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FULL-LENGTH REPORT

Gambling along the schizotypal spectrum: The associations between schizotypal personality, gambling-related cognitions, luck, and problem gambling

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ABSTRACT

Objective: Schizotypal personality (schizotypy) is a cluster of traits in the general population, including alterations in belief formation that may underpin delusional thinking. The psychological processes described by schizotypy could also fuel cognitive distortions in the context of gambling. This study sought to characterize the relationships between schizotypy, gambling-related cognitive distortions, and levels of problem gambling. *Methods:* Analyses were conducted on three groups, a student sample ($n = 104$) with minimal self-reported gambling involvement, a crowdsourced sample of regular gamblers (via MTurk; $n = 277$), and an additional crowdsourced sample with a range of gambling involvement (via MTurk; $n = 144$). Primary measures included the Schizotypal Personality Questionnaire – Brief (SPQ-B), the Peters et al. Delusions Inventory (PDI-21), the Gambling Related Cognitions Scale (GRCS), and the Problem Gambling Severity Index (PGSI). Luck was measured with either the Belief in Good Luck Scale (BIGLS) or the Beliefs Around Luck Scale (BALS). *Results:* Small-to-moderate associations were detected between the components of schizotypy, including delusion proneness, and the gambling-related variables. Schizotypy was associated with the general belief in luck and bad luck, but not beliefs in good luck. A series of partial correlations demonstrated that when the GRCS was controlled for, the relationship between schizotypy and problem gambling was attenuated. *Conclusions:* This study demonstrates that schizotypy is a small-to-moderate correlate of erroneous gambling beliefs and PG. These data help characterize clinical comorbidities between the schizotypal spectrum and problem gambling, and point to shared biases relating to belief formation and decision-making under chance.

KEYWORDS

schizotypal personality, schizotypy, gambling, gambling-related cognitive distortion, gambling beliefs, luck

INTRODUCTION

Schizotypal personality (henceforth schizotypy) refers to multidimensional traits that lie on a continuum with schizophrenia, but vary across the general population (Ettinger, Meyhöfer, Steffens, Wagner, & Koutsouleris, 2014; Raine, 1991), including delusion-proneness, disordered thought, and interpersonal difficulties. Schizotypy is a core dimension in neurobiologically-informed models of human personality, including the Eysenck 3-factor model in which it is termed Psychoticism (Eysenck, 1992). *Prima facie,* key aspects of schizotypy appear to correspond with erroneous beliefs and biases in decision-making and/or reasoning that occur in gambling, otherwise known as gambling-related cognitive distortions (Ejova & Ohtsuka, 2020; Leonard, Williams, & Vokey, 2015; Goodie, Fortune, & Shotwell, 2019). For

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example, gambling-related rituals or beliefs in personal luck are instances of magical thinking. Greater endorsement of these cognitions is reliably observed in disordered gambling (Griffiths, 1990; Kloosterman & Summerfeldt, 2015; Ladouceur, Sylvain, Letarte, Giroux, & Jacques, 1998; Moore & Ohtsuka, 1999), as are broader beliefs around luck (Chiu & Storm, 2010). There is a recognized comorbidity between schizophrenia and disordered gambling (McIntyre et al., 2007; Potenza & Chambers, 2001). However, schizotypy as a source of individual differences throughout the population has received limited empirical attention in relation to gambling.

In one of the few studies to consider this question, Abdollahnejad, Delfabbro, and Denson (2014, 2015) investigated the correlations between delusion-proneness, gambling beliefs, and problem gambling within 140 gamblers. Delusion proneness was assessed with the Peters et al. Delusions Inventory (PDI-21), and gambling cognitions were assessed with the Drake Beliefs about Chance Inventory (DBC; Wood & Clapham, 2005) and the Gambling Related Cognitions Scale (GRCS; Raylu & Oei, 2004a). The authors found moderate positive correlations (r = 0.40–0.48) between delusion-proneness and the gambling scales. The strength of this association indicates that delusion proneness could relate to erroneous gambling beliefs as strongly as more widely-studied traits such as impulsivity (associated with gambling cognitions r = 0.41 to 0.49 in Del Prete et al., 2017; Michalczuk, Bowden-Jones, Verdejo-Garcia, & Clark, 2011), and stronger than the "Big Five" facets (r = −0.12 to −0.23; MacLaren, Ellery, & Knoll, 2015).

As a clinical syndrome, schizophrenia is associated with an array of changes in cognition and information processing, including judgment and decision-making. Balzan, Delfabbro, Galletly, and Woodward (2012) found individuals with schizophrenia were prone to a reasoning bias of 'jumping to conclusions' that has been linked more specifically to delusion formation (Freeman, Pugh, & Garety, 2008). Both people with schizophrenia, and healthy participants high in delusion-proneness, displayed biases in search preferences (toward positive tests), emphasis on confirmatory evidence, illusory correlations, and the illusion of control (Balzan, Delfabbro, Galletly, & Woodward, 2013a, 2013b), which are all implicated in gambling-related cognitive distortions. Schizophrenia has an established comorbidity with gambling disorder. In patients with Gambling Disorder, Granero et al. (2021) found that 4.40% met criteria for schizophrenia, compared to the approximately 1.10% baseline prevalence of schizophrenia. Conversely, 19.0% of individuals diagnosed with either schizophrenia or schizoaffective disorder also met the criteria for problem gambling (Desai & Potenza, 2009). Yakovenko, Fortgang, Prentice, Hoff, and Potenza (2018) reported that gambling frequency among individuals with psychotic disorders was predicted by loss chasing, a behaviour associated with gambling cognitions.

There is also emerging evidence for neurobiological links between gambling and psychosis. According to the aberrant salience hypothesis (Kapur, 2003), elevated dopamine transmission drives attribution of salience to neutral or irrelevant stimuli, resulting in delusion formation. Such amplified dopaminergic activity has also been described in gambling disorder (Boileau et al., 2014) and it is posited that this could promote gambling-related cognitive distortions through a similar mechanism, amplifying attention to chance events (Zack, St. George, & Clark, 2020).

The modern conceptualization of schizotypy is organized into three subscales that align with key symptoms of schizophrenia: Cognitive-perceptual features, interpersonal deficits, and disorganized thought (Compton, Goulding, Bakeman, & McClure-Tone, 2009; Raine, 1991; Raine & Benishay, 1995). Of these, the most obvious candidate to relate to gambling cognitions is the cognitive-perceptual facet, which includes magical/supernatural beliefs and broader delusional thought. The other facets may also associate with aspects of gambling behaviour; for example, disorganization could impair understanding of gambling probabilities. In healthy video gamers, the interpersonal and disorganized facets of schizotypy decreased when participants thought about their 'virtual selves' within an online video game (Schimmenti, Infanti, Badoud, Laloyaux, & Billieux, 2017). By analogy, gambling could provide a similar source of coping and escape for those with high trait schizotypy, and increase engagement.

In the present study, Hypothesis 1 (H1) sought to replicate the association between delusion-proneness and gambling-related cognitions initially reported by Abdollahnejad et al. Second, we test an overarching hypothesis (H2) that schizotypy is correlated with gambling-related cognitions, beliefs about luck, and problem gambling. Third, we explore the hypothesis (H3) that the three facets of schizotypy will positively correlate with specific gambling distortions, derived from the Gambling Related Cognitions Scale (GRCS) subscales. Lastly, we hypothesize (H4) that the relationship between schizotypy and problem gambling will be attenuated after controlling for gambling-related cognitions on the GRCS. For robustness, we report results from three samples that relied upon undergraduate and crowdsourced recruitment, with a range of gambling involvement.

METHODOLOGY

Sample & procedure

Sample 1 consisted of university students with minimal levels of gambling involvement who completed an online survey for course credit. Participants were pre-screened for English fluency and were over 19 (the jurisdiction's legal gambling age). The survey was titled as *'Gambling & Personality'* on the university's website for student participants and took approximately 30 min to complete on Qualtrics®. Covert attention checks were used to promote data quality (recommended by Goodman, Cryder, & Cheema, 2013): i) abnormally fast survey completion (< six minutes), ii) endorsed playing a fictional slot machine, and iii) inconsistent responses to a repeated item. Participants failing any check were excluded and 104 participants (77.6%) passed. After consent, demographics were administered, followed by the scales outlined below (randomly ordered per participant) and study debriefing. Data collection occurred February to April 2017.

Samples 2 comprised of North American adults (USA & Canada) with gambling experience collected via Amazon's Mechanical Turk (MTurk), a crowdsourcing platform (Kim, Hollingshead, & Wohl, 2017; Mishra, Beshai, Wuth, & Refaie, 2019; Newall, Walasek, & Ludvig, 2020). A pre-screen questionnaire (compensation $0.15 USD) established eligibility: i) English fluency, ii) age 21 or over (legal gambling age in USA), iii) and an endorsed gambling frequency statement of 'once every few months' or greater. Those eligible could complete the survey described above (compensation $1.50 USD). For data quality, MTurk respondents had completed ≥1000 MTurk tasks with a >98% approval rating. Overall, 277 participants completed the questionnaire and passed the attention checks (83.4%). Data was collected from September to October 2017.

Sample 3 was a secondary dataset comprised of North American adults (USA & Canada) collected via MTurk, originally collected in February to March 2018 for an unrelated study question about video gaming (see Brooks & Clark, 2019), and titled *'Video Games & Loot Boxes – Research Study'*. In including Sample 3 here, we aim to replicate findings from Samples 1 & 2 among a group of participants with a broader range of gambling experience (non-gamblers to frequent gamblers), and further explore schizotypy's association with luck. A pre-screen questionnaire (compensation $0.10 USD) established eligibility: i) English fluency, ii) age 21 of over (legal gambling age in the United States), iii) and familiarity with video game 'loot boxes' (unrelated to the present question). The full survey provided compensation of $1.50 USD. For data quality, all MTurk respondents had completed ≥1000 MTurk tasks with a >98% approval rating. Overall, 144 individuals completed the questionnaire and passed the attention checks (94.1%).

Measures

An overview of the measures, their acronyms, and a description of the constructs each measure assesses is found in Supplementary Table 1.

Delusion proneness. The Peters et al. Delusions Inventory (PDI-21; Peters, Joseph, Day, & Garety, 2004) comprises 21 items about unusual beliefs (e.g., thought disturbances, references to the self, supernatural beliefs) to measure delusional ideation in the general population. Participants endorse each item as "Yes" or "No", and for each endorsed item, rate their degree of conviction, preoccupation, and level of distress, each on a 5-point scale, giving a total score from 0 to 336. Internal consistency was good ($\alpha = 0.86$) and excellent ($\alpha = 0.92$) in Sample 1 & Sample 2, respectively. This survey was included in Samples 1 and 2.

Schizotypal personality. The Schizotypal Personality Questionnaire-Brief (SPQ-B; Raine & Benishay, 1995) is an abbreviated, 22-item version of the SPQ (Raine, 1991), on which respondents answer 'Yes' or 'No'. Good total score internal consistency was demonstrated in Sample 1 ($\alpha = 0.80$), Sample 2 ($\alpha = 0.85$), and Sample 3 ($\alpha = 0.89$). In addition to the overall total, the scale comprises three factors of cognitive-perceptual features ($\alpha = 0.55$; $\alpha = 0.74$; $\alpha = 0.82$), interpersonal deficits ($\alpha = 0.80$; $\alpha = 0.81$; $\alpha = 0.82$), and disorganized thought ($\alpha = 0.75$; $\alpha = 0.74$; $\alpha = 0.81$; Compton et al., 2009).

Gambling beliefs. Gambling-related cognitive distortions were assessed with: 1) the Gambling Related Cognitions Scale (GRCS; Raylu & Oei, 2004a) consists of 23 questions scored on a seven-point scale ranging from 'strongly disagree' to 'strongly agree'. The GRCS has five subscales that measure illusion of control, interpretative bias, predictive control, gambling-related expectances, and the inability to stop gambling. Internal consistency was acceptable-to-good in Sample 1 ($\alpha = 0.78$–0.83), and acceptable-to-excellent in Samples 2 ($\alpha = 0.77$–0.93) and 3 ($\alpha = 0.83$–0.90). 2) The Belief in Good Luck Scale was used in Samples 1 & 2 (BIGLS; Darke & Freedman, 1997). This scale assesses the respondent's belief in good luck in Samples 1 & 2 ($\alpha = 0.84$; $\alpha = 0.89$). In Sample 3, the BIGLS was replaced with the 3) Beliefs Around Luck Scale (BALS; Maltby, Day, Gill, Colley, & Wood, 2008), comprising four subscales that measure belief in personal good luck, personal bad luck, general belief in luck, and rejection of luck (overall scores were not reported in the original paper). Internal consistency was good-to-excellent ($\alpha = 0.86$–0.97).

Problem gambling. The Problem Gambling Severity Index (PGSI; Ferris & Wynne, 2001) was used to assess problematic gambling in the past year. Items are scored 0 ('never') to 3 ('almost always'), giving a maximum score of 27. This scale is considered the gold standard self-report instrument for gambling problems (Dowling et al., 2018). Scores are categorized "non-problem gambler" (0), "low-risk" (1–4), "moderate-risk" (5–7), and "problem gambler" (8+; Currie, Hodgins, & Casey, 2013). Internal consistency was good ($\alpha = 0.84$) in Sample 1, and excellent ($\alpha = 0.93$; $\alpha = 0.91$) in Samples 2 & 3.

Analysis plan

The Peters et al. Delusions Inventory (PDI-21) was included as a direct replication of Abdollahnejad et al. (H1). To investigate H2, that the broader construct of schizotypy is related to gambling-related cognitive distortions, beliefs about luck, and problem gambling, correlations were conducted between the Schizotypal Personality Questionnaire-Brief (SPQ-B), Gambling Related Cognitions Scale (GRCS), and the luck-related scales (BIGLS/BALS). For H3, correlations between the separate facets of schizotypy (SPQ-B) and specific distortions (GRCS) were computed. Age, gender, and ethnicity were assessed as potential confounds with multiple linear regressions using R 4.1.2. For H1 – H3, Pearson bivariate correlations (two-tailed) were conducted using IBM SPSS® 28.0, and potential confounds were partialled. Partial correlations were used to assess H4, by recalculating the correlations between schizotypy and problem gambling controlling for the GRCS. Following Cohen (1988), effect sizes for r values are classified as 'small' (> 0.30), 'medium' ($0.30 \leq r < 0.50$), and 'large' ($r \geq 0.50$). Boxplots with cases above 3.0 times the interquartile range (IQR) were considered outliers (Field, 2017). Normality was assessed with P-P plots and histogram distribution and log transformations were applied to reduced skew, where appropriate. Spearman rank-order correlations were computed to assess for robustness of results under different assumptions.

Ethics

The procedures for this study were carried out in accordance with the Declaration of Helsinki. Surveys began with a consent form about study procedures, and for participants to either consent to participate or decline participation via two response buttons at the bottom of this page. Study approval was provided by the University of British Columbia Behavioural Research Ethics Board approved the study.

RESULTS

Summary demographics are presented in Table 1, and summary descriptive statistics for the scale measures are presented alongside the correlation matrices in Tables 2–4. The median endorsed gambling frequency was *"less than once a year"* for Sample 1, *"about once a month"* for Sample 2, and *"about once a year"* for Sample 3.

Multiple linear regressions

Multiple linear regressions tested for the impact of the demographic variables age, gender, and ethnicity. These significantly predicted gambling-related variables in some analyses (see Supplementary Tables 2–4).

Pearson bivariate correlation analyses

Table 2 summarizes full scale correlations between delusion proneness (PDI-21), schizotypal personality (SPQ-B), gambling cognitions (GRCS), luck beliefs (BIGLS/BALS), and problem gambling (PGSI). Table 3 summarizes the correlations between the SPQ-B and GRCS subscales, and their associations with the PGSI in Samples 1 & 2. Table 4 summarizes this for Sample 3.

As expected, the GRCS and its subscales demonstrated positive small-to-large correlations with the PGSI across all samples, except for the GRCS Gambling Expectancies subscale in Sample 1. Likewise, luck beliefs (BIGLS) were positively associated with gambling cognitions (GRCS) and problem gambling (PGSI). Delusion proneness (PDI-21) and schizotypy (SPQ-B) were also moderately-to-strongly intercorrelated. These associations each support construct validity.

For H1, positive correlations were detected between the delusion proneness (PDI-21) and gambling cognitions (GRCS) (Sample 1, $r = 0.348$; Sample 2, $r = 0.175$) and between the PDI-21 and problem gambling (PGSI) (Sample 1, $r = 0.212$; Sample 2, $r = 0.199$), supporting Abdollahnejad et al. (2014, 2015). There were small-to-moderate, positive associations between the SPQ-B and GRCS (Sample 1, $r = 0.283$ in; Sample 2, $r = 0.203$; Sample 3, $r = 0.321$) and between the SPQ-B and PGSI (Sample 1, $r = 0.235$; Sample 2, $r = 0.205$; Sample 3, $r = 0.295$). Luck beliefs (BIGLS) were not correlated with the SPQ-B total score, except for the Cognitive-Perceptual Features subscale in Sample 1 ($r = 0.307$; $P = 0.002$). In Sample 2, there were no

Table 1. Participant demographics

Variable	Sample 1: Student ($n = 104$)	Sample 2: MTurk ($n = 277$)	Sample 3: MTurk ($n = 144$)
Mean Age (*SD*)	20.3 (1.97)	39.3 (11.5)	35.6 (10.1)
Gender (% Female)	68.3%	55.2%	48.6%
Ethnicity:			
Asian	64.4%	6.90%	8.30%
African/Black	1.90	8.30	8.30
Caucasian/White	26.9	78.7	78.5
Latin American	2.90	5.10	1.40
Other Ethnicity	3.80	1.10	3.50
Gambling Frequency:			
Ever Gambled	58.7%	100.0%	83.9%
"never"	41.3	0.00	16.1
"less than once a year"	28.8	0.00	27.3
"about once a year"	15.4	0.00	17.5
"once every few months"	10.6	32.9	18.9
"about once a month"	2.90	18.8	7.70
"every few weeks"	1.00	19.1	0.00
"every week"	0.00	15.5	2.80
"a few days a week"	0.00	9.4	3.50
"most days of the week"	0.00	4.3	6.30

Note: Descriptive statistics were calculated using untransformed values. Most participants from Sample 1 indicated Asian ethnicity, and Samples 2 & 3 more closely represented the American population. Sample 2 was required to have at least 'once every few months' of gambling engagement.

Table 2. Full scale pearson bivariate correlations

Sample 1: Student (n = 104)

Variable	*M*	*SD*	2.	3.	4.	5.
1. PDI-21	50.2	33.3	0.570^{***}	0.348^{***}	0.338^{***}	0.212^{*}
2. SPQ-B	8.20	4.48	—	0.283^{**}	0.109	0.235^{*}
3. GRCS	40.9	18.6		—	0.409^{***}	0.336^{***}
4. BIGLS	36.27	9.30			—	0.239^{*}
5. PGSI	0.53	1.77				—

Sample 2: MTurk (n = 277)

Variable	*M*	*SD*	2.	3.	4.	5.
1. PDI-21	44.8	35.6	0.366^{***}	0.175^{**}	0.086	0.199^{***}
2. SPQ-B	8.04	4.95	—	0.203^{***}	0.023	0.205^{***}
3. GRCS	75.9	25.8		—	0.588^{***}	0.537^{***}
4. BIGLS	38.0	11.0			—	0.155^{*}
5. PGSI	4.64	5.13				—

Sample 3: MTurk (n = 144)

Variable	*M*	*SD*	2.	3.	4.	5.	6.	7.
1. SPQ-B	9.03	5.71	0.321^{***}	−0.051	0.320^{***}	0.420^{***}	−0.145	0.295^{***}
2. GRCS	53.2	27.2	—	0.368^{***}	0.130	0.502^{***}	-0.345^{***}	0.666^{***}
3. BALS-GL	17.1	7.13		—	-0.336^{***}	0.147	-0.180^{*}	0.199^{*}
4. BALS-BL	15.2	8.24			—	0.369^{***}	−0.042	0.117
5. BALS-GB	20.0	7.63				—	-0.356^{***}	0.370^{***}
6. BALS-RL	17.8	4.85					—	-0.296^{***}
7. PGSI	1.90	3.49						—

Note: * $P \le 0.05$, ** $P \le 0.01$, *** $P \le 0.001$ (two-tailed); partial correlations reported to control for Caucasian/White ethnicity and gender in Sample 1, Asian ethnicity, gender, and age in Sample 2, and gender in Sample 3. PDI-21 = Peters et al. Delusions Inventory; SPQ-B = Schizotypal Personality Questionnaire-Brief; GRCS = Gambling Related Cognitions Scale; BIGLS = Belief in Good Luck Scale; BALS-GL = belief in good luck; BALS-BL = belief in bad luck; BALS-GB = general belief in luck; BALS-RL = rejection of luck.; PGSI = Problem Gambling Severity Index; to reduce skew, the PGSI and GRCS in Sample 1, the PDI-21 and PGSI in Sample 2, and the PGSI, GRCS, and BALS-BL in Sample 3 were log transformed.

significant associations between the BIGLS and the SPQ-B (total or subscales). Switching from the BIGLS (beliefs in good luck) to the BALS in Sample 3, the SPQ-B moderately correlated with the BALS Belief in Bad Luck (r = 0.320) and General Belief in Luck subscales (r = 0.420), but not with the BALS Beliefs in Good Luck subscale. Thus, while no sample demonstrated a link between ‘good luck’ and schizotypy, Sample 3 indicates schizotypy could relate with other facets of luck cognitions.

Broadly, the SPQ-B Cognitive-Perceptual Features subscale most strongly associated with the GRCS subscales and the PGSI, but associations with the other facets of schizotypy were also detected across all samples (see Tables 3 and 4). In Sample 3, the BALS General Belief in Luck subscale correlated small-to-moderately with all facets of schizotypy, and Belief in Bad Luck demonstrated moderate correlations with SPQ-B Disorganized Thought and Interpersonal Deficits subscales (see Table 4).

To assess the final hypothesis (H4), partial correlations were conducted between schizotypy (SPQ-B) and problem gambling (PGSI), controlling for gambling cognitions (GRCS). The correlation between the full scale SPQ-B and PGSI was not significant after controlling for GRCS in Sample 1 (r = 0.155; P = 0.122), Sample 2 (r = 0.116, P = 0.055), and Sample 3 (r = 0.115; P = 0.173). Significant associations between the Cognitive-Perceptual Features subscale and the PGSI were retained in Samples 1, 2, & 3 (P < 0.05), although the coefficients reduced when contrasted to the values reported in Tables 3 and 4 (r = 0.250 vs. r = 0.296 for Sample 1; r = 0.116 vs. r = 0.233 for Sample 2; r = 0.204 vs. r = 0.366 for Sample 3).

Spearman rank-order correlation analyses

To assess robustness of our results, correlations matrices were recalculated with Spearman rank-order correlations (see Supplementary Tables 5–7). Overall, few differences emerged. Schizotypy (SPQ-B) was not significantly associated with the PGSI in Sample 1, but the SPQ-B subscale pattern did not change. The PDI-21 now correlated with the GRCS Gambling Expectancies subscale. In Sample 2, the PDI-21 exhibited a positive association with the BIGLS, the GRCS Gambling Expectancies subscale no longer correlated Interpersonal Deficits, whereas Predictive Control was. In Sample 3, the SPQ-B Disorganized Thought subscale now negatively correlated with the BALS Rejection of Luck subscale, and GRCS Inability to Stop subscale positively linked with BALS Beliefs in Bad Luck. The SPQ-B and PGSI (r = 0.125, P = 0.039) remained significant in Sample 2, when controlling for gambling cognitions to assess H4.

Table 3. Subscale pearson bivariate correlations

Variable	*M*	*SD*	2.	3.	4.	5.	6.	7.	8.	9.	10.
Sample 1: Student (*n* = 104)											
1. PDI-21	50.2	33.3	0.614***	0.281**	0.402***	0.170	0.355***	0.361***	−0.044	0.308**	0.212*
2. SPQ-CP	2.74	1.83	—	0.199*	0.205*	0.095	0.285**	0.149	0.016	0.125	0.296**
3. SPQ-IP	3.74	2.50		—	0.489***	0.187	0.095	0.134	0.050	0.205*	0.103
4. SPQ-DS	1.72	1.80			—	0.206*	0.236*	0.166	0.154	0.226*	0.132
5. GRCS-GE	6.74	3.69				—	0.476***	0.605***	0.576***	0.691***	0.174
6. GRCS-IC	7.36	4.40					—	0.584***	0.368***	0.413***	0.314**
7. GRCS-PC	12.4	6.59						—	0.370***	0.736***	0.303**
8. GRCS-IS	6.34	3.16							—	0.425***	0.310**
9. GRCS-IB	8.12	4.70								—	0.266**
10. PGSI	0.53	1.77									—
Sample 2: MTurk (*n* = 277)											
Variable	*M*	*SD*	2.	3.	4.	5.	6.	7.	8.	9.	10.
1. PDI-21	44.8	35.6	0.458***	0.221***	0.254***	0.064	0.196**	0.171**	0.065	0.189**	0.199***
2. SPQ-CP	3.10	2.52	—	0.593***	0.492***	0.112	0.277***	0.248***	0.166**	0.201***	0.233***
3. SPQ-IP	4.73	2.93		—	0.470***	0.122*	0.052	0.118	0.127*	0.127*	0.130*
4. SPQ-DS	1.74	1.79			—	0.086	0.195**	0.152*	0.138*	0.149*	0.166**
5. GRCS-GE	16.6	5.02				—	0.431***	0.674***	0.476***	0.652***	0.377***
6. GRCS-IC	10.1	5.77					—	0.762***	0.521***	0.500***	0.326***
7. GRCS-PC	33.1	12.1						—	0.615***	0.795***	0.428***
8. GRCS-IS	11.6	7.45							—	0.531***	0.651***
9. GRCS-IB	15.5	5.55								—	0.467***
10. PGSI	4.64	5.13									—

Note: * $P \le 0.05$, ** $P \le 0.01$, *** $P \le 0.001$ (two-tailed); partial correlations reported to control for Caucasian/White ethnicity and gender in Samples 1, and Asian ethnicity, gender, and age in Sample 2. PDI-21 = Peters et al. Delusions Inventory; Subscales: SPQ-CP = Cognitive-perceptual; SPQ-IP = interpersonal; SPQ-DS = disorganized thought; GRCS-GE = gambling expectancies; GRCS-IC = illusion of control; GRCS-PC = predictive control; GRCS-IS = inability to stop; GRCS-IB = interpretative bias; PGSI = Problem Gambling Severity Index; to reduce skew, the SPQ-DS, GRCS subscales, and PGSI values in Sample 1, and the PDI-21, SPQ-DS, GRCS-IC, GRCS-IS, and PGSI values in Sample 2 were log transformed.

DISCUSSION

Our analysis plan began with a replication of an earlier finding by Abdollahnejad et al. (2014, 2015) in which delusion-proneness (on the PDI-21) was associated with both erroneous gambling beliefs (GRCS) and degree of problem gambling (PGSI). H1 was supported: Both the university students (Sample 1) and experienced gamblers (Sample 2) demonstrated links between the PDI-21 and GRCS. The PDI-21 also demonstrated small correlations with the more range-restricted PGSI in both samples. Following this initial step, we examined if the broader construct of schizotypy associates with gambling cognitions and problem gambling (H2), and then, to further explore relationships between individual facets of schizotypy and specific cognitive distortions captured by the GRCS (H3). Supporting H2, we found small-to-moderate positive correlations between the schizotypy (SPQ-B) total score and the two gambling scales (GRCS and PGSI) within each sample. This was strongest in Sample 3, likely because of a wider range of gambling experience that spanned non-gamblers to experienced gamblers.

Hypothesis 2 also tested the link between schizotypy and trait-like beliefs in luck. Our results across the three samples provide some novel insights about this relationship. When luck is operationalized as "good luck" via the BIGLS, minimal associations were detected. However, a more nuanced understanding emerged in Sample 3 using the BALS, which deconstructs luck cognitions into four factors reflecting personal good luck, personal bad luck, a general belief in luck, and rejection of luck. Consistent with the BIGLS effects in Samples 1 & 2, the SPQ-B did not associate with the BALS Belief in Good Luck subscale, but moderate, positive correlations were observed with the Beliefs in Bad Luck and the General Belief in Luck subscales. Notwithstanding the possibility of psychometric differences between the BIGLS and the BALS, one interpretation is that individuals scoring highly on schizotypal traits may endorse beliefs in luck with the expectation that this force will work against them (i.e., bad luck). The Belief in Bad Luck and General Belief in Luck subscales also moderately correlated with interpersonal and disorganized traits of schizotypy. Future research may expand on these links between good and bad luck in the context of schizotypy.

The three SPQ-B subscales, reflecting well-established facets of schizotypy rooted in the clinical syndrome of schizophrenia, all displayed some significant correlations with

Table 4. Subscale pearson bivariate correlations

Sample 3: MTurk (n = 144)														
Variable	*M*	*SD*	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
1. SPQ-CP	2.43	2.43	0.403***	0.471***	0.262**	0.338***	0.287***	0.214*	0.274**	0.032	0.140	0.414***	−0.201*	0.366***
2. SPQ-IP	4.26	2.55	—	0.620***	0.114	0.141	0.185*	0.041	0.143	−0.069	0.366***	0.281***	0.099	0.113
3. SPQ-DS	2.34	2.09		—	0.214*	0.270**	0.231**	0.134	0.193*	−0.131	0.313***	0.348***	−0.158	0.247**
4. GRCS-GE	10.3	6.30			—	0.585***	0.703***	0.594***	0.800***	0.348***	0.068	0.412***	−0.248**	0.588***
5. GRCS-IC	8.09	5.58				—	0.690***	0.618***	0.650***	0.340***	0.051	0.447***	−0.418***	0.601***
6. GRCS-PC	16.3	8.31					—	0.481***	0.792***	0.382***	0.120	0.497***	−0.315***	0.483***
7. GRCS-IS	7.88	5.03						—	0.592***	0.228**	0.132	0.325***	−0.297**	0.730***
8. GRCS-IB	10.8	6.39							—	0.296***	0.118	0.424***	−0.246**	0.591***
9. BALS-GL	17.1	7.13								—	−0.329***	0.146	−0.185*	0.206*
10. BALS-BL	15.2	8.24									—	0.375***	−0.037	0.108
11. BALS-GB	20.0	7.63										—	−0.363***	0.373***
12. BALS-RL	17.8	4.85											—	−0.293**
13. PGSI	1.90	3.49												—

Note: * $P \leq 0.05$, ** $P \leq 0.01$, *** $P \leq 0.001$ (two-tailed); partial correlations reported to control for gender. Subscales: SPQ-CP = Cognitive-perceptual; SPQ-IP = interpersonal; SPQ-DS = disorganized thought; GRCS-GE = gambling expectancies; GRCS-IC = illusion of control; GRCS-PC = predictive control; GRCS-IS = inability to stop; GRCS-IB = interpretative bias; BALS-GL = belief in good luck; BALS-BL = belief in bad luck; BALS-GB = general belief in luck; BALS-RL = rejection of luck; PGSI = Problem Gambling Severity Index; to reduce skew, correlations with the SPQ-CP, SPQ-DS, GRCS subscales, BALS-BL, and PGSI values were log transformed.

the gambling-related variables. In the samples comprising more experienced gamblers, the Cognitive-Perceptual facet displayed small-to-moderate correlations with Predictive Control and Illusion of Control on the GRCS, which reflect faulty assumptions about randomness (e.g., that runs of losses signify a win is due) and causality (e.g., superstitious rituals). It also positively associated with the GRCS Interpretive Bias and Inability to Stop subscales. These describe the tendency to reframe gambling outcomes to support continued gambling (e.g., attributing wins to the self and explaining away losses) and perception that one's gambling behaviour is hard to control, respectively.

Expanding on the earlier study by Abdollahnejad et al. (2014, 2015), delusion proneness (PDI-21) demonstrated small-to-moderate correlations with Predictive Control, Illusion of Control, and Interpretive Bias on the GRCS. Overall, our results bolster the notion that subclinical psychosis-like experiences and delusion-proneness is clearly associated with levels of problem gambling and several specific forms of gambling distortions.

Nevertheless, the relationship between schizotypy and gambling extended to other facets of schizotypy – particularly disorganized thought – that has not been previously examined in this context. This factor displayed small associations with the GRCS Illusion of Control and Interpretive Bias subscales across all samples, in addition to the Predictive Control subscale in Samples 2 & 3. This finding suggests that healthy individuals who score highly on this trait may struggle to conceptualize randomness and causality. In Samples 2 & 3, Disorganized Thought was also linked to problem gambling (PGSI). Although, Interpersonal Deficits exhibited small associations with three of the GRCS subscales and the PGSI amongst experienced gamblers, this finding did not replicate across samples and thus should be treated with caution. Overall, these results partially support H3 and indicate that future research on schizotypy in the context of gambling should look beyond the narrow focus on delusion-proneness.

Given that the overall pattern of bivariate relationships was consistent with our hypotheses H1-H3, H4 tested for attenuation of the relationship between the SPQ-B and problem gambling (PGSI) when controlling for gambling cognitions (GRCS) via partial correlation. For all samples, this relationship was no longer statistically significant after controlling for shared variance with the GRCS. The association between the SPQ-B Cognitive-Perceptual subscale and PGSI was also attenuated but remained significant. This pattern is compatible with the idea that schizotypy may act as a risk factor for disordered gambling behaviour via elevated levels of erroneous gambling beliefs. Although cross-sectional data cannot be used to assert directionality, we note that longitudinal research also exists to support the notion that gambling cognitions can act as a precursor to gambling problems (Leonard & Williams, 2016; Leonard, Williams, & McGrath, 2021; Nicholson, Graves, Ellery, & Afifi, 2016; Yakovenko et al., 2016).

The overall pattern of our observed associations is congruent with Kapur's (2003) aberrant salience hypothesis, which implicates heightened dopamine activity (seen in both schizophrenia and gambling disorder) in the attribution of meaning to otherwise unconnected stimuli, as a mechanism for abnormal belief formation. In the context of gambling games, aberrant salience may take the form of erroneous associations between one's actions and random wins, resulting in ritualistic behaviour and misappraisal of skill. As a means for treatment, Metacognitive Training (MCT) is demonstrated as effective for symptom reduction of schizophrenia (Erawati, Keliat, Helena, & Hamid, 2014; Moritz et al., 2014) and improved insight (Lam et al., 2015). MCT targets cognitive biases associated with the formation and maintenance of delusions (e.g., 'jumping to conclusions'). Recently, MCT has also been piloted for problem gambling (Gehlenborg, Bücker, Berthold, Miegel, & Moritz, 2020). By linking schizotypy and gambling, this study both supports the continued development of MCT for problem gambling and also suggests targeting those broader biases, in addition to gambling-related cognitive distortions.

As strengths of our study, the use of three samples allowed for internal replication of effects and increased the robustness of our results, given that the number of correlational tests inflated the risk of type-1 errors. The replication of Abdollahnejad et al. (2014, 2015) further mitigates against this. At the same time, there are limitations inherent to our groups, survey design, and analyses. The demographics of our student sample includes a relatively high rate of Asian (or Asian Canadian) ethnicities, which have some further cultural links to gambling behaviour that we do not explore (Fong, Law, & Lam, 2014; Ji, McGeorge, Li, Lee, & Zhang, 2015; Raylu & Oei, 2004b). Nearly half of the student sample had never gambled, with range restriction especially evident on the continuous measure of problem gambling. Yet, the similar pattern of results with the crowdsourced samples of experienced gamblers suggests that data from non-gamblers can be relevant for addressing questions about gambling-related cognitions. Sample 2, recruited via MTurk, also suffered an intentional range-restriction by focusing recruitment on experienced gamblers. Consistent with other research using crowdsourcing samples (Angus, Pickering, Keen, & Blaszczynski, 2021; Kim & Hodgins, 2017; Mishra & Carleton, 2017; Walters, Christakis, & Wright, 2018), Sample 3 oversampled the moderate risk (9.00%) and problem gambling (7.60%) PGSI categories at much higher rates than the estimated prevalence of these categories (Currie et al., 2013), possibly indicating that those who gamble frequently are more likely to engage in a gambling-related survey. We also explained our results using the longstanding effect size convention of Cohen (1988), and this considers most of our effects as small. However, individual differences research often has small effect sizes and alternative guidelines exist. Gignac and Szodorai (2016) analyzed 708 correlations from 87 meta-analyses within individual differences research. They suggested $r = 0.11$ (small), $r = 0.20$ (medium), and $r = 0.29$ (large) because these values represented the 25th, 50th, and 75th percentiles of reported correlations. Thus, while many of our effects are “small” they can be considered meaningful within this context.

CONCLUSIONS

This study demonstrates that the previously documented links between the schizophrenia and gambling problems are not limited to clinical diagnoses, but also exist within the healthy population as a function of trait schizotypy. The relationships between the ‘traditional’ gambling-related cognitive distortions of predictive control, illusory control, and interpretive bias (Devos et al., 2020) were most pronounced with the schizotypy factors of cognitive-perceptual features and disorganized thought. Whereas, the broader conceptualization of luck, and a belief in personal bad luck exhibited a moderate relationship with the schizotypal traits of interpersonal deficits. Whilst cross-sectional, our results support the need for future studies testing the longitudinal hypothesis that high trait schizotypy may be a risk factor for disordered gambling. These findings thus implicate the nexus between delusional and magical thinking, and decision-making distortions as candidate psychological mechanisms for understanding the comorbidity between schizophrenia and gambling disorder (Potenza & Chambers, 2001).

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SUPPLEMENTARY MATERIAL

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