Personality and Individual Differences 169 (2021) 110400

Contents lists available at ScienceDirect

Personality and Individual Differences

journal homepage: www.elsevier.com/locate/paid

Applicability of the four-factor personality vulnerability model for substance misuse in understanding gambling behaviour and gambling problems

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ARTICLE INFO

Keywords:
Gambling
Personality
Risk factors
Addiction
Impulsivity
Hopelessness

ABSTRACT

The four-factor vulnerability model posits that the personality factors of hopelessness, anxiety sensitivity, impulsivity, and sensation seeking are relevant for engagement in and escalation of addictive behaviours (Conrod et al., 2000a). While initially validated for substance misuse, this model has not yet been utilized in studying behavioural addictions such as disordered gambling. We investigated the relationship between the four-factor personality variables and gambling frequency/problems using the Substance Use Risk Profile Scale (SURPS; Woicik, Stewart, Pihl, & Conrod, 2009), the Gambling Timeline Followback (G-TLFB; Weinstock, Whelan, & Meyers, 2004), and the Problem Gambling Severity Index (PGSI; Ferris & Wynne, 2001), respectively. Data were collected from a university sample (Study 1; $N = 255$) and a mixed sample of university and community-recruited adult gamblers (Study 2; $N = 198$). In cross-sectional regression analyses, impulsivity predicted gambling frequency and problems across samples; hopelessness predicted concurrent gambling problems in the mixed sample. Study 2 included a six-month follow-up assessment, allowing for longitudinal analyses. Hopelessness predicted escalation in gambling problems, and impulsivity predicted escalation in gambling frequency. Overall, our results demonstrate the utility of the four-factor vulnerability model as a tool for gambling research while identifying impulsivity and hopelessness as personality risk factors for frequent and problematic gambling.

Disordered gambling is associated with a wide array of harms, including financial difficulties, strain on interpersonal relationships, psychological distress, negative health effects, isolation and shame, reduced occupational performance, and criminal activity. These harms have a significant impact on the individual as well as their relatives, friends, and partners (Ladouceur, Boisvert, Pépin, Loranger, & Sylvain, 1994; Langham et al., 2016). The global prevalence of disordered gambling is estimated to be 1.5% (Gowing et al., 2015).

Identification of vulnerability factors for the development of disordered gambling is essential for early intervention with gamblers who may be at risk for disordered gambling. Personality has been extensively explored as one such vulnerability factor due to the relative stability of personality traits over the lifespan (Borghuis et al., 2017; Ferguson, 2010). Specific personality vulnerabilities have been proposed as important etiological variables within several theoretical frameworks of disordered gambling. The most widely-recognized such framework, the pathways model (Blaszczynski & Nower, 2002), proposes that there are three distinct "pathways" to disordered gambling, with two of these involving distinct personality vulnerabilities. The first consists of emotionally vulnerable (EV) gamblers who tend to experience a high degree of negative affect (i.e., high neuroticism) and gamble primarily to relieve such negative affect. The second comprises antisocial/impulsive (AI) gamblers who possess impulsive and antisocial traits (e.g., high trait impulsivity) that promote excessive gambling and co-occurring substance misuse. The third comprises behaviourally conditioned (BC) gamblers whose gambling problems stem less from dispositional factors and more from ecological factors (e.g., availability), forces of conditioning (e.g., early big wins), and distorted cognitions that support continued play. Moon, Lister, Milosevic, and Ledgerwood (2017) found three clusters roughly analogous to those

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https://doi.org/10.1016/j.paid.2020.110400
Received 22 January 2020; Received in revised form 22 July 2020; Accepted 13 September 2020
Available online 16 October 2020

theorized in the pathways model in a non-treatment seeking sample of disordered gamblers.

Similar yet distinct personality and motivational pathways have been found in relation to substance use disorders – a set of non-behavioural addictions that share many similarities with disordered gambling (see Rash, Weinstock, & Van Patten, 2016, for a review). Conrod, Pihl, Stewart, and Dongier (2000) posited that there are four personality vulnerabilities for substance misuse, each associated with particular sensitivities to certain drug reinforcement effects (e.g., anxiolytic, analgesic, stimulant reward), certain risky motivations for substance use, and specific forms of psychopathology that are commonly comorbid with substance misuse (e.g., anxiety disorders, mood disorders, antisocial personality disorder). These four personality vulnerabilities are anxiety sensitivity, hopelessness, impulsivity, and sensation seeking (Conrod, Pihl, et al., 2000).

Anxiety sensitivity is broadly defined as a fear of anxiety-related sensations (Reiss, Peterson, Gursky, & McNally, 1986), and is associated with a variety of anxiety disorders (Olatunji & Wolitzky-Taylor, 2009), many of which are highly comorbid with disordered gambling (Petry, Stinson, & Grant, 2005). Several studies have found a link between high anxiety sensitivity and substance misuse, particularly with respect to sedatives (Chinneck et al., 2018; Mahu et al., 2019), but also for tobacco (Leventhal & Zvolensky, 2015) and cannabis (Farris, Metrik, Bonn-Miller, Kahler, & Zvolensky, 2016). Theoretically, anxiety sensitivity might also be related to disordered gambling risk by increasing an individual's sensitivity to the distracting nature of some forms of gambling (see Cartmill, Slatter, & Wilkie, 2015). More specifically, people high in anxiety sensitivity might be drawn to gambling to provide a temporary escape from feared arousal sensations and/or anxious emotions. Although there is limited research into the relationship between anxiety sensitivity and disordered gambling, a recent study found that anxiety sensitivity was indirectly positively related to excessive gambling via a tendency to gamble alone (Bristow, Bilevicius, Stewart, Goldstein, & Keough, 2018).

The personality trait of hopelessness reflects a stable, global pessimism about the future (Beck, Steer, Beck, & Newman, 1993; Young et al., 1996). This pessimism includes negative expectancies about the likelihood of positive events occurring in one's future, and a feeling of helplessness and inability to act to increase this likelihood (Abramson, Metalsky, & Alloy, 1989). Hopelessness has been theorized to be a contributing cause of depression (Abramson et al., 1989; Joiner et al., 2001). Conrod, Pihl, et al. (2000) proposed that those high in hopelessness may be motivated towards the use of substances that have analgesic effects (e.g., opioids), as a coping mechanism to numb psychic pain. This preference has been demonstrated through associations between hopelessness and the misuse of opioids in undergraduates and methadone-maintained opioid use disorder samples alike (Chinneck et al., 2018; Mahu et al., 2019). Hopelessness has also been indirectly associated with alcohol use disorder and problem drinking via depressive symptoms and coping motives (Baines, Jones, & Christiansen, 2016; Stewart et al., 2016). This information, particularly when viewed in concert with the high levels of comorbidity between disordered gambling, depression, and SUD (Kessler et al., 2008; Petry et al., 2005), draws parallels between hopelessness and the EV gambler subtype from the pathways model (Blaszczynski & Nower, 2002; Moon et al., 2017). Thus, theoretically, high trait hopelessness might confer an increased risk for the development of disordered gambling.

Impulsivity has been defined as "the tendency to react rapidly in decision-making or behaviour with a lack of forethought" (Hodgins & Holub, 2015, p. 699). Impulsivity is one of the diagnostic criteria for both antisocial and borderline personality disorders (American Psychological Association, 2013), both of which are highly comorbid with disordered gambling (Bagby et al., 2007). Disordered gamblers with comorbid antisocial personality disorder have also been shown to exhibit greater impulsivity than controls (Blum, Leppink, & Grant, 2017). SUD is also highly comorbid with disordered gambling (Kessler et al., 2008; Petry et al., 2005). Impulsivity has been consistently associated with substance misuse (e.g. Verdejo-García, Lawrence, & Clark, 2008), particularly with stimulant use (Conrod, Stewart, et al., 2000; Conrod, Pihl, et al., 2000), an unconstrained pattern of substance misuse (Chinneck et al., 2018), and with risky means of substance use (e.g., injection drug use; Mahu et al., 2019). Impulsivity has also been extensively researched as a potential risk factor for disordered gambling. Using both self-report and behavioural measures, high trait impulsivity has been consistently associated with disordered gambling (e.g., Ioannidis, Hook, Wickham, Grant, & Chamberlain, 2019; MacLaren, Fugelsang, Harrigan, & Dixon, 2015).

Sensation seeking is defined as a "need for varied, novel and complex sensations and experiences and the willingness to take physical and social risks for the sake of such experience" (Zuckerman, 1979, p.10). Sensation seeking has been consistently associated with substance misuse (Hamdan-Mansour, Mahmoud, Al Shibi, & Arabiat, 2018; Sargent, Tanski, Stoolmiller, & Hanewinkel, 2010) in particular with heavy drinking (Conrod, Stewart, Comeau, & Maclean, 2006), cannabis use (Mahu et al., 2019), and stimulant misuse (Chinneck et al., 2018; Mahu et al., 2019). Sensation seeking is also associated with substance use motives involving a desire to enhance experiences and pleasurable emotional states (Comeau, Stewart, & Loba, 2001). With respect to gambling, Kim and Grant (2001) found disordered gamblers to be significantly higher in "novelty seeking", a construct which is highly correlated with sensation seeking (McCourt, Gurrera, & Cutter, 1993), on the Tridimensional Personality Questionnaire (TPQ; Cloninger, 1987) than both healthy controls and a clinical comparison group of individuals with OCD. Myrseth, Pallesen, Molde, Johnsen, and Lorvik (2009) similarly found disordered gamblers to score significantly higher than non-disordered gamblers on the Need for Stimulus Intensity subscale of the Arnett Inventory of Sensation Seeking (AISS; Arnett, 1994).

The Substance Use Risk Profile Scale (SURPS; Woicik, Stewart, Pihl, & Conrod, 2009) was developed as a brief measure of anxiety sensitivity, hopelessness, impulsivity, and sensation seeking. The 23-item SURPS is the first personality scale to capture all four of these traits concurrently without the need for additional measures, allowing for efficient data collection in surveys (Woicik et al., 2009). In an initial validation study (Woicik et al., 2009), SURPS scores exhibited incremental validity in predicting symptoms of alcohol dependence over a measure tapping the Five-Factor Model (FFM) of personality, a personality theory with less addiction-focused specificity (Costa & McCrae, 1992). The SURPS has since been validated for use in a variety of countries and cultural settings (Newton et al., 2016; Robles-García et al., 2014) and has demonstrated good predictive validity in longitudinal research on risk factors for substance misuse (Castellanos-Ryan, O'Leary-Barrett, Sully, & Conrod, 2013; Krank et al., 2011).

Despite the validation and adoption of the SURPS for measuring personality risk in substance use, its use in the study of behavioural addictions such as disordered gambling is still in its infancy (Bristow et al., 2018). There is a wealth of evidence for partially shared etiology between disordered gambling and substance misuse. This includes high comorbidity between SUDs and disordered gambling (Kessler et al., 2008; Petry et al., 2005), shared genetic vulnerabilities as evidenced by twin studies (Slutske, Ellingson, Richmond-Rakerd, Zhu, & Martin, 2013), as well as similarities in brain activity on decision-making tasks and in pursuit of rewards (Tanabe et al., 2007; Worhunsky, Malison, Rogers, & Potenza, 2014) and even FFM personality vulnerability profiles (Hopwood et al., 2007; MacLaren, Best, Dixon, & Harrigan, 2011). Given this overlap and certain shared vulnerabilities, as well as theory to suggest the role of each of Conrod, Pihl, et al.'s (2000) four traits in risk for disordered gambling, the SURPS may also prove useful for identifying personality risk factors for disordered gambling. The two current studies sought to investigate the utility of the SURPS as a predictor of disordered gambling (Studies 1–2) and gambling frequency (Study 2), both concurrently (Studies 1–2) and longitudinally (Study 2), in both a university sample (Study 1) and a mixed sample of university

and community-recruited adult gamblers (Study 2).

1. Study 1

Rates of disordered gambling are especially high in youth aged 15–24 (Huang & Boyer, 2007), and may be even higher among university students. One study found first-year university students in Alberta to exhibit particularly high rates of disordered gambling, at 7.6% (Williams, Connolly, Wood, & Nowatzki, 2006), compared to Canada's general population rate of 2.0% (Cox, Yu, Afifi, & Ladouceur, 2005), and the global prevalence rate of 1.5% (Gowing et al., 2015). Those who frequently gamble at a young age are more likely to develop gambling problems later in life (Carbonneau, Vitaro, Brendgen, & Tremblay, 2015) and young gamblers progress from non-disordered gambling to disordered gambling more quickly than older gamblers (Carneiro et al., 2014). For these reasons, it is important to study risk factors for disordered gambling, including personality vulnerabilities, in emerging adulthood (18–25 years), particularly among university students. The SURPS was originally validated for substance misuse risk in emerging adult university students (Woicik et al., 2009) but it remains to be determined if it is a valid tool for assessing personality risk for disordered gambling. This was the focus of Study 1. We predicted that each of the four SURPS scales (anxiety sensitivity, hopelessness, impulsivity, and sensation seeking) would positively and independently predict disordered gambling severity in a sample of university student gamblers.

2. Study 1: Method

2.1. Participants

A total of 3562 students at an Alberta university completed an online survey about cannabis use (Loverock, Yakovenko, & Wild, 2020). Of these 3562 students, $n = 2601$ completed the PGSI. As respondents were not directly asked whether or not they gamble, to be eligible for the present study, students had to score 1 or higher on the Problem Gambling Severity Index (to confirm their status as someone who has gambled in the past year). This brought our sample down to $n = 235$. Of these $n = 235$, $n = 93$ (3.6%) met criteria for disordered gambling (a score of 3+ on the PGSI). The gender split of these $N = 235$ participants who completed the survey and scored 1+ on the PGSI was 61.4% male ($n = 143$), 37.8% female ($n = 88$), 0.8% other ($n = 2$); another 0.8% ($n = 2$) did not report their gender. $N = 168$ (71.2%) indicated that they were in a Bachelors' degree program, while $n = 64$ (27.3%) indicated that were in either a graduate or "other" degree program, and $n = 3$ (1.3%) did not respond. The participants who reported their gender as "other" were excluded from our analyses due to the small cell size of this group. A further $n = 37$ participants (including the $n = 2$ who did not respond to the question about their gender) were excluded from our analyses due to missing data, leaving the final sample size included in our analyses at $N = 196$.

2.2. Measures

2.2.1. Problem Gambling Severity Index (PGSI; Ferris & Wynne, 2001)

The PGSI is a disordered gambling screening questionnaire that consists of nine items designed to assess gambling severity. The PGSI asks questions such as "In the past 12 months, have you bet more than you could really afford to lose?". On each item, the participant's response can be scored 0 (never), 1 (rarely/sometimes), 2 (often), or 3 (always). Scores on the PGSI can range from 0 to 27 and are interpreted as follows: 0 = non-gambler/non-disordered gambler, 1–2 = low risk gambler, 3–7 = moderate risk gambler, and 8+ = high risk gambler. The PGSI has high internal reliability ($\alpha = 0.84$), good construct validity, and high concurrent validity with scores on other disordered gambling measures such as the South Oaks Gambling Screen ($r = 0.83$) (Ferris & Wynne, 2001).

2.2.2. Substance Use Risk Profile Scale (SURPS; Woicik et al., 2009)

The SURPS is a 23-item questionnaire used to assess personality characteristics that are particularly relevant to substance use risk. The SURPS consists of four subscales: anxiety sensitivity (e.g., "It's frightening to feel dizzy or faint"), hopelessness (e.g., "I feel that I'm a failure"), impulsivity (e.g., "I often involve myself in situations that I later regret being involved in"), and sensation seeking (e.g., "I would like to skydive"). These subscales correspond to the four traits conceptualized by Conrod, Pihl, et al. (2000) in their personality vulnerability model for substance misuse. Participants respond to each item on a four-point scale ranging from 1 (strongly disagree) to 4 (strongly agree). The SURPS subscales display acceptable to excellent internal reliability ($\alpha = 0.7$–0.9) as well as incremental validity over the NEO-FFI scales (Costa & McCrae, 1992) in predicting alcohol outcomes (Woicik et al., 2009).

2.3. Procedure

Stratified by year of enrolment, 12,000 university students aged 18 or older were randomly selected by the Registrar's Office and invited to participate in an email survey concerning cannabis use. The invitation included a link to an online information and consent form. Ultimately, 3562 students responded to the invitation, representing a 29.7% response rate. After providing informed consent, participants were able to access an online survey that included Study 1 measures and several other measures not used in the current study (e.g., cannabis use, other substance use, internet gaming). The survey took ~30–45 min to complete. Participants were credited CAD $5 on their university service cards as compensation.

2.4. Analyses

Analyses were conducted in SPSS 23. Multiple linear regression analysis was used to determine the degree to which the SURPS personality variables were concurrently associated with gambling problems. The regression included age, sex, monthly disposable income, and the four SURPS subscale scores as predictors, and PGSI total scores as the outcome. To address missing data, we conducted Little's MCAR test, and the results were significant ($p < .001$), indicating a potential pattern in missing data. Despite this, missing value analysis showed that we had < 5% missing data for all but one variable (monthly disposable income). This amount of missing data is considered less serious and there is evidence that almost any procedure for handling missing values, including listwise deletion, yields similar results (see Tabachnick & Fidell, 2019). To further evaluate the nature of the missing data, we conducted a series of *t*-tests to compare participants with missing data ($n = 37$) to those with complete data ($n = 196$). There were no significant differences between individuals who had missing data and those who did not on PGSI score or any of the predictor variables included in our regression, indicating that dropping these participants would not bias our results and that the missing data are likely missing at random (MAR). Based on this analysis, we proceeded with listwise deletion, given that there was no systematic bias in missingness for any variables of interest. An a priori power analysis was conducted in G*Power Version 3.1.9.4 to determine the adequate sample size to obtain a statistical power of 0.80 to observe a medium effect size ($f \geq 0.15$), using seven predictor variables. This power analysis determined that a sample of $N = 103$ would be required to obtain a power of 0.80 under these parameters, which we exceeded with our final sample of $N = 196$.

3. Study 1: Results

Demographic data from our final sample ($N = 196$) (including

participant age, gender, academic program, and monthly disposable income) and bivariate correlations between study variables appear in Table 1. Internal consistency was high for the PGSI (α = 0.93) and adequate-to-good for the four subscales of the SURPS (sensation seeking α = 0.71; anxiety sensitivity α = 0.73; impulsivity α = 0.73; hopelessness α = 0.89). The results of the multiple regression analysis predicting PGSI total scores are displayed in Table 2. Our model involving demographic variables and the four SUPRS personality factors was significant (adjusted R^2 = 0.12, F (7,188) = 4.81, p < .001), predicting 12% of the variance in PGSI scores. The impulsivity subscale of the SURPS emerged as an independent positive predictor of total PGSI scores (β = 0.32, t (189) = 4.36, p < .001) after controlling the effects of the demographic variables and the other personality factors. None of the other SURPS subscales and none of the sociodemographic variables were significant independent predictors of PGSI scores.

4. Study 1: Discussion

Study 1 examined the utility of the SURPS in predicting concurrent gambling problems on the PGSI in a sample of Canadian university students. Our hypothesis that all four personality traits from Conrod, Pihl, et al.'s (2000) personality vulnerability model would be predictive of concurrent PGSI scores was only partially supported by our results. Impulsivity was the only SURPS variable that emerged as an independent predictor of disordered gambling severity in our model. This finding that high impulsivity is associated with greater severity of gambling-related problems in emerging adults is consistent with the existing literature, both with respect to university students (MacLaren et al., 2011) and other populations such as treatment-seeking gamblers (Myrseth et al., 2009) and electronic slot machine players (MacLaren et al., 2015). Given that impulsivity has been shown to predict disordered gambling longitudinally (see Dowling et al., 2017 for review), and that younger gamblers have been shown to progress from regular gambling to disordered gambling much more quickly that older gamblers (Carneiro et al., 2014), early identification and intervention for those at risk is perhaps especially salient for younger gamblers such as emerging adult university students. Impulsivity has also been shown to predict poorer treatment outcomes and early dropout in disordered gambling samples (Mallorquí-Bagué et al., 2018), underscoring the importance of developing treatments that specifically target this trait in order to improve outcomes for highly impulsive gamblers.

With respect to our null findings for positive associations between the other SURPS variables and gambling problems when considering the four personality vulnerabilities simultaneously, there are several possible explanations. First, the survey did not ask any specific questions about gambling behaviours beyond the PGSI, and it is possible that the other SURPS traits of sensation seeking, anxiety sensitivity, or hopelessness might have been significant predictors of more specific gambling behaviours, such as frequency of gambling. Lastly, the current analysis was conducted cross-sectionally, which precludes the observation of changes in gambling severity over time, which still might be predicted by other SURPS variables.

It is also worth mentioning the disparity between the prevalence of disordered gambling in our student sample and that of Williams et al. (2006) who also sampled from a population of Alberta university students; 3.6% of our sample scored 3+ on the PGSI, signifying "moderate to high risk" gambling which is a commonly used metric of disordered gambling in the prevalence literature (Cox et al., 2005; Gowing et al., 2015). Notably, this figure is less than half of that reported by Williams et al. (2006) in their study of Alberta undergraduate students (7.6%) using the same criteria, which could be due to differences between our samples. In Williams et al.'s study, the sample consisted of only first-year undergraduate students from three separate programs of study, while our sample was a stratified sample intended to be representative of all students at the university, including graduate students and undergraduates in any year of their program. Thus, while similar, our samples were reflective of different populations, and our sample is likely more representative of university students as a whole due to stratified sampling and much larger sample size. Additionally, when using a more stringent definition of disordered gambling reflective of more severe gambling problems (a score of 8+ on PGSI), our prevalence rates were comparable to those of the Williams et al. study (1.7% vs 1.4%, respectively). Nonetheless, our prevalence rates should be interpreted with caution, as they were calculated using the number of participants who filled out the PGSI (n = 2601) as the denominator rather than the n = 3562 including those who completed the survey but did not fill out the PGSI. Since the PGSI was our only measure of gambling behaviours in this survey, we have no way of knowing what percentage of the n = 961 participants who did not fill out the PGSI did not do so because they did not gamble, which would translate to a score of 0 on the PGSI; as such, our prevalence rates may be inflated. We sought to address some of these limitations in Study 2 by sampling from a population of self-reported gamblers.

5. Study 2

In Study 2, we sought to replicate the results from Study 1 in a sample that included older gamblers to see if the results of Study 1 would generalize to a broader sample, while also extending this line of inquiry by addressing some of the key methodological limitations identified for Study 1. To do so, we recruited gamblers from the community in addition to university student gamblers, added a second measure of gambling behaviour (i.e., gambling frequency) in addition to the PGSI, and introduced a follow-up assessment to allow for longitudinal analyses. Given that the null findings for anxiety sensitivity, hopelessness, and sensation seeking may have been partially or wholly attributable to the limitations of Study 1, we again hypothesized that each of the four factors of the SURPS would positively and uniquely predicts PGSI score and past month gambling frequency, both at baseline and 6-months later.

6. Study 2: Methods

6.1. Participants

We recruited a sample of 197 adult gamblers from the community and universities in the Canadian provinces of Nova Scotia, Manitoba, and Ontario. Of our total sample, 45.2% (n = 89) reported that they were currently university students, with the rest being community-recruited (n = 108; 54.8%). Additionally, N = 78 (39.6%) reported that their highest level of education attained was at least a college or undergraduate degree. Gamblers were defined as those who self-reported gambling two or more times in the past month (not including lottery tickets). Of the total sample, 68.5% (n = 153) met criteria for moderate/high-risk gambling according to the more liberal cut-off score of 3+ on the PGSI; using the more conservative cut-off score of 8+, 27.4% (n = 54) met criteria for disordered gambling.[1] The mean age of the sample was 33.7 (SD = 14.1) years; 64.0% (n = 126) identified as men, and 36.0% (n = 71) identified as women. Participants were asked to complete a follow up at six months after their initial lab session; retention at follow-up was 57.9% (n = 114).

6.2. Measures

As in Study 1, the SURPS was administered at baseline to assess the four personality characteristics of interest and the PGSI was used to

[1] Although these figures may seem high compared to the prevalence rates reported for Study 1, it is important to note that this sample consisted entirely of self-identified gamblers, unlike Study 1 which consisted of university students who were not directly recruited for their status as a gambler.

Table 1
Demographics and bivariate correlations for Study 1 (N = 196).

			Bivariate Correlations (r)							
Variable	Mean	SD	Age	Disposable income	Anxiety sensitivity	Hopelessness	Sensation seeking	Impulsivity	PGSI	Gender
Age (in years)	22.8	4.36	–							
Monthly disposable income ($CAD)	624.52	1286.15	0.03	–						
Anxiety sensitivity	12.98	2.65	−0.09	−0.08	–					
Hopelessness	12.94	3.63	0.04	−0.18*	0.11	–				
Sensation seeking	16.29	3.09	−0.07	−0.03	−0.12	−0.29**	–			
Impulsivity	10.78	2.73	−0.18*	−0.05	0.15*	0.22**	0.14*	–		
PGSI	3.74	4.61	−0.05	−0.07	0.06	0.18*	0.06	0.34**	–	
Gender (% female)	(44.8%)	–	−0.03	−0.02	0.25**	−0.03	−0.14	0.04	−0.13	–

Gender coded as = 1 for male, 2 for female. Correlations between Gender and other variables are point-biserial.
* $p < .05$.
** $p < .01$.

Table 2
Summary of regression analyses predicting PGSI score (Study 1; N = 196).

Variable	b	β	SE	R^2	F
Gender	−1.23	−0.13	0.67	–	–
Age	0.10	−0.86	0.07	–	–
Monthly disposable income	0.00	−0.04	0.00	–	–
SURPS anxiety sensitivity	0.07	0.04	0.12	–	–
SURPS hopelessness	0.13	0.10	0.10	–	–
SURPS impulsivity	0.53***	0.32	0.12	–	–
SURPS sensation seeking	0.04	0.03	0.11	–	–
				0.12	4.81***

*$p < .05$. **$p < .01$. ***$p < .001$. Gender coded as 1 = male, 2 = female.

assess gambling-related problems. Unlike in Study 1, the PGSI was administered both during a baseline session as well as at a 6-month follow-up session. Additionally, the Gambling Timeline Followback (G-TLFB; Weinstock, Whelan, & Meyers, 2004) was used as a measure of gambling frequency. The G-TLFB is used to enhance participants' memory accuracy with respect to their gambling episodes through reference to a calendar and significant memorable events in the individual's life. It has been shown to have adequate to excellent test-retest reliability for both frequent gamblers (r = 0.75 to 0.96) and disordered gamblers (r = 0.73–0.93), as well as convergent validity with daily self-monitoring reports (r = 0.59–0.87). For the present study, we were only concerned with the number of gambling episodes in the past 6-months reported on the G-TLFB. As with the PGSI, the G-TLFB was administered both at the initial lab session as well as at the 6-month follow-up session to allow for longitudinal analyses. The demographic variables used in Study 2 were modelled on those used in Study 1, with the addition of ethnicity, and were included in the online survey. The income variable used in Study 2 was annual income instead of Study 1's monthly disposable income, and participants were asked to respond using a Likert-type scale corresponding to different income brackets; the median income bracket was $20,000–$40,000, which is on par with the median individual income of Canadians of $34,204 reported in the most recent national census (Statistics Canada, 2017).

6.3. Procedure

Printed and online advertisements were used for recruitment. The advertisements invited people over the age of 19 who had gambled at least two times in the past month (not including on lottery tickets) to participate in a study on mood and gambling. Respondents to the advertisement completed a telephone screen with a research assistant to determine eligibility for the study. The telephone screen included questions about their age, gambling habits, and whether they were currently in treatment for a gambling problem (an exclusion criterion). Eligible participants were invited into the lab where, after giving their informed consent, they proceeded to complete both the G-TLFB and the PGSI with a research assistant, followed by a survey that included demographic measures and the SURPS. Completion of all measures took approximately 20 min. Participants then booked a time to return in 6 months for an identical follow-up session and were compensated CAD $20. After completion of the follow-up session, participants were debriefed and provided an additional CAD $20 compensation. Following participation in the study, participants were provided a pamphlet on disordered gambling, including information on accessing local services.

6.4. Analyses

As in Study 1, all analyses were conducted in SPSS 23. Multiple regression analyses were used for both the cross-sectional and longitudinal analyses to determine the degree to which SURPS variables were predictive of gambling frequency and problems, respectively. As in Study 1, the two cross-sectional regressions (one for each outcome) included age, sex, monthly income, and the four SURPS subscale scores as predictors, with days gambled in the past 6 months at baseline or PGSI total scores at baseline as the outcome variables, respectively. The two longitudinal regressions included the same predictors as the cross-sectional regressions along with baseline days gambled or baseline PGSI scores as additional predictors, respectively. Days gambled in the past six months at the follow-up, or PGSI total scores at the follow-up served as the outcome variables, respectively. Even with high attrition (42.9%), we still retained a reasonably high number of participants (n = 114) at follow-up, and only 1 participant was excluded from the regression analyses due to listwise deletion. As with Study 1, analyses were restricted to participants with full data on all variables of interest and who scored a minimum of 1 on the PGSI total score, which amounted to a final sample of N = 184 for cross-sectional analyses and N = 106 for longitudinal analyses. As in Study 1, an a priori power analysis was conducted in G*Power to determine the adequate sample size to obtain a statistical power of 0.80 to observe a medium effect size ($f \geq 0.15$), using 7 predictor variables (for cross-sectional analysis) and eight predictor variables (for the longitudinal analyses controlling for baseline gambling measures). The power analysis determined that we needed N = 103 participants to achieve a power of 0.80 to detect a medium effect size using 7 predictor variables, which we exceeded for the cross-sectional analyses, and N = 109 participants to achieve the same power to observe an effect size of 0.80 with 8 predictors in the longitudinal analyses, which we were slightly below in our final analyses (actual power = 0.79) due to attrition between the baseline and follow-up sessions and exclusion of participants with a PGSI score of 0. However, relaxing our exclusion to include.

7. Study 2: Results

Demographic data and a bivariate correlation matrix are displayed

Table 3
Demographic data and bivariate correlations for Study 2.

	Mean (median)	SD	Anxiety sensitivity	Hopelessness	Impulsivity	Sensation seeking	PGSI (baseline)	PGSI (follow-up)	G-TLFB (baseline)	G-TLFB (follow-up)	Age	Gender	Annual income
SURPS anxiety sensitivity	16.01	3.81	–										
SURPS hopelessness	15.11	4.62	0.03	–									
SURPS impulsivity	13.99	4.09	0.23**	0.20**	–								
SURPS sensation seeking	20.02	5.30	−0.08	−0.31**	0.22**	–							
PGSI (baseline)	5.93	4.59	0.21**	0.36**	0.44**	−0.21**	–						
PGSI (follow-up)	6.00	4.88	0.22*	0.42***	0.33**	−0.16	0.76**	–					
G-TLFB days gambled (baseline)	10.57	8.59	0.00	0.12	0.16*	−0.17*	0.24**	0.18	–				
G-TLFB days gambled (follow-up)	9.85	9.88	−0.05	0.18	0.20*	−0.20*	0.31**	0.24*	0.62**	–			
Age	33.70	14.12	0.05	0.17*	−0.06	−0.36**	0.24**	0.24*	0.39**	0.45**	–		
Gender (% Female)	(36.0%)	–	−0.27***	−0.08	0.00	0.19**	−0.08	−0.06	0.16*	0.15	0.13	–	
Annual income (CAD)	($20,000–40,000)	1.27	0.03	0.01	−0.08	−0.13	0.07	0.02	0.25**	0.27	0.39**	0.09	–

in Table 3. The income breakdown was as follows: 48.7% reported an annual income of less than $20,000 ($n$ = 96), 28.9% reported an income between $20,000 and $40,000 ($n$ = 57) and 22.3% reported an income of greater than $40,000 ($n$ = 44). Internal consistencies were as follows: PGSI α = 0.84; SURPS hopelessness α = 0.83; SURPS anxiety sensitivity α = 0.67; SURPS sensation seeking α = 0.76; and SURPS impulsivity α = 0.77. A series of t-tests were conducted to examine differences between participants who did and did not complete the follow-up assessment. Participants who did not complete the follow-up were younger on average (M = 28.90, SD = 11.05) than those who did complete (M = 37.16, SD = 15.10), $t(194) = -4.21$, $p < .001$, $d = 0.66$, 95% CI [−12.13, −4.36]. Additionally, participants who did not complete the follow-up scored lower, on average, on their baseline PGSI (M = 4.51, SD = 4.11) than those who did complete (M = 6.34, SD = 4.91), $t(195) = -2.77$, $p = .006$, $d = 0.40$, 95% CI [−3.14; −0.53].

7.1. Cross-sectional analyses

The results from the multiple regressions predicting baseline PGSI score and concurrent days gambled measured by the G-TLFB are displayed in Table 4. Taken together, the demographic variables and personality risk factors predicted a significant 33% of variance in PGSI scores (adjusted $R^2 = 0.33$, $F(7,176) = 12.57$, $p < .001$). Among the demographic variables, age emerged as an independent positive predictor of concurrent PGSI scores ($\beta = 0.20$, $t(183) = 2.84$, $p = .005$). Partially consistent with hypotheses, hopelessness ($\beta = 0.17$, $t(183) = 2.59$, $p = .011$) and impulsivity ($\beta = 0.40$, $t(183) = 6.689$, $p < .001$) were also positively associated with PGSI score. Contrary to hypothesis, sensation seeking ($\beta = -0.16$, $t(183) = -2.21$, $p = .028$) was *inversely* associated with PGSI scores. Also contrary to hypothesis, anxiety sensitivity was not a significant unique predictor of concurrent PGSI score.

For our multiple regression analysis predicting number of days gambled in the previous month at initial assessment, the demographic variables and personality risk factors together predicted a significant 22% of the variance in gambling frequency (adjusted $R^2 = 0.22$, $F(7,176) = 7.17$, $p < .001$). Age emerged as a unique positive predictor of days gambled in the past month ($\beta = 0.28$, $t(183) = 3.585$, $p < .001$), as did annual income ($\beta = 0.17$, $t(183) = 2.37$, $p = .019$).

Table 4
Summary of cross-sectional multiple regression predicting PGSI and past month days gambled at baseline (Study 2).

Variable	b	β	SE	R^2	F
DV: Baseline PGSI score					
				–	–
Gender	−0.38	−0.40	0.64	–	–
Age	0.07**	0.20	0.02	–	–
Annual income	0.17	0.05	0.25	–	–
SURPS Anxiety Sensitivity	0.17*	0.17	0.07	–	–
SURPS hopelessness	0.09	0.08	0.08	–	–
SURPS impulsivity	0.45***	0.40	0.08	–	–
SURPS sensation seeking	−0.14	−0.16	0.06	–	–
				0.59	17.51***
DV: Baseline days gambled in last 30 days (G-TLFB)					
				–	–
Gender	2.04	0.11	1.28	–	–
Age	0.17***	0.28	0.05	–	–
Annual income	1.17*	0.17	0.50	–	–
SURPS anxiety sensitivity	−0.03	−0.08	0.14	–	–
SURPS hopelessness	−0.18	−0.02	0.16	–	–
SURPS impulsivity	0.52***	0.25	0.16	–	–
SURPS sensation seeking	−0.18	−0.11	0.13	–	–
				0.17	7.17***

*$p < .05$. **$p < .01$. ***$p < .001$.
Gender coded as 1 = female, 2 = male.

Table 5
Summary of longitudinal multiple regression predicting PGSI and past month days gambled at 6 month follow-up.

Variable	*b*	β	SE	R^2	*F*
DV = PGSI at follow-up					
Gender	0.25	0.02	0.74		
Age	0.03	0.08	0.03		
Annual income	−0.13	−0.03	0.26		
Baseline PGSI	0.71***	0.69	0.08		
SURPS anxiety sensitivity	0.17	0.13	0.09		
SURPS hopelessness	0.17*	0.16	0.08		
SURPS impulsivity	−0.10	−0.09	0.09		
SURPS sensation seeking	0.04	0.05	0.07		
				0.59	17.51***
DV = G-TLFB days gambled in last 30 days at follow-up					
Gender	1.40	0.07	1.74		
Age	0.12	0.17	0.06		
Annual income	0.83	0.11	0.63		
Baseline G-TLFB days	0.47***	0.44	0.09		
SURPS anxiety sensitivity	−0.29	−0.11	0.21		
SURPS hopelessness	0.03	0.01	0.18		
SURPS impulsivity	0.54**	0.23	0.21		
SURPS sensation seeking	−0.17	−0.10	0.16		
				0.45	9.83***

*$p < .05$. **$p < .01$. ***$p < .001$.
Gender coded as 1 = female, 2 = male.

Impulsivity was the only SURPS variable to emerge as a significant and unique concurrent predictor of days gambled in the past month ($\beta = 0.25$, t (183) = 3.34, $p = .001$).

7.2. Longitudinal analyses

Results from our longitudinal multiple regression analyses predicting PGSI scores and G-TLFB days gambled in the last month at 6-month follow-up are displayed in Table 5.

Our longitudinal regression model predicting PGSI scores at 6 month follow-up included gender, age, annual income, baseline PGSI score, and the SURPS variables as predictors, and was significant (adjusted $R^2 = 0.59$, $F = 17.51$ $p < .001$), predicting 59% of the variance in concurrent PGSI scores. As expected, baseline PGSI emerged as a strong, independent positive predictor of follow-up PGSI scores ($\beta = 0.69$, $t(105) = 8.73$, $p < .001$). Hopelessness ($\beta = 0.16$, t (105) = 2.23, $p = .028$) emerged as the only significant SURPS predictor, positively predicting follow-up PGSI scores. Anxiety sensitivity trended towards significance as an independent positive predictor of PGSI score at follow-up ($\beta = 0.13$, $t(105) = 1.83$, $p = .07$).

For our longitudinal multiple regression analysis predicting the number of days gambled in the previous month at follow-up assessment, gender, age, annual income, and baseline G-TLFB days gambled in the past month were included as predictor variables and the model was significant (adjusted $R^2 = 0.45$, F (8,97) = 9.83, $p < .001$), predicting 45% of the variance in days gambled in the past month at follow-up. As expected, baseline days gambled in the past month significantly and positively predicted days gambled in the past month at follow-up ($\beta = 0.44$, t (105) = 5.08, $p < .001$). Similar to the results of the cross-sectional regression analysis predicting days gambled in the past month at baseline, impulsivity was the only SURPS variable to emerge as a significant predictor, positively predicting days gambled in the past month at follow-up ($\beta = 0.23$, $t(105) = 2.64$, $p = .010$).

8. Study 2: Discussion

The results of Study 2 demonstrated a longitudinal association between impulsivity and change in PGSI scores, which replicated and extended the cross-sectional association between these variables observed in Study 1. Hopelessness emerged as a second positive predictor of concurrent PGSI score, and sensation seeking as an inverse predictor of concurrent PGSI score. Impulsivity also positively predicted gambling frequency as measured by the G-TLFB and was the only SURPS variable to do so. Anxiety sensitivity did not significantly predict scores on either of our gambling measures. and sensation seeking predicted gambling problems in the opposite direction to that hypothesized. While our hypotheses for cross-sectional analyses were only partially supported, these results further highlight the importance of impulsivity as a potential risk factor for gambling problems, while also identifying impulsivity as an important trait associated with higher gambling frequency.

With respect to the longitudinal analyses, our hypotheses were once again partially supported: baseline impulsivity predicted an escalation in gambling frequency from baseline to follow-up, whereas hopelessness predicted an escalation in gambling problems. The differences in gambling outcomes predicted by impulsivity vs. hopelessness concurs with extant research from the gambling motives literature, as hopelessness and the related personality trait of neuroticism have been associated with coping motives for substance misuse (Mackinnon, Kehayes, Clark, Sherry, & Stewart, 2014; Theakston, Stewart, Dawson, Knowlden-Loewen, & Lehman, 2004). A recent study by Grubbs and Rosansky (2020) found baseline endorsement of coping motives to uniquely predict future gambling problems six months later, including when controlling for baseline gambling behaviours, similar to the effect of hopelessness in the present study. It is important to note that we were slightly underpowered (power = 0.79) for our longitudinal analyses due to attrition from baseline to follow-up, which is a limitation of the present study. Nonetheless, we were adequately powered when we did not drop those gamblers with a PGSI score = 0, and the pattern of results was the same when the regression was run without those gamblers excluded.

9. General discussion

The current two studies presented here were conducted to garner preliminary validation for the use of the SURPS to identify personality risk factors relevant to disordered gambling. Thus, this study represents the first known application of the full four-factor personality vulnerability model (Conrod, Pihl, et al., 2000) towards behavioural addictions.

Based on previous findings that each of the four SURPS scales has been implicated in substance abuse risk (e.g., Conrod, 2016; Conrod, Pihl, et al., 2000), we hypothesized that each of these traits would be unique positive predictors of our two measures of gambling involvement. We hypothesized that this effect would be observed both concurrently and longitudinally, across both a university student sample and a mixed sample of community-recruited and university student gamblers. Overall, our hypotheses in both studies were partially supported.

Though comparisons of results between the two studies must be made cautiously given differences in populations sampled and study design, impulsivity and hopelessness clearly emerged as the two SURPS traits most consistently associated with gambling problems and frequency. Only one finding emerged for sensation seeking (Study 2 concurrent prediction of gambling problems) and, contrary to prediction, that was a protective effect.

With respect to impulsivity, our results add to the existing literature (e.g., Ioannidis et al., 2019) implicating impulsivity as a highly important risk factor in the development of disordered gambling. In fact, impulsivity predicted escalations in gambling frequency in the longitudinal analyses with the mixed gambler sample of Study 2. Contrary to prior evidence that impulsivity predicts escalation in PGSI scores (see Dowling et al., 2017), we did not find impulsivity to be related to an increase in PGSI scores from baseline to follow-up, however. One explanation is that there was a relatively short interval between sessions

in our study in comparison to other longitudinal studies. For example, Shenassa, Paradis, Dolan, Wilhelm, and Buka (2012) found childhood impulsive behaviour to predict future gambling problems; however, their follow-up interview was conducted over 30 years after initial assessment. Given the evidence put forth by the Dowling et al. (2017) meta-analysis that implicates impulsivity as a positive prospective predictor of future gambling problems, it may be that we would have seen such an effect had we included a longer follow-up interval. Additionally, the studies in the Dowling et al. (2017) review were conducted longitudinally from a young age before gambling behaviours generally begin, while our Study 2 was conducted on individuals who are already gamblers; this may help explain our failure to observe a longitudinal effect of impulsivity on disordered gambling severity.

The fact that we observed an escalation in gambling frequency predicted by impulsivity over this interval might suggest that changes in gambling behaviour occur prior to, and mediate, longer-term changes in gambling-related problems. Alternatively, SURPS impulsivity may be more predictive of future gambling behaviour than the consequences of said behaviour. The finding supports the connection between impulsivity and an increase in risk-oriented behaviour such as gambling but is inconsistent with the hypothesized clinical features of the AI subtype from the pathways model (Blaszczynski & Nower, 2002), which posit that greater impulsivity should predict greater impairment and pathology.

The idea that trait hopelessness would predict an escalation in future gambling problems is consistent with the EV gambler subtype theorized in the pathways model (Blaszczynski & Nower, 2002). EV subtype gamblers have been shown to gamble in order to cope with negative affective states (Moon et al., 2017), and disordered gamblers with comorbid depression also endorse high rates of coping motives (Quigley et al., 2015). Though we did not measure gambling motives and their relation to the SURPS variables in the present study, hopelessness has been shown to be related to coping motives for alcohol use (Mackinnon et al., 2014) and high hopelessness may lead to negative drinking outcomes indirectly via these motives (Baines et al., 2016). As such, future studies using the SURPS to examine risk factors for disordered gambling should include measures of gambling motives such as the Gambling Motives Questionnaire (GMQ; Stewart & Zack, 2008) to properly evaluate the mechanism of action through which the SURPS traits confer increased risk of gambling problems.

Our finding of sensation-seeking inversely predicting concurrent gambling problems in Study 2 was unexpected, though not entirely inconsistent with the prior literature. A previous review of sensation-seeking and disordered gambling conducted by Hammelstein (2004) found that all 13 studies reviewed using the SSS-V (Zuckerman, 1994) as a measure for sensation seeking found gamblers and disordered gamblers to exhibit either no significant differences or *lower* sensation seeking than controls. Blaszczynski, Wilson, and McConaghy (1986) posited that the variable results in the literature with respect to the relationship between sensation seeking and disordered gambling may be due to differences in sensation seeking between gamblers who prefer different types of gambling games (e.g., horse race betting vs slot machines). This would mirror the heterogeneity found between substances when using the SURPS to predict substance misuse (Conrod, Pihl, et al., 2000). However, Hammelstein (2004) also questioned the validity of the SSS-V as a measure of sensation seeking in gambling samples and noted that this may partially account for the mixed effects observed with this measure. Given our variable results concerning the relationship between sensation seeking and PGSI scores in our two studies, there may also be issues with the validity of the sensation seeking subscale of the SURPS when applied to gambling; however, more research using the SURPS in gambling populations is needed before this can be concluded. Additionally, it is worth noting that in two studies (Kim & Grant, 2001; Myrseth et al., 2009) using alternative measures of sensation seeking (the AISS and the TPQ, respectively) rather than the SSS-V, sensation seeking was found to be positively associated with disordered gambling, consistent with our theoretical hypothesis. Given that the observed result of sensation seeking inversely predicting gambling problems was not observed in our student only sample (Study 1) and did not appear in the longitudinal analyses for Study 2, it is important to cautiously interpret this finding about the possible protective effects of high sensation seeking on concurrent disordered gambling. Regardless, our finding that impulsivity and sensation seeking predicted concurrent disordered gambling in opposite directions in the mixed sample (Study 2) highlights the important differences between these two constructs (e.g., Magid, MacLean, & Colder, 2007).

While interpreting the novel effects of hopelessness and sensation seeking in Study 2 that were not observed in Study 1, there are several points worth noting. First, Study 2 was conducted in an older sample (*M* age = 33.7 years) than Study 1 (*M* age = 22.8 years). Age appeared as a significant positive predictor of scores on both gambling measures in Study 2. This may suggest that hopelessness and sensation seeking are especially important risk and resilience variables for gambling problems and frequency in middle-aged adult gamblers, more so than in emerging adult university student gamblers. Given the established association between hopelessness and depression (Beck et al., 1993; Young et al., 1996), it is possible that our mixed sample from Study 2 had higher rates of psychiatric comorbidity than the student only sample from Study 1, which may help account for the lack of consistency in the significance of this result across studies. Additionally, Study 2 specifically recruited gamblers, whereas Study 1 did not. While we maintained the inclusion criteria of a score ≥ 1 on the PGSI in Study 2 to be consistent with Study 1, our pattern of results was the same with and without this inclusion criterion.

Contrary to our hypotheses, we found no significant effects in any of the regressions relating anxiety sensitivity to gambling problems or gambling frequency across either study. Although there was a marginal effect ($p = .07$) of anxiety sensitivity positively predicting gambling problems longitudinally in Study 2, this was not observed cross-sectionally in either model, further limiting our ability to interpret this effect meaningfully. Although the link between anxiety sensitivity and substance misuse has been established (e.g., Mahu et al., 2019), and anxiety sensitivity seems to dovetail with the EV disordered gambling subtype theorized in the pathways model (Blaszczynski & Nower, 2002), the link between anxiety sensitivity and disordered gambling in the previous literature is unclear. Some studies have found a positive relationship between anxiety sensitivity and excessive gambling (Bristow et al., 2018), while others have found anxiety sensitivity to be negatively related to gambling related risk-taking behaviours such as performance on the Iowa Gambling Task (Broman-Fulks, Urbaniak, Bondy, & Toomey, 2014). Notably, in Bristow et al.'s study, the link of anxiety sensitivity to excessive gambling was not direct. Rather it was an indirect effect – mediated through solitary gambling. It is also possible that there is a direct effect of anxiety sensitivity to disordered gambling only for some but not all gamblers. Future studies should include potential moderators. For example, it is possible that anxiety sensitivity predicts disordered gambling only among gamblers who are also highly trait anxious (see Stewart & Kushner, 2001).

Given that certain SURPS variables have been shown to predict specific forms of substance use behaviour (e.g., hopelessness predicting opioid use; anxiety sensitivity predicting sedative use; impulsivity predicting stimulant use; sensation seeking predicting heavy drinking; Conrod, Pihl, et al., 2000), it stands to reason that the same might be true for different modalities and forms of gambling. Moreover, it may be that some types of gamblers are more susceptible to the protective, risk-aversion-inducing elements of anxiety (Giorgetta et al., 2012) while others gamble as a coping mechanism to distract them from their anxiety.

9.1. Limitations and future directions

The time lag of six months between baseline and the follow-up

assessment may not have been long enough to observe changes in gambling outcomes from Time 1 to 2. To address this, future longitudinal studies using the SURPS to identify risk factors for disordered gambling should include a longer interval between assessments to allow for greater precision in assessing escalation of gambling problems and behaviours; alternatively, a shorter interval could be used to examine the relations of personality to shorter-term fluctuations in gambling behaviour and problems, which could be accomplished through daily diary methods.

We also did not evaluate the incremental validity of the four-factor model against any other competing models of personality. Future studies seeking to validate the SURPS for disordered gambling should include a measure of a competing personality model such as the FFM (Costa & McCrae, 1992) to allow for an assessment of incremental validity, as several FFM traits (e.g. high neuroticism, low conscientiousness) have been associated with disordered gambling (Bagby et al., 2007). Another potential candidate for model comparison in future studies seeking to determine the incremental validity of the SURPS is the reinforcement sensitivity theory of personality (Corr & Cooper, 2016), as reward reactivity (a component of this personality theory involving sensitivity to feeling pleasure in response to rewards) has been shown to positively predict disordered gambling (Farrell & Walker, 2019).

In addition, though we measured impulsivity as a unitary construct through the SURPS, other research has shown that various facets of impulsivity are differentially associated with both coping and enhancement motives and in turn, alcohol use and alcohol related problems (Curcio & George, 2011). The fact that we did not evaluate impulsivity at the facet level may be another limitation of the current study. Had we separated impulsivity into its facets, as is possible with measures such as the Urgency, Premeditation, Perseverance, and Sensation Seeking Impulsivity Scale (UPPS; Whiteside & Lynam, 2001), we may have observed differential effects of the facets on our two gambling outcomes. To address this limitation, future studies using the SURPS to evaluate disordered gambling should consider also including a separate measure of impulsivity such as the UPPS to investigate the relationship between high trait impulsivity and gambling outcomes with greater precision.

Another potentially promising area of future research extending the scope of our present line of inquiry would be to apply a similar methodology while separating gamblers according to their preferred game or modality of play (e.g., online vs in casino). In the present set of studies, we considered “gamblers” to be a unitary and cohesive group. However, gamblers who prefer different types of gambling activities (e.g., electronic slot machines, lottery, poker) have been shown to exhibit differences in temperament (Challet-Bouju et al., 2015) similar to what others (e.g., Conrod, Pihl, et al., 2000; Mahu et al., 2019) have found with respect to the SURPS and different substance preferences. If one were to conceptualize the differences between two forms of gambling, such as slot machine gaming vs poker, as akin to the differences between two substances, such as cannabis and alcohol, a similar effect may be found such that different SURPS scales predict preferences for different gambling activities that meet distinct needs.

Aside from its potential utility as a brief, easy-to-administer screening tool for identifying individuals who may be at risk of escalating their gambling frequency or of developing more severe gambling problems, another important potential future use for the SURPS is in matching individuals with disordered gambling to treatment that best suits their own personality and gambling motive profile.

Personality-matched treatments that specifically target the four factor variables of the SURPS have been shown to be effective interventions in reducing substance use problems (see Conrod, 2016, for a review of randomized controlled trials). Moreover, some studies have compared personality-matched treatments that target the SURPS variables and related motives to control treatments and found personality targeted treatments to be more effective than control treatments in reducing substance use problems (Conrod, Stewart, et al., 2000; Olthuis, Watt, MacKinnon, & Stewart, 2015; Watt, Stewart, Birch, & Bernier, 2006). Cluster analysis of the motivations for gambling has found evidence for a cluster involving primarily enhancement motives directed towards increasing positive affect and another cluster involving primarily coping motives directed towards relief from negative affect (Stewart, Zack, Collins, Klein, & Fragopoulos, 2008), that are consistent with our findings with respect to impulsivity and hopelessness, respectively, as well as the motivations outlined for the IA and EV subtypes in Blaszczynski and Nower's (2002) pathways model, respectively. A pilot case series intervention study conducted by Stewart, Davis-MacNevin, Hodgins, Barrett, Swansburg, and Stewart et al. (2016) used a novel *BEAT Gambling* CBT treatment program, which specifically targets these underlying motivations as a part of the treatment process, to treat disordered gamblers who were matched to treatment in line with their primary motivations for gambling (enhancement or coping). Stewart et al. (2016) showed that this motivation matched treatment was effective for most participants in reducing gambling activity and severity from pre- to post-treatment and at 6-month follow up. This preliminary pilot study, in concert with the present results, highlights the promise and need for further controlled research into the efficacy of personality and motivation matched treatments for disordered gambling to assure that disordered gamblers are receiving the best standard of care available.

In terms of explaining our results through the lens of existing theoretical models of gambling, our findings that hopelessness and impulsivity predict gambling severity and frequency gives further credence to the EV and AI pathways towards disordered gambling from the pathways model (Blaszczynski & Nower, 2002). However, though this study provides a starting point and promising preliminary evidence in favour of the use of the SURPS in identifying risk pathways towards disordered gambling, more research is needed before we can conclude that the four-factor personality vulnerability model is useful in interventions for disordered gambling treatment and prevention.

Acknowledgements/funding sources

The research reported in this paper was partially supported by funding from the Canadian Research Initiative in Substance Misuse (CRISM|Prairies), the Canadian Institutes of Health Research (MOP 137073), and the Manitoba Gambling Research Program (MGRP-LG-12-11). Additionally, SHS was supported through a CIHR Tier 1 Canada Research Chair in Addictions and Mental Health, and AJG was supported through a Tier 2 Canada Research Chair in the Psychology of Emerging Adulthood.

CRediT authorship contribution statement

Eli Otis: Conceptualization, Methodology, Formal analysis, Writing - original draft, Writing - review & editing. **Igor Yakovenko:** Conceptualization, Funding acquisition, Data curation, Resources, Investigation, Methodology, Formal analysis, Writing - review & editing, Supervision, Project administration. **Simon Sherry:** Investigation, Writing - review & editing. **Martin Smith:** Investigation, Writing - review & editing. **Abby Goldstein:** Funding acquisition, Investigation, Writing - review & editing, Project administration. **Michael Ellery:** Funding acquisition, Investigation, Writing - review & editing, Project administration. **Alexandra Loverock:** Investigation, Data curation, Writing - review & editing. **T. Cameron Wild:** Investigation, Funding acquisition, Data curation, Writing - review & editing. **Benjamin Weilgart-Whitehead:** Investigation, Writing - review & editing. **Sherry H. Stewart:** Conceptualization, Funding acquisition, Data curation, Resources, Investigation, Methodology, Formal analysis, Writing - review & editing, Supervision, Project administration.

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