involvement and problem gambling tendencies were associated with impulsivity, sensation-seeking, and low self-control. In this study, general gambling involvement was measured through past-year self-reports of the number of different gambling activities engaged in, and the average monthly frequency of gambling. Problem gambling tendencies were assessed using scores on the benchmark Problem Gambling Severity Index (Ferris and Wynne 2001). Mishra et al. (2010a) also found that both higher gambling involvement and problem gambling were associated with risk-prone attitudes in a number of content domains (i.e., investment, gambling, health/safety, ethical). Furthermore, higher gambling involvement and problem gambling tendencies each loaded onto parsimonious single factors of "taste for risk" with other measures of risky personality, risk attitudes, and behavioral risk-taking.

Mishra et al. (2011a) examined the relationship between gambling and antisocial behavior. They found strong and consistent associations between higher levels of general gambling involvement, problem gambling tendencies, and minor, moderate, and severe antisocial behavior. Furthermore, they demonstrated that personality traits associated with risk—impulsivity, sensation-seeking, and low self-control—explains a significant portion of the variance in problem gambling tendencies, general gambling involvement, and all forms of antisocial behavior. The relationships between gambling and antisocial behavior were greatly diminished when individual differences in risky personality were controlled for, suggesting that these personality traits explain a key portion of common variance in the "generality of deviance".

Extant research suggests that high frequency gambling, problem gambling tendencies, risk-taking, and antisocial behavior are linked. This body of research suffers from two key shortcomings, however. First, most studies of the generality of deviance involving gambling use either convenience samples (e.g., undergraduate students; Mishra et al. 2010a, 2011a) or special populations (e.g., clinical samples; Blaszczynski et al. 1989, Blaszczynski et al. 1997). Relatively few studies have examined associations between gambling, risk-taking, and antisocial behavior in general community samples. Second, although there is convergent evidence for the generality of deviance, inclusive of gambling, these studies largely represent conceptual replications of each other (i.e., tests of similar or identical hypotheses, but with different methods). To our knowledge, there have been no direct replications (i.e., tests of similar hypotheses with identical methods) of any of the studies reporting associations between gambling, risk-taking, and antisocial behavior. Recently, substantial attention in the field of psychology has been dedicated to the so-called "replicability crisis". Large-scale direct replications of previous research suggest that many studies in social and cognitive psychology cannot be successfully replicated, and those that are often show smaller effect sizes (Open Science Collaboration 2015). This attention has led to a clarion call for more replication studies to be conducted.

In the spirit of this call for replication studies, we report a high-powered replication of our own work (Mishra et al. 2010a, 2011a) examining the associations between gambling, risk-taking, and antisocial behavior using a large ($n = 328$) community sample. This sample allows us greater generalizability of our results compared to previous work that has utilized only undergraduate convenience samples or special populations. Our large sample size also allows us to meet stringent criteria for confidence in replication studies. Simonsohn (2015) provides evidence indicating that in order to have strong confidence in a replication, such studies should include a sample size that is 2.5 times the sample size of the original. The original studies that we replicate here had a sample sizes of $n = 115$ (Mishra et al. 2010a) and $n = 180$ (Mishra et al. 2011a); we firmly meet the replication criterion for our set of analyses replicating Mishra et al. (2010a), and come close to doing so for our second set of analyses replicating Mishra et al. (2011a). Finally, participants in this study were paid for all relevant decision-making tasks (with an average payout of over $60). Participants received a generous flat fee payment ($30) in addition to performance-based payment. Both generous pay (Gneezy and Rustichini 2000) and performance-based payment (Brase 2009; Camerer and Hogarth 1999) have been shown to significantly improve task performance and successful task completion in experimental studies. Our design feature of generous and performance-based pay is particularly important given previous research indicating that payment structures can significantly affect behavioral risk-taking (e.g., Ferrey and Mishra 2014).

Methods

Three hundred twenty-eight participants (160 women, 165 men, 3 unreported sex; age: $M = 31.0$, $SD = 12.5$, *Range*: 18 to 73) were recruited from a small Canadian city using posters in the general community, the local university and college, homeless shelters, local employment offices, food banks, and the John Howard Society (a non-profit organization dedicated to helping former inmates). These sources were used to maximize variance in measures of problem gambling, general gambling involvement, risk propensity, and criminality. The recruitment poster specifically advertised a 1.5 to 2.5 h "Personality

Study" where participants could "Earn $30 or more". The same participants were used in Mishra and Carleton (2015) and Mishra and Novakowski (2016) to answer different research questions related to health and relative deprivation.

The sample had relatively low median personal income ($10,001 to $20,000) and low median household income ($30,001 to $40,000) reported in the last year. The sample comprised 164 non-problem gamblers (50 %), 114 at-risk gamblers (34.8 %), and 50 problem and pathological gamblers (15.2 %), as determined using the clinically-informed Problem Gambling Severity Index cutoff scores recommended by Williams and Volberg (2014). Many participants reported having ever been arrested (29.0 %), charged (27.1 %), convicted (25.9 %), or incarcerated (17.4 %) for a crime.

Participants completed measures of personality and individual differences, risk attitudes, behavioral risk-taking, antisocial behavior and crime, and antisocial tendencies in random order on a computer. The software computed and outputted total scores for all measures as described below. All participants were provided with compensation for their participation ($30), and earned additional money for decisions made as described.

Personality and Individual Differences

Ten Item Personality Measure (TIPI)

The TIPI (Gosling et al. 2003) is a brief measure of the "Big Five" personality traits (neuroticism/emotional stability, extraversion, openness to experience, agreeableness, and conscientiousness). Each item involves providing a rating of a personality description from 1 (*disagree strongly*) to 7 (*agree strongly*). For example, an item assessing extraversion is, "I see myself as extraverted, enthusiastic." Total scores were computed for each of the Big Five domains. This measure has been extensively used and has good content validity and high test–retest reliability (e.g., Ehrhart et al. 2009). Because of its very brief format, it is not appropriate to evaluate or report internal consistency and factor structure (Gosling et al. 2003).

Eysenck's Impulsivity Scale (EIS)

The EIS (Eysenck et al. 1985) consists of 19 yes/no statements about impulsive behaviors (e.g., "Do you often buy things on impulse?"). A total score was obtained by summing the number of "yes" answers.

Retrospective Behavioral Self-Control Scale (RBS)

The RBS (Marcus 2003) consists of 67 items measuring the frequency of behaviors associated with low self-control across the lifespan (e.g., ''I have been late for school or work because I stayed out too late the night before'', 1 = *never*, 7 = *always*). A total self-control score was obtained by summing ratings of frequency of engagement in risky behavior. The RBS measure has been linked with numerous risk-related outcomes (e.g., Mishra et al. 2010a, 2011a); and has high internal reliability (>.91) and test–retest reliability (.89) (Marcus 2003).

Zuckerman's Sensation-Seeking Scale (SSS)

The SSS consists of 40 choices between paired statements regarding preferences for varied, stimulating experiences and disinhibited behavior (e.g., "A sensible person avoids activities that are dangerous" versus, "I sometimes like to do things that are a little frightening"; Zuckerman 1994). A total score was obtained by summing the number of high sensation-seeking choices. This measure has been extensively used in thousands of studies and is highly reliable and valid (reviewed in Zuckerman 2007).

Risk Attitudes

Domain-Specific Risk-Taking Scale (DOSPERT)

Risk attitudes in six content domains (ethical, financial, health/safety, social, gambling, and recreational) were measured using the revised version of the DOSPERT (Blais and Weber 2006). This instrument consists of 30 items that measure the likelihood of engagement in risky behavior on a scale from 1 (*extremely unlikely*) to 7 (*extremely likely*). For example, an item assessing gambling risk attitudes is, "Betting a day's income on the outcome of a sporting event." The DOSPERT has been widely used, including cross-culturally, and has been shown to have acceptance internal reliability (approximately .78) and moderate test–retest reliability (approximately .65) (reviewed in Blais and Weber 2006).

Behavioral Measures of Risk

We administered two behavioral measures of risk-taking. We note that the two previous studies being replicated here (Mishra et al. 2010a, 2011a, b) included the Variance Preference Task (VPT; Rode et al. 1999) in addition to the two measures below, but this measure was not included in the present study.

Choice Task (CT)

Participants made six decisions, each between two monetary options (Mishra and Lalumière 2010; adapted from Fessler et al. 2004). Both options had equal expected values but differed in variance (e.g., "Would you rather choose [A] $3 guaranteed, or [B] a 30 % chance of earning $10?"). At the conclusion of the experimental session, participants rolled a die and received the value of one of the six choice they made corresponding with the number on the die (i.e., if a probabilistic choice was chosen—e.g., a 10 % chance of $30—a computer simulation determined the outcome) and the participant received the value of the choice they made in cash. A total score of number of risky choices was computed.

Balloon Analogue Risk Task (BART)

Participants saw a computer screen with a deflated balloon and a "PUMP" button. Each pump of the balloon increased participants' earnings by one cent, and increased the degree to which the balloon was inflated. The balloon was set to pop randomly, with 65 pumps required on average before popping. If the balloon popped, participants lost all money gained for that trial. Participants could end a trial at any time by clicking on a

"COLLECT" button. Thirty trials were presented. The first five trials were excluded from computation as training. The average number of pumps for all trials where the balloon did not pop was computed (Lejuez et al. 2002). Participants received the amount of their earnings from the BART following completion of the task. The BART has acceptable internal reliability (>.70) and test–retest reliability (.77) and has been associated with a wide array of real-world risky behaviors (reviewed in Ferrey and Mishra 2014).

Antisocial Behavior and Crime

Self-Report Early Delinquency Instrument (SRED)

The SRED (Moffitt and Silva 1988) consists of a list of 36 antisocial behaviors (e.g., ''Carried a weapon'', 0 = *never*, 1 = *once*, 2 = *more than once*). The rating scale was modified to assess past year frequency instead of lifetime frequency to better capture present tendencies for antisocial behavior. Items were divided into three categories of antisocial behavior: minor (e.g., ''Trespassing'', ''Taking a car without permission''), moderate (e.g., ''Stealing over $10'', ''Getting suspended or expelled from school''), and severe (e.g., ''Struggling with a police officer'', ''Hitting a person to seriously hurt them''). Minor, moderate, and severe antisocial behavior scores were calculated by summing the relevant items for each subscale. This measure has high internal consistency (.90) and test–retest stability (.85) (Moffitt and Silva 1988).

Criminal Outcomes

Participants self-reported if they were ever arrested, charged, convicted, or incarcerated for a crime.

Antisocial Tendencies

In the original Mishra et al. (2011a) study, antisocial tendencies were assessed using Levenson's Psychopathy Scale (Levenson et al. 1995), the Aggression Questionnaire (Buss and Perry 1992), and the Child and Adolescent Taxon Scale (Harris et al. 1994). These three measures have been previously shown to be highly correlated (e.g., Lalumière and Quinsey 1996). In this replication study, only Levenson's Psychopathy Scale was administered.

Levenson's Psychopathy Scale (LPS)

The LPS measures antisocial dispositions in non-institutionalized populations, and is comprised of primary and secondary psychopathy scales (Levenson et al. 1995). Primary psychopathy refers to deliberate and premeditated antisocial conduct resulting from emotional detachment and indifference to others' interests, and a consistent pattern of callous, remorseless, and insincere behavior (e.g., ''For me, what's right is whatever I can get away with,'' 1 = *disagree strongly*, 4 = *agree strongly*). Secondary psychopathy reflects antisocial behavior borne of emotional disorder or distress, such as anger, anxiety, or distress (e.g., ''I have been in a lot of shouting matches with other people''). Some items were reverse scored, in accordance with Levenson et al. (1995). Total scores were

computed for both primary and secondary psychopathy. This measure has been shown to be both reliable and valid (reviewed in Lynam et al. 1999).

Gambling

Gambling Behavior Scale (GBS)

The GBS (Mishra et al. 2010a) assesses total number of different gambling activities engaged in within the past year as well as the frequency of engagement in each. A total score of what we call *general gambling involvement* was computed by summing the *z*-scores of the two general gambling measures.

Table 1 Descriptive statistics from raw data for all continuous measures

Measure	M (SD)	Median
Gambling		
PGSI	2.3 (4.4)	.5
GGI-Num	3.0 (2.4)	3.0
GGI-Freq	3.4 (6.7)	.5
Personality		
TIPI-ES	9.1 (2.9)	9.0
TIPI-E	9.1 (2.9)	9.0
TIPI-O	10.7 (2.1)	11.0
TIPI-A	9.7 (2.3)	10.0
TIPI-C	10.4 (2.4)	10.0
EIS	8.3 (4.8)	8.0
SSS	21.0 (6.8)	21.0
RBS	368.4 (62.19)	381.0
Risk attitudes		
DOS-I	11.2 (4.0)	12.0
DOS-G	6.1 (4.0)	4.0
DOS-H	22.1 (6.8)	21.0
DOS-R	23.9 (7.6)	24.0
DOS-S	27.7 (4.9)	28.0
DOS-E	16.3 (6.1)	15.0
DOS-T	107.4 (21.3)	106.0
Behavioral risk		
CT	2.5 (1.8)	1.8
BART	42.2 (17.0)	41.0
Antisocial behavior		
SRED-Min	2.9 (2.5)	2.0
SRED-Mod	.56 (1.0)	0
SRED-Sev	.47 (.94)	0
Antisocial tendencies		
LPS-P	48.3 (7.8)	49.0
LPS-S	28.2 (5.2)	28.0

PGSI problem gambling severity index, *GGI-Num* number of gambling activities in the last 12 months, *GGI-Freq* frequency of gambling activity in the last 12 months, *TIPI-ES* emotional stability (low neuroticism), *TIPI-E* extraversion, *TIPI-O* openness to experience, *TIPI-A* agreeableness, *TIPI-C* conscientiousness, *EIS* impulsivity, *SSS* sensation-seeking, *RBS* low self-control (i.e., higher scores = lower self-control), *DOS-I* investment risk attitudes, *DOS-G* gambling risk attitudes, *DOS-H* health risk attitudes, *DOS-R* recreational risk attitudes, *DOS-S* social risk attitudes, *DOS-E* ethical risk attitudes, *DOS-T* total risk attitudes score, *CT* Choice Task, *BART* Balloon Analogue Risk Task, *SRED-Min* number of minor antisocial behaviors in the past year, *SRED-Mod* number of moderate antisocial behaviors in the past year, *SRED-Sev* number of severe antisocial behaviors in the past year, *LPS-P* primary psychopathy, *LPS-S* secondary psychopathy

Problem Gambling Severity Index (PGSI)

Problem and pathological gambling tendencies were assessed using the nine-item PGSI (Ferris and Wynne 2001), which measures frequency of nine outcomes and behaviors associated with disordered gambling (e.g., "Have you bet more than you could really afford to lose?"). Items were rated on a scale from 0 (*never*) to 3 (*almost always*). For categorical analyses, we used the following revised cutoff scores based on the recommendations of Williams and Volberg (2014): non-problem gamblers (0), at-risk gamblers (1–4), and problem and pathological gamblers (5–27). The PGSI is one of the most used measures of problem gambling, and has been shown to be highly reliable with excellent external and internal validity (e.g., Orford et al. 2010; Stinchfield et al., in press).

Results and Discussion

Missing values were observed for the following measures: EIS ($n = 1$); RBS ($n = 1$); all traits measured in the TIPI ($n = 7$); DOSPERT social, recreational, gambling, investment, and ethics subscales ($n = 1$ each); DOSPERT total ($n = 1$); BART ($n = 1$); delinquency reported over the lifetime and the past year ($n = 1$ for all measures); and having been arrested ($n = 4$), charged ($n = 3$), convicted ($n = 3$), or incarcerated ($n = 3$) for a crime. Because fewer than 5 % of cases were missing for these variables, we did not use an imputation procedure. As in the original studies, the PGSI, general gambling involvement, and DOSPERT ethics and gambling measures were very highly skewed and so underwent logarithmic transformation. Descriptive statistics for all measures are provided in Table 1.

Gambling as a Form of Risk-Taking

Mishra et al. (2010a) provided evidence indicating that gambling involvement and problem gambling tendencies were associated with various measures of risky personality (impulsivity, sensation-seeking, self-control), behavioral risk-taking (as measured by the BART, CT, and the Variance Preference task), and risk attitudes (measured with the DOSPERT).

The pattern of correlations between the gambling measures, personality measures associated with risk, and behavioral risk-taking was identical to those found in Mishra et al.

Table 2 Pearson correlations between gambling measures, personality traits associated with risk, and behavioral measures of risk preference

	GGI	EIS	SSS	RBS	BART	CT
PGSI	.41***	.37***	.15**	.53***	−.032	.18***
GGI		.23***	.22***	.26***	.014	.20***
EIS			.29***	.55***	−.036	.19**
SSS				.42***	.24***	.15**
RBS					.063	.15**
BART						.12*

PGSI problem gambling tendencies, *GGI* general gambling involvement, *EIS* impulsivity, *SSS* sensation seeking, *RBS* low self-control, *BART* Balloon Analogue Risk Task, *CT* Choice Task

* $p < .05$; ** $p < .01$; *** $p < .001$

(2010a), and the correlations in most cases were of a similar or larger magnitude (Table 2). The Choice Task in particular was consistently associated with all measures of gambling and risky personality, whereas in the original study it was only associated with impulsivity and BART scores.

We also examined correlations between problem gambling tendencies, general gambling involvement, and the six subscales and total score of the DOSPERT (Table 3). Problem gambling tendencies and general gambling involvement were associated with risk-prone attitudes in gambling, health/safety, and ethical domains (as well as overall risk-prone attitudes). General gambling involvement was associated with risk-prone attitudes in the social domain. Problem gambling tendencies were negatively associated with risk-prone attitudes in the investment domain.

This pattern of results was nearly identical to that observed in Mishra et al. (2010a), with two exceptions involving risk attitudes in the investment and recreational domains. Contrary to the original study, risk attitudes in the investment domain were negatively associated with problem gambling tendencies and not associated with general gambling involvement. These results may be because the original study utilized a student sample, and students by and large have no experience with investing. Items in the DOSPERT investment subscale involve more planning and control; for example, one item assesses the likelihood of "Investing 10 % of your annual income in a moderate growth mutual fund". Investing necessarily involves risk, but it is unlikely that more impulsive, lower self-controlled problem gamblers would positively endorse non-impulsive, future-oriented risk-taking. No relationship between recreational risk-attitudes and gambling was observed (whereas in the original study, general gambling involvement and recreational risk attitudes were associated). Together, these results largely replicate those of Mishra et al. (2010a), although there is some evidence of stronger domain-specific associations between gambling and risk attitudes, likely due to our non-student sample.

Mishra et al. (2010a) also demonstrated that problem gambling tendencies and general gambling involvement each loaded onto single factors along with measures of risky personality (impulsivity, sensation-seeking, self-control), risk attitudes (DOSPERT total score), and behavioral risk-taking (CT, BART), suggesting that problem gambling tendencies and general gambling involvement shared key variance with measures of risk-

Table 3 Pearson correlations between gambling measures and risk-attitudes in six content domains

	DOS-I	DOS-G	DOS-H	DOS-R	DOS-S	DOS-E	DOS-T
PGSI	−.14*	.63***	.32***	.019	−.056	.32***	.27***
GGI	.053	.40***	.23***	.051	.12*	.29***	.28***
DOS-I		.07	−.052	.24***	.23***	.14*	.36***
DOS-G			.45***	.21***	.13*	.48***	.55***
DOS-H				.31***	.20***	.63***	.71***
DOS-R					.43***	.37***	.73***
DOS-S						.33***	.61***
DOS-E							.78***

PGSI problem gambling tendencies; *GGI* general gambling involvement, *DOS-I* investment risk attitudes, *DOS-G* gambling risk attitudes, *DOS-H* health/safety risk attitudes, *DOS-R* recreational risk attitudes, *DOS-S* social risk attitudes, *DOS-E* ethical risk attitudes, *DOS-T* overall risk attitudes

* $p < .05$; ** $p < .01$; *** $p < .001$

propensity. Goodness-of-fit tests using the maximum likelihood procedures show that these single factor structures did not replicate in the present study for problem gambling, $\chi^2(14) = 168.84$, $p < .001$, or general gambling involvement, $\chi^2(14) = 99.94$, $p < .001$. However, the variance explained by the single problem gambling factor (31.3 %) and general gambling involvement factor (30.6 %) were remarkably similar to those obtained in the original study (35.8 and 34.5 %, respectively). The factor structures are presented in Table 4.

To better understand the factor structure underlying risky personality, risk attitudes, and gambling, we conducted two exploratory principal components analyses (PCA; one for each of problem gambling tendencies and general gambling involvement) with Varimax rotation to allow for clarity of factors. We used the same variables as in the factor analysis above. Each of the two PCAs showed two principal components with eigenvalues greater than 1.0 (Table 5).

In the exploratory PCA examining problem gambling tendencies, problem gambling loaded on a principal component along with impulsivity and self-control. These results suggest that problem gambling tendencies may be most parsimoniously conceived as a behavioral manifestation of poor trait impulse control. Sensation-seeking, risk-prone attitudes, and the BART all loaded on a second principal component. This result suggests that risk-prone attitudes (i.e., assessments of the favorability of risk in multiple domains) and risk-taking in the BART are manifestations of trait sensation-seeking. This result also helps to shed light on inconsistent associations between risk and gambling measures and the BART; the BART may better capture behavioral sensation-seeking as opposed to poor behavioral impulse control.

In the exploratory PCA examining examining general gambling involvement, we found that general gambling loaded on a principal component with sensation-seeking, impulsivity, low self-control, and risk-prone attitudes. This finding suggests that general gambling involvement is motivated by both trait impulsivity and trait sensation-seeking. Sensation-seeking, risk-prone attitudes and BART scores again loaded on a second component that best captures various manifestations of sensation-seeking.

Table 4 Single item factors for problem gambling and general gambling involvement and other risk-propensity measures

	Problem gambling (31.3 %)	General gambling (30.6 %)
SSS	.77	.79
EIS	.46	.43
RBS	.63	.59
DOS-T	.85	.87
CT	.25	.25
BART	.23	.25
PGSI	.38	–
GGI	–	.33

Proportion of item variance explained by each single factor is provided

SSS sensation seeking, *EIS* impulsivity, *RBS* low self-control, *DOS-T* overall risk attitudes, *CT* Choice Task, *BART* Balloon Analogue Risk Task, *PGSI* problem gambling tendencies, *GGI* general gambling involvement

Table 5 Exploratory principal components analysis with Varimax rotation for problem gambling and general gambling involvement

	Problem gambling		General gambling	
	PC1 (31.1 %)	PC2 (27.0 %)	PC1 (31.4 %)	PC2 (23.7 %)
SSS	.29	**.79**	**.47**	**.68**
EIS	**.77**	.12	**.80**	−.05
RBS	**.79**	.31	**.79**	.19
DOS-T	.40	**.77**	**.55**	**.66**
CT	.24	.29	.29	.26
BART	−.28	**.70**	−.24	**.81**
PGSI	**.77**	.01	–	–
GGI	–	–	**.53**	.10

Proportion of item variance explained by each single factor is provided. Values over .40 are bolded

SSS sensation seeking, *EIS* impulsivity, *RBS* low self-control, *DOS-T* overall risk attitudes, *CT* Choice Task, *BART* Balloon Analogue Risk Task, *PGSI* problem gambling tendencies, *GGI* general gambling involvement

Mishra et al. (2010a) also conducted hierarchical regressions on problem gambling and general gambling involvement with three blocks of variables (in order): personality traits associated with risk (SSS, EIS, RBS), behavioral risk-taking (CT, BART), and risk-accepting attitudes (all six DOSPERT subscales).

Problem Gambling

Personality traits associated with risk significantly predicted PGSI scores, *adjusted* $R^2 = .29$, $p < .001$. Self-control ($\beta = .37$, $p < .001$) was the only significant individual predictor, consistent with the original study. Behavioral measures of risk marginally added to variance explained, R^2 *change* $= .012$, $p = .064$. Neither the CT or the BART was a significant individual predictor (both $ps > .21$). In the original study, the single item Variance Preference Task (not included here, but conceptually similar to the CT) was the only significant predictor. Risk-accepting attitudes explained significant additional variance, R^2 *change* $= .23$, $p < .001$, with social risk attitudes as a significant negative predictor, $\beta = -.11$, $p = .018$, and gambling risk attitudes as a significant positive predictor, $\beta = .54$, $p < .001$. In the original study, only gambling risk attitudes were significant.

General Gambling Involvement

Personality traits associated with risk significantly predicted GGI, *adjusted* $R^2 = .086$, $p < .001$. Only sensation-seeking ($\beta = .16$, $p = .038$) was a significant individual predictor. In the original study, only impulsivity was a significant individual predictor. Behavioral risk-taking significantly added to variance explained, R^2 *change* $= .021$, $p = .023$, with CT as the only significant individual predictor ($\beta = .11$, $p = .031$). In the original study, the behavioral risk-taking measures block was marginally significant, and the VPT (as described above, a measure similar to the CT) was the only significant predictor. Risk-accepting attitudes explained significant additional variance, R^2

change = .094, $p < .001$, with recreational risk attitudes as a significant negative predictor, $\beta = -.19$, $p = .007$, and gambling risk attitudes as a significant positive predictor, $\beta = .30$, $p < .001$. In the original study, this block was not significant and there were no significant individual predictors.

Overall, the pattern of results for the replication of Mishra et al. (2010a) were largely consistent with the original findings, although with some key differences. Behavioral risk-taking as measured by the Choice Task was consistently associated with gambling in this study. This may be because the Choice Task by its design closely resembles conventional gambling (i.e., it involves choice between a high-risk/high-reward option and a "safe" option). Problem gambling and general gambling involvement did not load on single factors with other measures of risk-propensity. Associations of gambling and risk attitudes in multiple domains were more heterogeneous. Taken together, the results suggest that gambling may not necessarily be part of a domain-general "taste for risk". Rather, gambling appears to be a more domain-specific manifestation of antisocial risk-taking associated with poor impulse control, as evidenced by consistent associations of gambling with impulsivity, low self-control, and attitudes in risk domains associated with impulsive risk-taking.

Gambling and Antisocial Behavior

Mishra et al. (2011a) demonstrated that both problem gambling tendencies and general gambling involvement were associated with antisocial behavior, and that this relationship was in large part due to personality traits associated with risk. Problem gambling tendencies were positively and significantly associated with engagement in minor ($r = .26$, $p < .001$), moderate ($r = .34$, $p < .001$), and severe ($r = .25$, $p < .001$) forms of antisocial behavior. General gambling involvement was also positively associated with engagement in minor ($r = .30$, $p < .001$), moderate ($r = .14$, $p = .01$), and severe ($r = .18$, $p = .001$) forms of antisocial behavior.

Primary psychopathy was associated with both problem gambling tendencies ($r = .29$, $p < .001$) and general gambling involvement ($r = .22$, $p < .001$). Secondary psychopathy was also associated with both problem gambling tendencies ($r = .38$, $p < .001$) and general gambling involvement ($r = .18$, $p = .001$). Both primary and secondary psychopathy were significantly associated with minor, moderate, and major forms of antisocial behavior (all rs $> .14$, ps $< .01$).

The Big Five traits were also associated with gambling. Problem gambling tendencies were significantly associated with lower emotional stability (higher neuroticism; $r = -.23$, $p < .001$) and lower conscientiousness ($r = -.17$, $p = .002$), but not with openness to experience ($r = -.09$, $p = .11$), agreeableness ($r = -.08$, $p = .14$), or extraversion ($r = -.02$, $p = .77$). General gambling involvement was associated with lower emotional stability (higher neuroticism; $r = -.17$, $p = .002$), marginally associated with agreeableness ($r = -.10$, $p = .09$) and conscientiousness ($r = -.10$, $p = .08$), and not associated with openness to experience ($r = -.001$, $p = .99$) or extraversion ($r = .08$, $p = .15$). Mishra et al. (2011a) did not report any of these bivariate associations. However, these results are largely consistent other findings that have linked gambling and problem gambling with lower emotional stability (higher neuroticism), lower conscientiousness, and lower agreeableness in both clinical and undergraduate samples (e.g., Bagby et al. 2007; Miller et al. 2013; MacLaren et al. 2011). It is worth noting, however, that the only consistent association observed in the present study was between gambling and emotional

stability. Associations with conscientiousness and agreeableness were less strong and often marginally significant.

In the present replication study, we used an abbreviated measure of the Big Five (the TIPI; Gosling et al. 2003), whereas in the original Mishra et al. (2011a) study the full NEO-FFI measure was used (Costa and McRae 1992). The TIPI has been used in thousands of studies and has excellent psychometric properties (Ehrhart et al. 2009). However, it is possible that we did not observe significant relationships because of the substitution of this brief measure. It is worth noting that in the original Mishra et al. (2011a) study, the Big Five explained meaningful additional variance (above and beyond risky personality traits) only in problem gambling and minor antisocial behavior, and that these effects were small.

What Predicts Level of Gambling Involvement?

Problem gambling and general gambling involvement were regressed on three blocks of variables: Personality traits associated with risk (SSS, EIS, RBS), the Big Five personality traits (openness to experience, conscientiousness, extraversion, agreeableness, emotional stability), and antisocial tendencies (primary and secondary psychopathy).

Problem Gambling

Personality traits associated with risk significantly predicted PGSI scores, *adjusted* $R^2 = .31$, $p < .001$. Self-control ($\beta = .48$, $p < .001$) was the only significant individual predictor. The Big Five traits did not add to variance explained, R^2 *change* $= .020$, $p = .11$; agreeableness was the only significant individual predictor ($\beta = .11$, $p = .04$). Antisocial tendencies did not significantly add to variance explained in problem gambling, R^2 *change* $= .007$, $p = .19$. These results differ from the Mishra et al. (2011a) study in two ways: First, in the original study, impulsivity was the only significant individual predictor; second, in the original study, the second block of Big Five traits explained significant additional variance (with neuroticism and extraversion as significant individual predictors). Again, these results may be due to the use of the TIPI measure of the Big Five traits rather than the more comprehensive NEO-FFI.

General Gambling Involvement

Personality traits associated with risk significantly predicted general gambling involvement, *adjusted* $R^2 = .097$, $p < .001$, although no individual predictors were significant in the full model. The Big Five personality traits (R^2 *change* $= .016$, $p = .35$) and antisocial tendencies did not explain additional variance (R^2 *change* $= .004$, $p = .48$). These results replicate those in the original Mishra et al. (2011a), except that sensation-seeking was previously found to be a significant individual predictor.

What Predicts Antisocial Behavior?

Antisocial behavior (minor, moderate, and severe) was regressed on three blocks of variables: Personality traits associated with risk (SSS, EIS, RBS), the Big Five personality traits (openness to experience, conscientiousness, extraversion, agreeableness, emotional stability), and antisocial tendencies (primary and secondary psychopathy).

Minor Antisocial Behavior

Personality traits associated with risk significantly predicted minor antisocial behavior in the last year, *adjusted* $R^2 = .33$, $p < .001$, with sensation-seeking as the only significant predictor, $\beta = .52$, $p < .001$. The Big Five personality traits (R^2 *change* $= .007$, $p = .65$) and antisocial tendencies did not explain additional variance (R^2 *change* $= .003$, $p = .51$). In the previous study, low self-control was an additional predictor in Block 1, and the Big Five traits (specifically, emotional stability and extraversion) explained additional variance. Antisocial tendencies did not explain variance in minor antisocial behavior in either analysis.

Moderate Antisocial Behavior

Personality traits associated with risk significantly predicted minor antisocial behavior in the last year, *adjusted* $R^2 = .21$, $p < .001$, with sensation-seeking ($\beta = .14$, $p = .023$) and low self-control ($\beta = .41$, $p < .001$) as significant individual predictors. The Big Five personality traits (R^2 *change* $= .008$, $p = .69$) and antisocial tendencies did not explain additional variance (R^2 *change* $= .002$, $p = .67$). These findings identically replicate Mishra et al. (2011a).

Severe Antisocial Behavior

Personality traits associated with risk significantly predicted minor antisocial behavior in the last year, *adjusted* $R^2 = .18$, $p < .001$, with sensation-seeking ($\beta = .16$, $p = .01$) and low self-control ($\beta = .38$, $p < .001$) as significant individual predictors. The Big Five personality traits (R^2 *change* $= .002$, $p = .97$) and antisocial tendencies did not explain additional variance (R^2 *change* $= .001$, $p = .84$). These findings are similar to those observed in Mishra et al. (2011a), except that antisocial tendencies explained additional variance in the original study.

Table 6 Pearson correlations between measures of gambling and antisocial tendencies before and after controlling for personality traits associated with risk

	Before controlling for personality				After controlling for personality			
	PGSI	SRED1	SRED2	SRED3	PGSI	SRED1	SRED2	SRED3
GGI	.41***	*.30***	*.14***	*.18***	.33***	*.19***	***.017***	***.072***
PGSI		*.26***	*.34***	*.25***		*.17***	*.15***	***.078***
SRED1			.53***	.43***			.47***	.34***
SRED2				.46***				.32***

Key correlations of interest between gambling and antisocial behavior are italicized

Bold values indicate lost significance after controlling for personality traits associated with risk

PGSI problem gambling tendencies, *GGI* general gambling involvement, *SRED1* minor antisocial behavior, *SRED2* moderate antisocial behavior, *SRED3* severe antisocial behavior

Significant associations are noted: * $p < .05$; ** $p < .01$; *** $p < .001$

Are Gamblers Antisocial?

Associations between the gambling measures (PGSI, GGI), and the three measures of antisocial behavior were examined; as in the original study, all measures of problem gambling and antisocial behavior were significantly associated (all $rs > .14$, $ps < .01$; Table 6).

Kruskal–Wallis tests were conducted to examine whether minor, moderate, and severe antisocial behavior differed based on degree of problem gambling as measured in the PGSI. Minor antisocial behavior significantly varied based on degree of problem gambling, $\chi^2(3) = 23.05$, $p < .001$; non-problem: $M = 2.34$; at-risk: $M = 3.34$; problem: $M = 4.28$. Moderate antisocial behavior significantly varied based on degree of problem gambling, $\chi^2(3) = 29.74$, $p < .001$; non-problem: $M = .24$; at-risk: $M = .78$; problem: $M = .89$. Severe antisocial behavior significantly varied based on degree of problem gambling, $\chi^2(3) = 15.52$, $p < .001$; non-problem: $M = .30$; at-risk: $M = .45$; problem: $M = .83$. These results are summarized in Fig. 1.

As in the original study, the regression analyses reported earlier indicated that personality traits associated with risk explained significant variance in minor, moderate, and severe antisocial behavior. To examine whether the relationship between gambling and antisocial behavior was due to the common effects of personality traits associated with risk, we conducted partial correlations between measures of gambling and antisocial behavior controlling for personality traits associated with risk. Correlations between gambling and antisocial behavior controlling for risky personality traits were smaller in all cases. In the original study, four of the six comparisons lost significance; in this replication study, three of the six comparisons lost significance. These results are summarized in Table 6. Together, these results conceptually replicate the vast majority of analyses in the original Mishra et al. (2010a) study. The results provide further evidence that gambling and antisocial behavior are highly associated, largely due to shared personality traits associated with risk.

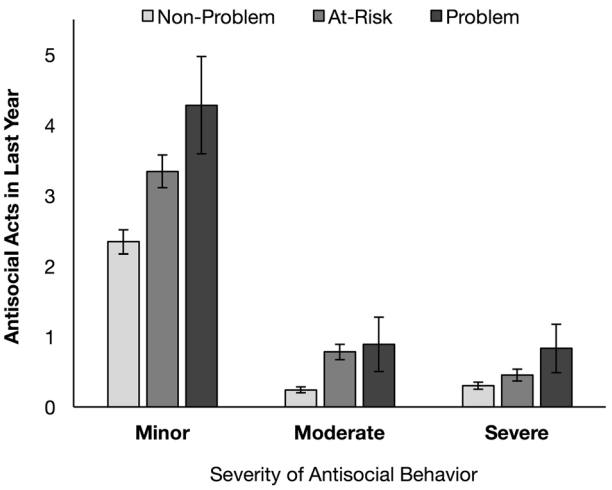

Fig. 1 Number of antisocial acts in the last year by act severity and problem gambling severity

Criminal Outcomes and Gambling

In this study, we also collected self-reports of whether participants were ever arrested ($n = 95$), charged ($n = 89$), convicted ($n = 85$), or incarcerated ($n = 57$) for a crime. These measures allowed us to extend previous findings by examining whether problem gambling and general gambling involvement differ based on criminal outcomes. Mann–Whitney tests were used to examine whether those who reported having experienced criminal outcomes also reported greater problem gambling tendencies and general gambling involvement. People who were arrested, charged, convicted, or incarcerated for a crime all reported greater problem gambling tendencies (all Zs > 6.16, ps $< .001$). These results are summarized in Fig. 2.

People who were arrested for a crime reported marginally higher problem gambling tendencies ($Z = 1.90$, $p = .058$). People who were charged, convicted, or incarcerated for a crime all reported significantly greater general gambling involvement (all Zs > 1.98, ps $> .048$). These results are summarized in Fig. 3.

General Discussion

The results of two sets of replication analyses among a diverse community sample provide further support for the generality of deviance. We found strong correlations between problem gambling tendencies, general gambling involvement, and numerous risk-related measures: personality traits associated with risk (impulsivity, low self-control, sensation-seeking), risk attitudes in multiple domains, behavioral risk-taking, antisocial tendencies, and antisocial behavior. These findings largely replicate those reported by Mishra et al. (2010a, 2011a). We also extended previous findings by demonstrating that problem gambling tendencies and general gambling involvement vary by categorical criminal outcomes: those who reported having been arrested, charged, convicted, or incarcerated for a crime report substantially higher levels of gambling than those who had not reported such outcomes.

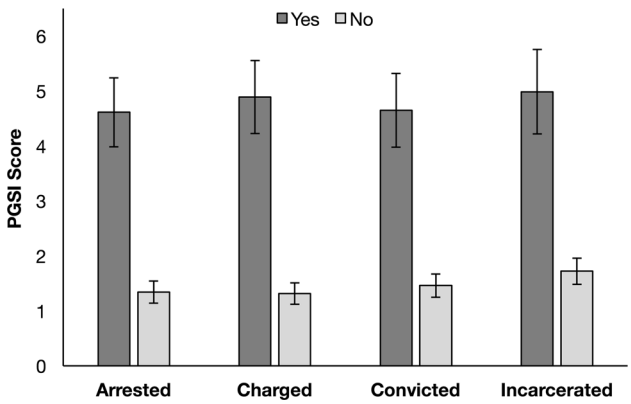

Fig. 2 Problem gambling severity scores (as measured with the PGSI) by whether or not participants reported having been arrested, charged, convicted, or incarcerated for a crime

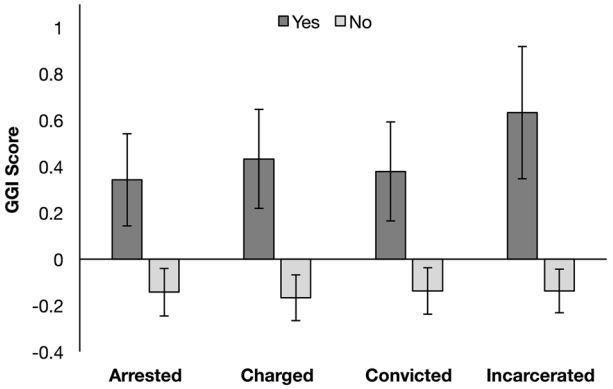

Fig. 3 General gambling involvement (GGI) scores by whether or not participants reported having been arrested, charged, convicted, or incarcerated for a crime

The Importance of Replication

This study represents a near-direct replication of two previous studies with a superior sample. The present study used a large sample size and was conducted in a more representative community population (compared to previous studies, which have focused on undergraduate convenience samples or special populations). Substantial recent attention has been focused on the issue of replicability in the psychological sciences. Open Science Framework (2015) demonstrated in a large-scale, many-site, large-*n* study that only 36 % of psychology studies chosen from three top journals in 2008 could be directly replicated (39 % if the success rate is computed based on studies expected to be significant based on power calculations). Many have called for replication studies to be conducted more frequently as part of a more robust science process (reviewed in Pashler and Wagenmakers 2012). We conducted the present study in the spirit of this call, in the hopes that the field of gambling research embraces replication as a matter of typical course. We hope to see further replications of gambling research, especially those conducted by independent researchers (which would increase the impact of such replication studies).

Domain-Specificity and the Generality of Deviance

The generality of deviance framework suggests that various forms of antisocial behavior, including problem gambling, tend to co-occur among individuals, and that these individuals share traits that motivate "taste for risk" more generally (reviewed in Mishra and Lalumière 2009; Mishra 2014; Zuckerman 2007). Furthermore, in the behavioral sciences, risk-propensity has been historically understood as a domain-general stable trait that varies among individuals (e.g., Bromiley and Curley 1992; Eysenck and Eysenck 1985; Friedman and Savage 1948; Pratt 1964; Slovic 1964). Our results largely support the generality of deviance: personality traits associated with risk, behavioral risk-taking, risk attitudes, and antisocial behavior and antisocial tendencies were all consistently associated. However, more recent evidence suggests that people engage in risk-taking in a more domain-specific manner, especially if non-deviant risk-taking is included (reviewed in Mishra et al., in press). For example, some people engage in high levels of recreational risk-taking, but low levels of financial or gambling risk-taking (Hanoch et al. 2006). Other studies appear to

suggest that antisocial (deviant) risk-taking is qualitatively difference from non-antisocial (i.e., prosocial or asocial) risk-taking (e.g., Gomà-i-Freixanet 1995, 2001; Levenson 1990; Wood et al. 2013).

We found some evidence for domain-specificity among antisocial and non-antisocial risk domains: Problem gambling tendencies and general gambling involvement were positively associated with pro-risk attitudes in the gambling, health/safety, and ethical domains, negatively associated with pro-risk attitudes in the investment domain, and not associated with social risk attitudes. Interestingly, many items in the DOSPERT measuring risk attitudes in the gambling (e.g., "Betting a day's income at a high-stake poker game"), health/safety (e.g., "Engaging in unprotected sex"), and ethical (e.g., "Having an affair with a married man/woman") domains all involve some antisocial components that involve some risk of harm to self or others. Conversely, items in the investment (e.g., "Investing 10 % of your annual income in a moderate growth mutual fund") and social (e.g., Speaking your mind about an unpopular issue in a meeting at work") domains generally involve non-antisocial risk-taking. However, we also found associations between antisocial and non-antisocial forms of risk-taking. The Choice Task—which measures non-antisocial risk-taking as a simple preference for variable over fixed monetary outcomes—was consistently associated with all others measures of risk in this study.

Previous research focused on gambling specifically also provides some indication of domain-specificity of "deviance" conceived broadly. Smith et al. (2003) showed that engagement in non-continuous gambling behaviors (e.g., purchasing lottery tickets) is actually associated with less criminal behavior. Continuous, faster-paced gambling behaviors, on the other hand, have been associated with greater antisocial outcomes (e.g., theft, fraud, domestic violence; Smith et al. 2003). Similarly, more "benign" forms of gambling (e.g., lottery, bingo) have different etiologies compared to more "hazardous" forms of gambling (e.g., video lottery terminal machines) and these different etiologies likely have resultant implications for domain-specificity and domain-generality of "deviance". These observations and other mixed results for the domain-specificity and domain-generality of deviance (and of risk more broadly) suggest that further research is necessary to examine the domain-specificity of risk (Mishra et al., in press). It is likely that non-antisocial and antisocial forms of risk-taking share some portion of overlapping variance (i.e., domains of risk-taking are not fully independent).

Strengths and Limitations

This study had strengths and limitations that provide guidance for future research. This study did not represent a full direct replication of Mishra et al. (2010a, 2011a). Some original measures were omitted (one-shot variance preference; the aggression questionnaire; an early developmental antisociality index), and in the case of the Big Five personality traits, an abbreviated measure was substituted (10 items in the TIPI instead of the original 60 in the NEO-FFI). However, it is unlikely these measure changes had large consequences for the conclusions of our study. All measures in the original studies and the present replication were presented in random order. Therefore, the omission or change in any measures would not have manifested in any systematic order effects. Also, the measures omitted showed very small and/or non-existent correlations with other convergent measures. For example, the one-shot variance preference measure was not associated with either other measure of behavioral risk-taking in Mishra et al. 2010a (although we do note that it is important to also replicate null findings). Finally, only in multivariate analyses would the measure omissions have been a concern (as far as directly comparing the present

results with past results). Bivariate associations between our other measures represent direct replications of analyses in Mishra et al. (2010a, 2011a), and the vast majority of these analyses provide strong support for our previous findings.

As in many studies examining the generality of deviance, we cannot establish any direction of causality. It is unclear whether gambling succeeds or precedes engagement in other forms of risk-taking and antisocial behavior. Some longitudinal evidence suggests that stable individual differences in self-control and impulsivity that are determined early in life (i.e., as a product of early developmental environments interacting with genetic predispositions) facilitate lifelong engagement in antisocial behavior. For example, Moffitt et al. (2011) showed that childhood self-control predicted later substance dependence and criminal offending outcomes. Others have shown that antisocial behavior can develop as a consequence of gambling addictions (Blaszczynski and McConaghy 1994), and that some people engage in criminal behavior in order to directly finance gambling habits (Blaszczynski et al. 1997; Turner et al. 2007; Williams et al. 2005).

We argue that our study utilizes a representative community sample that is superior to conventional undergraduate convenience samples. However, it is important to note that this community sample still represents a sort of convenience sample, with resultant limitations. We recruited within a single community, and our sample was necessarily self-selected through passive advertising of posters. Our recruitment posters also explicitly indicated a high level of compensation ("Earn $30 or more"), which may have further biased our sample toward more indigent participants who might be more motivated by such payments. Our sampling approach stands in contrast to superior methods involving recruitment of participants from many geographical areas and through truly random sampling methods (e.g., through systematic telephone calling). Further studies should examine whether truly random samples exhibit relationships consistent with the "generality of deviance".

Our study involved both self-report "trait" measures, and behavioral "state" measures. As a consequence, any correlations among dependent measures utilizing common methods are likely to be inflated (i.e., subject to common method variance; Podsakoff et al. 2003). By the same mechanism, correlations between self-report and behavioral measures are likely to be under-estimated. Further examination of associations between gambling, antisocial behavior, and risk should integrate more behaviorally oriented self-report measures (e.g., average duration of gambling session and/or expenditures), behavioral measures (e.g., measured in-lab gambling behavior) and/or archival data to better examine interrelationships (e.g., Mishra et al. 2010b).

Implications

Many interventions for problem gambling involve specific targeting of mechanisms associated with gambling itself. This study, along with the large literature supporting the generality of deviance, suggests that a more effective target for interventions is risk-propensity more generally. Other gambling researchers have echoed this prescription (Stinchfield 2004; Vitaro et al. 2001), citing evidence linking common instigative factors to both gambling and more general antisocial risk-acceptance (i.e., poor educational outcomes; being male; disruptive or traumatic life events; poor social support and family relationships; low socioeconomic status; inequality and relative deprivation; e.g., Mishra and Novakowski 2016; reviewed in Stinchfield 2004). It is likely that any targeting of these "root causes" for antisocial risk-taking is likely to yield broad societal benefits, including a reduction in problematic gambling behavior.

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Compliance with Ethical Standards

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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