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The Structure of Impulsivity in Pathological Gambling

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Abstract

Pathological gambling is a disorder of impulse control, and impulsivity has been shown to be a key characteristic of this disorder. Impulsivity has been theorized to be multidimensional. However, definitions of impulsivity vary across research perspectives and the factors that comprise impulsivity have not been clarified. Commonalities across theories include acting without planning, quick decision-making, reward sensitivity, boredom proneness, lack of forethought, poor behavioural inhibition, neurobiologically-based abnormalities, and neuropsychological dysfunction. In addition, sensation seeking is another personality characteristic associated with disordered gambling. This study investigated the structure of the trait of impulsivity in a sample of 104 pathological gamblers (51% female) using structural equation modeling (SEM). It was hypothesized that four components to impulsivity, reflecting major perspectives of research inquiry with pathological gamblers, would load on a single latent factor of impulsivity, which in turn would predict gambling severity. Sensation seeking was also hypothesized to predict gambling severity. Comorbid impulse control disorders and individual difference factors were also assessed.

Results of principal components analyses conducted prior to SEM suggested five, rather than four, factors related to impulsivity. The main finding from the SEM analyses, however, suggested that five components did not in fact load on a single latent factor of impulsivity. Only motor impulsivity, reward dependence, and sensation seeking were significantly related to severity of pathological gambling. These findings may suggest that the labeling of variables assessed from various research perspectives as impulsivity may not be appropriate. Instead, the characteristics termed impulsivity may in fact reflect distinct constructs. Theoretical, practical, and clinical implications of this finding are discussed.

Participants were found to score high on impulsivity and sensation seeking. There were no gender differences on impulsivity, sensation seeking, or pathological gambling, but sensation seeking seemed to decline with age. High rates of comorbid substance use and impulse control disorders not otherwise specified were found, consistent with prior research with pathological gamblers. Self-reported childhood ADHD was more prevalent in this

sample than general population base rates, suggesting that a cognitive-developmental risk factor may confer vulnerability to later impulse control disorders. Future research using longitudinal designs would help clarify this developmental pathway.

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INTRODUCTION

Gambling is defined as wagering something of value on an uncertain outcome. Many individuals today participate in a range of gambling activities such as stocks or other investments, lotteries, informal card games with friends and family, sports betting, casino games, slot machines, or video lottery terminals. For the majority of people, gambling is a harmless source of recreation. However, for about 1.5% of North American adults, gambling leads to psychological distress and impairment of relational, occupational, or adaptive functioning and would be described as pathological gambling (Shaffer & Hall, 2001; Shaffer, Hall, & Vanderbilt, 1999). Higher rates of pathological gambling (e.g., 4.0-7.4%) have been reported in adolescents (Derevensky & Gupta & Derevensky, 1998; Lesieur & Kline, 1987; Shaffer & Hall, 1996) and in university students (e.g., Oster & Knapp, 2001). Prevalence rates of pathological gambling also have been found to be higher in certain clinical samples, such as those with substance use disorders and in general psychiatric patients (prevalence rates between 7–39%; Raylu & Oei, 2002).

The major classification system for mental disorders in North American psychology and psychiatry categorizes Pathological Gambling under Impulse Control Disorders Not Otherwise Specified (Diagnostic and Statistical Manual of Mental Disorders; DSM-IV, APA, 2000). The characterization of pathological gamblers, particularly young gamblers, as highly impulsive has been well established in the gambling research literature (Blaszczynski, Steel & McConaghy, 1997; Langewisch, 1997; Langewisch & Frisch, 1998; Nower, 2000). Impulsivity has been found to be positively related to severity of gambling

on various indices of pathology (Blaszczynski, 2000; Blaszczynski, Steel & McConaghy, 1997; Breen & Zuckerman, 1999; Castellani & Rugle, 1995; Fernandez & Echeburua, 2001; Steel & Blaszczynski, 1998; Vitaro, Arseneault, & Tremblay, 1999; Vitaro, Ferland, Jacques & Ladouceur, 1998). High impulsivity has been associated with increased time and money spent gambling, larger debts incurred, and tendencies to chase losses (Breen & Zuckerman, 1999; O'Connor & Dickerson, 2003).

Definition of Impulsivity

Impulsivity is generally defined as "acting without planning or thought" (Liebeck & Pollard, 1997). This construct has been defined in multiple ways, based on both theoretically and empirically-driven approaches (Moeller, Barratt, Dougherty, Schmitz, & Swann, 2001). This trait has been viewed from the perspective of personality development and expression; neurobiological factors (e.g., arousal systems, reward sensitivity); behaviour (e.g., behavioural inhibition, reaction time, or decision time); cognition (e.g., decision-making, planning, forethought, time perspective); and neuropsychological functioning (attention, cognitive inhibition, self-monitoring).

Impulsivity in Models of Pathological Gambling

Theoretical models of gambling psychopathology view impulsivity as an important risk or maintenance factor but recognize that there are likely multiple patterns of disordered gambling behaviour (i.e., the clinical presentation is heterogeneous). Some have proposed that the patterns are so distinct as to warrant sub-typing. For example, Blaszczynski and colleagues (Blaszczynski, 2000; Blaszczynski & Nower, 2002) proposed three typologies of pathological gamblers, based on distinct hypothesized etiological pathways. The types were termed *Normal*, *Emotionally Vulnerable*, and *Biologically Based Impulsive*. The *Normal* subtype consists of individuals who do not exhibit significant premorbid

psychopathology. These gamblers tend to fall into the more mild range of gambling severity and move between infrequent, heavy, and excessive gambling (Blaszczynski & Nower, 2002). For these individuals, loss of control over gambling results from a combination of poor decisions and chasing money due to financial pressures. Symptoms of preoccupation, dependence, and disruption of social-relational or occupational functioning are thought to be secondary to, rather than causes for disordered gambling. These individuals are also less likely to exhibit comorbid psychopathology such as other addictions. The *Emotionally Vulnerable* subgroup of gamblers is distinguished by having history of psychopathology, such as substance use disorders, depression, or anxiety, coupled with stressful childhood or current events. The gambling behaviour of these individuals is thought to develop through negative reinforcement; gambling provides escape from stressful circumstances and relief from feelings of anxiety, stress, depression or emotional states. Gambling becomes habitual through this association of gambling with relief of distress. These individuals are thought to be vulnerable to gambling due to their use of avoidant coping strategies and lack of more adaptive coping skills. Blaszczynski (2002) described the *Biologically Based Impulsive* subgroup of gamblers as exhibiting "neurological or neurochemical dysfunction reflecting impulsivity" (p. 6). These dysfunctions lead to differential responses to reward and punishment (e.g., high reward sensitivity and low punishment sensitivity) and deficient behavioural regulation, leading to the development gambling addiction through physiological mechanisms of dependence. The *Biologically Based Impulsive* group is more likely to show a range of behavioural-regulation problems and comorbid disorders, such as impulse control disorders, substance abuse or dependence, and criminal involvement. They are thought to benefit least from psychological interventions, as impulsive patterns are developmentally-based, but they may

be amenable to pharmacologic therapies that correct imbalances in neurotransmission (Blaszczynski, 2000). Blaszczynski and colleagues' work implicates several pathways to pathological gambling and suggests that impulsivity is an important determinant of gambling behaviour in at least a subgroup of pathological gamblers.

Sharpe and colleagues (Sharpe, 2002; Sharpe & Tarrier, 1993) developed a theory of gambling development that also allows for multiple pathways to pathological gambling involving biological, cognitive, emotional, and social/environmental factors. Sharpe's (2002) model hypothesizes that specific psychological and biological vulnerabilities lead to initial gambling behaviour and later addiction to gambling through behavioural reinforcement and emotional-regulation feedback loops. Psychological vulnerabilities included inattention, disinhibition, sensation seeking, boredom proneness, and failure to consider the future when planning. Biological vulnerabilities specified in their model included impulsivity and reward sensitivity. The biological-based predispositions were hypothesized to be related to alterations in dopamine and serotonin function, making individuals more reactive to the stimulation provided by gambling. Arousal related to wins or "near-misses" leads to the association of gambling with pleasure and the development of cognitive distortions related to a perception of control over gambling. The model shows that the development of pathological gambling (e.g., urges, continued gambling despite consequences) can result from behavioural disinhibition, physiological factors, sensation seeking, avoidant coping for stress or depression, or dependence reward sensitivity. The vulnerability factors listed are actually consistent with different conceptualizations of impulsivity. That is, impulsivity has been defined in terms of behavioural disinhibition (Cloninger, 1987) or as reward sensitivity (Bechara, 2001), suggesting that impulsivity may have biological and psychological components.

Consistent with the idea that impulsivity may have multiple components, Nower and Blaszczynski (2006) provided a descriptive model of impulsivity in pathological gambling that took a multifactorial perspective. Specifically, impulsivity was viewed as comprising a cyclical relationship involving predisposing factors (emotional regulation, psychosocial, biological, or cognitive deficits); gambling behaviour; gambling-related cognitions; affective interpretations (e.g., pleasure); and behavioural reinforcement.

These etiological theories of pathological gambling point to impulsivity as an important variable for study and include conceptualizations of this trait as biological (e.g., reward sensitivity, seeking arousal related to dopamine/serotonin function) or psychological (attentional or cognitive-inhibitional deficit, boredom proneness, sensation seeking, poor planning).

Some models of pathological gambling also include the component of sensation seeking. For example, Nower & Blaszczynski (2006) and Sharpe (2002) included sensation seeking as a trait correlated with impulsivity and with pathological gambling. Sensation seeking has been defined as a preference for novel experiences, varied or complex sensations, and for intense (i.e., arousing) stimuli (Breen & Zuckerman, 1999). High sensation seeking individuals may be characterized as prone to boredom and may engage in activities such as extreme sports, travel and adventure, or potentially harmful, risky behaviour such as gambling, to achieve their desired sensations. Both impulsive and sensation seeking individuals engage in risky behaviour. However, in contrast to impulsive individuals, whose risk taking tends to be unplanned, sensation seekers may be thoughtful and planful about their actions. Still, some view sensation seeking as a component of impulsivity (e.g., Buss & Plomin, 1975), while others conceptualize it as a distinct trait (e.g., Eysenck, 1991, Raylu and Oei, 2002).

In sum, models of pathological gambling include impulsivity and sensation seeking as important risk factors for disordered gambling and support a conceptualization of impulsivity as multifactorial. In describing impulsivity as a risk factor, researchers seem to conceptualize impulsivity as a trait variable. It is not clear whether impulsivity is also a state variable, influenced by more immediate environmental factors (e.g., disinhibition as a result of alcohol intoxication).

Despite the apparent emphasis on impulsivity in clinical descriptions of pathological gamblers and consistent research evidence of impulsivity as an important factor in theoretical models of pathological gambling, relatively less is known about the composition of this trait. Impulsivity has been approached in the gambling literature from a number of different perspectives (e.g., neurobiological, behavioural, or cognitive). However, consensus has yet to be reached regarding the number and types of specific cognitive, behavioural, and other psychological features that comprise this construct. With research knowledge now mounting from multiple perspectives on impulsivity, it is possible to develop more integrative theories of the development of disordered gambling.

Exploratory research using factor analysis of impulsivity scales has identified multiple factors, but studies have provided inconsistent results regarding the number of factors, leading to an unclear picture of the structure of impulsivity (Nower & Blaszczynski, 2006). Buss and Plomin's (1975) scale of personality identified four main factors comprising impulsivity: inhibitory control, decision time, lack of persistence, and boredom/sensation seeking. Impulsive individuals tended to score low on inhibitory control, made quick decisions, lacked perseverance, were prone to boredom, and were seek high sensation-seekers. In contrast, research with the Barratt Impulsivity Scale (BIS; Patton, Stanford, & Barratt, 1995) suggested three components to impulsivity, termed

cognitive, *motor*, and *non-planning* factors. The Eysenck Impulsivity Scale (Eysenck, 1983; Eysenck & Eysenck, 1991) was found to be composed of two factors: *impulsiveness*, defined as unconscious risk-taking, and *venturesomeness*, defined as conscious risk-taking and sensation-seeking. Interestingly, this two-factor structure is inconsistent with the four factors described for impulsivity in his general personality theory. In sum, 2, 3, and 4 factor solutions have been suggested by research on measures of impulsivity.

With an aim of using aggregate data from multiple scales to arrive at an overall factor structure of impulsivity, Gerbing, Ahadi, and Patton (1987) administered several measures to 393 university students: personality inventories, including the Barratt Impulsivity Scale, the Eysenck Impulsivity Scale, the Zuckerman Sensation Seeking Scale, and several behavioural tasks (involving matching figures, time perception, and reaction time). Exploratory factor analyses identified twelve self-report and three behavioural components of impulsivity. The self-report measures assessed impulsivity as well as sensation seeking, suggesting that the traits are related. As it was deemed impractical and not particularly enlightening to include all fifteen main factors into a model of impulsivity, a second order analysis was conducted, which indicated three overarching factors that they termed *spontaneous*, *not persistent*, and *carefree*. The second order factors appeared to encompass a heterogeneous set of concepts. Overall, their findings suggested that a parsimonious conceptualization of impulsivity had three or four factors.

Research on the construct of impulsivity is extensive, having come from a number of different fields, including genetics, neurobiology / neurodevelopment, cognitive-behavioural psychology, criminology, neuropsychology, and personality research (McCown, Johnson, and Shure, 1993; Raylu & Oei, 2002). These different perspectives on pathological gambling have led to different definitions of impulsivity and explanations of

the role of impulsivity in gambling disorder development. These inconsistencies have made it difficult to define impulsivity and make cross sample comparisons of pathological gamblers. Most currently accepted models of disordered gambling integrate several theoretical perspectives, suggesting that the field should move toward a multifactorial definition of impulsivity.

The present research study focuses on testing a theoretically derived model of the structure of impulsivity in pathological gamblers. The components hypothesized to comprise impulsivity measured in this project reflect different theoretical perspectives on impulsivity found in the research literature. Improved understanding of the dimensions comprising impulsive behaviour has the potential to inform clinicians of risk factors for targeting primary prevention efforts and help identify gamblers at risk of developing problems before the disorder progresses. This information may also isolate factors impacting treatment success. For example, highly impulsive clients may have difficulty enacting new behavioural regimens and resisting urges to gamble, placing them at higher risk for relapse. Thus, it will be useful to identify the components comprising impulsivity. The research may also inform clinical assessment or intervention approaches with pathological gamblers or delineate limitations to interventions. Importantly, this research has the potential to contribute to theories regarding the developmental pathway to pathological gambling.

In the following literature review, definition of the trait of impulsivity is presented from several major perspectives that have been taken in research on impulsivity: neurobiological, behavioural, neuropsychological, and other cognitive factors. The state of current knowledge about pathological gamblers from each of these perspectives is also reviewed. Sensation seeking is then defined, and knowledge about sensation seeking in

pathological gambling is presented. Issues related to the measurement of impulsivity and sensation seeking are then discussed, as variability in measurement across samples studied used have contributed to difficulties in understanding the structure of impulsivity and the relationship to sensation seeking. The literature review concludes by presenting a testable model of the structure of impulsivity and a plan for the assessment of this model on a sample of pathological gamblers.

LITERATURE REVIEW

Neurobiology

Neurobiological Perspectives on Impulsivity

Neurobiological perspectives on impulsivity are focused upon genetic transmission of disinhibited behaviour or identifying external influences on biological systems involved in impulsivity. The neurotransmitters dopamine and norepinephrine have been associated with impulsive, pleasure-seeking, compulsive, and risk-taking behaviour (Daruna & Barnes, 1993). Impulsive behaviour has also been associated the activity of serotonin (5-hydroxy tryptophan; 5-HT), monoamine oxidase (MAO), and gamma aminobutyric acid (GABA; Raylu & Oei, 2002). Serotonin and monoamine oxidase functioning is associated with impulsive and sensation seeking behaviour in clinical and non-clinical samples (Barratt & Patton, 1983; Zuckerman, 1983). Psychopathology associated with MAO deficiency involves various disorders or behaviours characterized by disinhibition and risk-taking (Zuckerman & Kuhlman, 2000). Increased rates of alcohol dependence (Paaver, Eensoo, Pulver, & Harro, 2006; Schuckit, 2006), cluster B personality disorders (Lidberg, Modlin, Oreland, Tuck, & Gillner, 1985; Reist, Haier, deMet, & deMet, 1990) and higher impulsivity (Paaver, et al., 2006) are all linked to low levels of MAO.

Neurobiological Factors in Pathological Gambling

Dysfunction in neurobiological systems is associated clinically with a number of factors related to disordered gambling: failure to inhibit impulses to gamble; loss of control over time and money spent gambling; increased responsivity or arousal to gambling related cues; and reward- or pleasure-seeking. Familial transmission of pathological gambling, through both biological and environmental influences, has been identified in research. Genetic transmission is thought to involve the inheritance of impulsive and sensation seeking personality traits, behavioural inhibition deficits, or susceptibility to the arousal provided by gambling. These characteristics are related to the activity of multiple neurotransmitter systems, which lead to a propensity toward risky and potentially maladaptive behaviours, including substance use, arousing behaviours (e.g., gambling, sex, shopping, fire-setting, over-eating), or aggressive/violent behaviour toward person or property (Potenza, 2001; Potenza & Hollander, 2002). The high incidence of the above problems in families of pathological gamblers (Gambino, et al., 1993; NRC, 1999; Raylu & Oei, 2002) lend support to the notion of a generalized biological vulnerability to impulsive behaviour that includes gambling.

Genetic contributions to gambling were assessed in a study of male twins (N = 3359 pairs from the Vietnam era twin registry) by Eisen (1999), who reported a heritability of 0.54 for pathological gambling. This study estimated that 35% of the variance in twin gambling was accounted for by genetic inheritance alone, and 21% of additional variance was attributed to familial and environmental factors. A study by Tellegen, et al. (1988) also indicated strong heritability of impulsivity and gambling problems. Winters and Rich (2000) found significant heritability for participants who engaged in some “high activity”

gambling types (e.g., poker blackjack) but not other games (e.g., lottery). Heritability coefficients were significantly higher in monozygotic than dizygotic twin pairs.

In terms of specific neurotransmitters, research with pathological gamblers has identified the presence of abnormalities (e.g., polymorphisms or other allelic variants) in genes coding for the neurotransmitters dopamine (DA), norepinephrine (NE), endogenous opioids, serotonin (5-hydroxy tryptamine; 5-HT), monoamine oxidase (MAO), and gamma aminobutyric acid (GABA) and/or their receptors (Comings, et al., 2001). Comings and colleagues (1996) found strong evidence for a genetic risk for pathological gambling. Their sample showed a twice-higher incidence of a gene variant coding for the dopamine-2 receptor in gamblers than controls. These in turn lead to under- or over-functioning of neurotransmitter systems and increase one's vulnerability to developing impulsive behaviour (Chambers & Potenza, 2003). Similar genetic abnormalities related to dopamine, norepinephrine, and serotonin transmission in pathological gambling have been found with other disorders such as ADHD, substance dependence, and conduct disorder (Comings, et al., 2001), suggesting that the biological risk may not be specific to pathological gambling, but for impulse-control problems more generally. A study of male twins by Slutske, et al (2000) estimated that 12 to 20 percent of genetic variation in pathological gambling was accounted for by risk for alcohol dependence.

Differences in norepinephrine (NE) have also been implicated in pathological gambling. Bergh and colleagues' (1997) sample exhibited elevated NE. Norepinephrine has been thought to mediate selective attention and may also be related to sensation seeking and risk-taking in gamblers (Raylu & Oei, 2002). Bergh et al suggested that reduced DA was associated with increased risk-taking and experience of positive reward, and increased NE could be associated with changes in attention. Reduced dopamine and increased

epinephrine levels, have been thought to account for the drive for physiological arousal leading to impaired gambling behaviour (National Research Council, 1999) and for the development of physiological dependence (APA, 2000). That is, individuals seek to enhance arousal or excitement resulting from endorphin release in the brain during gambling (Coventry & Norman, 1998; Sharpe, Tarrier, Schotte, & Spence, 1995). Increased tolerance is evidenced by individuals needing to bet higher amounts of money and take greater risks to achieve arousal, leading to increasingly problematic gambling behaviour. An increased level of NE in gamblers has also been linked to increased extraversion scores, which in turn have been found to be positively correlated with impulsivity (Roy, deJong, & Linnoila, 1989).

An association between MAO-A gene polymorphisms and pathological gambling has been found (Ibanez, Perez de Castro, Fernandez-Piqueras, Blanco, & Saiz-Ruiz, 2000; Ibanez, Blanco, Perez de Castro, Fernandez-Piqueras, & Saiz-Ruiz, 2003; Perez de Castro, Ibanez, Saiz-Ruiz, & Fernandez-Piqueras, 2002). Further, Carrasco, Saiz-Ruiz, Hollander, Cesar, and Lopez-Ibor (1994) found that pathological gamblers evidenced reductions in measured levels of platelet monoamine oxidase compared to controls. In contrast, no significant differences in levels of platelet MAO were found in a study by Blanco, Oresanz-Munoz, Blanco-Jerez, and Saiz-Ruiz (1996).

Several serotonin genes have been identified that are associated with pathological gambling (Comings et al., 2001; Ibanez, et al., 2003). Serotonin is strongly associated with impulse control, with low serotonin levels found in individuals engaging in impulsive violent acts, fire-starting, and pathological gambling (Chambers & Potenza, 2003). GABA has been investigated only rarely, but is potentially involved in gambling, given its role in

excitatory neural communication. Comings, et al., 2001 found no significant association between GABA genes and pathological gambling.

Functioning of neurotransmitter systems and communication along their associated pathways may also be affected by disordered gambling. As pleasure pathways are repeatedly stimulated, dopamine receptors may up- or down-regulate, changing the brains reactivity to the dopamine released during gambling. A small study by Bergh, Eklund, Sodersten and Nordin (1997) found reduced dopamine levels in pathological gamblers compared to controls, suggesting that individuals may gamble as a means of increasing dopamine release. However, Roy, et al., 1988 did not find differences in dopamine levels in a sample of male gamblers. Reward processing systems active in gambling involves various dopamine receptors throughout the brain with extensive connections to frontal brain areas that mediate reward dependency, behavioural inhibition, and forethought and planning (Blaszczynski, 2000; Comings, et al., 1996; National Research Council, 1999; Sharpe, 2002). No studies have assessed gene-environment interactions in pathological gambling.

In a comprehensive literature review assessing vulnerability to pathological gambling, Chambers and Potenza (2003) concluded that the relatively strongest evidence implicated dopamine and serotonin and their effects on pathways connecting prefrontal cortical areas of the brain. Impulsivity in behaviours such as drug or sexual addiction, eating disorders, and pathological gambling are reflective of a predisposition toward sensitization of dopamine-mediated reward pathways in the addiction process. New investigative techniques may result in the identification of other neurotransmitters and receptors potentially involved in addictive disorders. This quickly evolving knowledge base poses difficulties in assessing trends and comparing past and new research to understand the neurobiological basis of impulsivity and its clinical outcomes.

Personality Factors Related to Impulsivity

Aside from influencing gambling directly, via increased sensitivity to reward provided by gambling, biological factors are understood to underlie basic personality expression. For example, low platelet MAO levels has been associated with stronger impulsivity, and sensation seeking traits. Noradrenergic function is positively associated with extraversion scores in pathological gamblers (Roy, deJong, & Linnoila, 1989). Personality research characterizes pathological gamblers as high on measures of the traits impulsivity, sensation seeking, extraversion, psychoticism, and neuroticism (Raylu & Oei, 2002). The field has been unable to reach consensus on a specific addictive personality, or single set of traits that describes all gamblers. Gamblers are considered to be a heterogeneous group. However, gamblers do share personality profiles with individuals with other addictive disorders. A prospective study of young adults in New Zealand (N = 939) found that problem gambling at age 21 was associated with elevations on scales measuring negative emotionality, impulsivity, and risk-taking, and lower scores on constraint at age 18 (Slutske, Caspi, Moffitt, & Poulton, 2005). Similar patterns were observed in young adults with substance use problems at age 21 (alcohol, nicotine, cannabis). Only 1% of their sample met criteria for pathological gambling, limiting generalization to more disordered samples. Pathological gambling has also been positively associated with antisocial personality disorder and narcissistic personality disorder (Blaszczynski & Steel, 1998; Ibanez et al., 2001; Raylu & Oei, 2002), which are also associated with impulsivity and sensation seeking.

Personality theories may shed light on the structure of impulsivity in pathological gambling. Some theories cited in relation to work in pathological gambling include Cloninger's Tridimensional Model (Cloninger, 1987), Eysenck's model (Eysenck, 1991),

Gray's (1987) two dimensional theory of anxiety and impulsivity, and Costa & McCrae's Five Factor Model (Costa & McCrae, 1997).

Cloninger's Tridimensional Model of personality (Cloninger, 1987) states that personality is comprised of three heritable independent dimensions that interact to produce behaviour. The first dimension, *Novelty Seeking*, is associated with intense emotional reactions to novel stimuli, as well as a need for excitement. High novelty seeking is associated with both reward seeking and avoidance of punishment, and generally represents behavioural activation. The second dimension, *Harm Avoidance*, refers to behavioural inhibition and a tendency to develop fears and anxiety. Individuals with high harm avoidance tend to be sensitive to punishment. *Reward Dependence* is Cloninger's third factor, characterized by a high need for approval and high responsiveness to rewarding stimuli. In highly reward dependent people, behaviour tends to be resistant to extinction once it has previously been rewarded (e.g., an early large win reinforces continued gambling). Impulsivity is represented by / explained by each of these factors, but seems to be more closely associated with novelty seeking and reward dependence.

Eysenck's model (Eysenck, 1991) comprises three dimensions that are fundamentally related to personality systems: *Psychoticism* (P), *Neuroticism* (N), and *Extraversion* (E). These constructs are thought to be dimensional. P, N, and E are described as interrelated to individual differences in cortical arousal and responsiveness to the environment (termed *conditionability*). P refers to degree of empathy and tendency to conform to rules and norms. Individuals high on the P dimension tend to act without regard or appreciation of the effects of their actions on others. N describes degree of emotional stability; those high in neuroticism show maladaptive coping skills and proneness to psychological distress, while those who are low tend to be more stable. E describes a

general externalizing trend in behaviour and emotions. Individuals high on the E dimension tend to have low basal levels of cortical arousal and a high need for external stimulation. Learning in these individuals is more strongly influenced by reward than punishment. There has been some support for the idea that E is related to levels of the neurotransmitter norepinephrine, suggesting a link between neurotransmission and personality expression (Roy, DeJong, & Linnoila, 1989). Eysenck (1983) viewed E as comprising sociability, sensation seeking, and impulsivity. As regards the structure of impulsivity, Eysenck (1983, 1991) described four sub-traits: narrow impulsivity, a tendency not to plan ahead (non-planning), risk taking, and liveliness (tendency to react or decide quickly).

The Five Factor Model of personality (FFM; McCrae & Costa, 1997) outlines five broad traits. *Openness to Experience* refers to willingness to explore and tolerance or even preference of the unfamiliar. The second factor, *Conscientiousness*, reflects perseverance, dependability, and self-discipline. Third, A*greeableness* refers to the degree of compassion or empathy as opposed to antagonism in thoughts, emotion, and behaviour. The last two factors of the FFM, *Neuroticism* and *Extraversion*, are conceptually identical to Eysenck's N and E dimensions. Eysenck's factor of psychoticism has been found to be negatively related to agreeableness and conscientiousness (McCrae & Costa, 1996). Eysenck (1991) reconciled the differences between these two theories by stating that the factors are hierarchical, with psychoticism, extraversion, and neuroticism being at the highest level. The factors of agreeableness and conscientiousness belong at a lower level in the hierarchy than psychoticism, extraversion, and neuroticism. Psychoticism was viewed as comprising the inter-correlations of lower-level factors of agreeableness and conscientiousness, similar to the idea that extraversion is comprised of sociability, sensation seeking, and impulsivity.

Gray's model of anxiety and impulsivity comprises two orthogonal dimensions: a *Behavioural Inhibition System (BIS)* and the *Behavioural Activation System (BAS).* The *Behavioural Inhibition System* resembles Cloninger's harm avoidance and Eysenck's neuroticism. It is described as analogous to anxiety, comprising level of anxiety, harm avoidance, and sensitivity to punishment. The *Behavioural Activation System* dimension, is similar to Cloninger's novelty seeking dimension and Eysenck's extraversion, and is stimulated by cues for reward. The BAS is analogous to impulsivity, and refers to the system responsible for regulating responses to appetitive stimuli (e.g., food, sex, drugs, gambling; Avila & Parcet, 2001). Individuals with high degrees of impulsivity tend to prefer immediate over delayed rewards and show greater disinhibition in the presence of cues for reward. In comparison to those with high anxiety, who are punishment-averse, those with high impulsivity will be relatively insensitive to punishment.

In summary, researchers taking a neurobiological perspective on impulsivity define this construct in primarily terms of reactivity to potential reward, namely, high sensitivity to reward. This reward sensitivity leads to impulsive and disadvantageous gambling decisions. These perspectives emphasize the relationship between reward sensitivity and genetic or acquired differences in the activity of various neurotransmitters and receptors. They also emphasize the neurobiological basis of personality expression. Individuals with genetic or acquired differences in dopamine, serotonin, MAO, or GABA functioning are likely to show impulsive personality traits, which may make them more susceptible to risk-taking more generally, and specifically, with developing problems with gambling.

Behaviour

Behavioural Perspectives on Impulsivity

Behavioural perspectives on impulsivity define this construct in terms of speed of individuals' decision-making, motor response speed, or behavioural inhibition. Others define impulsivity as a result of behavioural reinforcement. For example, the Barratt Impulsivity Scale includes a subscale devoted to measuring motor impulsivity. This scale assesses speed of decision-making and motor activity and characterizes impulsive individuals as making quick, rather than planned or deliberate, decisions and being restless when required to be still. As a result of impulsive individuals acting on the spur of the moment, decisions can have disadvantageous short- or long-term consequences. Eysenck also defines impulsivity in terms of disinhibited behaviour. Similar to the Barratt motor subscale, the impulsivity subscale of the Eysenck I7 questionnaire measures speed of decision-making and the tendency to act quickly and without deliberation.

Gray's model of anxiety and impulsivity (1987) also provides a behavioural perspective on impulsivity. Gray's *Behavioural Activation System* is the dimension that represents impulsivity. Gray defines impulsivity as comprising poor behavioural inhibition in situations when the potential for reward or non-punishment exists. In his theory, the behavioural activation system becomes activated when individuals are exposed to potential rewards, and individuals have difficulty inhibiting reward seeking behaviours. Studies assessing behavioural inhibition have used a number of behavioural paradigms, the most popular of which is the Matching Familiar Figures Test (Salkind, 1978). Impulsive individuals are shown to have quick response times but high rates of errors on this task (e.g., Gerbing, Ahadi, & Patton, 1987; Thompson, Teare, & Elliott, 1983).

Conceptualizations of impulsivity based on behavioural reinforcement have also been proposed. These theories state that classical conditioning principles lead to the initial association of a specific behaviour (e.g., a risky behaviour, substance use, etc.) with arousal, pleasure, or other positive affect. The behaviour is subsequently reinforced through operant conditioning, whereby continued behaviour leads to pleasure or arousal, or the reduction of negative affect such as anxiety or depression.

Behavioural Factors in Pathological Gambling

There is no literature specifically addressing the relationship between pathological gambling and impulsivity using Gray's Behavioural Activation System as a framework. However, other research with supports the idea of gamblers having difficulty with behavioural inhibition. For example, Alessi & Petry (2003) found higher scores on the Eysenck I7 impulsivity sub-scale in pathological gamblers, which was positively correlated with delayed discounting, or the tendency to prefer smaller, immediate rewards over larger but delayed rewards. Research using the Barratt Impulsivity Scale (BIS; Patton, Stanford, & Barratt, 1995) has been conducted with a number of samples of pathological gamblers. Most research with BIS has identified significant differences between pathological gamblers and controls (Blaszczynski, Steel, & McConaghy, 1997; Carlton & Manowitz, 1994; Fuentes, Taveras, Artes & Gorenstein, 2006; National Research Council, 1999). Unfortunately, most have not reported performance on the subscales of the BIS separately. In one study that did look at subscales, scores on the BIS-motor subscale did not significantly differentiate non-problem, problem, and pathological gamblers, whereas the Attention, Non-Planning subscales did (Skitch & Hodgins, 2004).

In support of behavioural theories in developing gambling problems, research has shown that a large win early in one's gambling experience leads to a strong link between

pleasure/arousal and gambling (Griffiths, 1990; Ladouceur, Gaboury, Dumont, & Rochette, 1988; National Research Council, 1999; Raylu & Oei, 2002). Gambling behaviour is subsequently maintained through operant conditioning, where intermittent wins positively reinforce continued gambling, and relief from anxiety or stress negatively reinforces gambling (National Research Council, 1999; Sharpe, 2002). The unpredictable quality of games is thought to be central to the acquisition of gambling problems and to relapse, as variable schedules of reward are known to lead to the strongest degree of stimulus-response association.

Cognition

Cognitive Perspectives on Impulsivity

Research taking a cognitive perspective on impulsivity defines the construct as related to forethought or consideration of the future, delay discounting, and time perspective. Other cognitive variables (i.e., mental flexibility, cognitive inhibition, self-monitoring, response-shifting, and attentional processes) fall into the category of executive cognitive functions and will be discussed in the section on neuropsychological aspects of impulsivity. The Barratt Impulsivity Scale includes a sub-scale termed Non-Planning, which measures the use of forethought in decision-making. Pathological gamblers have been found to score low on this sub-scale, suggesting that impulsivity is associated with a lack of planning (Skitch and Hodgins, 2004). Several studies have characterized pathological gamblers as insensitive to the future consequences of their actions (e.g., Bechara, 2003; Cavedini, Riboldi, Keller, D'Annucci, & Bellodi, 2002; Goudriaan, Oosterlaan, de Beurs, & van den Brink, 2005; Petry, 2001). Alessi and Petry (2003) showed that impulsive responses on a delayed discounting task significantly predicted gambling severity in a sample of pathological gamblers.

The extent of consideration of future consequences has also been measured using financial decision-making laboratory tasks, such as the Iowa Gambling Task (IGT). The IGT assesses whether individuals seek immediate rewards (suggestive of reward sensitivity) or consider potential losses to make financial decisions (i.e., forethought) as they choose cards from several decks that result in either a net gain or loss. Individuals found to be impulsive tend to seek large rewards and do not to change their strategy when they incur increasing losses in the disadvantageous decks (Bechara, Damasio, Damasio, & Anderson, 1994). Similar conclusions about impulsive individuals are drawn from studies using a delay-discounting procedure, where individuals are asked to choose between smaller, but more immediate rewards and larger, but more distant rewards. Impulsive individuals have been shown to generally prefer the immediate rewards over delayed rewards, despite the delayed rewards being more advantageous (Crean, deWit, & Richards, 2000).

Lack of consideration of the future is thought also to be related to one's time perspective (e.g., present- versus future-oriented) which impacts decision-making. Time perspective is a proposed trait variable that is defined as the extent to which an individual considers and plans his or her future, and the extent to which future information is used when making present decisions. This orientation exerts a dynamic influence on many important judgments, decisions, and actions ranging from environmentally conscious practices to coping strategies and addictive behaviours (Zimbardo & Boyd, 1999). Individuals who are future-oriented are more likely to take potential consequences into consideration and make less risky decisions, whereas present-oriented individuals are more strongly influenced by immediate consequences and immediate rewards. In a study conducting a principal components analysis of several measures of impulsivity, Petry

(2000) identified future-oriented time perspective as one of three main components of impulsivity.

Cognitive Factors in Pathological Gambling

As mentioned earlier, the Barratt Impulsiveness Scale *Non-Planning* subscale has been found to differentiate pathological gamblers from controls (Skitch & Hodgins, 2004). In studies assessing decision-making strategies, research with pathological gamblers suggests that gamblers fail to consider the future in decision-making, thereby choosing disadvantageously. Several studies with pathological gamblers have indicated that higher rates of delay discounting are associated with higher degrees of impulsivity and sensation seeking (e.g., Alessi & Petry, 2001; Goudriaan, Oosterlaan, deBeurs, & van den Brink, 2006; Petry and Casarella, 1999; Petry, 2001). This relationship could suggest that gamblers make decisions based on the immediate context, or that they fail to consider the future when making decisions. Although delay discounting procedures are useful for assessing the importance of the immediate reward in a gamblers decision, it does not allow for assessment of punishment aversion or insensitivity to consequences in general. Further, delay discounting has not been shown to differentiate sensation seeking and impulsivity, limiting its usefulness in the current research study, which aims to look at these constructs separately.

Time perspective has also been associated with decision-making. In the first study of the association between time perspective and pathological gambling, Hodgins and Engel (2002) found that pathological gamblers tended to show a greater present-focus than recreational gamblers and psychiatric controls, as measured by a self-report inventory of time perspective, the Zimbardo Time Perspective Inventory. This suggests that future time orientation may be an important variable related to whether a gambler considers future

consequences during decision making. The relationship between time orientation as a personality trait variable and the trait of impulsivity remains to be explored further.

Neuropsychology

Neuropsychological Perspectives on Impulsivity

Research on neuropsychological aspects of impulsivity has focused on executive cognitive functions. Executive cognitive functions are a group of abilities responsible for self-awareness and monitoring; guiding and organizing behaviour toward a goal; behavioural, cognitive, and emotional inhibition; and direction of arousal and attention (Lezak, 2001; Stuss & Levine, 2003). Individuals who are viewed clinically as impulsive have difficulties with all of the above behaviours. Research with children and adults with ADHD, a disorder primarily characterized by deficits in impulse-control, suggests that the impulsive behaviour of these individuals is related to delays in the development of executive cognitive functions, leading to problems with self-monitoring and with inhibiting cognitive, emotional, and behavioural responses (Barkley, 1997; Taylor, 1999).

Neuropsychological Factors in Pathological Gamblers

Evidence suggesting executive functioning deficits in pathological gamblers has accrued from three main sources: 1) studies of individuals (non-gamblers) with frontal lobe lesions (ventromedial, orbitofrontal), 2) studies of brain function in non-gamblers performing gambling tasks, and 3) direct studies of executive functioning in pathological gamblers. New research indicating greater histories of childhood ADHD and higher current ADHD symptoms in pathological gamblers (Rugle & Melamed, 1993; Littman-Sharp & Jain, 2000) also implicates executive functioning, as the primary deficit in this developmental disorder concerns behavioural inhibition and other frontal-mediated functions. Thus, this line of research also supports a connection between frontal pathology,

executive function, and pathological gambling, specifically, a potential developmental vulnerability.

In individuals with frontal lobe pathology, an impulsive syndrome has been described, characterized by disinhibition, lack of self-awareness, poor planning or forethought, and low cognitive flexibility (Lezak, 1995). Studies of individuals with brain lesions indicate that damage in the prefrontal areas has been associated with disadvantageous decision-making on analogue gambling tasks (Gehring & Willoughby, 2002; Manes, et al., 2002). Gehring and Willoughby concluded that the reason for poor performance was aversion to loss, rather than sensitivity to reward. In that study, individuals were more likely to avoid an immediate loss than to pursue a future gain on a gambling task, suggesting a strong harm aversion effect. In addition, Bechara, Tranel and Damasio (2000) and Manes, et al (2002) concluded that poor decisions represented insensitivity to future consequences in samples of individuals who had frontal lobe lesions but no history of pathological gambling. Another study suggested that the disadvantageous decisions made by individuals with prefrontal brain lesions were due to their failure to consider past experience (past losses) when making choices (Bechara, Damasio, Tranel, & Damasio, 1997). There has been some suggestion that the right frontal hemisphere is more strongly associated with poor performance on gambling decision-making tasks than the left (Tranel, Bechara, & Denburg, 2002).

Functional studies of brain activity during gambling-like decision-making tasks (in both gamblers and non-gamblers) have also implicated frontal cortical areas, specifically, ventromedial and orbitofrontal areas, in maladaptive decision-making. One study in particular associated value-based learning and decision-making to ventromedial pre-frontal function (Fellows, 2007). It suggests that the VMF area may be involved in adjusting

behaviour in response to feedback (e.g., changing strategy when losing money). An EEG study of non-pathological gambling participants performing a monetary gambling task found that medial-frontal brain regions were significantly more active after losses than gains (Gehring & Willoughby, 2002). This suggested that medial frontal activity is also involved in monetary decision-making.

Cavedini, Riboldi, Keller, D'Annucci, and Bellodi (2002) conducted a functional neuroimaging study of pathological gamblers, and found that participants' choices revealed lack of forethought in that the immediate reward of a gambling decision was the most important factor in their decision-making, despite later negative consequences. These studies generally find that frontal lobe lesions are associated with heightened sensitivity to reward, rather than punishment aversion, and that decisions reflect disregard of future consequences. In gamblers, specifically (with or without lesions), the results have pointed most strongly to a lack of appreciation of future consequences. Whether this is related to executive deficits in forethought and planning abilities has not been specifically tested. The tendency to prefer immediate over delayed rewards has also been found to be associated with scores on the *impulsiveness* subscale of Eysenck's I_7 Scale but not with Cloninger's *novelty seeking* subscale on the Tridimensional Personality Questionnaire, which is more similar to sensation seeking than impulsivity (Dawe & Loxton, 2004).

There have been two published studies addressing neuropsychological functioning in pathological gamblers. Rugle and Melamed (1993) administered a battery of neuropsychological tests to 33 pathological gamblers and 33 age-matched controls. Tests assessed executive functions related to frontally-mediated aspects of attention, cognitive inhibition, and planning as well as lower order aspects of attention (e.g., attention span, alertness, and visual search). Pathological gamblers performed as more impaired than

controls on tests related to executive aspects of attention (Wisconsin Card Sorting Test; Embedded Figures Test), but were not significantly different from controls on the other neuropsychological measures. A more recent study by Marazziti, et al. (2008) assessed memory function, verbal fluency, and executive function (using the Wisconsin Card Sorting Test) in 20 outpatient pathological gamblers (25% females). When compared to age-matched normative data, participants showed deficits on the WCST measures of perseverative errors, failures to maintain a correct set, and difficulty in learning from feedback to alter their responses. No memory or verbal fluency deficits were identified. Both of these studies support the presence of deficits in the area of executive cognitive functioning in pathological gamblers.

Sensation Seeking

Sensation seeking has been defined as a preference for novel experiences, varied or complex sensations, and for intense (e.g., arousing) stimuli (Breen & Zuckerman, 1999). High sensation seeking individuals may be characterized as prone to boredom and may engage in activities such as extreme sports, travel and adventure, or potentially harmful, risky behaviour such as gambling, to achieve their desired sensations. Both impulsive and sensation seeking individuals engage in risky behaviour. However, in contrast to impulsive individuals, sensation seekers may be thoughtful and playful about their actions. Some view sensation seeking as a component of impulsivity, and others conceptualize it as a distinct trait.

Sensation Seeking in Pathological Gamblers

Sensation seeking has been found to be correlated with impulsivity and gambling, although their exact relationship remains unclear. Kuley and Jacobs (1988) found that problem gamblers scored higher on measures of sensation seeking than social/recreational

gamblers. Pathological gamblers have also been found to show increased sensation seeking behaviour relative to controls (Blaszczynski, Wilson, & McConaghy, 1986; Langewisch & Frisch, 1998; Zuckerman, 1983) and sensation seeking correlates positively with chasing behaviour (Breen & Zuckerman, 1999; Dickerson, Hinchy, & Fabre, 1987; Langewisch, 1997). The finding of high sensation seeking in gamblers is not universal, as some studies have failed to find higher levels of sensation seeking and risk-taking behaviour in gamblers (Coventry & Norman, 1998). Anderson and Brown (1984) found that sensation seeking was positively correlated with bet size but did not distinguish between problem gamblers and recreational gambling students. Dickerson, Hinchy, and Fabre (1987) found lower sensation seeking scores in regular gamblers, but did not report how many in their sample, if any, were pathological gamblers. Coventry and Brown (1993) found lower sensation seeking scores in off-course betting gamblers (non-pathological) but higher scores for casino and racetrack gamblers. Their research also showed that sensation seeking was a significant predictor of impaired control over gambling. In studies of pathological gamblers, Blaszczynski, Wilson, and McConaghy (1986) found lower sensation seeking scores compared to the general population. McDaniel and Zuckerman (2003) found that sensation seeking scores in gamblers showed significant age and gender effects, with males scoring higher than females and sensation seeking decreasing with age. Others have also found higher levels of sensation seeking among problem or pathological gamblers (e.g., Breen & Zuckerman, 1999). Thus, findings of associations with sensation seeking may be dependent on the outcome measures used. In general, the literature on sensation seeking has supported much stronger associations between sensation seeking and involvement in gambling activities, than sensation seeking as a predictor of gambling problems (Raylu & Oei, 2002).

Nower (2000) found dissociation between the dimensions of sensation seeking, in which the pursuit of intense stimuli was a better predictor level of gambling problems than was seeking novel stimuli. Boredom proneness, a component of sensation seeking in Zuckerman's model, has also been found to be high in pathological gamblers (Blaszczynski, McConaghy, & Frankova, 1990). In general, tendencies toward novelty seeking have been found to correlate positively with degree of gambling problems (Kim & Grant, 2001; Skitch & Hodgins, 2004; Tavares & Gentil, 2002).

Relationship between Sensation Seeking and Impulsivity

Associations have been found between the construct of sensation seeking and impulsivity in disordered gambling. Sensation seeking was found to be positively correlated with impulsivity using the Tridimensional Personality Questionnaire and the Zuckerman Sensation Seeking Scale (Langewisch & Frisch, 1998). Skitch and Hodgins (2004) found that elevations in cognitive aspects of impulsivity (*Non-Planning* factor of the Barratt Impulsiveness Scale) were positively associated with novelty seeking, a component of sensation seeking. Thus, although impulsivity and sensation seeking are different constructs, they have a degree of overlap. Impulsivity and sensation seeking are both associated with increased risk-taking behaviour. Impulsivity can be conceptualized as subconscious risk-taking and sensation seeking as conscious risk taking.

Raylu and Oei (2002) suggested that impulsivity and sensation seeking were separate traits that impact different phases of gambling disorders. That is, sensation seeking may stimulate individuals to initiate gambling activity. The element of risk, unpredictability, excitement, and novelty inherent in gambling would make gambling an appealing activity for sensation-seeking individuals. Impulsivity (e.g., difficulty resisting an urge) is thought to maintain the pattern of gambling despite losses and other negative

consequences. Further, impulsive individuals' tendency toward high reward sensitivity but low punishment sensitivity would seem to make them particularly vulnerable to the detrimental effects of gambling.

Demographic Variables

Age and gender are individual difference variables that have often been included in research with pathological gamblers. Research on socioeconomic status (SES) will not be reviewed here, as this variable was not well-assessed in the present study (i.e., only educational attainment and income data were collected, which may not be good indicators of overall SES). The relationship between age and gender and impulsivity, sensation seeking, and pathological gambling severity are reviewed here.

Research with pathological gamblers has identified age differences in impulsivity and sensation seeking. A negative relationship between age and both impulsivity and sensation seeking has been found in prior research (e.g., Chambers & Potenza, 2003; McCown & de Simone, 1993). Younger individuals, particularly adolescents, evidence greater impulsivity and sensation seeking and engage in more risk-taking behaviours than older individuals (National Research Council, 1999). Age has also been consistently negatively associated with gambling severity (Petry, 2005; Shaffer, Hall & Vanderbilt, 1999) with some studies estimating rates of pathological gambling as three times higher in adolescents than adults (e.g., National Research Council, 1999). Overall lowest rates of pathological gambling are found in samples of elderly individuals (Gerstein, et al., 1999). Others have suggested that cohort effects related to the availability of gambling opportunities in a given time frame, rather than age effects per se, are associated with the different rates of pathological gambling seen across the age span (National Research Council, 1999).

Gender differences have also been identified in pathological gamblers. Males tend to score higher on both impulsivity and sensation seeking than females in samples of gamblers (e.g., Nower, 2000; Volberg, 1993) and in general population samples (Webster & Jackson, 1997; Zuckerman, 1983). Regarding pathological gambling severity, it has been shown that fewer females are represented in treatment samples of pathological gamblers. Factors that lead to lower treatment-seeking in females (e.g., stigma) have been queried. A difficulty in estimating gender effects is that many studies have used all-male or predominantly male samples (Raylu & Oei, 2002; Toneatto & Nguyen, 2007). A "telescoping effect" has often been reported, where women exhibit a later onset of gambling involvement but shorter course before showing severe problems, while men tend to show earlier onset of gambling involvement but a longer time to develop pathological gambling disorder (Tavares, et al., 2003; Tavares, Zilberman, Beites, & Gentil, 2001). Gender differences may interact with age, in that the prevalence difference between males and females is wider in young samples than older samples (Toneatto & Nguyen, 2007). Overall across the age span, no consistent gender differences in pathological gambling have been established.

Comorbidity

The notion of a developmental vulnerability to pathological gambling involving high impulsivity and poor behavioural inhibition are consistent with the high rates of comorbidity between pathological gambling and other disorders featuring impulse dyscontrol. Common comorbid disorders in pathological gamblers are substance abuse or dependence, other impulse control disorders not otherwise specified, and Attention Deficit/Hyperactivity Disorder.

Crockford and el-Guebaly (1998), in a review of the empirical literature on psychiatric co-morbidity in pathological gambling, found rates of substance use disorders among gamblers ranging from 25% to 63%. Ibanez, et al (2001) identified substance use disorders in 35% of their sample of pathological gamblers. In studies of substance use, nine to sixteen percent of individuals with substance use disorders were rated as probable pathological gamblers, and McCormick (1993) found that in a sample of 2171 substance abusers, 13% were probable pathological gamblers. A review of recent large-scale epidemiological surveys conducted in the United States and Canada indicated rates of alcohol use disorders in lifetime pathological gamblers ranging from 25.0% to 73.3% (Petry & Weinstock, 2007). Regarding other drug abuse or dependence, 38.1% of lifetime pathological gamblers were found to have drug abuse or dependence, compared with 8.8% of non-gamblers (Petry, 2005).

Little research has previously been done to establish the degree of comorbidity between pathological gambling and other impulse control disorders, NOS. Specker, Carlson, Christenson, and Marcotte (1995) found that 35% of pathological gamblers, compared with only 3% of controls, met criteria for at least one other impulse control disorder. An additional 18% missed diagnostic criteria by one symptom. Compulsive buying, compulsive sexual behaviour, and intermittent explosive disorder were most common, and were most often reported to precede gambling problems. In a later study of 96 pathological gamblers, 22.9% reported a comorbid impulse control disorder (Grant & Kim, 2003). Consistent with Specker, et al's study, compulsive sexual behaviour and compulsive buying were the most common.

Regarding comorbid ADHD, previous research has found elevated rates of current self-reported behaviours consistent with ADHD (Rugle & Melamed, 1993; Specker,

Carlson, Christenson, & Marcotte, 1995). Pathological gamblers have also been found to have childhood histories consistent with ADHD at higher rates than non-clinical comparison groups (Carlton & Goldstein, 1987). Attention deficit disorder, as measured by semi-structured interview, was diagnosed in 20% of a sample of pathological gamblers (N = 64; Specker, et al., 1995). Attention deficits in previous research were reported to precede gambling, with childhood onset typically reported. Such research also may indicate that primary problems in behavioural inhibition (the primary deficit in ADHD) may be important vulnerability factors, predisposing some individuals to develop problems with gambling.

Measurement of Impulsivity

Given the various ways of conceptualizing impulsivity, there have been a number of different ways of measuring the construct across studies. Approaches include biological investigations, laboratory/behavioural studies, self-report personality questionnaires, neuropsychological tests, decision-making tasks, and measures of response speed and behavioural inhibition. Differences across measures of impulsivity make defining the construct of impulsivity more challenging.

Neurobiological Methods of Study

A number of different approaches have been used to investigate neurobiological aspects of impulsivity. Genetic aspects of impulsivity have been assessed using twin comparisons and genetic assays. Others have studied physiological factors using cell /receptor studies, measures of blood metabolites of neurotransmitters, and, evidence from medication trials. Research on brain functioning has used methods such as functional magnetic resonance imaging (f-MRI) and electro-encephalograms (EEG's). Research using

all of these techniques has provided important information about the possible origins of impulsivity and may inform models about the structure of this trait.

Self-Report Personality Measures

The Barratt Impulsivity Scale (BIS; Patton, Stanford, & Barratt, 1995) is a self-report scale containing three sub-scales related to impulsivity: *cognitive*, *motor*, and *non-planning*. This measure has been widely used in pathological gambling research. The Eysenck Impulsivity Scale (Eysenck, 1983; Eysenck & Eysenck, 1991) is another measure of impulsivity, composed of two factors: *impulsiveness*, defined as unconscious risk-taking, and *venturesomeness*, defined as conscious risk-taking and sensation-seeking. Another scale used in personality research with gamblers is the Tridimensional Personality Questionnaire (Cloninger, 1992), which yields factors related to *harm avoidance* (negatively correlated with impulsivity); *novelty seeking;* and *reward dependence*. Research using the Eysenck I_7 and Zuckerman-Kuhlman Personality Questionnaire (ZKPQ) suggest that risk-taking is a behavioural component of impulsivity (Eysenck, 1991) and of sensation seeking (Zuckerman, 1983). Risk taking refers to engaging in behaviour or activities that expose the individual to potential danger or suffering harm (Liebeck & Pollard, 1997). Sensation seeking, on the other hand, has been defined as the "need for novel, varied, and complex sensations and experiences" (Zuckerman, 1983). That is, sensation seeking does not necessarily involve taking risks. He proposed that sensation seeking involves both intensity seeking behaviour, defined as a drive for intense levels of stimulation, and novelty seeking behaviour, defined as a preference for novel (though not necessarily intense) stimulation. Both of these behavioural dimensions can be associated with risk taking behaviour, and moderate relationships with impulsivity have also been found (Zuckerman, 1979).

Self-report personality measures are usually face valid and relatively easy to use. Disadvantages include difficulty in using these with individuals who do not speak or read English fluently, and the fact that some of these inventories are quite long (up to 98 questions), which may be fatiguing to participants. A potential conceptual problem may be difficulty in knowing whether the questionnaires are measuring a trait or a state variable. Many of these inventories measure a broad range of aspects of impulsivity, making it difficult to differentiate between distinct facets of the construct.

Behavioural Tasks as Measures of Impulsivity

Behavioural tasks assessing various aspects of impulsivity have been used in research on impulsivity. More direct measures of impulsive behaviour include measures of reaction time or response speed, such as those assessed using in computerized tasks such as the Wisconsin Card Sorting Test or the Conners' Continuous Performance Test. The latter test also measures response inhibition. Other measures of response inhibition include Go-No Go paradigms and the Stroop test. An advantage of behavioural measures is their ability to assess narrow aspects of impulsivity to help inform theorists of the structure of impulsivity.

Cognitive Approaches to Measuring Impulsivity

Cognitive approaches involve measuring planning, decision-making, and time perspective. Several studies have employed analogue gambling tasks to assess the decision making in gambling tasks in gamblers and non-gamblers. Factors involved in decision-making that have been commonly measured in relation to pathological gambling are the extent of forethought used versus a disregard of future consequences, delayed discounting, and degree of orientation toward future, rather than immediate, goals.

A commonly used instrument for assessment of reward sensitivity (conceptualized as a biologically driven variable) and regard of consequences is the Iowa Gambling Task (Bechara, Damasio, Damasio, & Anderson, 1994). The Iowa gambling task involves drawing cards from one of several decks. Each card indicates the amount of money won or lost. As participants draw cards, it becomes apparent that some decks generally result in loss and others result in gains. The pattern of response to this task can indicate whether an individual's decision is primarily influenced by reward seeking or whether the individual is insensitive to future consequences, advantageous or not.

Delay discounting refers to the deciding on the relative importance placed on future rewards in the presence of immediate rewards. As the delay between an immediate reward and a future reward increases, individuals may be more likely to choose an immediate reward, even if this is of lower value than the delayed reward, rather than wait. That is, the value of the later reward becomes discounted.

Another approach to measuring the primacy of immediate versus future considerations is the Zimbardo Time Perspective Inventory (Zimbardo & Boyd, 1999), which identifies individuals' perspectives in terms of present versus future oriented. This self-report scale has characterized pathological gamblers as relatively low on future orientation and high on present orientation, suggesting a vulnerability to disadvantageous decision making due to lack of forethought or deliberation.

Neuropsychological Measures of Impulsivity

The Wisconsin Card Sorting Task (WCST) is an instrument that is used to assess executive function. The WCST measures the specific executive functions of higher order attention, cognitive flexibility, and forethought / planning (Lezak, 1995). Performance on this task was found to be impaired in one study of pathological gamblers (Rugle &

Melamed, 1993). Skitch & Hodgins (2004) found that university student pathological gamblers scored highest on self-report sub-scales measuring inattention and lack of planning. Thus, both direct and indirect support has been found for a role of neuropsychological deficits (i.e., in executive functioning) in gambling behaviour, and these deficits may be important in understanding impulsivity in gamblers.

The Conners' Continuous Performance Test, often used as a measure of sustained attention in clinical and research work with individuals with ADHD, may provide information about higher order attention processes related to executive function. There are no reports of the use of this measure with pathological gamblers, but the association of pathological gambling with ADHD now appearing in research reports (Littman-Sharp & Jain, 2000; Specker, Carlson, Christenson, & Marcotte, 1995) suggests that this may be a valuable tool for assessing neuropsychological function in pathological gamblers. The CPT also assesses cognitive disinhibition, which may be central to impulsive behaviour.

Measurement of Sensation Seeking

Zuckerman (1983) described in detail the phenomenology of sensation seeking based on his scale development research. Factor analysis led to a four-factor description of sensation seeking: *thrill and adventure seeking* (TAS), *experience seeking* (ES), *disinhibition* (DIS), and *boredom susceptibility* (BS). TAS is associated with a desire for physical activities involving elements of speed and danger, and is linked to both novelty seeking and intensity seeking. ES refers to preferences for novel experiences, creativity, and a non-conforming lifestyle. DIS refers to a need to engage in uninhibited social activities, with or without use of alcohol, while BS is characterized by aversion to repetitive and routine experience. Individuals high in BS tend to feel restless when exposed to such experience. Both DIS and BS are associated with novelty and intensity seeking behaviour.

Summary

A review of the research on impulsivity reveals that this is a multifactorial construct that has been addressed from a number of different perspectives, including neurobiology, personality theory, behaviour, cognition, and neuropsychology. These perspectives provide different definitions of the construct of impulsivity and have also led to different approaches to measuring the construct. Although these differences lead to difficulty comparing research and developing a common definition of the construct of impulsivity, they also add richness to an understanding of impulsivity. Both impulsivity and sensation seeking have been assessed in research with pathological gamblers. However, past research has not specifically aimed to clarify the components involved in impulsivity and their relationship to sensation seeking in the risk pathway to pathological gambling.

The present research aims to define the structure of impulsivity by integrating the different perspectives on this construct and its relationship to the trait of sensation seeking. This research has the potential to inform other models of pathological gambling by clarifying the construct of impulsivity. A better understanding of the components that comprise impulsivity can lead to changes in the clinical assessment of gamblers seeking treatment, and may lead to the development of more effective intervention strategies for modifying gambler behaviour. Knowledge of neuropsychological deficits may be particularly important in understanding possible limitations of some treatment strategies.

A Model of the Structure of Impulsivity in Pathological Gambling

Using the different perspectives on impulsivity presented earlier as a guide to what comprises this trait, a model representing multiple factors was developed. Figure 1 presents a hypothesized model of the structure of impulsivity, based on the above review. Personality theories and gambling measurement research have converged on between 3-4

components, related to reward sensitivity, behavioural inhibition/ response latency, and planning in decision-making. Neuropsychological aspects of impulsivity that have been recently addressed in pathological gambling centre on executive aspects of attention (Rugle & Melamed, 1993). Executive functions have not been integrated into models of impulsivity, but have been identified as important variables in gambling behaviour.

Neurobiological research suggests that an important indicator of neurotransmitter dysfunction is reward seeking. Behavioural aspects of impulsivity include quick responses and tendencies to act before thinking (behavioural disinhibition). On assessments, such individuals may tend to complete tasks quickly but with more errors reflecting lack of deliberation or inaccuracy. The gambler's lack of control over their gambling (i.e., inability to resist an impulse to gamble) may represent behavioural disinhibition. An important cognitive component related to decision-making that has emerged from the research in gambling is forethought, or consideration of future consequences, when making decisions. Poor gambling decisions are thought to be due to inability to conceive of future consequences of gambling decisions in the presence of immediate rewards (e.g., termed 'myopia for the future' by Bechara, Tranel, & Damasio, 2000).

As research has shown that impulsivity is associated with maladaptive gambling decision-making (Alessi & Petry, 2001), it seems reasonable that a model should also include impulsivity in the progression from recreational to impaired gambling, rather than solely as a vulnerability factor to initiating gambling.

The proposed model of impulsivity for this study reflects that impulsivity is multidimensional; that impulsivity is correlated with sensation seeking; and that both traits predict the severity of gambling problems. Although theoretical disagreement as to sensation seeking being orthogonal to versus a component of impulsivity exists, some

theory and recent research suggests that these are distinct but related traits. A new contribution of the proposed model is a better specification of components of impulsivity (i.e., motor/behavioural components, two aspects of decision making) and the inclusion of executive functions. The path model in Figure 1 specifies the subscales and measures for the above components of impulsivity. Measures are described in detail in the *Methods* section.

Study Hypotheses

Primary Hypotheses: Structural Equation Modeling

The following primary hypotheses were tested using structural equation modeling (refer to Figure 1 for the path diagram):

1. Impulsivity was predicted to contain four components related to: sensitivity to reward; behavioural/motor factors; lack of forethought in decision-making; and executive function deficits (i.e., disinhibition). These four components were hypothesized to directly predict a latent variable of impulsivity. The latent variable of impulsivity was hypothesized to directly predict pathological gambling severity. This overall model of the structure of impulsivity was hypothesized to be a good fit to the data.
2. Sensation seeking was hypothesized to be positively correlated with but not redundant to impulsivity and composed of one primary component. The strength of the correlation was expected to be moderate, reflecting that these are distinct but related traits, as found in previous research. Sensation seeking was hypothesized to directly predict severity of gambling problems
3. Each of the measured variables representing the impulsivity components and sensation seeking was hypothesized to contain one primary component, as assessed by principal components analysis.

Secondary Hypotheses

The following hypotheses were based on a review of the literature on impulsivity in pathological gambling.

1. A negative relationship between age and both impulsivity and sensation seeking was anticipated. It was hypothesized that younger individuals would show greater impulsivity on all measures of impulsivity and sensation-seeking, consistent with prior research.
2. Gender differences in impulsivity and sensation seeking were anticipated. Males were expected to score higher on both traits. It was hypothesized that males would show greater impulsivity on all measures of impulsivity and sensation-seeking.

Patterns of comorbidity were expected to reflect prior research with a pathological gambling sample. This information would provide support for the idea of a shared vulnerability of impulsivity to developing a number of impulse control problems, and may help direct future research.

3. High rates of comorbid DSM-IV substance abuse and dependence were predicted.
4. Comorbid impulse control disorders not otherwise specified (i.e., kleptomania) were expected.
5. Rates of Attention Deficit/Hyperactivity Disorder, by self report, were expected to exceed general population base rates, consistent with limited research with gamblers.
6. It was hypothesized that comorbid past and current ADHD would be associated with a greater problem gambling severity. These individuals were also expected to show higher impulsivity scores on both self report measures and a test of sustained attention.

METHOD

This study examined the structure of the construct of impulsivity in a sample of pathological gamblers using structural equation modeling. This technique was chosen because of its flexibility in assessing the relationships between observed and latent constructs (impulsivity, sensation seeking, and pathological gambling severity), particularly at an exploratory stage of research and theory development. This method allowed the assessment of the significance of each of the separate paths between the components of impulsivity and gambling behaviour, and the relationship between impulsivity and sensation seeking. In addition, modification indices provided by the analysis allowed for further exploration of relationships among the factors themselves and between the individual factors and sensation seeking.

Aggregate data were used to test a structural model of the construct of impulsivity. Multiple methods were used to assess the various factors comprising impulsivity, including interview, laboratory tasks, neuropsychological tests, and self-report questionnaires. This chapter describes the sampling and data collection procedures used, as well as the planned statistical analyses for each hypothesis.

Sample size

A power analysis was undertaken to estimate the sample size that was needed to detect a medium effect size. Previously reported effect sizes for the relationship between impulsivity, sensation seeking and gambling severity have fallen in the medium range (e.g., Blaszczynski, Steel & McConaghy, 1997). As a general estimate, using procedures conducted and published by Cohen (1992), a sample size of 76 problem gamblers was calculated for adequate detection of medium effect sizes. As structural equation modeling was used for the primary hypotheses, a further estimate of required sample size was

calculated based on the rule of thumb of a minimum of 10 participants per path in the model (Tabachnick & Fidell, 2007). As shown in Figure 1, there were nine paths to be estimated, thus a minimum sample size of 90 was planned for the study.

Participants

This study aimed to gain a better understanding of the construct of impulsivity in a pathological gambling sample, and non-pathological gamblers were excluded from the study. Individuals younger than 18 years were also excluded.

A community-dwelling sample of adult gamblers was recruited via media advertisement throughout Calgary and by contacting individuals from a participant pool in the Addictive Behaviours Laboratory who had indicated interest in further research participation. Gambling problems were assessed via telephone screening using the Problem Gambling Severity Index (PGSI) of the Canadian Problem Gambling Index (Ferris & Wynne, 2001). Individuals who met criteria for probable pathological gambling (scores of 8 or higher on the PGSI) were invited to the laboratory to participate.

A total of 256 individuals responded to advertisements, or were contacted from a registry of past participants at the Addictive Behaviours Laboratory. Thirty four individuals could not be reached and 47 individuals decided that they were not interested in participating after hearing more about the study. The projected time commitment of 90-120 minutes was unacceptable to some of the individuals who declined to participate in the study. The remaining 175 gave verbal consent to be telephone screened; 129 were deemed eligible and invited to participate and a total of 104 (51% females) completed the study.

Procedure

Written informed consent was obtained for all participants at the face to face meeting (see Appendix A). Severity of gambling problems and whether participants met

DSM-IV criteria for pathological gambling was assessed using Stinchfield's 19 questions (Stinchfield, 2003; see Appendix B) and the Problem Gambling Severity Index of the Canadian Problem Gambling Index (PGSI; see Appendix C). The interview also gathered data on substance use disorder history, impulse control disorders not otherwise specified (NOS), and ADHD using the Structured Clinical Interview for DSM-IV Diagnosis (SCID; First, Spitzer, Gibbon, & Williams, 1997), as these disorders have also been associated with elevated impulsivity. ADHD symptoms were also assessed using the Conners' Adult ADHD rating scale (*Conners, Erhardt, & Sparrow, 1999*). A continuous measure of substance use (e.g., the Alcohol Use Disorders Identification Test; AUDIT, Babor, Higgins-Biddle, Saunders, & Monteiro, 2001) was not employed, as comparable measures for past and present cigarette and other drug use are currently not available. Similarly, only dichotomous data were collected for other DSM-IV diagnoses (e.g., impulse control disorders NOS and ADHD). In addition, it was desirable to limit the amount of questionnaires to the fewest possible to keep the workload on participants manageable. Medical history (see Appendix D) was also included for the purpose of context when interpreting the neuropsychological results and understanding the sample.

Measures

Measurement of the variables hypothesized to comprise impulsivity was guided by their use in previous research with gamblers. To avoid similar-method variance, the present study employed several modalities for measuring variables where available, including face to face interview, self-report of personality and behaviour, behavioural tasks, and neuropsychological tests. Self-report inventories were selected if they 1) made theoretical sense and measured the constructs of most relevant interest to the research, 2) treated impulsivity as multidimensional and included sub-scales to represent those dimensions, 3)

were reported to have acceptable reliability in past research, 4) have been used in previous research with gamblers, 5) were accessible and cost efficient. A larger battery of tests could have been justified on conceptual grounds. However, these needs were balanced with the goal of not overburdening participants with a lengthy session. Pilot-testing of the protocol approximated a 90 to 120 minute time requirement.

Several assessment measures of the components of impulsivity and sensation seeking were administered. All questionnaires were administered in their entirety to preserve internal consistency reliability, and specific subscales were extracted as measures of specific observed variables. Please see Table 1 for a summary of measures included in the path model and the constructs assessed by each.

Barratt Impulsiveness Scale (BIS; Patton, Stanford, & Barratt, 1995; see Appendix E)

This 30-item measure of trait impulsivity contains three second-order factors that are positively correlated with lack of self-control: cognitive impulsiveness (e.g., "I have 'racing' thoughts"), motor impulsiveness (e.g., "I am restless at the theatre or lectures"), and non-planning impulsiveness (e.g., "I plan tasks carefully" (reverse-scored)). It has been widely used in the measurement of impulsivity in pathological gambling research with adults in the general population and in clinical samples. The BIS has been found to have good internal consistency (Cronbach's a = 0.82).

Conners' Adult ADHD Rating Scales: Short Version (CAARS; Conners, Erhardt, & Sparrow, 1999; see Appendix F)

This is a 26-item measure, rated on a four-point Likert scale, assessing ADHD symptoms of hyperactivity, inattentiveness, and impulsivity in adults. According to the technical manual (Conners, et al., 1999) internal reliability of the overall scale and its four subscales are reported in the technical manual to be high (a = 0.80 – 0.88). Reliability for

the overall scale was 0.85. For the subscales, internal reliability coefficients were reported as follows: hyperactivity/restlessness, a = 0.81; inattention/memory problems, a = 0.81; impulsivity/emotional lability, a = 0.81; and problems with self-concept, a = 0.88). Assessments of several types of validity are reported in the CAARS technical manual. Confirmatory factor analytic studies resulted in a good fit to the data, supporting the four-factor structure of the scale (Conners, et al, 1999). Discriminant validity assessment of the ability of the scale to correctly classify individuals with and without ADHD indicates that the CAARS can discriminate between groups with an overall classification rate of 73% (Conners, et al, 1999). Finally, construct validity has been supported by moderate to high consistency between retrospective childhood ratings of ADHD symptoms and the CAARS, and by moderate to high correlations between observer rating of adult ADHD symptoms and CAARS self-report data (Conners, et al, 1999).

Conners' Continuous Performance Test (CPT; Conners, 1995; see Appendix G)

The test is administered via computer, and requires the participant to push a key on the keyboard only in response to a target (i.e., the letter *X*) appearing on the screen and to withhold that response when other letters appear. A high number of errors are suggestive of greater impulsivity and lower response inhibition. The CPT was designed to measure cognitive impulsivity, and has been used extensively as a research tool in the assessment of cognitive performance in children with ADHD (Riccio & Reynolds, 2003). These authors consider the CPT to have great promise as a clinical tool in ADHD assessment, although its utility as a specific diagnostic tool has not been consistently supported. The CPT has also been applied to adult research. This measure has been in found to be a stronger indicator of impulsivity than other sustained attention tasks such as the stop-signal task (Epstein, Johnson, Varia, & Conners, 2001).

Demographic Information Questionnaire (see Appendix H)

This questionnaire was developed based on the demographic categories presented on the Statistics Canada website (www.statcan.ca). Participants were asked to provide their date of birth, sex, marital status, ethnicity, occupational status, educational attainment, and religious. Additional questions assessed extent and type of gambling involvement. Participants indicated frequency of involvement in 15 different gambling activities (e.g., casino games, video lottery terminals, sports betting, stock market), rated daily, weekly, monthly, or occasionally. Participants also indicated the form of gambling that was currently the most problematic.

Eysenck Impulsivity Scale - I_7 (Eysenck & Eysenck, *1991; see Appendix I)*

The I_7 is one scale of the Eysenck Personality Scales that measures impulsiveness. The I_7 scale contains 54 items, rated yes or no, that measure three sub-scales. The *impulsiveness* subscale measures unplanned impulsive behaviour without consideration of the consequences, while the *venturesomeness* subscale assesses thrill-seeking types of impulsive behaviour, where consequences have been considered (i.e., sensation seeking). The *empathy* subscale was designed to contain "buffer items" (page 28, Eysenck & Eysenck, 1991) and was not used for any analyses in the present study. Internal consistency reliability of the *impulsiveness* subscale was reported in the technical manual as a =0.84 (males) and a = 0.83 (females). The *venturesomeness* subscale internal reliabilities were a = 0.85 and a = 0.84 for males and females, respectively.

Iowa Gambling Task (IGT; Bechara, et al., 1997; see Appendix J)

This task is used as a measure of decision-making processes. It was originally designed to assess the degree to which an individual anticipates the long-term negative consequences of their gambling choices, and also indicates the degree to which individuals are drawn to the

immediate rewards. For this task, participants begin with $2000 in casino chips (worth $25, $50, and $100). Participants then select a total of 100 cards from one of four decks. The cards indicate whether an amount of money is won or whether an amount must be paid. Two of the decks result in net gains while drawing from the other two decks results in net losses. The number of cards selected from the unfavourable decks is measured, with high scores suggesting poorer appreciation of long term consequences of decisions. This task has been used by a number of gambling researchers, and failure to appreciate future consequences has been positively linked to impulsivity (e.g., Alessi & Petry, 2001; Petry and Casarella, 1999).

Problem Gambling Severity Index (PGSI; Ferris & Wynne, 2001; see Appendix C)

The Problem Gambling Severity Index is a nine-item measure of gambling severity derived from a larger instrument, the Canadian Problem Gambling Index. The PGSI is rated on a four-point Likert scale, and assesses cognitions, behaviours, and consequences related to gambling involvement. A score of 8 of higher on the PGSI meets DSM-IV criteria (APA, 2000) for pathological gambling. The PGSI shows very good internal consistency reliability (a = 0.78) and moderate correlations with an interview-based DSM-IV diagnosis of pathological gambling (r = 0.48; Ferris & Wynne, 2001).

Sensation Seeking Scale, Form V - SSS-V (Zuckerman, Kuhlman, Joirement, Teta, & Kraft, 1993; see Appendix K)

This 19-item scale measures four subsets of sensation seeking: disinhibition, experience-seeking, thrill and adventure seeking and boredom susceptibility. Responses are rated true or false. *Disinhibition (DIS)* refers to seeking release in uninhibited social activities; *Experience Seeking (ES)* refers to seeking novelty through artistic endeavors (e.g., music), travel, and to a tendency towards a nonconforming lifestyle; *Thrill and*

Adventure Seeking (TAS) reflects the drive to engage in physical activities involving danger, speed, and novelty (e.g., skydiving, mountain climbing); and *Boredom Susceptibility (BS)* refers to individuals' aversion to routine, repetitive activity, or predictability. The total score of the scale will be used as a general index of sensation seeking. Cronbach's alpha for the scale as a whole was reported as a =0.77 and a =0.80 for males and females, respectively (Zuckerman, 2002).

Stinchfield's DSM-IV Questions (Stinchfield, 2003, see Appendix B)

This 19-item examiner-rated measure of the DSM-IV diagnostic criteria for pathological gambling was developed as a way of operationalizing the DSM-IV pathological gambling criteria. Using a cutoff of five positively endorsed criteria, the measure was found to be a reliable and valid indicator of DSM-IV pathological gambling in a sample of 803 adults from the general population and 259 individuals seeking gambling treatment. A cutoff of four improved classification accuracy and reduced false negatives (Stinchfield, 2003).

Tridimensional Personality Questionnaire (Cloninger, Pryzbeck, & Svrakic, 1991; see Appendix L)

The TPQ is a scale designed to assess the three basic personality dimensions described in Cloninger's (1987) model of personality: *novelty seeking*, *harm avoidance*, and *reward dependence*. The TPQ contains 98 descriptions of personality traits and behavioral patterns, answered in a true / false format. Otter, Huber, and Bonner (1995) evaluated the reliability of the TPQ in a British sample and found good subscale reliabilities (0.74 – 0.87). Sher, Wood, Crews, and Vandiver (1995) also found an adequate range of reliabilities for the TPQ subscales, ranging from 0.72 – 0.85. This questionnaire was chosen because it has been used in previous research with gambling and because the three sub-scales are consistent with characteristics found to be relevant for pathological gambling.

Wisconsin Card Sorting Test (Wisconsin Card Sorting Test: Computer Version-2 for Windows; WCST: CV2, Research Edition 2.; Heaton, 1993; see Appendix M)

The WCST is a computer-administered visual/perceptual concept formation task that is sensitive to frontal lobe based executive dysfunction. Participants are required to sort 64 cards into piles based on a certain feature of the card. Minimal instructions are given, and participants must identify the correct solutions based on examiner feedback. Adequate performance on the WCST requires good planning and problem-solving ability, capacity to integrate feedback and adjust ongoing behaviour, and cognitive flexibility (Lezak, 1995). Highly impulsive gamblers, particularly those scoring high on non-planning factors of impulsivity, are expected to make more errors on this task compared to controls. Shorter response latency may indicate a lack of forethought and higher impulsivity. Deficits in WCST performance have previously been demonstrated in a sample of pathological gamblers (Rugle & Melamed, 1993).

Zimbardo Time Perspective Inventory (ZTPI; Zimbardo & Boyd, 1999; see Appendix N)

The ZTPI is a 56-item self report measure, rated on a five-point Likert scale, of orientation to time in the context of present decisions and behaviour. This measure has been found to contain five factors explaining 40% of the item variance (Zimbardo & Boyd, 1999). The *past-negative* orientation reflects a generally negative, aversive view of the past, involving pain and regret. These negative attitudes may be due to actual experiences of unpleasant events or to negative reconstruction of benign events, i.e., negative cognitive schema. In contrast, the *past positive* orientation reflects a warm, sentimental attitude toward the past. The *present-hedonistic* orientation reflects a pleasure-seeking, risk-taking and carefree attitude toward time and life. This construct is equivalent to reward dependence. In contrast, the *present fatalistic* orientation is associated with a fatalistic,

helpless, and hopeless attitude toward the future and life. Finally, *future orientation* refers to a general orientation toward future goals and events. Two of these factors are likely to be strongly related to impulsivity and to gambling. *Present hedonistic* orientation should be related to reward sensitivity, while *future orientation* would be related to consideration of future consequences in decision making. Thus, scores on these factors will be used as measures of the two decision making styles. Internal reliability of the *present hedonistic* subscale was a =0.79 and the *future orientation* subscale was a =0.77. Test–retest reliabilities of the subscales of the ZTPI ranged from 0.70 to 0.80 (Zimbardo & Boyd, 1999).

Analytic Plan

Analytic Plan for Primary Hypotheses

The data were inspected for normality by using the skewness and kurtosis statistics. Only two variables had skewness statistic values greater than 1; the CAARS Impulsivity/Emotional Lability was slightly positively skewed (1.27) and the ZTPI Past Positive subscale score was highly positively skewed (8.56). Natural log transformation was conducted to adjust the latter variable, resulting in a normal distribution. The remainder of the variables were not found to be significantly skewed or kurtotic.

Data analyses were conducted with Statistical Package for the Social Sciences (SPSS 15.0.1; SPSS Inc., 2006) and AMOS 7.0 (Arbuckle, 2003). Missing value analyses were carried out for demographic variables, gambling severity measures, and all other self-report scales and performance tasks. Variables that had more than five percent of cases missing were: IGT (37%), annual income (9.6%), ZTPI (8%) and CPT (n= 5.8%). The WCST was only missing 1.9%. There were no missing data on either gambling severity measure or the other self-report measures included in the analyses.

Missing data were handled conservatively, as structural equation modeling is sensitive to missing data. (Kline, 2005; Schumaker & Lomax, 2004; Tabachnick & Fidell, 2007). The pattern of missing were investigated, as it is the pattern rather than the amount of missing data that has a more important potential effect on results. The pattern of missing data for the IGT was not random; thirty participants declined to do the task because they were quitting gambling and did not wish to expose themselves to a gambling-like activity. Principal components analyses for the IGT were run both by excluding missing data and with replacement by regression (using all continuous data as predictors) to compare the results. If no differences were found, regression would be used, so as to maximize the sample size for structural equation modeling and minimize problems with restricted range. For annual income, ten percent of data were missing. These data were used for estimating the socio-economic status of the sample but was not used in the primary (SEM) or secondary analyses. Missing data were judged to have a negligible potential impact on the analysis therefore desriptive statistics for income were run using listwise deletion. Following guidelines by Schumacher and Lomax (2004) missing data on the Zimbardo Time Perspective Inventory and Conners' Continuous Performance Test were handled with regression imputation, as this method is appropriate when there is a small (i.e., less than 10%) amount of missing data that appears to be missing at random. All variables were examined for outliers and no cases had standardized scores greater than 3 (Tabchnick & Fidell, 2001).

The primary hypotheses were tested using structural equation modeling. Four summary variables were created for impulsivity: Reward Sensitivity, Forethought, Executive Function, and Behavioural/Motor. A separate variable represented Sensation Seeking. As shown in the Figure 1, Reward Sensitivity was comprised of choice of higher-

reward/high-penalty cards on the Iowa Gambling Task (IGT – Disadvantageous), the *Reward Dependence* sub-scale of the Tridimensional Personality Questionnaire (TPQ – reward dependence), the *Cognitive* subscale of the Barratt Impulsiveness Scale (BIS - cognitive), and the *Present Hedonistic* subscale of the Zimbardo Time Perspective Inventory (ZTPI – present hedonistic). Forethought was composed of the *Non-Planning* sub-scale of the BIS (BIS – non-planning), the *Harm Avoidance* subscale of the TPQ (TPQ – harm avoidance), and choice of lower-reward/low-loss cards on the IGT (IGT – advantageous). The Motor / Behavioural component used mean response latency on the Wisconsin Card Sorting Test (WCST) and CPT, the *Motor* sub-scale of the BIS (BIS – motor), and the *Impulsiveness* subscale of the Eysenck Impulsivity Scale (I_7 – impulsiveness). For the Executive Function component, measures of attention and inhibition on the WCST and CPT were used. Sensation Seeking was assessed using Zuckerman's Sensation Seeking Scale, the TPQ – *Novelty-Seeking* subscale and the *Venturesomeness* subscale of the I_7 (I_7 – Venturesomeness).

To create composite scores for each variable in the model, subscale raw scores from the measures were entered into a principal components analysis (PCA). PCA was used because each variable was thought to be composed of one main component, making PCA the more appropriate data reduction technique (Tabachnick & Fidel, 2007). To assess the number of components, those with eigenvalues greater than one were considered to be a main component. The scree plot was also used to assess factor structure. Summary scores (for entry into the SEM analysis) were calculated by summing the component scores for the primary component derived from PCA. It was hypothesized that each summary variable would fit a one-component solution. Component scores were used to calculate a single composite score for each of the four components of impulsivity and one for sensation

seeking. The composite score was thought to be most efficient use of the available data, as it was not feasible to include all of the measures as separate measured variables. From a practical standpoint, separate paths for each measure would have resulted in more paths in the analysis and a much larger sample size requirement. Summary scores were created by summing composite scores of the components of each of the principal components analysis that had eigenvalues greater than 1.0.

Structural equation modeling was used to examine the data in light of current theory of gambling. Three main hypotheses were proposed. To test the hypothesis that the model was a good fit as a description of impulsivity and sensation seeking in gambling, model fit indices generated by AMOS (Arbuckle, 2003) were inspected. Standardized path coefficients for the SEM provided an estimate of relative strengths of relationships between components of impulsivity, sensation seeking, and gambling severity. As the structure of impulsivity has not previously been assessed in gambling research, there were no prior findings to guide hypotheses regarding which of these components would be most strongly related to gambling problem severity; all were expected to have significant relationships and to load on a latent factor of impulsivity, which would predict gambling problem severity. Finally, modification indices were used to identify potential changes to better describe that data and to suggest avenues for future research. As this research was exploratory, the modification indices were inspected to determine whether any paths could be deleted from the model to improve its stability. Only paths that could be theoretically justified were considered for modification.

Analytic Plan for Secondary Hypotheses

In addition to assessing impulsivity using SEM, the relationship between demographic variables and impulsivity and gambling severity were also assessed.

1. A significant negative relationship between age and both impulsivity and sensation seeking was anticipated. Pearson correlations were used to test this hypothesis.
2. Gender differences in impulsivity and sensation seeking were anticipated. Males were expected to score higher on both traits. For severity of pathological gambling, there was no consistent pattern of differences discernible from the research literature that would allow prediction of rates of gambling severity for each sex. Gender differences on the primary variables of interest (i.e., impulsivity, sensation seeking, and severity of gambling problems) were explored using analysis of variance (ANOVA).

This study also aimed to provide descriptive information related to the relationships between gambling behaviour and the predictors comorbid substance use problems, ADHD, and impulse control problems NOS. Specifically, patterns of comorbidity were expected to reflect prior research with a pathological gambling sample, with individuals with comorbid substance use, impulse control disorders NOS, and ADHD exhibiting higher gambling severity scores and meeting more DSM-IV criteria for pathological gambling. Two separate ANOVAs (for severity and for number of DSM-IV criteria) were run to test these hypotheses.

3. High rates of DSM-IV substance abuse and dependence comorbidity were predicted. Frequency analyses were used to identify rates of substance use comorbidity. ANOVA was used to investigate differences in gambling severity for those with comorbid DSM-IV substance abuse and dependence
4. Comorbid impulse control disorders NOS (e.g., kleptomania) were expected. Frequency analyses were used to identify rates of impulse control disorder NOS

comorbidity. ANOVA was used to investigate differences in gambling severity for those with comorbid impulse control disorders NOS

5. Rates of ADHD, by self report, were expected to exceed base rates. Frequency analyses were planned for assessing rates of comorbidity of ADHD symptoms. It was hypothesized that comorbid past and current ADHD would be associated with a greater gambling problem severity. These individuals were also expected to show higher impulsivity scores on both self report measures and performance tests (e.g., CPT). ANOVA was planned for testing this hypothesis. Differences in gambling severity between individuals with and without a self-reported diagnosis of ADHD were explored using ANOVA. Correlation analyses were also used to explore the relationship between self-reported symptoms consistent with ADHD (4 subscales of the CAARS) and level of gambling severity.
6. The degree and direction of relationships between comorbid DSM-IV disorders and: pathological gambling severity, separate impulsivity components, and sensation seeking were explored using Pearson correlations. Strong positive relationships between comorbid problems and gambling severity were expected. A conservative alpha level was adopted using Bonferroni correction to combat the family-wise error rate for 7 tests (alpha = 0.05/7 = 0.007). Individuals with comorbid disorders were expected to show greater gambling severity scores, higher impulsivity, and higher sensation seeking. ANOVAs were planned for testing this hypothesis.

RESULTS

A total of 104 individuals (51% female) who met DSM-IV criteria for pathological gambling participated in the study. It took most participants about 105-minutes to complete the study. The mean age of the sample was 43.5 years (SD = 13.2 years; range 19 – 75 years). This was a well-educated sample (mean years of education = 14.6 years, SD = 5 years, range 5 – 20 years). Other demographic information appears in Table 2.

In terms of medical information, 53% of participants reported a history of brain injury, with 19% reporting two or more brain injuries, primarily due to accidents and assaults. In total, 36% reported experiencing loss of consciousness or disorientation and 31% reported being hospitalized as a result of the injury. No medical reports were available to corroborate the self-report information. In addition, the incidence of self-reported brain trauma in the general population is not known. Therefore, whether these gamblers are showing higher than average incidence of brain trauma is not clear. The finding of self-reported brain trauma in half of this sample may impact conclusions about the relationship between pathological gambling and impulsivity and sensation seeking, particularly with respect to cognitive performance measures.

Regarding cardiovascular problems, 8.7% of the sample reported a history of stroke or heart attack, and 1.9% (n = 2) indicated having lasting motor weakness following the stroke. In response to the question assessing other neurological or medical problems, participants reported a wide range of difficulties. The most common reported problem was migraines and headaches (11.5%), followed by mood disorders (5.8%), angina or hypertension (5.8%), and diabetes (4.8%). Of those who reported mood disorders, one participant had a diagnosis of Bipolar II disorder requiring medication and the other four reported depression. The remainder of reported problems included stress/anxiety, asthma,

cancer, sleep apnea, irritable bowel syndrome, fibromyalgia, back pain, and learning disabilities.

An unexpected 20% of the sample self-identified as aboriginal (category includes First Nations, Metis, and Inuit). Investigation of ethnic differences in gambling severity using ANOVA was conducted as a post hoc analysis. Aboriginal participants were not found to have significantly different severity scores than non-aboriginal participants. Aboriginals scored significantly higher on BIS Attentional Impulsivity (F (1, 103) = 4.30, p = 0.04). However, using a more conservative alpha rate of 0.005 to account for multiple comparisons, this difference was no longer significant. Aboriginal participants were not significantly different from non-aboriginal participants on other measures of impulsivity or sensation seeking.

Table 3 presents a summary of the reliabilities calculated for all self-report questionnaires used in this study. Cronbach's alpha was used to estimate internal consistency reliability.

Pathological Gambling

Participants described their patterns of gambling involvement in terms of frequency of play of various types of gambling and listed the type of gambling with which they experienced the most problems. About one third (35%) of the sample reported problems with video lottery terminal (VLT) play and 70% of the sample was involved with VLT play on a daily or weekly basis. An additional 23% reported problems with slot machines, while the remainder of individuals indicated problems with casino-based games (13%), bingo (6%), scratch/lottery tickets (5%) and other types of gambling (e.g., horse racing, keno, stock market). Particpants engaged in a mean of 6.4 (SD = 3.6) different types of gambling activities.

All participants met criteria for Pathological Gambling on the PGSI but not necessarily on Stinchfield's DSM-IV interview. A minimum of 5 criteria were needed for diagnosis and participants endorsed a mean of 7.1 (*SD* = 1.8; *range* = 2 - 8) of a possible 10 DSM-IV criteria. Nine individuals (8.7%) met fewer than 5 criteria on the DSM-IV screen. For these individuals, mean PGSI score was 9.44 (*SD* = 2.7, *range* = 8 – 16). For the entire sample (N = 104), participants' average score of 14.4 (*SD* = 4.8; *range* = 8 - 27) on the PGSI indicated severity within the middle third of the pathological gambling range. Using Pearson correlation, the PGSI was moderately correlated with number of DSM-IV criteria met ($r = 0.59$, $p \leq 0.001$). Both gambling measures assessed past-year gambling problems, rather than lifetime gambling problems.

Impulsivity and Sensation Seeking

Pathological gamblers in this sample scored high on several self-report measures of impulsivity compared with published norms for non-problem gambling samples, consistent with previous findings. Table 4 presents a summary of the participants' performance on all measures and sub-scales assessing impulsivity. Table 5 presents the intercorrelations between subscales measuring impulsivity. Only the TPQ Novelty Seeking subscale and the Eysenck Impulsiveness subscale showed a strong positive relationship ($r = 0.71$, $p < 0.01$). The BIS subscales showed significant moderate correlations with TPQ Novelty Seeking ($r = -0.19 – 0.28$, $p < 0.05$). The Eysenck I7 was moderately correlated with two subscales of the BIS (Attention and Non-Planning; $r = 0.33$ and $r = 0.26$, $p < 0.01$) and TPQ Harm Avoidance ($r = 0.23$, $p < 0.05$). Executive function aspects of impulsivity (i.e., behavioural inhibition, sustained attention, and mental flexibility) were measured by the Conners' Continuous Performance Test (CPT), and the Wisconsin Card Sorting Test (WCST). WCST mean scores fell into the average range (23rd – 32nd percentile) based on U.S.

normative samples of normal adults. Mean CPT-ADHD index was also in the average range (mean T = 51, SD = 20), indicating performance more consistent with non-clinical adults (e.g., normal adults from a U.S. general population sample; N = 1920) rather than clinical adults (e.g., U.S. adults diagnosed with ADHD in the normative sample; N = 378). The Iowa Gambling Task results provided information about participants' decision-making strategies, e.g., whether they were cautious and future-oriented, choosing advantageous cards overall or reward-seeking, making disadvantageous choices. Results of the IGT revealed a tendency to chase higher payouts, despite higher associated losses, suggestive of reward dependence and a disregard for future consequences.

With regard to the relationship between measures of impuslvity and severity of pathological gambling behaviour, the Eysenck I7 Impulsiveness subscale showed a low but significant correlation with the PGSI ($r = 0.29$, $p < 0.01$) and a moderate positive correlation with the DSM-IV screen ($r = 0.43$, $p < 0.01$). Two of the three Barrat Impulsiveness Scale subscales were positively correlated with the DSM-IV screen; BIS-Attention ($r = 0.28$, $p < 0.01$) and BIS-Non-planning ($r = 0.26$, $p < 0.01$). These subscales were not signifciantly correlated with the PGSI measure. None of the other measures of impulsivity showed significant relationships with pathological gambling severity.

Table 4 contains descriptive information on participants' scores on measures of sensation seeking. This sample scored within the moderate range of sensation seeking. On the ZKPQ, mean scores were equivalent to published means of the normative sample of 2969 U.S. college students ($M = 10.18$, $SD = 4.09$; Zuckerman & Kuhlman, 2000) and slightly higher than norms for U.S. adults ($N = 589$; $M = 9.10$, $SD = 4.30$). On the TPQ, comparison to norms based on U.S. adults, this sample showed mean novelty seeking scores that were 1.5 – 2 standard deviations higher than published average scores. On the

Eysenck I7, comparison of the study sample to the published norms (based on a general U.K. population sample, $N = 1320$) indicated that study participants scored one standard deviation higher.

The relationship among the three measures of sensation seeking (ZKPQ Sensation Seeking Scale, TPQ-Novelty Seeking, and I7-Venturesomeness) and measures of pathological gambling severity were assessed. TPQ-Novelty Seeking showed moderate, significant correlations with both measures of gambling severity, the PGSI ($r = 0.35$, $p < 0.0001$) and number of DSM-IV criteria met ($r = 0.42$, $p < 0.0001$). The ZKPQ was significantly correlated with the number of DSM criteria met ($r = 0.23$, $p = 0.020$), but not with severity scores on the PGSI. The I7-Venturesomeness subscale was not significantly correlated with either measure of gambling severity.

Primary Hypotheses: Structural Equation Modeling

Measurement Model

Each construct was measured by multiple indicators (e.g., sub-scale on self-report inventory; performance on decision-making task; neuropsychological test result). A principal components analysis was conducted for each variable to assess whether the construct was composed of a single component. Varimax rotation rather than oblique rotation was chosen, as it was desirable to maximize the independence of factors for the components representing impulsivity. The summed factor scores of the variables comprising the primary component were then used as input data for structural equation modeling. As shown in the model in Figure 1, there was one measured variable for Sensation Seeking and there were four measured variables comprising the latent variable of Impulsivity,entitled Reward Sensitivity, Forethought, Executive function- Attention and

Motor Impulsivity. Pathological gambling severity was represented by scores on the PGSI measure and DSM-IV questionnaire.

For the principal components analysis for Sensation Seeking, a strong single component was found (initial eigenvalue = 2.13) and explained 72% of the variance. Communalities ranged from 0.66 – 0.84. All measures (ZKPQ Total, I_7 Venturesomeness, and TPQ Novelty Seeking, loaded strongly on the primary component and the scree plot supported a one-component solution. Factor loadings for the main components for all constructs are summarized in Appendix O.

For Impulsivity – Reward Sensitivity, a strong single component was also found (initial eigenvalue = 1.49) and accounted for 50% of the variance. Communalities ranged from 0.44 – 0.57, indicating that the variables were well-described. The scree plot indicated a single component solution. IGT – Reward Seeking, TPQ Reward Dependence, and ZTPI – Present Hedonistic all loaded onto the first component.

For Impulsivity – motor, the PCA rotated scree plot and statistics indicated a single component solution (initial eigenvalue = 1.19) that accounted for 42% of the variance. The communalities were between 0.66 – 0.79. All three variables (BIS-Motor, CPT-Commisson errors, and I7 Impulsiveness) loaded on the first component.

The PCA for the Cognitive- Forethought aspect of impulsivity generated a strong single component (initial eigenvalue = 1.35) with communalities ranging from 0.44 – 0.67. BIS-Non-planning, TPQ Harm Avoidance, and ZTPI-Future loaded on the first component whereas the IGT did not. These suggest that the component was related to caution and consideration of the future in decision-making, but that the IGT may have been measuring a somewhat different construct.

For the Impulsivity - executive measured variable, the PCA results indicated a two factor solution with initial eigenvalues of 3.20 and 2.03. Communalities were strong (0.42 – 0.91) for all but one variable, CPT - Vigilance, which had a communality of only 0.05. The first factor seemed to be related to cognitive inhibition, as it included the measure of perseverative responses on the WCST and commission errors on the CPT. The second factor was related to inattention, as it included CPT-impulsiveness and CPT-inattention. Both of these factors seem to represent a different conceptual aspect of executive functioning. Theory and clinical assessment of executive function suggests that these functions are a collection of abilities, rather than one ability (Lezak, 1995). Both factors were justified by developmental theory, which suggests that shifting from one response set to another is an executive cognitive function that is dependent on basic attentional processes (Taylor, 1997). In support of including the factor related to attentional aspects of executive function, prior research with pathological gamblers has suggested that executive attentional functions were impaired in individuals with gambling pathology (Rugle & Melamed, 1993). It was therefore deemed reasonable to include the two paths suggested by PCA, labelled Exec-Attention and Exec-Inhibit, rather than one, for the observed measure of executive aspects of impulsivity. Please see Figure 2 for the modified path model for structural equation modeling.

Pathological gambling severity was to be represented by the PGSI and DSM-IV questionnaire. The latter provided the number of DSM-IV criteria met. It was not justifiable to combine these variables into one latent variable, as there would only be 2 indicators, and guidelines for SEM suggest that a minimum of 3 indicators should be used to represent a latent variable (Kline, 2005; Schumaker & Lomax, 2004). PCA was conducted using individual items from the PGSI (9 items) and DSM-IV (10 criteria). The results did not

provide a clear conceptual structure when rotated. Therefore, it was decided that the PGSI would be used to represent severity, as it was the measure used to screen participants for inclusion in the study.

Structural Model Estimation

Table 6 displays the Pearson correlations among the variables included in the structural model. The model was run with the computer program AMOS 7.0 (Arbuckle, 2006) and estimated using maximum likelihood estimation. The first model run assessed the five observed measures of impulsivity (Reward Sensitivity, Forethought, Motor, Executive – Attention, and Executive – Inhibit) and their loadings on a latent factor of impulsivity. Seven iterations were completed. The data were not a good fit for the model X^2 (5, N = 104) = 55, p = 0.001, GFI = 0.93, RMSEA = 0.17. According to Hu and Bentler (1999), the Goodness of Fit Index should be greater than 0.95 and the RMSEA should be less than 0.06. Modification indices suggested that the fit would improve by adding paths between Motor and Reward Sensitivity, Reward Senstivity and Sensation Seeking, as well as by correlating the errors for Reward and Forethought, and Forethought and Executive-Attention.

Relationships with sensation seeking were investigated by inspecting the correlation table (see Table 5 for values and significance levels). Sensation seeking was found to show significant moderate positive correlations with Executive-Attention, Executive-Inhibit, and number of DSM-IV criteria met (all $p \leq 0.01$). A significant moderate negative correlation was found with Forethought ($p \leq 0.01$). A weaker, but statistically significant positive correlation was also found with the PGSI total score ($p \leq 0.05$). None of the other relationships were significant.

A model was tested using the five components of impulsivity, and sensation seeking, to directly predict gambling severity. Modifications suggested by the first analysis were included (see Figure 3). The model completed 5 iterations and fit the data well: X^2 (3, N = 104) = 3.042, p = 0.385, GFI = 0.990, RMSEA = 0.012. The standardized regression weights indicated that only one of the five components of impulsivity, Motor, significantly predicted severity of pathological gambling (*B* = -0.19). In addition, Sensation Seeking also significantly predicted pathological gambling (*B* = 0.27). Impulsivity strongly predicted Sensation Seeking, but this relationship was not bidirectional. No modification indices were suggested for this model.

Comorbidity

The secondary hypotheses regarding comorbid impulse control disorders and their relationships to impulsivity, sensation seeking, and pathological gambling were investigated. Participants' history of substance use disorders, impulse control disorders NOS, and Attention Deficit/Hyperactivity Disorder was assessed and comorbidity patterns were examined. High rates of comorbid substance use, impulse control disorders NOS, and ADHD were expected, compared to base rates published in the DSM-IV.

Substance Use Disorders

Results of structured interviews indicated elevated rates of DSM-IV Substance Abuse and Substance Dependence compared to the general population base rates published in the DSM-IV (APA, 2000). 44.2% met criteria for alcohol dependence and an additional 13.5% met criteria for alcohol abuse (past or present). Twenty five percent of the sample met criteria for drug dependence and an additional 16.3% met criteria for drug abuse (past or present).

ANOVAs conducted to compare mean PGSI scores for those with and without substance use disorders revealed that individuals with a history of alcohol abuse, alcohol dependence, or drug dependence did not score significantly differently on the PGSI or DSM-IV measures. Individuals with a history of drug abuse scored significantly lower on the PGSI (M = 12.06, SD = 3.21) than those with no history of drug abuse (M = 14.95, SD = 4.99), F = 5.27, p = 0.02. Individuals with drug abuse histories also met fewer DSM-IV criteria (M = 6.24, SD =1.71) than those without a history of drug abuse (M = 7.31, SD =1.79), F = 5.57, p = 0.02.

Regarding impulsivity and sensation seeking, individuals' scores on sensation seeking and the five indices of impulsivity used in SEM were compared for those with and without histories of substance use disorders. Individuals meeting DSM criteria for past or present alcohol or drug dependence were found to score significantly higher on the index of motor impulsivity (M = 0.25, SD = 0.92) than those without drug or alcohol dependence (M = 0.07, SD = 0.71), F = 4.28, $p \leq 0.05$). Those with a history of alcohol dependence showed lower executive-inhibit scores (M = 0.17, SD = 0.85) than those with no alcohol dependence history (M = 0.37, SD = 1.16) F = 7.83, $p \leq 0.01$). Interestingly, those with history of drug dependence scored lower on sensation seeking (M = 0.14, SD = 0.95) compared to those not reporting a history of drug dependence (M = 0.41, SD = 1.06), F = 6.18, p = 0.01.

Impulse Control Disorders, NOS

In total, 4.8% of participants met criteria for Intermittent Explosive Disorder (IED), and an additional 3.8% were in the sub-threshold range (defined as having one fewer than the required number of symptoms). No participants met criteria for any other Impulse Control Disorder NOS, though two were in the sub-threshold range for pyromania. Two

one-way ANOVAs were conducted using Intermittent Explosive Disorder diagnosis as the classification variable and gambling severity as the dependent variable; one analysis used the PGSI as a measure of gambling severity, and the other used the number of DSM criteria met. Because two analyses were done, the alpha level of 0.05 was divided in half (a = 0.025) to accommodate for the family wise error rate. Results indicated that people with a past or current comorbid Intermittent Explosive Disorder met significantly more criteria for pathological gambling on the DSM-IV interview ($M = 9$, $SD = 0.7$) than those with no history of comorbid IED ($M = 7$, $SD = 1.7$); F (1, 103) = 6.30, $p = 0.014$. There were no significant mean differences between groups on the PGSI measure. For those individuals with no IED diagnosis, mean PGSI score was 14.4 ($SD = 4.9$), whereas for participants with a history of IED, mean PGSI score was 14.6 ($SD = 4.0$).

Attention-Deficit/Hyperactivity Disorder

On interview, 14% of the sample was certain of a past or present diagnosis of ADHD, while an additional 23% had concerns but had never been diagnosed. A one-way ANOVA was used to examine mean PGSI score and mean number of DSM criteria met between individuals with and without a history of ADHD diagnosis. The group means were not significantly different in terms of gambling severity on either measure.

On a self-report scale assessing ADHD symptoms (CAARS; Conners, Erhardt, & Sparrow, 1999), individuals were rated on five subscales: Inattention/Memory Problems; Hyperactivity/Restlessness; Impulsivity/Emotional Lability; Problems with Self-Concept; and an ADHD Index. Regression analysis of CAARS data (ADHD symptom self-report) revealed that scores on all subscales taken together accounted for 16.3% of the variance in PGSI scores. Scores on the Inattention/Memory problems were found to significantly predict severity of PG ($p \leq 0.01$), and accounted for 9% of the variance. Impulsivity /

Emotional Lability accounted for only 3% of the variance, suggesting relatively weak practical significance, though it reached statistical significance ($R^2 = 0.03$, $p = 0.04$). The subscales of Hyperactivity/Restlessness, Problems with Self-Concept, and the ADHD Index were not significantly predictive of severity of pathological gambling on the PGSI. Scores on the ADHD and Inattention/Memory Problems indices ($R^2 = 0.089$, $p < 0.01$ and $R^2 = 0.091$, $p < 0.01$, respectively), but neither the Hyperactivity/Restlessness nor Impulsivity/Emotional Lability indices, were significantly predictive of gambling severity on the DSM-IV questionnaire.

Scores on all of the CAARS subscales were moderately positively correlated with scores on I_7 impulsiveness ($r = 0.42 – 0.52$, $p \leq 0.001$). CAARS Inattention/Memory Problems was significantly correlated with Commission errors on the CPT ($r = 0.30$, $p = 0.003$), which are indicative of inattention and poor impulse control. The Hyperactivity/Restlessness scale also had a weak but significant relationship to Commission errors on the CPT ($r = 0.22$, $p = 0.028$). ADHD Index scores were significantly correlated with Omission errors on the CPT (indicative of inattention) $r = 0.39$, $p \leq 0.001$. These results suggest that participants with self-reported attention/memory problems and ADHD symptoms also show impairments on performance tasks.

Demographic Variables

Secondary hypotheses regarding age and gender differences in impulsivity, sensation seeking, and pathological gambling severity were examined. It was hypothesized that impulsivity and sensation seeking would both decrease with age and that males would show higher impulsivity and sensation seeking scores than females. On measures of pathological gambling, severity of gambling was expected to decrease with age. It was

difficult to hypothesize gender differences, as no consistent pattern of differences in rate of pathological gambling has been established.

Age

There were no significant relationships with age on any of the measures of impulsivity. However, there were significant relationships between age and all three measures of sensation seeking; the ZKPQ Sensation Seeking Scale (r = -0.38, $p \leq 0.001$); I_7 Venturesomeness sub-scale (r = -0.31, $p \leq 0.001$), and the TPQ Novelty Seeking sub-scale (r = -0.21, $p \leq 0.04$). All correlations were in the mild to moderate range and in the negative direction, indicating that sensation seeking decreased with age. Age was not significantly correlated with either measure of pathological gambling.

Gender

Gender differences were explored for the measures of impulsivity, sensation seeking, and pathological gambling in the study. Results of one-way ANOVA for gambling severity by sex were non-significant, indicating no gender differences in gambling severity. With regard to impulsivity, there was no main effect of sex on the Barratt Impulsivity Scale scores or on the sub-scales. However, there was a main effect of sex on the TPQ Harm Avoidance (F (1, 102) = 16.7, $p \leq 0.001$) and TPQ Reward Dependence (F (1,102) = 11.9, $p \leq 0.001$) subscales. On both impulsive measures, females showed higher impulsivity than males. For sensation seeking, there was a significant main effect of sex (F (1, 102) = 13.4, $p \leq 0.001$) with males demonstrating higher sensation seeking than females.

DISCUSSION

This study assessed a model of impulsivity in pathological gambling that included five components, derived from distinct perspectives in impulsivity research. A latent impulsivity variable, along with a separate construct of sensation seeking, was hypothesized to predict pathological gambling severity. Results indicated that five components did not in fact load on a latent factor of impulsivity. The following section discusses the pattern of relationships found in the structural model and addresses the theoretical and research implications of these findings for an understanding of the construct of impulsivity. This chapter then describes the research sample characteristics, including findings regarding pathological gambling severity, impulsivity, and sensation seeking. Other findings of interest in this research regarding comorbid impulse control disorders and individual differences are also discussed. The limitations of the research, in terms of theoretical, practical, and methodological issues, are addressed. The chapter concludes by offering ideas for future research directions.

Structural Model

The main finding of this study was that five components hypothesized to comprise impulsivity did not load on a latent factor of impulsivity. This finding was surprising, and may suggest that the components proposed to comprise impulsivity are actually representative of distinct variables. The literature on impulsivity in pathological gamblers clearly suggests that impulsivity is a multi-dimensional trait. On initial exploration of the literature describing various aspects of impulsivity, the different factors explored in research seem to share commonalities, in that underlying biological factors may drive behaviour, neuropsychological performance, and motor or behavioural outcomes. The factors are described from different theoretical perspectives such as neurobiology,

cognition, neuropsychology, and behaviourism, and are all labeled as impulsivity. However, given the results of the present study, this label may not be appropriate, at least not in reference to pathological gamblers. Instead, it may be more useful to conceptualize separate constructs that address reward dependence, response inhibition, cognitive aspects of impulsive behaviour, and neuropsychological functioning, all of which may differentially contribute to gambling pathology.

Investigation of the pattern of relationships in the SEM suggested that motor aspects of impulsivity and reward dependence were related to each other and to severity of pathological gambling. This relationship may indicate that individuals who are focused on immediate reward do not take the time to deliberate about their decisions, therefore showing faster response times. The likelihood of incurring greater financial losses and to experiencing greater loss of control over gambling behaviour would therefore make these individuals more likely to experience problems related to gambling. If this relationship between motor impulsivity and reward dependence is confirmed in future research studies, this may lead to specific treatment strategies that may help pathological gamblers manage their behaviour (e.g., stop and think strategies such as those used for treatment of anger outbursts).

As most variables in the model were not significantly predictive of gambling severity, the structural equation model was not a good fit for the data. However, sensation seeking did predict pathological gambling severity, consistent with some prior research, indicating that this construct is important in understanding pathological gambling. Although the main model was not a good fit for the data, the modified model leads to new questions about impulsivity.

Sample

This sample was composed of pathological gamblers recruited from media advertisements and a participant pool at the Addictive Behaviours Laboratory. Most participants were involved in multiple gambling activities. Over one third of the sample reported problems with video lottery terminal (VLT) play and 70% of the sample was involved with VLT play on a daily or weekly basis. VLT machines are widely available in Alberta, found in casinos, bars, hotel lobbies, and restaurant lounges. In total, Alberta has 6000 VLT machines in 1045 locations, which is the maximum number of machines allowed by law. Estimated VLT annual revenue for 2007 was $705 million (AGLC, 2008).

An additional 23% of participants reported problems primarily with slot machine play, which brought an additional $748 million in revenue in 2007. This pattern of gambling involvement was consistent with reports of typical gambling participation in Alberta.

As the study was time-intensive and required travel to the University of Calgary, the study may have attracted a relatively higher-functioning, motivated selection of individuals than may actually be representative of the general population of pathological gamblers. The estimated time commitment of 90 – 120 minutes was not acceptable to some of the potential participants who declined to participate. An additional challenge faced in this study was the large number of missed appointments that had to be rescheduled, at times more than once.

Half of the participants in this study self-reported a history of brain trauma, such as concussion and other closed head injuries. It is not known whether this rate of brain trauma is greater than what would be reported in the general population. Furthermore, the medical questionnaire used to obtain this information was not a standardized or validated measure.

Similarly, the validity of this information was not corroborated by medical reports. Nevertheless, this information may impact conclusions about the relationship between pathological gambling and impulsivity and sensation seeking, particularly with respect to cognitive performance measures. These results may also reflect that impulsive individuals are generally more likely to sustain brain injuries due to their impulsive behaviours, as has been reported in adolescents with ADHD (Barkley, Guevremont, Anastopoulos, DuPaul, & Shelton, 1993). Future research with pathological gamblers, particularly research investigating cognitive or neuropsychological factors, should use a validated, standardized assessment of brain trauma history to provide a more accurate understanding of the importance of this variable.

Pathological Gambling

Level of pathological gambling was found to be in the moderate to severe range. Two measures of pathological gambling were used, the PGSI and a set of semi-structured questions for DSM-IV diagnosis. Both measures assessed gambling symptoms over the past year but did not assess lifetime diagnoses (i.e., pathological gambling more than one year in the past). In this study these measures were only moderately correlated ($r = 0.6$), which is lower than found in previous research. For example, Wynne (2003) reported correlations of $r = 0.8$ between the PGSI and DSM-IV measure in a validity study of the PGSI. The agreement on diagnosis was consistent across measures for most participants (that is, 91.3% of participants met criteria for pathological gambling on both measures). For 8.7% of participants, 4 or fewer criteria of the minimum of 5 were met on the DSM-IV screen. The modest correlation may indicate that these are measuring distinct aspects of pathological gambling severity, or alternatively, that one measure may have been less valid than the other. However, reliability analyses indicated very similar reliability coefficients

for this sample (see Table 2). These measures may also have been affected by a restricted range, as only individuals in the pathological gambling range on the PGSI were included in the study. Restricted range may explain the weak overall relationships between measures of impulsivity and sensation seeking with gambling severity. Differences between the measures of gambling severity in terms of their relationship to various aspects of impulsivity were found, as these questionnaires use different response formats. The PGSI asks for frequency of behaviour and aims to assess severity as well as presence of a symptom. Stinchfield's DSM-IV questions, however, were specifically developed to assess each criterion of a pathological gambling diagnosis and required a yes/no response. The DSM-IV criteria contain predominantly behavioural items and signs of negative consequences of gambling (with the exception of the criteria of preoccupation with gambling and irritability when not gambling). However, it is not designed to assess severity or degree of gambling problems. On the other hand, it may be reasonable to assume that meeting more than the minimum of five criteria is indicative of a more severe gambling problem, as this would indicate more extensive interference of gambling with functioning, more areas of life affected by gambling, or engagement in more maladaptive behaviours related to gambling disorder. Thus, this measure may not be assessing the same aspects of gambling severity as the PGSI.

Impulsivity

In the present study, participants were found to score high on measures of impulsivity. On the Eysenck I7 Impulsiveness scale and on the Tridimensional Personality Questionnaire (TPQ) Reward Dependence, and Harm Avoidance scales, mean scores in the study sample were greater than 1 standard deviation above published means for normal adults (U.S. and British samples), suggesting somewhat elevated impulsivity. On the

Barratt Impulsiveness Scale (BIS) Attentional, Motor, and Non-Planning subscales, mean scores were 2.1 – 2.4 standard deviations greater than published norms for American adults with no clinical disorder (N = 60; Gorlyn, Keilp, Tryon & Mann, 2005). These BIS scores were suggestive of significantly elevated impulsivity. BIS scores were consistent with mean scores found for pathological gambling samples (e.g., Fuentes, Tavares, Artes, & Gorenstein, 2006). Thus, research participants showed elevated impulsivity on several measures of impulsivity. Only some of these impulsivity measures were correlated with each other, with strengths of the relationship ranging from weak (0.19) to moderate (about 0.30) correlations and only the TPQ Novelty Seeking and Eysenck Impulsiveness showing a strong correlation (0.71). These results provide further support for the idea that the impulsiveness measures may be assessing distinct constructs.

The role of impulsiveness has been widely studied in various contexts, including aggressive and violent behaviour, substance use, obsessive-compulsive disorder, eating disorders, impulse control disorders, and personality disorders (McCown, Johnson, & Shure, 1993; Webster & Jackson, 1997). Conceptualizations of impulsivity vary by setting, for example, legal definitions of impulsivity focus on whether a dangerous offender could resist or control violent impulses (i.e., define impulsivity in terms of impaired control; Webster & Jackson, 1997). In paediatric research, definitions of impulsivity tend to focus on hyperactivity, behavioural inhibition, and risk-taking (Taylor, 1997). Adult studies may use interview, observational methods, or self-report to assess impulsivity. Adult studies can also assess functions potentially impaired by impulsivity that had not yet developed in children (e.g., complex decision-making, planning, cognitive inhibition). Past research on impulsivity in various clinical and non-clinical samples agreed that impulsivity is multifactorial. The number of hypothesized factors making up impulsivity varies across

theories, as well as between factor-analytic results from personality measures (Moeller, Barratt, Dougherty, Schmitz, & Swann, 2001). Studies have reported two (Eysenck, 1993; Gray, 1987; Dickman, 1990), three (Patton, Stanford, & Barratt, 1995), or four factors (Eysenck, 1983, Buss & Plomin, 1975).

Some measures of impulsivity used in gambling research were developed based on general theories of personality (e.g., Eysenck, 1987, 1991) whereas others have resulted from factor analytic studies of instruments designed to measure multiple personality traits (e.g., Patton, Stanford, & Barratt, 1995). With regard to pathological gambling, fewer studies have addressed the structure of impulsivity, instead adopting definitions from various research perspectives (e.g., neurobiology, cognitive psychology, or neuropsychology).

In addition to differing definitions, various samples have been studied, leading to difficulties making comparisons across groups. For example, much research on gambling and pathological gambling has been conducted with predominantly male samples (Raylu & Oei, 2002), limiting knowledge on possible gender differences. Populations of gamblers sampled range from university students with relatively high prevalence of gambling problems, adolescents involved in underage gambling, treatment-seeking pathological gamblers, and community-dwelling individuals. Finally, samples also differ in the participants' type gambling involvement (e.g., scratch tickets, horse racing, or stock market investing), which may be associated with distinct relationships to or expression of impulsivity (National Research Council, 1999).

Most of the research on impulsivity is focused on maladaptive outcomes of impulsive behaviour. However, aspects of impulsivity can also be both adaptive and socially sanctioned. The willingness of stock brokers, for example, to act quickly,

decisively, and without lengthy deliberation is praised as an attribute needed for success. When outcomes are positive, impulsive individuals (such as business men, athletes, professional gamblers) are seen as successful; in contrast, when the outcome is self-destructive, impulsivity will be viewed as maladaptive. Dickman (1990) recognized this discrepancy and distinguished between two subtypes of impulsivity, termed *functional* and *dysfunctional* impulsivity. Dickman conceptualized impulsivity as a multifactorial trait, wherein numerous factors such as forethought, speed of response, or accuracy interacted to produce functional or dysfunctional impulsivity. Dickman (1990) identified three components of dysfunctional impulsivity, termed attentional, reflection-impulsivity, and disinhibition, but stated that there may be more components. Nower and Blaszczynski's (2006) theory also distinguished between functional and dysfunctional impulsivity as mediating the link between predisposing factors and disordered gambling behaviour. Clinically, it may be very useful to determine whether and to what extent an individual's impulsive behaviour is dysfunctional.

Sensation Seeking

Sensation seeking has been found to be correlated with impulsivity and gambling, although their exact relationship remains unclear. In the present study, results suggested that the sample showed moderate elevation on sensation seeking, compared with published normative data on two of the three subscales used. However, scores were not extremely high (1-2 standard deviations above the mean, rather than 3 standard deviations, which is typically considered to be clinically significant; Kazdin, 2003). Results also suggested a positive relationship between sensation seeking and pathological gambling scores on two of the measures. These results are comparable to some prior research that suggests that high sensation seeking is associated with greater gambling problems. However, the research

regarding this association is unclear, with some studies suggesting lower sensation seeking in pathological gamblers and others identifying higher rates. Review of this research indicates that the relationship between pathological gambling and sensation seeking may differ according to type of gaming (e.g., higher scores for casino and race track gamblers). This sample reported primarily having problems with video-lottery terminal (VLT) play. It is unclear whether the findings of general elevated sensation seeking are specific to VLT gambling. The number of individuals engaged in other types of gambling was too small to permit comparisons of sensation seeking scores by type of gambling activity.

Comorbidity

Substance Use Disorders

Participants in the present study were found to report high rates of substance abuse and dependence. The rates found in this sample, ranging from 13.5% to 44.2% for alcohol use problems and 16.3% to 25% for drug use problems, are much higher than general population base rates, which are estimated between 4%-20% (APA, 2000).These figures are consistent with prior research with pathological gamblers that has identified rates of substance use problems ranging from 25% – 63% across multiple studies and reviews (Crockford & el-Guebaly, 1998; Ibanez, et al., 2001; McCormick, 1993; Petry, 2005; Petry & Weinstock, 2007). These studies were reviewed in the literature review chapter. These data suggest that the present sample bears similarities to other pathological gambling samples in terms of comorbidity rates. However, individuals with and without substance use problems were not found to show different degrees of pathological gambling severity, perhaps because all participants had gambling problems. As continuous measures of substance use were not used, the statistical power to detect relationships between substance use and gambling problems was weaker. Those with histories of alcohol or drug

dependence showed slightly elevated scores on one measure of impulsivity (motor impulsivity). In addition, those with alcohol dependence history had lower executive-inhibit scores. However, those with drug dependence history showed lower sensation seeking scores than those without drug dependence. These results suggest possible differences in impulsivity and sensation for individuals with substance use disorders. However, these differences were not found on most of the measures. In addition, once the alpha level for significance was adjusted for multiple comparisons, only the findings of lower executive-inhibition scores for those with alcohol dependence histories remained significant. Thus, little overall evidence for clinically significant differences in impulsivity and sensation seeking related to substance use problems was found.

Clinical parallels between pathological gambling and DSM-IV Substance Dependence are tolerance (need for increasingly bigger bets or more frequent betting); withdrawal during abstinence (irritability when not gambling); continued gambling despite negative consequences; and mental preoccupation with a substance or gambling. Substance dependence and pathological gambling also share physiological characteristics (e.g., altered dopamine functioning), compulsive behaviour, and personality traits such as impulsivity, sensation seeking, boredom-proneness, narcissism, or antisocial traits. Similar motivations to engage in substance use or gambling, (e.g., avoidance of emotional distress; failure to resist urges) and risk factors for relapse have led theories of gambling etiology to be informed by research on substance dependence. Commonalities between pathological gambling and substance dependence have led some to conceptualize gambling as an addiction and to approach gambling problems accordingly.

Impulse Control Disorders, NOS

In the present research, only Intermittent Explosive Disorder (IED) was found to be comorbid with pathological gambling, which is consistent with prior research identifying elevated rates of IED in pathological gamblers (e.g., Specker, Carlson, Christenson, & Marcotte, 1995). Compulsive sexual behaviour and compulsive buying, which do not appear in the DSM, have also shown strong comorbidity with pathological gambling (Specker, et al, 1995). These disorders were not assessed in this study. Higher rates of IED may have been found if the present study used a clinical (i.e., treatment-seeking) sample of pathological gamblers. If this sample was indeed better functioning than the overall population of pathological gamblers (e.g., based on motivation to attend the study and education levels), lower overall rates of comorbid impulse control disorders may not be surprising.

Attention Deficit Hyperactivity Disorder (ADHD)

Participants in this study self-reported childhood or present diagnoses of Attention Deficit Hyperactivity Disorder (ADHD). 14% were certain of a past or present ADHD diagnosis, whereas an addition 23% reported having concerns but had never been diagnosed. Individuals with and without a self-reported ADHD history did not show significant differences on measures of pathological gambling. However, symptom subscales measuring memory and inattention and general ADHD indices did predict gambling severity. In addition, those with memory and attention problems and with ADHD symptoms showed impairments on one of the performance tasks (CPT). Caution is advised in interpreting these findings, as ADHD history in this study was based on self report and not on formal diagnostic assessment. No corroboration of these reports by collateral source, medical records, or formal assessment was conducted. However, it is supported by research

that ADHD history is reflective of a developmental vulnerability to later impulse control disorders, including pathological gambling.

Some research suggests that individuals with ADHD may be vulnerable to addictions more generally by virtue of their impulse control difficulties (Cantwell, 1972; Hardoon, 2004; Rodriguez-Jimenez, et al., 2006). Taylor (1999) noted that the genetic abnormalities associated with ADHD involve genes that have been linked to diminished sensitivity to dopamine as well as increases in sensation seeking behaviour, which is consistent with the neurobiological findings in pathological gamblers already discussed. Moreover, brain imaging studies of individuals with ADHD have discovered structural abnormalities in the frontal lobes of the brain (Taylor, 1999), areas which are associated with impulse control and other aspects of behaviour regulation, so called executive functions (Lezak, 1995). These same brain areas (e.g., orbitofrontal and ventromedial prefrontal areas) have also been associated with impaired decision-making more generally (Bechara, Damasio, Damasio, & Anderson, 1994; Bechara, Tranel, & Damasio, 2000). The frontal lobe areas associated with ADHD are consistent with those implicated in the executive deficits of pathological gamblers. Executive functioning deficits are also central to a well-accepted, empirically supported model of the pathogenesis of ADHD, specifically implicating deficient behavioural and emotional inhibition as central to the disorder (Barkley, 1997).

There is a building empirical support for the notion of an inherited predisposition toward impulsivity that may stem from biologically-based deficits in executive brain functions (e.g., attention, inhibition). This can be construed as a developmental vulnerability to impulse control problems in general, leading to pathological gambling and other disorders that are often comorbid with gambling problems, such as substance abuse

and ADHD as found in this study and others. The finding of 14.5% positive self-reported history of ADHD and positive relationship between ADHD index scores and gambling problems support this idea. Corroboration of self-reported ADHD status was not conducted, thus the validity of ADHD diagnoses in this sample is unknown.

Other Comorbid Disorders

Pathological gambling was formally recognized as a clinical syndrome, rather than a moral or legal issue, by the Western medical and mental health community in 1980 when it was included as a mental disorder in the Diagnostic and Statistical Manual of Mental Disorders (DSM-III; American Psychiatric Association [APA], 1980) under the category of *Impulse Control Disorders*. In the current edition of the manual, diagnostic criteria include problematic behaviours with three major themes: disruption of personal, social, occupational, or academic functioning; physiological dependence; and loss of control over time and money spent gambling, despite negative consequences (APA, 2000). Pathological Gambling is classified under Impulse Control Disorders Not Otherwise Specified. The NOS category includes kleptomania (compulsive stealing), tricotillomania (compulsive hair-pulling), pyromania (compulsive fire-setting), and intermittent explosive disorder, characterized by episodes of excessive rage and aggression. Although the DSM-IV is presented as an atheoretical system, classification of pathological gambling as an impulse control disorder suggests that impulsivity and impaired control are central features of the psychopathology of the disorder.

The DSM-IV specifies a number of disorders for which impulse control is a central symptom. Impulse control disorders include Attention Deficit/Hyperactivity Disorder, Anorexia Nervosa – Binge-Purge type, Bulimia Nervosa – Binge type, Obsessive-Compulsive Disorder, Substance Abuse and Dependence, Bipolar Disorders (manic and

hypomanic phases), some dementias (e.g., frontal-temporal dementia), and some Axis II personality Disorders (e.g., Antisocial, Narcissistic, Obsessive-Compulsive). The manual describes impulse control disorders as generally involving one or more of the following: inability to resist urges to engage in the behaviour; cognitive preoccupation with the maladaptive behaviour; increased feelings of tension or arousal before engaging in the behaviour; and subjective pleasure, gratification, or relief of tension after engaging in the behaviour (APA, 2000).

Pathological gamblers have been shown to have higher rates than the general population base rates of a number of DSM-IV impulse control disorders, in addition to substance use, impulse control disorders, NOS, and ADHD, discussed earlier. Ibanez and colleagues (2001) reported that 62% of an outpatient sample of gamblers had at least one comorbid disorder, including antisocial personality disorder (15%), other personality disorders (27%), mood disorders (16%), and anxiety disorders (7%). In a study assessing DSM-IV personality disorders, Blaszczynski and Steel (1998) reported that 93% of their sample of 84 pathological gamblers met criteria for at least one personality disorder, particularly the erratic-dramatic cluster B disorders (Antisocial, Borderline, Narcissistic, and Histrionic). Those with antisocial and narcissistic personality disorders in particular scored significantly higher on measures of gambling severity and on self-report of impulsivity. Consistent with this, Farmer and Nelson-Gray (1995) found that the cluster B personality disorders were highly associated with novelty seeking behaviour, impulsivity, and sensitivity to reward. These findings would support that those with cluster B personality disorders would be attracted to gambling activities. Research has not yet clarified the issue of whether a history of other psychological disorder should be interpreted

as a predisposing factor to developing gambling problems, a sign of shared vulnerability to a host of disturbances, or a statistical coincidence (Sharpe, 2002).

Although it shares core characteristics with other impulse control disorders, such as tension when not gambling and failure to resist the urges to gamble despite negative consequences, the symptoms of pathological gambling also overlap with that of other categories of Axis I disorders. These disorders include substance use disorders, Obsessive-Compulsive Disorder (OCD), and eating disorders (in particular, binge symptoms). Comorbidity with Axis II personality disorders have also been noted in pathological gamblers, particularly Antisocial Personality Disorder and others within the dramatic/erratic cluster (e.g., Black & Moyer, 1998; Blaszczynski & McConaghy, 1994; Lesieur & Blume, 1990; Specker, et al., 1996).

Pathological gamblers and individuals with Bulimia Nervosa or Binge Eating Disorder (as per DSM-IV research criteria) share tendencies to be highly impulsive and to have difficulties resisting urges to engage in the behaviour, despite negative consequences and difficulties stopping the behaviour (binging, gambling) once initiated. Although few studies of gamblers have assessed eating pathology, Black & Moyer (1998) reported that 7 percent of their pathological gambling sample met criteria for current Bulimia Nervosa. Similarities between pathological gambling and OCD include preoccupation with gambling (akin to obsessions), urges to gamble (compulsions), repeated failure to resist urges to gamble, and anxiety when not responding to an urge to gamble. Some research has suggested conceptualizing pathological gambling as part of an impulsive-compulsive spectrum that includes OCD (Frost, Meagher, & Riskind, 2001). Ten percent of Black and Moyer's sample met criteria for OCD, while Cunningham-Williams and colleagues (2000) found that four percent of pathological gamblers and three percent of problem gamblers

met criteria for current OCD. However, these rates were not significantly higher than that of the non-gamblers in their sample (2%). Other studies have assessed obsessive or compulsive symptoms, regardless of OCD diagnosis. Skitch and Hodgins (2004) found elevated obsessive symptoms, compulsive behaviour, and impulsivity in pathological gamblers compared to problem gamblers or non-gambling controls. Impulsivity and compulsivity were interrelated. Three other studies compared pathological gamblers and controls on self-report measures of obsessive-compulsive symptoms. These studies also found that gamblers showed elevated obsessive and compulsive symptoms compared to controls (Black Moyer, & Schlosser, 2003; Blaszczynski, 1999a; 1999b; Frost, Meagher, & Riskind, 2001). This research supports the characterization of pathological gamblers as both compulsive and impulsive.

In summary, the rates of comorbidity found in this sample are consistent with prior literature on gambling. Much higher rates of comorbid addictions than impulse control disorders suggest that an understanding of impulsivity in gamblers should include difficulties with impulse inhibition, emotional regulation, and susceptibility to both physiological and psychological dependence. The relatively high comorbidity rates between pathological gambling and the above disorders, particularly substance dependence, are suggestive of a common etiological pathway (Petry & Weinstock, 2007).

Demographics

Age

There were no significant relationships between age and any of the measures of impulsivity in this study, in contrast to prior research which suggests that impulsivity generally decreases with age.

In the case of sensation seeking, results were consistent with previous research that suggested a decrease in sensation seeking with age, consistent with prior research. For example, Zuckerman (1994) found peak sensation seeking scores in adolescence, followed by a decrease with age. Studies by Blaszczynski, Wilson, and McConaghy (1986) and Dickerson, Hinchy, and Fabre (1987) also found a negative relationship between sensation seeking scores and age. Both of these latter studies used all-male samples, therefore whether these results hold true for females of different ages is uncertain.

Gender

The majority of research on impulsivity and sensation seeking in pathological gambling has been conducted primarily with male samples. Studies that have assessed gender differences suggest that males tend to score higher on indices of impulsivity (Nower, 2000; Volberg, 1993) and sensation seeking (e.g., McDaniel & Zuckerman, 2003; Zuckerman, 1994). This study was composed of an even balance of gender, potentially permitting better analyses of gender effects. The sample size for each gender (n = 51 and n= 53) was too small to afford adequate power to run the structural model for males and females separately. However, results indicated that, on two of the measures of impulsivity, females scored higher than males. Lower scores for females on measures of harm avoidance and reward dependence are contrary to the expectation of females being less impulsive than males. The finding of a lack of gender differences on most other measures of impulsivity was also inconsistent with previous research.

Study Limitations

This study made useful contributions to an understanding of impulsivity in pathological gamblers and suggests that the labeling of the various factors studied from a

number of different theoretical perspectives as impulsivity may not be appropriate. However, the research contained some limitations that are discussed here.

First, the use of a pathological gambling-only sample, rather than using a broader sample ranging from recreational to pathological gambling, was a practical and theoretical decision. Practically, a limited amount of time was available to recruit a fairly large number of participants, and it was desired to understand the nature of impulsivity in pathological gambling, as this is the point where gambling becomes problematic. Because a pathological gambling sample was recruited, those in the at-risk range of gambling severity were excluded, despite these individuals potentially having clinically relevant problems related to their gambling. Similarly, recreational gamblers who may also have occasional problems related to gambling were excluded. Those not meeting criteria for pathological gambling at the time of study €might go on to develop the disorder or may have met criteria in the past (beyond 1 year prior). Because past year, and not lifetime gambling, was assessed, such participants were missed. The research literature does suggest that impulsivity is related to gambling involvement, therefore, recreational or at risk gamblers may have contributed to an understanding of the structure of impulsivity. Perhaps impulsivity and sensation seeking traits, risk factors such as ADHD, or comorbid addictions may have been different for problem or at-risk gamblers (i.e., those experiencing negative effects of gambling but not meeting criteria for pathological gambling).

Restricted range of severity of gambling due to recruitment of a pathological gambling sample may also have been a factor in the low correlations found between constructs. Restricted range can have a significant effect on correlation analyses, leading to attenuated correlations. Correlations are the basis of structural equation modeling; therefore restricted range likely weakened the overall SEM results. A better understanding of the

severity of gambling in this sample may have been limited by not assessing other facets of pathological gambling. For example, time and money spent gambling were not directly assessed, and these have been identified as important predictive variables in determining gambling severity (Walker, et al., 2006).

Theoretically, the use of a pathological gambling sample was meant to be more generalizable to clinical work with pathological gamblers, maximizing ecological validity. However, ecological validity could also have been limited in that the participants may have represented only a sub-sample of the full spectrum of pathological gamblers, those who were motivated enough and able to organize themselves to participate in this research. Perhaps this sample was a well-functioning group of gamblers. The relatively high level of education reported by participants, averaging 14.6 (*SD* = 5) years compared to the overall national average of 11.8 years (Statistics Canada, 1996), supports this idea. In the City of Calgary specifically, census data suggests that the Calgary population is generally well-educated, with 34.6% of individuals having completed 14 to17 years of education. In the current sample, 51% reported having completed 14 to 17 years of education. The current sample may also have been narrow in terms of type of gambling, as the majority of people reported problems with VLTs and slot machines. According to the Alberta Alcohol Use and Drug Commission, the types of games most strongly associated with problem gambling are VLT's and slot machines (Wynne Resources, 1998). In contrast, the most frequently reported gaming activity in which the general population of Alberta participates is lotteries. Therefore, the present sample seems to reflect provincial trends in problem gambling.

A broader range of gambling involvement or severity, particularly with a broad age range and larger sample, would have allowed a better cross-sectional description of impulsivity. Assessment of a full range of gambling severity would be an important next

step in research, ideally in a large-sample longitudinal design to identify potential causal relationships. The lack of a control group was also a potential weakness of this study, as it was therefore not possible to compare rates of impulsivity, sensation seeking, pathological gambling, or other comorbid disorders to a sample of non-gamblers or individuals who gambled without experiencing significant problems.

A procedural difficulty encountered in this research was recruiting a large enough sample of problem and pathological gamblers from the general public. There were 19 missed appointments (no shows) among those who did eventually participate; an additional 25 individuals did not show up for their appointment at all with a mean of 2 appointments made per person. Attempts were made to reduce no shows, including reminder phone calls; reimbursement of parking or transit costs; flexibility in appointment times (evenings, weekends); and $20 grocery store gift certificates.

Sample size issues may also have been at play in weakening SEM results. The sample was minimal in terms of power to detect effects using SEM and a more conservative guideline of n = 15 per parameter could have been used to protect against failure to detect small but statistically significant effect sizes. Another statistical issue was around the non-random pattern of missing date for Iowa Gambling Task, as only 61% of participants completed the task. The IGT exposed participants to a gambling-like situation, and thirty participants were not willing to participate in the task because they were attempting to quit gambling. This may also suggest that the task provided a good approximation of a gambling activity, supporting its use as a measure of gambling-related decision making.

With regard to data analysis, an additional difficulty of lower statistical power was identified with the assessment of past and present ADHD and substance use problems as

predictors of current impulsivity and current gambling severity. While the Conners' Adult ADHD Rating Scale provides a continuous measure of ADHD symptoms, the SCID-DSM-IV for substance use disorders only provides categorical data (i.e., fails to meet criteria, meets criteria for abuse, or meets criteria for dependence). Although there exists a good continuous measure of current alcohol use disorder (e.g., the AUDIT Questionnaire; Babor, Higgins-Biddle, Saunders, & Monteiro, 2001), there are no well-validated continuous measures of past alcohol use disorder or of past or present abuse of other drugs. Thus, the analysis was limited to the use of categorical data to investigate the relationship between substance use, impulsivity, and gambling problems.

The construct of executive cognitive functions was not thoroughly assessed in the study, as only two measures were employed. Prior research using the WCST in research with gamblers guided the choice of this neuropsychological test. The CPT was used because of its ability to measure both response inhibition and sustained attention. However, the desire to conduct a comprehensive assessment of all constructs of interest using a larger battery of tests was balanced by the desire not to overburden participants with too many activities. With unlimited resources and time, a better assessment of neuropsychological performance in pathological gamblers would ideally include self-report measures of several aspects of executive functioning (e.g., BRIEF questionnaire; Gioia, Isquith, Guy & Kenworthy, 2000), direct measures of executive abilities such as working memory, cognitive interference (e.g., STROOP test, go/no go paradigm), planning and organizing (e.g., Tower of London test), in addition to using the WCST to assess cognitive shifting, perseveration, and problem-solving (Lezak, 2005).

Another potential study limitation was the number of comorbid conditions assessed. Again, a balance was struck between assessing a wide range of impulse control problems

commonly found to be comorbid with pathological gambling. Drug and alcohol use disorders were measured, but cigarette smoking was not specifically addressed, despite research identifying high rates of current and past smoking in pathological gamblers (Grant & Potenza, 2005). A broader look at other comorbid conditions, including mood disorders, obsessive-compulsive disorder, eating pathology, or personality disorders, may have identified other difficulties associated with impulsivity and gambling. In particular, the DSM instrument used to establish diagnosis did not include assessment of bipolar disorder. If participants engaged in pathological gambling behaviour solely during the course of a manic, hypomanic, or mixed episode, a diagnosis of Pathological Gambling would not be made. Even if gambling did not occur solely within the context of a manic episode, knowing about the prevalence of bipolar disorder in this sample would have informed the results. In addition, investigation of comorbid conditions was limited to those listed in the DSM-IV. Other impulse control problems, such as compulsive buying and compulsive sexual behaviour, were therefore excluded. However, these problems have been reported to show a high incidence in pathological gambling samples, suggesting that their inclusion may have been informative in study (Grant & Kim, 2003).

Future Directions in Gambling Research

Future research examining the structure of impulsivity may benefit from conceptualizing the factors identified in previous research as distinct variables, rather than as all representing impulsivity. The use of a sample with a broader range of gambling involvement would have the potential to identify which factors would best predict the development of pathological gambling. Longitudinal studies following individuals who are beginning to become involved with gambling (e.g., adolescents) could be used to track the progression of gambling problems as well as factors that may protect people from

developing an addiction. In terms of a developmental pathway, it may be particularly enlightening to track long-term outcomes of children with ADHD, who would seem to have a significant early vulnerability to a number of problems related to impulse control.

Future studies may benefit from studying a broader range of comorbid problems, including cigarette smoking, mood disorders, eating pathology (e.g., binge-purge behaviours), and personality disorders. Bipolar disorder and impulse control disorders not included in the DSM (e.g., compulsive buying and compulsive sexual behaviour) should be included. This would yield more complete information about the types of comorbid impulse control problems associated with gambling, and could also inform work assessing the outcomes of developmental risk factors related to impulsivity.

As mentioned in the previous section, the measures of neuropsychological functioning in this study were limited to two measures. A study focused solely on a comprehensive assessment of neuropsychological variables in gamblers using a broad range of self-report, collateral report, direct testing, and potentially including functional neuroimaging may provide a clearer picture of the cognitive processes involved in disordered gambling. Previous research identifying the orbitofrontal and ventromedial cortical areas as involved in gambling-related decisions provides a start point for such investigations. These investigations should also include a standardized assessment of medical history, particularly with respect to brain trauma, including brain injury, stroke, and other neurological problems.

Future research should also aim to use more gender-balanced samples, as the present research managed to do, as much of the prior reseach upon which we base our knowledge of impulsiveness, sensation seeking, and other characteristics of pathological gamblers have used predominantly male samples.

Summary and Conclusions

The results of this study suggest that a model of the structure of impulsivity as a latent construct with five components is not a good explanation of this trait. The five components, related to reward sensitivity, quick motor responses, lack of forethought in decision-making, and two aspects of executive functioning, were derived from diverse research perspectives on a wide range of clinical and general samples, including samples of pathological gamblers. Although all of these factors have been labeled as representing impulsivity, this label may in fact not be appropriate, at least in respect to pathological gamblers. In the present research study, only motor impulsivity (quick decision making) and reward dependence were significantly related to severity of pathological gambling, as was the trait of sensation seeking. In contrast to previous research, age and gender influences on impulsivity, sensation seeking, and pathological gambling were minimal. Regarding gender, this sample differed from previous samples in that about half of the participants were female, in contrast to the predominantly male samples that characterize much of the published research with pathological gamblers. Rates of comorbidity in this study mirrored published rates, and this study also provided further support for a potential cognitive-developmental vulnerability to gambling based on self-reported ADHD symptomatology.

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Table 1

Constructs Assessed by Each Instrument

Measure	Constructs assessed by subscales or total scores
Barratt Impulsivity Scale	Cognitive: cognitive impulsivity, e.g., lack of deliberation
	Motor: behavioural impulsivity, e.g., speed of response
	Non-planning: insensitivity to future consequences
Continuous Performance Test	Number of commission errors: response inhibition
	Impulsivity Index: response inhibition
	Inattention Index: sustained attention
Eysenck Impulsivity Scale	Impulsiveness: rash, unplanned behaviour
	Venturesomeness: sensation seeking or risky acts where consequences have been weighed
Iowa Gambling Task	Number of selections from Disadvantageous decks: sensitivity to immediate reward
	Number of selections from Advantageous decks of cards: consideration of future consequences
Tridimensional Personality Questionnaire	Novelty Seeking: sensation seeking
	Harm Avoidance: sensitivity to punishment or consequences
	Reward Dependence: sensitivity to reward

Table 1 (continued). Constructs Assessed by Each Instrument

Measure	Constructs assessed by subscales or total scores
Wisconsin Card Sorting Test	Number of perseverative errors: cognitive flexibility, maintaining a response set, response inhibition
	Mean response latency: motor impulsivity
	Shift of response: cognitive flexibility
Zimbardo Time Perspective Inventory	Past positive: satisfied with past
	Past negative: negative, aversive view of past
	Future: behaviour guided by future goals
	Present hedonistic: seek pleasure, carefree
	Present fatalistic: feel hopeless and helpless
Zuckerman-Kuhlman Personality Questionnaire - Sensation Seeking Scale	Total Score: general sensation seeking
	Disinhibition: seeking release via uninhibited social activities
	Experience Seeking: seeking novelty through artistic endeavors or experiences
	Thrill/Adventure Seeking: drive to engage in physical activities involving danger, speed, and novelty
	Boredom Susceptibility: aversion to routine, repetition, or predictability

Table 2

Demographic Composition of the Sample (N = 104)

Variable	Percent of Sample
Residence	
Urban	89.4
Rural	10.6
Marital Status	
Single	28.8
Married/Common Law	38.5
Separated/Divorced	28.8
Widowed	2.9
Occupational Status	
Full or Part Time Employed	56.7
Unemployed	12.5
Retired	11.5
Ethnicity	
White/Caucasian	72.0
Aboriginal	20.2
Asian/South Asian/Filipino	5.8
Mixed Ethnicity	3.0

Table 3

Reliability of Assessment Instruments Used

Measure	Reliability[1]	Qualitative Rating
Barratt Impulsivity Scale	0.64	poor
Conners' Adult ADHD Rating Scales	0.91	excellent
DSM-IV Questions	0.71	fair
Eysenck I7 Impulsivity Scale	0.68	poor
Pathological Gambling Severity Index	0.74	fair
Sensation Seeking Scale	0.73	fair
Tridimensional Personality Questionnaire	0.82	good
Zimbardo Time Perspective Inventory	0.88	good

Note. [1] Cronbach's alpha

Table 4

Summary of Participants' Performance on Measures of Impulsivity and Sensation Seeking

Measure	Mean (SD)	Range
Barratt Impulsivity Scale (Total Score)	74.29 (4.66)	61 - 88
BIS Attentional Impulsivity	20.72 (2.49)	13 - 29
BIS Motor Impulsivity	22.86 (2.56)	16 - 32
BIS Non-Planning Impulsivity	30.70 (2.44)	24 – 38
Eysenck I7 Impulsivity Scale (Total Score)	32.74 (7.79)	12 - 49
I7 Impulsiveness	10.66 (4.73)	0 - 18
I7 Venturesomeness	8.57 (4.49)	0 - 16
Tridimensional Personality Questionnaire (Total Score)	51.66 (10.98)	24 - 75
TPQ Harm Avoidance	14.76 (8.13)	0 - 33
TPQ Reward Dependence	18.07 (4.47)	8 - 28
TPQ Novelty Seeking	18.82 (4.96)	2 - 30
Zimbardo Time Perspective Inventory		
ZTPI Present Hedonistic	52.30 (8.27)	19 - 69
ZTPI Future Orientation	43.12 (5.78)	31 - 56
Zuckerman-Kuhlman Personality Questionnaire - Sensation Seeking Scale	10.20 (4.50)	1 - 19

Table 5

Zero Order Correlations between Measures of Impulsivity

	BIS Attentional	BIS Motor	BIS Non-Planning	TPQ Harm Avoidance	TPQ Novelty Seeking	TPQ Reward Dependence	Eysenck I7 Impulsiveness
BIS Attentional	1						
BIS Motor	.038	1					
BIS Non-Planning	.325**	-.114	1				
TPQ_Harm Avoidance	-.094	-.025	-.105	1			
TPQ Novelty Seeking	.281**	-.193*	.269**	-.044	1		
TPQ Reward Dependence	-.142	-.187	-.163	.086	.147	1	
Eysenck I7 Impulsiveness	.329**	-.137	.260**	.225*	.707**	.016	1

Note. $*p \leq 0.05$; $**p \leq 0.01$

Table 6

Zero Order Correlations between Measures of Impulsivity and Sensation Seeking Used for Structural Equation Modeling (N = 104)

	PGSI Total	Sensation Seeking	Motor	Reward Sensitivity	Forethought	Executive-Attention	Executive-Shift	DSM-IV Criteria
PGSI Total	1.00							
Sensation Seeking	0.21*	1.00						
Motor	-0.19*	0.19*	1.00					
Reward Sensitivity	0.04	0.17	0.19*	1.00				
Forethought	-0.06	-0.35**	0.04	0.28**	1.00			
Executive-Attention	0.05	0.32**	0.06	-0.14	-0.31**	1.00		
Executive-Inhibit	0.17	0.25**	0.50**	0.11	0.10	0.00	1.00	
DSM-IV Criteria	0.56**	0.31**	0.02	0.06	-0.14	0.10	0.15	1.00

Note. *$p \leq 0.05$; **$p \leq 0.01$

Figure 1. Path diagram of a structural model of impulsivity in pathological gamblers.

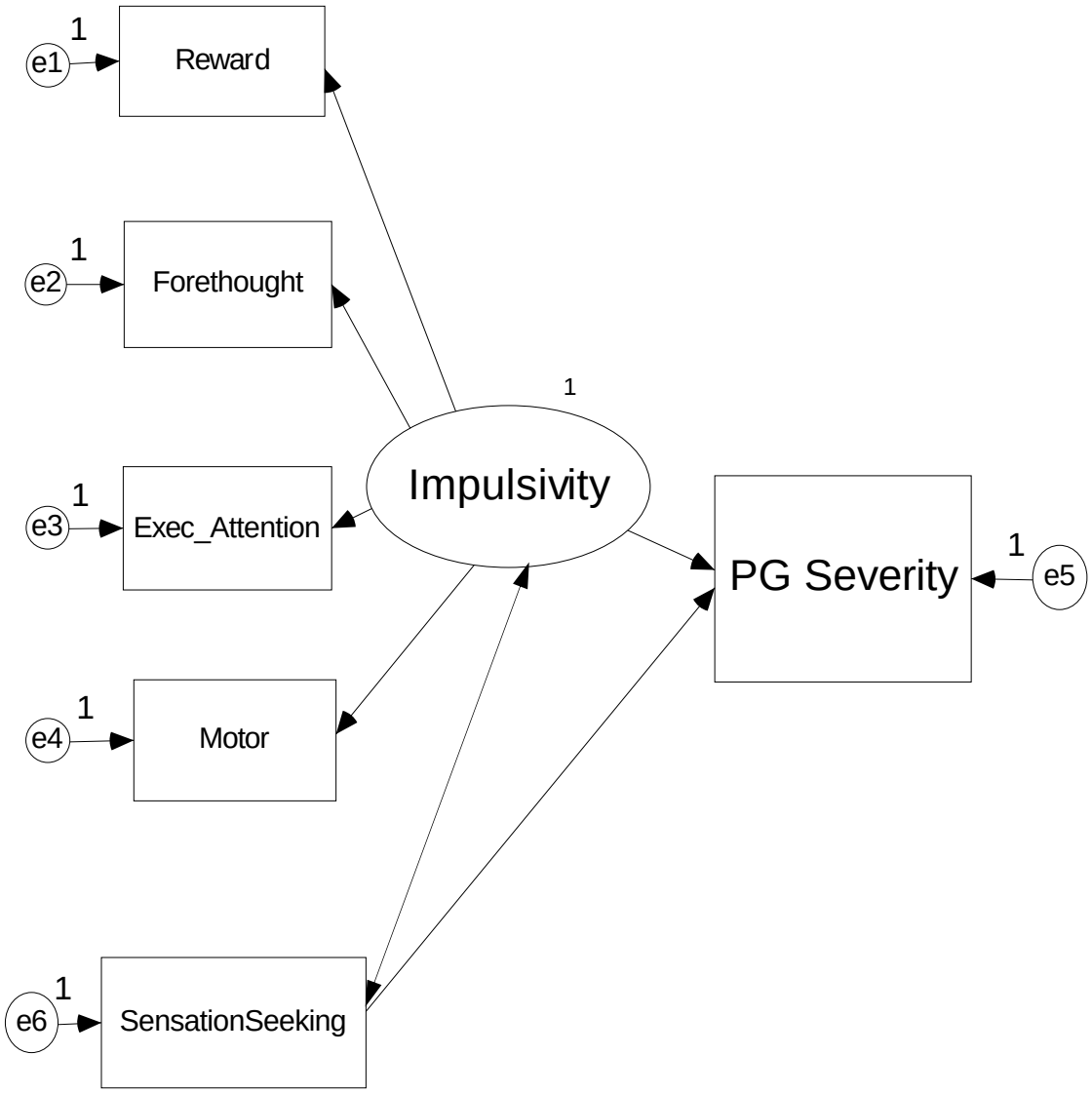


Figure 2. Path diagram of a structural model of impulsivity in pathological gamblers, including 5 components for impulsivity.

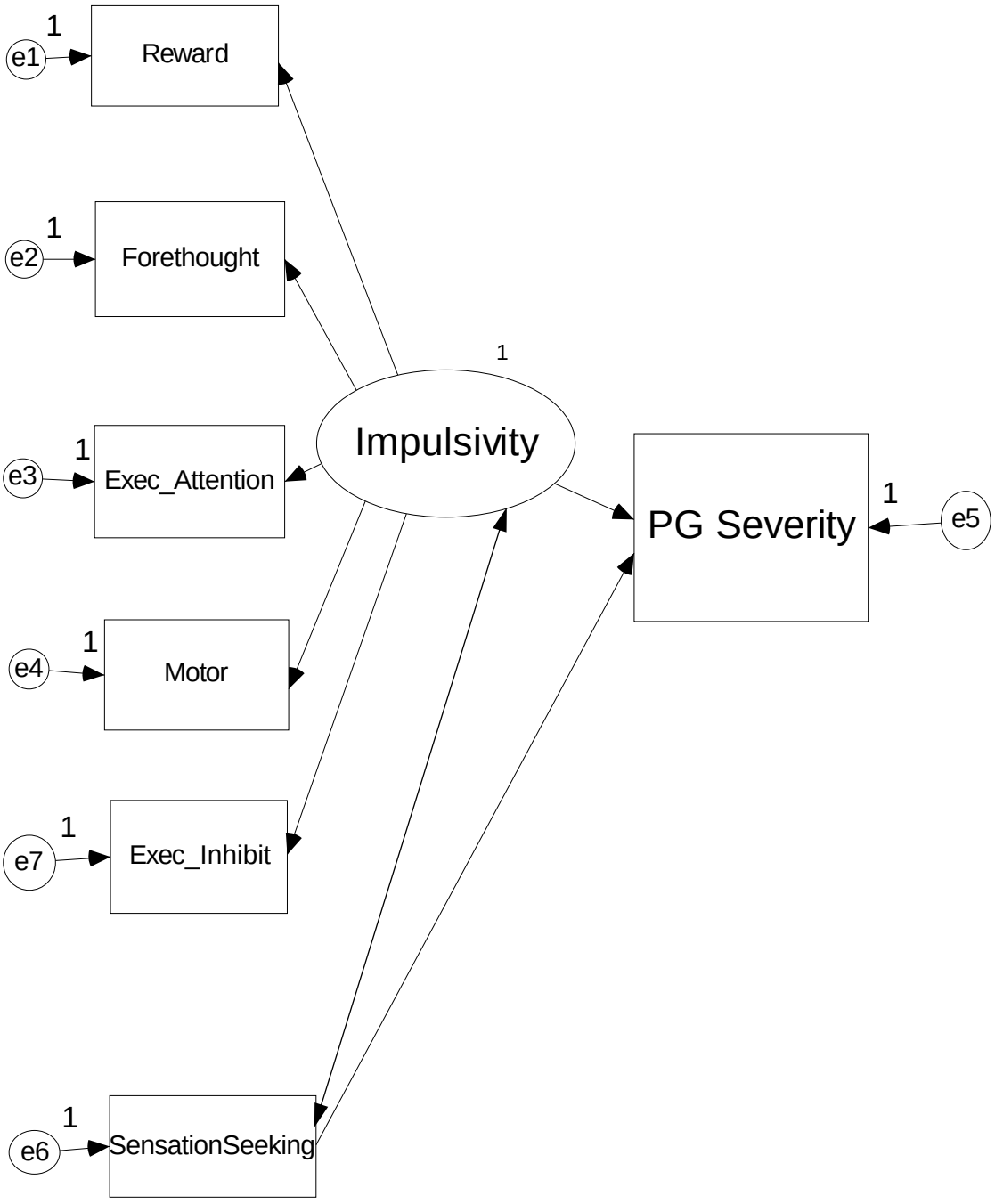
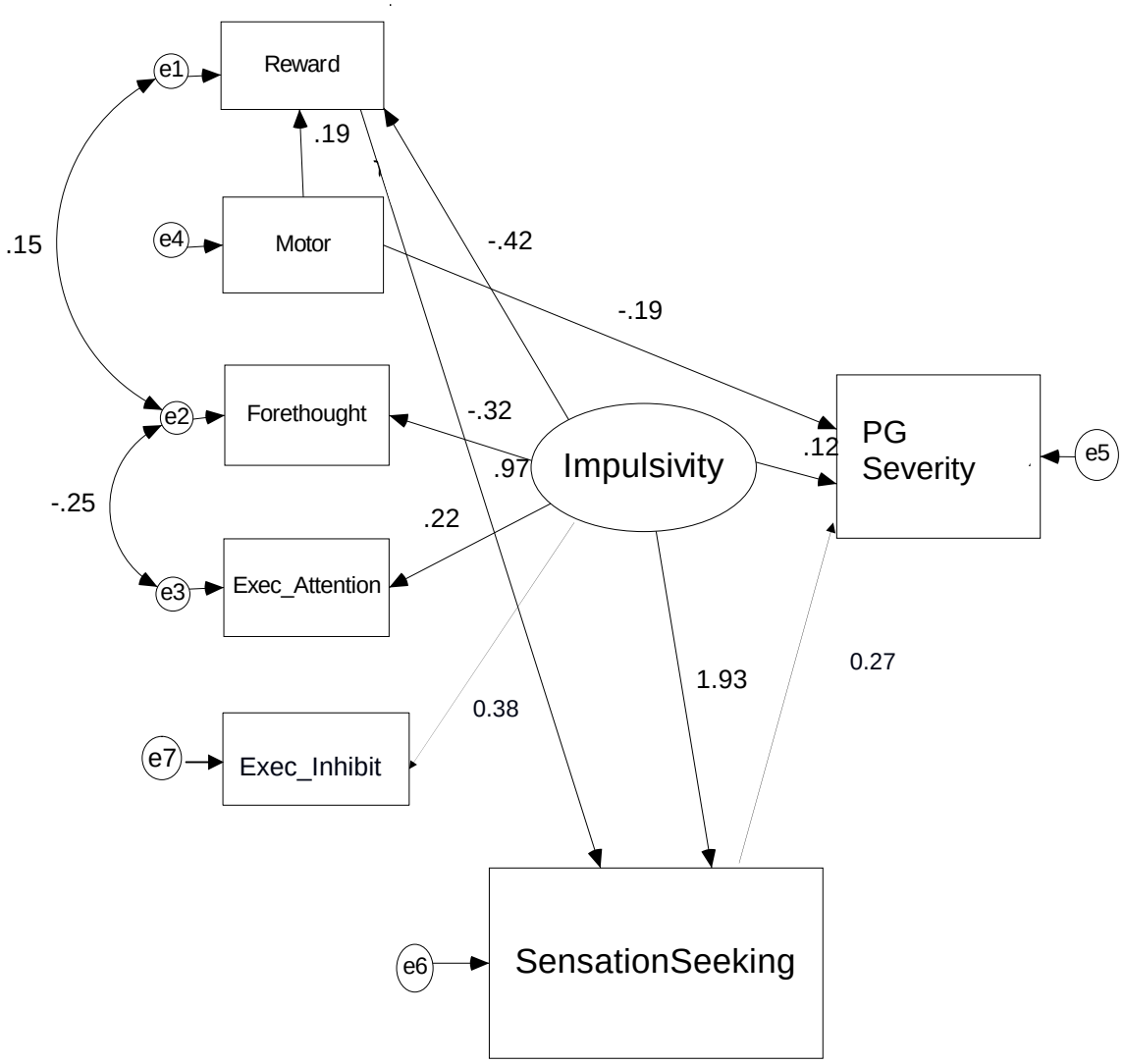


Figure 3. Modified path diagram of a structural model of impulsivity in pathological gamblers showing standardized path coefficients.



Appendix A: Consent Form

Research Project Title: The Role of Personality Characteristics in Understanding Gambling Behaviour

Investigators: Alice Holub, M.Sc., Clinical Psychology Student, Department of Psychology, University of Calgary, and David C. Hodgins, Ph.D., Professor, Department of Psychology, University of Calgary.

This consent form, a copy of which has been given to you, is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, please ask. Please take the time to read this carefully and to understand any accompanying information.

This study aims to gain a better understanding of the characteristics and behaviours that are related to gambling. That is, we aim to determine what characteristics or ways of responding can make people vulnerable to developing gambling problems. This information can then be used to find ways of preventing individuals from developing serious problems with gambling, and to devise more effective ways of providing treatment to those who already have problems. The results of this study will be completely confidential and your name will not be used on any of your responses. Information from this study will not be made public in any form in which you personally can be identified as a participant. Data from this study will be stored on computer disks that will be stored in a locked cabinet at the University of Calgary.

Your signature on this form indicates that you have understood to your satisfaction the information regarding participation in the research project and agree to participate. In no way does this waive your legal rights nor release the investigators, sponsors, or involved institutions from their legal and professional responsibilities. You are free to not answer specific items or questions in interviews or questionnaires. You are free to withdraw from the study at any time without penalty, and still receive the grocery store gift certificate. Your continued participation should be as informed as your initial consent, so you should feel free to ask for clarification or new information throughout your participation. If you have further questions concerning matters related to this research, please contact Alice Holub at 210-9500 or aholub@ucalgary.ca.

If you have any questions concerning your participation in this project, you may also contact Mrs. Bonnie Scherrer, Research Services Office, telephone: 220-3782. If you have concerns regarding your gambling, help is available from the problem gambling helpline: 1-800-665-9676 and AADAC: 297-3337.

Participant _____ Date _____

Appendix B: Stinchfield's DSM-IV Questions for Pathological Gambling

1. Have there been periods in the past year when you spent a lot of time thinking about past gambling experiences or thinking about future gambling ventures? (Addresses criterion 1).
2. Have you frequently thought about ways of getting money with which to gamble? (Addresses criterion 1).

3. Have you had periods when you needed to gamble more often in order to obtain the same excitement? (Addresses criterion 2)

4. Have you needed to gamble with larger amounts of money or with larger bets in order to obtain the same feeling of excitement? (Addresses criterion 2)

5. Have you tried to cut down or control your gambling several times in the past and found it difficult? (Addresses criterion 3)

6. Have you tried to stop gambling several times in the past and been unsuccessful? (Addresses criterion 3)

7. Did you feel quite restless or irritable after you tried to cut down or stop gambling? (Addresses criterion 4)

8. Do you feel that you gamble as a way to escape personal problems? (Addresses criterion 5)

9. Does gambling seem to relieve uncomfortable emotions, such as anxiety or depression? (Addresses criterion 5)

10. When you lose money on a given day, do you often return soon another day to win back your losses? (Addresses criterion 6)

11. When you had a large gambling debt, did you gamble more often in the hopes of winning back your money? (Addresses criterion 6)

12. Have you often lied to family members, friends, co-workers or teachers about the extent of your gambling debt? (Addresses criterion 7)

13. Have you often hidden or tried to hide your gambling from others - e.g., family members?
(Addresses criterion 7)

14. Have you forged a check or stole something in order to finance your gambling habit?
(Addresses criterion 8)

15. Have you committed any illegal acts, such as embezzlement or fraud, to support your gambling habit?
(Addresses criterion 8)

16. Have you had periods when your gambling caused problems in your relationships with family, friends, co-workers or teachers?
(Addresses criterion 9)

17. Have you missed work, school or important social or family activities because of gambling?
(Addresses criterion 9)

18. Have you asked people to lend you money because of your financial problems due to gambling?
(Addresses criterion 10)

19. Have you had others pay your gambling debts for you (i.e., bail you out) when you felt desperate about your financial situation?
(Addresses criterion 10)

Scoring:
More than 1 item is used assess each diagnostic criterion. If a respondent endorses either item representing a criterion, that criterion is considered endorsed for scoring purposes.

Pathological gambling is diagnosed when:
- at least 5 separate criteria positively endorsed
- there is significant distress and / or impairment in functioning
- behaviour is not better explained by a manic episode

Appendix C: Problem Gambling Severity Index from the Canadian Problem Gambling Index

Instructions: *"Think about the **last 12 months**. Choose the best answer for each question. The response choices for item 1-9 are Never; Sometimes; Most of the time; Almost always; or don't know."*

1. Have you bet more than you could really afford to lose?
2. Still thinking about the last 12 months, have you needed to gamble with larger amounts of money to get the same feeling of excitement?
3. When you gambled, did you go back another day to try to win back the money you lost?
4. Have you borrowed money or sold anything to get money to gamble?
5. Have you felt that you might have a problem with gambling?
6. Has gambling caused you any health problems, including stress or anxiety?
7. Have people criticized your betting or told you that you had a gambling problem, regardless of whether or not you thought it was true?
8. Has your gambling caused any financial problems for you or your household?
9. Have you felt guilty about the way you gamble or what happens when you gamble

Appendix D: Medical History Questions

1. Have you ever had a head injury (includes before or during birth)?
1a. If *yes*: how many?

For each:
- How old were you?
- Did you lose consciousness?
- Were you hospitalized?
- Did / do you have any lasting effects?

2. Have you ever had a stroke or heart attack?
2a. If *yes*: how many?

For each:
- What areas (functions) were affected?
- Did / do you have any lasting effects?

3. Have you been diagnosed with any other neurological conditions?
(e.g., epilepsy, MS, dementia, meningitis, CNS cancer, chemo-tx, radiation-tx)

Appendix E: Barratt Impulsiveness Scale

Instructions: *This questionnaire consists of thirty questions that ask you to rate how well certain statements apply to you. To answer these questions, please determine to what degree each of these statements applies to you and choose the appropriate response. How well does each of these statements describe you?*

Response Scale: Never
Occasionally
Often
Always

1. I plan tasks carefully.
2. I do things without thinking.
3. I make-up my mind quickly.
4. I am happy-go-lucky.
5. I don't "pay attention."
6. I have "racing thoughts."
7. I plan trips well ahead of time.
8. I am self-controlled.
9. I concentrate easily.
10. I save regularly.
11. I "squirm" at plays or lectures.
12. I am a careful thinker.
13. I plan for job security.
14. I say things without thinking.
15. I like to think about complex problems.
16. I change jobs.
17. I act "on impulses."
18. I get easily bored when solving thought problems.
19. I act on the spur of the moment.
20. I am a steady thinker.
21. I change residences.
22. I buy things on impulse.
23. I can only think about one problem at a time.
24. I change hobbies.
25. I spend or charge more than I earn.
26. I often have extraneous thoughts when thinking.
27. I am more interested in the present than the future.
28. I am restless at the theater or lectures.
29. I like puzzles.
30. I am future oriented.

Appendix F: Conners' Adult ADHD Rating Scales, Form: CAARS – Self-Report: Long Version

As this test is protected by copyright, the test items and test forms will not be provided in the appendix. The instructions and sample items are as follows:

Instructions: Listed below are items concerning behaviours or problems sometimes experienced by adults. Read each item carefully and decide how much or how frequently each item describes you recently. Indicate your response for each item by circling the number that corresponds to your choice.

Response Scale:
0 = Not at all, never
1 = Just a little, once in a while
2 = Pretty much, often
3 = Very much, very frequently

Sample Items:
It's hard for me to keep track of several things at once.
I am always on the go, as if driven by a motor.

Appendix G: Conners' Continuous Performance Test

This test is administered by computer. Instructions will appear on the computer screen, instructing participants to press a specified key on the keyboard (e.g., space bar) *only* when the target (e.g., the letter X) appears on the screen, and not to press the button when any other character appears on the screen. Administration time is 14 minutes.

Scoring: The computer program provides the following measures: omission errors, risk taking, average reaction time, commission errors.

Appendix H: Demographic Information Questionnaire

DATE OF BIRTH: month_____ day_____ year_____
SEX: ___ [0] male ___ [1] female

MARITAL STATUS:

__ [1] single
__ [2] married (and not separated)
__ [3] common law
__ [4] separated/divorced
__ [5] widowed

AREA OF RESIDENCE: ___[0] urban ___ [1] rural

EDUCATION: *(check off highest level only)*
__ [0] No degree, certificate or diploma
If so, please indicate the last grade you completed: ____
__ [1] Secondary (high) school graduation certificate or equivalent
__ [2] Trades certificate or diploma
__ [3] Other non-university certificate or diploma
__ [4] University certificate or diploma below bachelor level
__ [5] Bachelor's degree
__ [6] University certificate or diploma above bachelor level
__ [7] Degree in medicine, dentistry, veterinary medicine or optometry
__ [8] Master's degree
__ [9] Earned doctorate

OCCUPATION:
__ [1] Employed full-time (30 or more hrs/week)
__ [2] Employed part-time (less than 30hrs/week)
__ [3] Unemployed (out of work but looking for work)
__ [4] Student - employed part-time or full-time
__ [5] Student - not employed
__ [6] Retired
__ [7] Homemaker
__ [8] Other *(Specify)*: _____

Position/Job Title: _____
Approximate Net Yearly Income, to the Nearest $1,000: $ _____

ETHNICITY: *(check all that apply; clarify if necessary)*

__ [1] Aboriginal (Inuit, Métis, North American Indian, etc.)
__ [2] Arab/West Asian (Armenian, Egyptian, Iranian, Lebanese, Moroccan…)
__ [3] Black (African, Haitian, Jamaican, Somali, etc.)
__ [4] Chinese
__ [5] Filipino
__ [6] Japanese
__ [7] Korean
__ [8] Latin American
__ [9] South Asian
__ [10] South East Asian
__ [11] White (Caucasian)
__ [77] Other *(specify)*: _____

RELIGION:
__ [0] Not affiliated with a religious group
__ [1] Affiliated with a religious group

If you are affiliated, please specify:

__ [1] Aboriginal or First Nations spirituality
__ [2] Catholic
__ [3] Muslim
__ [4] Protestant
__ [5] Orthodox
__ [6] Jewish
__ [7] Eastern non-Christian
__ [8] Other *(Specify)*: _____

How Important Is Religion In Your Life?
__ [1] Very important
__ [2] Somewhat important
__ [3] Not very important
__ [4] Not important at all

Appendix I: Eysenck Impulsivity Scale (I_7)

As this test is protected by copyright, the test items and test forms will not be provided in the appendix. The Eysenck Impulsivity Scale is one of the scales of the Eysenck Personality Inventory

Response Scale: Yes or No

Sample Item:
Do you generally do and say things without stopping to think?

Appendix J: Iowa Gambling Task

Instructions: Participants will be presented with four decks of 60 cards labeled A, B, C, and D that are face-down and equal in appearance. The researcher will read the following set of instructions to each participant prior to beginning the Iowa Gambling Task:

"Each of these cards indicates an amount of money that has been won. Some cards will also indicate an amount of money that must be paid as a penalty. You are to select the top card from any of the four decks. The objective is to maximize your profits. However, you will not receive or pay any amount indicated on these cards. You may turn over cards from any deck you wish and you may switch decks at any time and as often as you like. After each card is overturned, the values will be announced for that card. Continue to overturn cards until I instruct you to stop."

Appendix K: Sensation Seeking Scale

As this test is protected by copyright, the test items and test forms will not be provided in the appendix. The instructions and three sample items are as follows:

Instructions: Please complete the following questions. There are no right or wrong answers; everyone is an individual, just respond to the statement. For each statement, choose either true or false. If you do not like either choice, mark the choice you dislike the least.

Response Scale: True or False

Sample Questions:

- I like to have new and exciting experiences and sensations even if they are a little frightening.
- I am an impulsive person.
- I often get so carried away by new and exciting things and ideas that I never think of possible complications.

Appendix L: Tridimensional Personality Questionnaire

As this test is protected by copyright, it is not permissible to reproduce the test items or test forms in this appendix. This is a 100-item scale designed to assess three basic personality dimensions - novelty seeking, harm avoidance, and reward dependence.

Response Scale: True or False

Sample Item:

- I often follow my instincts, hunches or intuition without thinking through the details

Appendix M: Wisconsin Card Sorting Test

As this test is protected by copyright, it is not permissible to reproduce the test items or test forms in this appendix. The test will be administered by computer. The instructions provided to participants when the test is administered by hand are as follows. Computer screen instructions will be similar.

Instructions: This test is a little unusual because I am not allowed to tell you very much about how to do it. You be asked to match each of the cards in these decks with one of these four key cards. You must always take the top card from the deck and place it below the key card you think it matches. I cannot tell you how to match the cards, but I will tell you each time whether you are right or wrong. If you are wrong, simply leave the card where you have placed it and try to get the next card correct. There is no time limit on this test. Are you ready?

Scoring: Measures provided by the program include
number of errors
number correct
number of categories completed
number of trials to first category
failure to maintain a set (error following 5 or more consecutive correct sorts)
mean response latency

Appendix N: Zimbardo Time Perspective Inventory

This measure contains 56 self-report items. Respondents are asked to read each item and, as honestly as they can, answer the following question: “How characteristic or true is this of you?”

Response Scale:
1 = very uncharacteristic
2 = uncharacteristic
3 = neutral
4 = characteristic
5 = very characteristic

Sample Items:

- I believe that getting together with one's friends to party is one of life's important pleasures.
- When I want to achieve something, I set goals and consider specific means for reaching those goals
- I think about the good things that I have missed out on in my life

Appendix O: Factor Loadings

Component Name	Loading[1]	Reliability[2]
Sensation Seeking		0.90
ZKPQ Total Score	0.91	
Eysenck I7 Venturesomeness	0.80	
TPQ Novelty Seeking	0.82	
Reward Dependence		0.51
TPQ Reward Dependence	0.55	
ZTPI Present	0.74	
IGT – Disadvantageous	0.69	
Forethought		0.43
BIS Non-planning	0.79	
TPQ Harm Avoidance	0.32	
ZTPI Future	-0.75	
IGT - Advantageous	0.30	
Executive – Attention		0.53
CPT Attentional	0.85	
BIS Attentional Impulsivity	0.70	
CPT Vigilance	0.50	
Executive – Inhibit[3]		0.55
WCST Perseverative Errors	0.48	
CPT Commission Errors	0.65	
Impulsivity – Motor		0.44
Eysenck I7 Impulsiveness	0.75	
BIS Motor Impulsivity	0.75	
CPT Impulsive	0.95	

[1] factor loadings on first principal component; [2] Cronbach's alpha; [3] factor loadings on second principal component