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# Exploring a Multidimensional Approach to Impulsivity in Predicting College Student Gambling

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## Abstract

Impulsivity has been implicated as a contributing factor in the development of gambling problems among college students, but attempts to confirm this relation have been inconsistent. One explanation for these incongruent findings is that impulsivity may be multidimensional and that distinct dimensions differentially predict separate behaviors. Using a large, diverse sample of college students, a factor analysis of self-report measures related to impulsivity revealed a three-factor structure of Behavioral Activation, Preference for Stimulation, and Inhibition Control that was similar to the structure found by Meda and colleagues (2009) in a different adult sample. Low risk gamblers and symptomatic gamblers scored significantly lower on Behavioral Activation and Inhibition Control than non-gamblers. Conversely, low risk gamblers and symptomatic gamblers scored significantly higher on Preference for Stimulation. Prevalence of gambling and gambling activity preference for this sample was also assessed.

Late adolescents and young adults are primed to behave impulsively and readily exposed to a multitude of opportunities to gamble (Goudriaan, Slutske, Krull, & Sher, 2009). Cortical immaturity in this age group appears to contribute to greater sensation and novelty seeking that translates to increased impulsivity (Chambers & Potenza, 2003; Steinberg et al., 2008). Some suggest that adolescent and young adult impulsivity may be linked to this cohort's higher than expected rate of gambling and problem gambling (e.g., Villella et al., 2011). The published research on this question, however, has yielded mixed results. Some have found that adolescent and adult gamblers are more impulsive than controls (e.g., Ledgerwood, Alessi, Phoenix, & Petry, 2009; Powell, Hardoon, Dervensky, & Gupta, 1999; Loxton, Nguyen, Casey, & Dawe, 2008), while others have found gamblers have comparable or less

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impulsiveness than controls (Langewisch & Frisch, 1998; Petry, 2001). In a recent paper on impulsivity in at-risk drug and alcohol users, Meda and colleagues (2009) argued that there are multiple dimensions of impulsivity and only specific dimensions would be associated with specific behavior excess. Inconsistent findings in the gambling literature may be due to variations in the one-dimensional impulsivity facet that is measured. The present investigation used a multidimensional and comprehensive profile of impulsivity related measures to consider if the factors of impulsivity found by Meda et al. (2009) replicated in a college student sample and if these factors corresponded to gambling frequency and gambling pathology.

Gambling occurs when something of value, often money, is risked on an outcome that is determined at least partially by chance (Whelan, Steenbergh, & Meyers, 2007). A review of prevalence studies reported that approximately 87% of college students have gambled (Shaffer, Hall, & Vander Bilt, 1999) and between 42%, and 75% (Barnes, Welte, Hoffman, & Tidwell, 2010; LaBrie, Shaffer, LaPlante, & Wechsler, 2003) gambled in the past year. About 9% appeared at-risk for the development of gambling problems during their lifetime and 4.7% were likely to meet diagnostic criteria for pathological gambling (Shaffer et al., 1999). When compared to their peers, college students who gambled at a diagnosable level performed more poorly in their classes and engaged in a wider variety of risk taking behaviors including excessive alcohol consumption, drug use, and unprotected sex (Engwall, Hunter, & Steinberg, 2004; LaBrie et al., 2003). They were also more likely to experience significant emotional, financial, and social distress due to their gambling compared to their peers (Weinstock, Whelan, & Meyers, 2008).

Impulsivity is a possible risk factor for the development of gambling problems (e.g., Petry, 2001), although research has not consistently supported this hypothesis (Allcock & Grace, 1988; Langewisch & Frisch, 1998; Petry, 2000). One explanation for this inconsistency is that studies typically approach impulsivity as a uni-dimensional construct. It is possible that the discrepancy is due to failure to adequately assess urges and impaired control over mental behavior that in turn drive the impulsive gambling behavior (e.g. Blaszcynski, 1999; Frost, Meagher, & Riskind, 2001; Blanco et al., 2009). It is reasonable that the decision to gamble, the adoption of wagering as a preferred activity, urges to continue to gamble, and the resistance to stopping gambling despite losing reflect different types of impulsivity. Therefore, a multidimensional approach to impulsivity measurement might provide a more comprehensive explanation for gambling behavior (e.g., Nower & Blaszczynski, 2006).

A multidimensional approach to impulsivity has received theoretical and empirical support. Reynolds, Ortengren, Richards, and de Wit (2006) defined impulsivity as “a multidimensional concept that includes inability to wait, a tendency to act without forethought, insensitivity to consequences, and an inability to inhibit inappropriate behaviors” (p. 306). Additional efforts have also been made to operationalize impulsivity as multiple, discrete, personality facets that lead to impulsive behavior (Whiteside & Lynam, 2001; Whiteside, Lynam, Miller, & Reynolds, 2005).

More recently, Meda and colleagues (2009) attempted to clarify dimensions of the construct from a perspective of substance abuse risk. The measures of impulsivity chosen by Meda et al. (2009) were selected for their established ability to connect subsets of behaviors related to impulsivity to aspects of substance abuse. The study included three groups: individuals at-risk for addiction, former and current cocaine addicts, and healthy controls. All participants completed a series of self-report impulsivity related measures and two behavioral impulsivity related measures. Measures were chosen based on their use in the addiction literature and their relevance to theoretically unique impulsivity related dimensions (Meda et al., 2009). A factor analysis of the subscales of these measures indicated a five-factor model that accounted for about 70% of the variance. The first three dimensions were assessed with self-report measures. The subscales of the Behavioral Inhibition/Activation Scale (Carver & White, 1994) comprised the first factor. The subscales of the Sensitivity to Punishment and Sensitivity to Reward Questionnaire (Torrubia, Ávila, Moltó, & Caseras, 2001) and the Padua Inventory total score (Sanavio, 1988) loaded on the second. The Barratt Impulsiveness Scale: 11$^{th}$ Version second-order subscales (Patton, Stanford, & Barratt, 1995), and the Sensation Seeking Scale Form-V total score (Zuckerman, 1996) comprised the third factor. The final two factors were behavioral tasks included to measure state impulsivity. Meda and colleagues' (2009) findings indicated increased impulsivity on the second and third factors were related to higher risk for addiction. The substance use literature that informed the measure selection in Meda et al., (2009) has also informed measure selection in impulsivity related research with gamblers. Gambling investigations have largely used the self-report measures identified by Meda et al.'s first three factors; however, investigators have not considered how these specific measures intersect to predict different gambling behaviors (e.g., Blanco et al., Breen & Zuckermann, 1999; Langewisch & Frisch, 1998; Ledgerwood et al., 2009; Loxton et al., 2008; Powell et al., 1999).

The current study explored the relations among the assessment tools completed by a diverse college sample, and investigated how dimensions related to impulsivity correspond to gambling pathology and gambling frequency. It was hypothesized that with a comprehensive and multidimensional measure of impulsivity, specific factors related to impulsivity would emerge as strong correlates for gambling pathology and gambling frequency. It was also hypothesized that the factors revealed by Meda et al. (2009) in a drug abusing and at-risk for addiction sample would replicate in a sample of college students who gamble.

## Method

### Participants

To ensure a diverse sample, recruitment was completed at three universities: one southern university (*n* = 279) and two northeastern institutions (*n* = 97). For inclusion in the study, participants needed to be between 18 and 25 years of age ($M_{age}$ = 19.55; *SD* = 1.72), as research has shown a marked decrease in impulsivity after age 25 years (Steinberg et al., 2008). Participants were 55.6% female (*n* = 209). The participants placed themselves in ethnic and racial categories, as follows: 54.8% Caucasian, 32.2% African American, 3.2% Hispanic, 2.7% Asian, 0.5% American Indian, 0.3% Native Hawaiian or Other Pacific Islander, and 6.4% Other.

## Measures

**Demographic Questionnaire—**Participants completed a demographics questionnaire to assess their age, gender, race, and ethnicity. Questions about family history of gambling, and maximum amounts of money gambled in a single day were also included.

**National Opinion Research Center Diagnosis Screen (NODS)—**The NODS (Toce-Gerstein, Gestein, & Volberg, 2003) is based on the *DSM-IV* diagnostic criteria for Pathological Gambling. It has a single factor structure and is sensitive for identifying pathological gambling among individuals older than 17 years (Toce-Gerstein et al., 2003). A score of 0 to 2 indicates low risk gamblers. A score of 3 – 4 indicates at-risk pathological gambling. Five or greater equates to meeting diagnostic criteria. Given the base rate of at-risk and pathological gamblers, this project classified any gamblers experiencing adverse symptoms as symptomatic gamblers. Non-gamblers and low risk gamblers have overlapping scores of zero on the NODS and as such are combined in the regression analyses of gambling symptomatology. In this study, for the multivariate analysis of variance, non-gamblers were explicitly specified. The NODS has been shown to have an internal consistency of 0.79 and to have a 2- to 4- week test-retest reliability of 0.98. It detects problem gambling in 95% of individuals receiving treatment for problem gambling (Hodgins, 2004).

**Gambling Frequency Measure—**The frequency table used in the South Oaks Gambling Screen (Lesieur & Blume, 1987) was modified to assess the frequency of nine specific gambling activities. Specifically, the original frequency table was expanded to request that for each gambling activity participants indicate whether they gambled, “Not at all,” “A few times a year,” “About once a month,” “About once a week,” “A few times per week,” and “Almost daily.” This change allowed for a more precise estimate of gambling frequency. Gambling frequencies for each gambling activity and the total gambling frequency were calculated.

**Barratt Impulsiveness Scale: 11th version (BIS-11)—**The BIS-11 (Patton et al., 1995) was developed to assess biological and behavioral correlates of impulsiveness. Respondents ranked 30-items on a 4-point scale anchored to responses of “Rarely/Never,” “Occasionally,” “Often,” and “Almost Always.” There are three second-order factors or subscales (Stanford et al., 2009): attentional impulsiveness, motor impulsiveness, and nonplanning impulsiveness. Higher scores on any subscale indicate higher impulsivity (Patton et al., 1995). When tested in an adult sample ages 17–45, the three second order factors had Cronhach's alphas ranging from 0.59 to 0.74 (Stanford et al., 2009).

**Behavioral Inhibition/ Behavioral Activation Scales (BIS/BAS)—**The BIS/BAS (Carver & White 1994) assesses the two components of Gray's reinforcement sensitivity theory (Gray, 1970). Participants rate 24 questions on a 4-point scale (“Very true for me” to “Very false for me”). The BIS is used to assess the behavior inhibition system, and high BIS predicts feelings of anxiety and withdrawal behavior when placed in a new situation (Carver & White, 1994). The BAS assesses the behavioral approach system. High BAS predicts greater brain activation to positive events and a strengthened drive to behave in a way that produces approach behavior for both conditioned and unconditioned stimuli (Carver and White, 1994; Smillie, Pickering & Jackson, 2006). A factor analysis of the BIS/BAS using college students yielded three BAS-related subscales: Reward Responsiveness, Drive, and Fun Seeking. A fourth subscale, BIS, is theoretically opposite and psychometrically independent from the BAS scales (Carver & White, 1994). In an parametric analysis with a college students, Cronbach's alpha was 0.73 for Reward Responsiveness, 0.65 for Drive, .72 for Fun-Seeking, and 0.82 for the BIS subscale (Caseras, Avila & Torrubia, 2002).

**Sensation Seeking Scale: Form V (SSS Form V)—**This 40-item self-report measure indicates a person's affinity for or against a variety of activities considered risky behaviors or high sensation activities (Zuckerman, Eysenck, & Eysenck, 1978). The SSS Form V yields the total Sensation Seeking Score (Zuckerman et al., 1978). In an analysis of reliability and validity with college students, the SSS Form V total score showed moderate reliability with a Cronbach's alpha of 0.75 (Ridgeway & Russell, 1980).

**Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ)—**The SPSRQ (Torrubia et al., 2001) was also designed to assess BIS and BAS (Dawe & Loxton, 2004). The 48 yes-no questions assess two dimensions. The first, Sensitivity to Punishment (SP), assesses the inability to stop potential behavior when made aware of potential punishment, and the second, Sensitivity to Reward (SR), is the tendency to engage in goal-focused behavior in situations associated with reward (Torrubia et al., 2001). With a sample of college students, the Cronbach's alphas for SP and SR were .83 and .76, respectively (Caseras et al., 2003).

**Padua Inventory (PI)—**The PI (Sanavio, 1988) has been used to assess obsessionality and compulsivity in community samples. The measure was devised using statements made by individuals meeting criteria for obsessive compulsive disorders and then reduced through factor and item analysis to its present 60 items (Sanavio, 1988). The measure uses a five-point severity inventory (0 = not at all, 1= a little, 2 = quite a lot, 3 = a lot, 4 = very much). A score is obtained by summing all responses. The PI has also been used with clinical samples with Obsessive Compulsive Disorder and substance use disorders (Blanco et al., 2009). Cronbach's alpha with college students ranged from 0.77 to 0.89 (Sternberger & Burns, 1990).

## Procedure

The Institutional Review Boards of each university reviewed and approved the protocol. All participants were provided with informed consent materials that emphasized the voluntary nature of participation, a participant's right to withdraw, and the protection of confidentiality. Those providing consent were then administered the assessment packet.

Data collection procedures varied by site. At the southern university, participants were recruited from the undergraduate subject pool. They completed the survey questionnaires online during a single data collection session and were awarded course credit as compensation. At the two northeastern institutions, participants completed the measures as part of data collection for a large study looking at biomarkers of substance use in a college sample (Brain and Alcohol Research in College Students: BARCS: RO1 AA016599 and RC1 AA019036 to Dr. Godfrey Pearlson). Participants in this larger study completed half of the impulsivity questionnaires in computerized form during an initial visit and then the second half of the impulsivity questions online shortly following their initial visit. A few weeks following the initial sessions, a subset of subjects was randomly chosen for a follow-up appointment. This appointment allowed for a more comprehensive assessment battery that included the gambling assessment measures in paper and pencil form. Participants at the two northeastern schools were paid $15 per hour for the initial session, $10 for the online questionnaire, and $20 per hour for the follow-up session.

## Results

### Analytic Plan

The database was examined to determine if omitted items on impulsivity measures were missing at random (Brown, 2006; Downey & King, 1998). Any missing values were imputed as appropriate. To replicate the efforts of Meda et al. (2009), a principal components analysis with Varimax rotation was used to generate factor scores. The overall fit of the subsequent measurement model was also evaluated.

Once the factor structure was determined, factor scores were calculated and two sets of correlations and regressions were completed. The first set assessed impulsivity by gambling frequency, and the second analyzed impulsivity by a continuous variable symptomatology score. A multivariate analysis of variance was used to compare the effects of impulsivity factor scores on the gambling classifications of non-gamblers, low risk gamblers, and symptomatic gamblers.

### Missing Data

Unanswered responses were determined to be missing at random. Missing responses for the impulsivity items were uncommon; every item was completed by at least 95.4% of respondents. For any missing items in the impulsivity measures, an individual's item score was imputed using the sub-score average from the completed items. Missing data on the gambling frequency measure items and pathology measure (NODS) items were also uncommon (< 1%). Nonresponses on these measures were not added into individual sum scores. The data imputation allowed for 376 subjects to be included in the analyses.

### Gambling Behavior

Sixty-three percent ($n$ = 232) of participants gambled in the past year. The largest number (28.2%, $n$ = 106) indicated that the greatest single bet they had placed in the past year was more than $1 but less than $10. Twenty-one and a half percent ($n$ = 106) reported a greatest single bet of more than $10 but less than $100 and only 5% ($n$ = 19) had placed a single bet for more than $100 in the past year. Additionally, 10.2% ($n$ = 38) indicated that one or both of their parents had a gambling problem. Men were more likely than women to have gambled during the past year ($\chi^2$ (1, $n$ = 376) = 10.77, $p$ < .05), and minorities and Caucasians did not differ in their gambling frequency during the past year ($\chi^2$ (1, $n$ = 376) = 2.23, $p$ =*.14*). The majority of participants gambled a few times per year and engaged in a variety of gambling activities with lottery ticket purchases being the most popular activity (39.6%, *n* = 149). As shown in Table 1, participants also endorsed gambling in a variety of other ways. Seventy-nine percent who endorsed having gambled in the past year reported engaging in more than one form of gambling.

Participants' past year NODS scores classified 36.4% (*n* = 137) as non-gamblers, 54.5% (*n* = 205) as low risk gamblers, and 9.1% (*n* = 34) as symptomatic gamblers. Male participants were significantly more likely to be symptomatic gamblers than female participants, $\chi^2$ (1, *n* = 376) = 18.54, $p < .05$. Caucasian and minority participants did not differ on their NODS scores, $\chi^2$ (1, *n* = 376) = .90, *p* = .34.

## Internal Consistency of Impulsivity Measures

The internal consistencies of the subscale scores included in the factor analysis were estimated using coefficient alpha with 95% confidence intervals (Iacobucci & Dunacheck, 2003). These values, shown in Table 2, ranged from .54 to .96.

## Factor Structure of Impulsivity Measures

Principal components analysis with Varimax rotation with Kaiser Normalization was performed to develop aggregate impulsivity factor scores for the proposed multidimensional set of impulsivity measures. The Kaiser-Meyer-Olkin Measure of sampling adequacy (.70) and the Bartlett's Test of Sphericity ($\chi^2$ (1, *n* = 55) = 1487.63, $p < .05$) indicated that the use of a factor analysis for structure detection was a valid test. The impulsivity domains aligned in a three factor structure when eigenvalues greater than 1.0 were extracted by the analysis. Following Gorsuch's recommendation (1983), a subjective examination of the scree plot supported that three factors be retained in the model. The eigenvalues for these three factors were 3.19, 2.29, and 1.41. These three factors accounted for 62.59% of the total item variance in the sample.

Results of the rotated component matrix can be seen in Table 3. The first component was titled Behavioral Activation. This factor was comprised of the BAS Drive subscale, the BAS Fun Seeking subscale, and the BAS Reward Responsiveness subscale and accounted for 24.5% of the variance. The second component, Preference for Stimulation, was comprised of the Sensation Seeking Scale total score, the SPSRQ Sensitivity to Reward subscale, and the three BIS-11 subscales of Attentional Impulsiveness, Motor Impulsiveness, and Nonplanning Impulsiveness. Preference for Stimulation accounted for 20.1% of the variance. Inhibition Control, the third component, accounted for 18% of the variance. It was comprised of the SPSRQ Sensitivity to Punishment subscale, the Padua total score, and the BAS BIS score. The BAS BIS score was reverse-scored at this point so it would load in a positive direction on the Inhibition Control factor. The strength and location of the loadings were unaltered by this reverse-scoring procedure.

To verify the factor structure, the overall fit of the measurement model was evaluated using Confirmatory Factor Analysis (e.g., Bollen, 1989). Because the impulsivity instruments used different measurement scales, subscale scores were standardized to z-values and the factor analysis was repeated. Subscales loaded identically on the rotated component matrix both

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pre- and post- standardization. The three-factor structure was cross-validated against a standardized model (e.g., Brown, 2006). Variance for the three factors was set to one. Behavioral Activation and Preference for Stimulation were allowed to covary because of their theoretical correlation, but Preference for Stimulation and Inhibition Control were constrained to zero. The model chi-square was rejected indicating that while the model fit was close, there was some variation from the assumed factor structure ($\chi^2$ (32) = 181.59, $p < .001$, GFI = .92). Conversely, the factor loading direction and relative magnitude were confirmed for all subscale loadings and all error variances were greater than zero. The ratio of the model chi-square to its degrees of freedom indicated a reasonable model fit (as recommended by Bollen, 1989, p. 278). These results indicate that while the model chi-square may be significantly different from the ideal standardized model, overall the model fit was good, with the variability of the data largely accounted for by the factor structure.[1]

## Relation between Impulsivity Factors and Gambling Behavior

The impulsivity measures used several different rating scales. In order to examine the relation between the three factors and gambling behavior, these scales were converted to standardized factor scores using a least squares regression approach to predict factor scores. A negative correlation was found between gambling frequency and Behavioral Activation, $r = -.16$, $p < .05$ with decreases in Behavioral Activation associated with increases in gambling frequency. A positive correlation was found between Preference for Stimulation and gambling frequency, $r = .26$, $p < .05$ where increases in Preference for Stimulation were associated with increases in gambling frequency. Significant correlations were not found between Inhibition Control and gambling frequency.

Regression analyses were then completed. The overall model of the three impulsivity factors significantly predicted gambling frequency, $R^2 = .10$, $F(3,372) = 14.26$, $p < .05$. A closer examination of how the individual factors contributed to the model indicated that Behavioral Activation scores, $b = -.16$, $t(375) = -3.34$, $p < .05$, and Preference for Stimulation scores, $b = .26$, $t(375) = 5.37$, $p < .05$ significantly contributed to the model, but Inhibition Control did not, $b = -.08$, $t(375) = -1.67$, $p = ns$.

A second set of correlations revealed a positive correlation between the score of gambling symptomatology and Preference for Stimulation $r = .10$, $p < .05$. No significant correlations were found between gambling symptomatology and Behavioral Activation or Inhibition Control. Higher scores on Preference for Stimulation were associated with higher rates of gambling symptomatology. However, when placed in a regression model, none of the impulsivity factors significantly predicted the NODS score, $R^2 = .01$, $F(3,372) = 1.77$, $p = ns$.

A multivariate analysis of variance compared the effect of each impulsivity factor score on gambling classification (non-gamblers, low risk gamblers, symptomatic gamblers). A non-

[1]Given the mixed findings for model fit, and because when model chi-square is calculated with more than three scales loading on one factor a significant amount of error variance is introduced to the model, an exploratory follow up model was run to consider the contributions of unexplained error variances to the model. This model revealed that the commonality for SPSRQ SR was 10%. This suggests that the factor structure left a sizable percent variance unexplained for the SPSRQ SR scale.

significant Box's test $F(12, 39132.76) = 1.77$, $p = ns$ suggested the homogeneity of variance-covariance matrix assumption was not violated.

Significant differences were found among the three impulsivity factors and the gambling classification, Wilks' $\lambda = .87$, $F(6,742) = 8.61$, $p < .05$. Follow-up univariate analyses of variance showed each impulsivity factor score significantly corresponded to gambling classification; Behavioral Activation, $F(2,373) = 6.55$, $p < .05$, Preference for Stimulation, $F(2,373) = 12.83$, $p < .05$, and Inhibition Control, $F(2,373) = 5.42$, $p < .05$. Post hoc comparisons for Behavioral Activation using the LSD test, showed that non-gamblers ($M = .20$, $SD = .95$) scored significantly higher than low risk gamblers ($M = -.06$, $SD=1.02$) and symptomatic gamblers ($M = -.43$, $SD = .88$). Additionally, low risk gamblers scored significantly higher than symptomatic gamblers. Comparisons for Preference for Stimulation revealed that non-gamblers ($M = -.29$, $SD = 1.03$) were significantly lower than low risk gamblers ($M = .10$, $SD = .95$), and symptomatic gamblers ($M = .55$, $SD = .83$). Low risk gamblers were also significantly lower than the symptomatic gamblers. Post hoc comparisons for Inhibition Control revealed that non-gamblers ($M = .22$, $SD = 1.01$) scored significantly higher than low risk gamblers ($M = -.12$, $SD = 1.01$) and symptomatic gamblers ($M = -.15$, $SD = .79$). Low risk gamblers and symptomatic gamblers were not significantly different from each other. See Figure 1.

## Discussion

Impulsivity has been identified as a risk factor for gambling-related problems with varying degrees of certainty (Langewisch & Frisch, 1998; Ledgerwood et al., 2009; Powell et al., 1999; Petry, 2001). One explanation for the inconsistent findings is that impulsivity may be a multidimensional construct (Reynolds et al., 2006; Whiteside & Lyman, 2001) and that different dimensions of impulsivity have different predictive values. Exploring this possibility, the current study had a diverse college student sample complete a set of impulsivity and gambling measures. In addition to closely replicating three of the impulsivity dimensions revealed by Meda and colleagues (2009), we found that these factors differentially related to gambling frequency and gambling symptomology.

The recruited sample was diverse. Over 55% were women and about 45% identified as an ethnic minority. The prevalence of gambling and symptomatic gambling in this cohort was consistent with reports in the literature. The rates of past year gambling and symptomatic gambling were consistent with national surveys of college student gambling (e.g., Barnes et al., 2010; LaBrie et al., 2003). On average, participants reported gambling a few times per year and a small number reported daily gambling. As intended, the sample was quite different from those participating in Meda et al. (2009). Meda et al's. study involved adults who were considered healthy controls, individuals at risk for alcohol abuse/dependence, or former and current cocaine addicts. Additionally, the Meda et al. (2009) study included a similar percentage of women, but fewer ethnic minorities.

Even employing a distinctly different sample, the factor structures and predictive ability of the factors identified in the current study were largely consistent with Meda et al. (2009). Also consistent with Meda and colleagues, the Behavioral Activation factor contributed the largest amount of sample variance. This factor was comprised of the three activation subscales of Carver and White's (1994) measure. All three subscales were developed to assess the reward drive system of Gray's theory of reinforcement sensitivity. Behavioral activation corresponds to an internal motivation system that drives cue response and reduces distance between a desired behavior and engagement in behavior. However, while scoring lower on behavioral activation corresponds to less time between desire for engagement and engagement, the behavioral activation system stops short of creating the initiation for engagement in or prediction of final behavior (Corr, 2002). These measures of the behavioral approach system capture aspects of cue response which allow prediction of a variety of health risk behaviors in college students including past month drinking and cigarette smoking involvement (O'Connor, Stewart, & Watt, 2008), as well as risk for alcohol and drug abuse (e.g., Franken, Muris, & Georgieva, 2006; Pardo, Aguilar, Molineuvo, & Torrubia, 2007).

Our second factor, Preference for Stimulation, is largely consistent with another of Meda and colleagues factors. It was made up of the Sensation Seeking Scale total score, the SPSRQ Sensitivity to Reward subscale, and the three BIS-11 subscales. This second factor can be conceptualized as a person's perceptions of whether they would actually initiate a specific risk behavior. The Sensation Seeking total score measures a propensity towards new and exciting behaviors (Zuckerman et al., 1978). While the Sensitivity to Reward subscale did not load on this factor during Meda and colleagues' initial factor analysis, the literature does provide support for its placement on this factor. The Sensitivity to Reward subscale includes questions intended to gain information about specific “situations in which people could do something to obtain rewards” (Torrubia et al., 2001, p. 844), and from its initial psychometric validation process, Sensitivity to Reward was shown to correlate strongly with sensation seeking. The BIS-11 was designed to capture rash impulsivity, as opposed to conceptualizing impulsivity as a desire to engage in pleasurable activities, and was intended to “relate impulsiveness, along with anxiety, to psychomotor efficiency” (Stanford et al., 2009, p. 386). Throughout the addiction literature, sensation seeking, sensitivity to reward, and rash impulsivity have been independently shown to be predictive of health risk behaviors, particularly alcohol and drug abuse (Jaffe & Archer, 1987, Johnson & Cropsey, 2000).

Our final factor was Inhibition Control. This factor was similar, but not identical, to a third factor found by Meda and colleagues (2009). The Padua Inventory was designed to capture obsessions and compulsions within a community sample (Sanavio, 1988). The behavioral inhibition system (BIS) is “a conflict resolution system; one that moves individuals towards a decision of behavior approach or avoidance by drawing attention to potential dangers of a behavior” (O'Connor et al., 2009, p. 515). The Sensitivity to Punishment scale was specifically designed to assess BIS activity (Torrubia et al., 2001). This subscale is sensitive to feelings of anxiety and worry as well as internal processing of high-risk behavior with uncertain outcome (Torrubia et al., 2001). Measures of Inhibition Control have been shown to correspond to increased substance use (e.g., O'Connor et al., 2008; Pardo et al., 2007, Simons & Arens, 2007; Sumnall, Wagstaff, & Cole, 2004). Within the substance use disorder literature, it is unclear if it is the anxiety that corresponds with high inhibition control that leads individuals to self-medicate, or if the converse occurs where those with high inhibition control are able to avoid high-risk behaviors because of their sensitivity to potential poor outcomes (Ball, 2005; Eitle & Traylor, 2010; O'Connor et al., 2009).

Meda et al. (2009) found no significant group differences on Behavioral Activation, but in our sample low risk and symptomatic gamblers scored significantly lower on Behavioral Activation than non-gamblers. Research with healthy controls has been able to show conclusively that those scoring higher on behavioral approach took larger risks in an experimental manipulation (Demaree, DeDonno, Burns, & Everhart, 2008). However, the limited findings on gamblers have shown, as in our sample, the inverse conclusion with gamblers scoring lower in behavioral activation than non-gamblers, and low behavioral activation scores corresponding to increased spending when gambling (O'Connor et al., 2008). An explanation is not apparent and further inquiry is needed.

Both in the present study and in Meda et al. (2009), those with higher addictive behavior symptomatology scored higher on Preference for Stimulation. Specific subscales within this factor have been shown independently to predict gambling behavior. In an adult sample, Ledgerwood and colleagues (2009) found specific subscales of rash impulsivity helped identify pathological gamblers. Similarly, Loxton et al. (2008) found adult pathological gamblers to be more impulsive and more sensitive to reward drive when compared to non-pathological gamblers when specifically measuring rash impulsivity and the sensitivity to reward subscale, respectively. Conversely, Langewisch and Frisch (1998) looked at male college students and found sensation seeking was related to gambling symptomatology for the non-pathological gambling group, but did not differentiate pathological gamblers from nonpathological gamblers. This suggests that the addition of rash impulsivity and sensitivity to reward may help further specify gambling risk in a more precise fashion from non-gambler to low risk gambler to symptomatic gambler.

On the factor of Inhibition Control, Meda et al. (2009) found healthy controls were less compulsive and less sensitive to punishment and reward than at risk and addicted individuals. In the current study this same pattern was not found. While individuals who have gambled before scored significantly lower on Inhibition Control than non-gamblers, Inhibition Control was not found to significantly correlate with gambling frequency or gambling symptomology. Another recent study has found similar results when looking at behavior inhibition and past month gambling behavior (O'Connor et al., 2008). Conversely, research looking at sensitivity to punishment and reward, or specifically at compulsivity in a sample of adult gamblers, found that problem gamblers were more sensitive to punishment and more compulsive than non-problem gamblers (Loxton et al., 2008, Skitch & Hodgins, 2004). The differentially predictive value of Inhibition Control for gamblers versus those at risk for or addicted to substances may be explained in at least two ways. First, it may be due to the different subscales loading on this factor than in the original study. Alternatively, these findings could provide further evidence that it is inability to inhibit and insensitivity to punishment (Vitaro, Arseneault & Tremblay, 1999, Vitaro & Wanner, 2011) that differentiates gamblers from other addicts.

While providing interesting findings on the relation between impulsivity and gambling, our study had several limitations. First, we did not theoretically approach the question of impulsivity. This was intentional as there continues to be a need to build an empirical foundation for the role of impulsivity in gambling in order to promote more complete theory building. For these empirical efforts, we chose a selection of impulsivity related measures that were commonly used in the addiction literature. However, these measures were not initially created with the intention that they serve as a comprehensive battery for impulsivity assessment. Second, despite a substantial sample size of similarly aged college students, the amount of variance predicted by the impulsivity model was small and the number of individuals with gambling symptomatology was modest. This prevented further investigations of gambling symptomology rates by region. Replication with a larger sample of symptomatic gamblers is necessary to further evaluate how these impulsivity factors correspond to high pathology gambling behavior. Finally, it is not clear that the NODS was the best tool to assess problem gambling in college students. The NODS was originally designed to sample adults and to date no research fully explains its utility in a college sample.

Given the rates of gambling pathology in college student samples, there is a continued need to identify impulsivity-based risk factors within this population. In order to more precisely define the risk, further attention should be paid to the impulsivity factors' utility in an over-sampling of college students who are gambling with high symptomatology. Additionally, future research efforts should begin to more precisely identify the specific items within the larger impulsivity factors that most strongly correspond to increased gambling frequency and increased gambling symptomatology. This will allow us to more succinctly specify the factors. By further specifying the impulsivity factors that predict gambling pathology we hope to build a more precise theory of the role of impulsivity in problematic gambling behavior.

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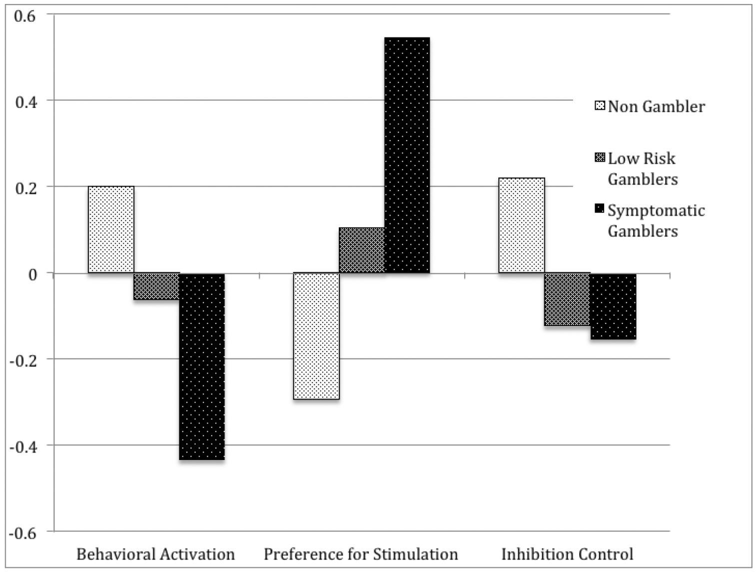


**Figure 1.**

Differences between non-gamblers, low risk gamblers and symptomatic gamblers on each Impulsivity Factor

*Note:* Non-gamblers are individuals who indicated they had not gambled in the past year. Low risk gamblers wagered in the past year without adverse effects as measured by the National Opinion Research Center Diagnosis Screen (NODS; Toce-Gerstein, Gestein, & Volberg, 2003). Symptomatic gamblers were those who reported experiencing at least one adverse effect from their gambling during the past year as measured by the NODS.


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## Table 1

Frequency of Past Year Gambling Involvement (n =376)

| | Not at all | | A few times a year | | About once a month | | About once a week | | A few times per week | | Almost daily | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Activity** | ***n*** | **%** | ***n*** | **%** | ***n*** | **%** | ***n*** | **%** | ***n*** | **%** | ***n*** | **%** |
| Cards | 282 | 75.0 | 81 | 21.5 | 9 | 2.4 | 1 | 0.3 | 0 | 0 | 0 | 0 |
| Animals | 350 | 93.1 | 17 | 4.5 | 7 | 1.9 | 2 | 0.5 | 0 | 0 | 0 | 0 |
| Sports | 283 | 75.3 | 70 | 18.6 | 13 | 3.5 | 7 | 1.9 | 2 | 0.5 | 1 | 0.3 |
| Dice | 341 | 90.7 | 23 | 6.1 | 7 | 1.9 | 2 | 0.5 | 2 | 0.5 | 1 | 0.3 |
| Lottery | 227 | 60.4 | 102 | 27.1 | 27 | 7.2 | 15 | 4.0 | 4 | 1.1 | 1 | 0.3 |
| Binso | 354 | 94.1 | 16 | 4.3 | 3 | 0.8 | 2 | 0.5 | 1 | 0.3 | 0 | 0 |
| Stock Market | 349 | 92.8 | 19 | 5.1 | 3 | 0.8 | 3 | 0.8 | 1 | 0.3 | 0 | 0 |
| Slots | 321 | 85.4 | 43 | 11.4 | 5 | 1.3 | 5 | 1.3 | 1 | 0.3 | 0 | 0 |
| Games of Skill | 281 | 74.7 | 65 | 17.3 | 17 | 4.5 | 4 | 1.1 | 6 | 1.6 | 1 | 0.3 |

*Note.* Participants who failed to indicate the frequency of which they gambled for an activity were excluded from the frequency count by item.

## Table 2

Internal Consistency of Impulsivity Measures with 95% Confidence Intervals

| Measure | Subscale | α | 95% CI |
|---|---|---|---|
| BIS-11 | Attention Impulsiveness | 0.72 | [0.67, 0.76] |
| BIS-11 | Motor Impulsiveness | 0.54 | [0.48, 0.61] |
| BIS-11 | Nonplanning Impulsiveness | 0.69 | [0.65, 0.74] |
| BIS- BAS | Drive | 0.79 | [0.76, 0.83] |
| BIS- BAS | Fun Seeking | 0.79 | [0.76, 0.83] |
| BIS- BAS | Reward Responsiveness | 0.95 | [0.94, 0.96] |
| BIS- BAS | BIS | 0.76 | [0.72, 0.79] |
| SSS | Total | 0.84 | [0.81, 0.86] |
| SPSRQ | Sensitivity to Punishment | 0.86 | [0.84, 0.88] |
| SPSRQ | Sensitivity to Reward | 0.82 | [0.79, 0.84] |
| Padua | Total | 0.96 | [0.96, 0.97] |

*Note.* CI = confidence interval. Barratt Impulsiveness Scale: 11th version (BIS-11; Patton et al., 1995), Behavioral Inhibition/ Behavioral Activation Scales (BIS/BAS; Carver & White, 1994), Sensation Seeking Scale: Form V (SSS; Zuckerman, Eysenck, & Eysenck, 1978), Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ; Torrubia et al., 2001) Padua Inventory (PI; Sanavio, 1988).

## Table 3

Rotated component matrix for the exploratory factor analysis (n=376)

| Measure | Subscale | Mean | SD | Behavioral Activation | Preference for Stimulation | Inhibition Control |
|---|---|---|---|---|---|---|
| BIS/BAS | Drive | 9.56 | 2.69 | **.81** | −.06 | .03 |
| BIS/BAS | Fun Seeking | 9.46 | 2.97 | **.84** | −.02 | −.18 |
| BIS/BAS | Reward Responsiveness | 10.27 | 5.04 | **.85** | .30 | −.19 |
| SSS | Total | 17.70 | 6.86 | −.03 | **.76** | −.33 |
| SPSRQ | SR | 12.01 | 5.69 | −.29 | **.51** | .25 |
| BIS-11 | Attention Impulsiveness | 17.25 | 3.90 | .24 | **.56** | .49 |
| BIS-11 | Motor Impulsiveness | 22.56 | 3.55 | .17 | **.75** | .04 |
| BIS-11 | Nonplanning Impulsiveness | 24.54 | 4.85 | .44 | **.50** | .25 |
| SPSRQ | SP | 11.51 | 4.81 | .00 | −.01 | **.82** |
| Padua | Total | 42.75 | 33.56 | −.18 | .20 | **.65** |
| BIS/BAS | BIS | 18.88 | 4.26 | −.46 | −.31 | **.58** |
| Variance explained (%) | | | | 28.99 | 20.83 | 12.78 |

*Note.* Factor loadings are the identical if measure scores are standardized or unstandardized. Highest factor loadings are in boldface. Barratt Impulsiveness Scale: 11$^{th}$ version (BIS-11; Patton et al., 1995) Behavioral Inhibition/ Behavioral Activation Scales (BIS/BAS; Carver & White, 1994), Sensation Seeking Scale: Form V (SSS; Zuckerman, Eysneck & Eysenck, 1978), Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ; Torrubia et al., 2001) Padua Inventory (PI; Sanavio, 1988).