AN EVALUATION OF THE PATHWAYS MODEL OF PROBLEM GAMBLING USING THE QUINTE LONGITUDINAL DATASET

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B.A., University of Lethbridge, 2012

A Thesis
Submitted to the School of Graduate Studies
of the University of Lethbridge
in Partial Fulfillment of the
Requirements for the Degree

MASTER OF EDUCATION
(COUNSELLING PSYCHOLOGY)

Faculty of Education
University of Lethbridge
LETHBRIDGE, ALBERTA, CANADA

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Date of Defence: January 30, 2017

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Abstract

The pathways model proposed by Blaszczynski and Nower (2002) suggests that problematic gambling may result from three related but distinguishable etiological paths. The present study sought to test the tenets of the model by using the Quinte Longitudinal Dataset (Williams et al., 2015). A latent class analysis was completed using 125 first-time problem gamblers and in line with the model, a three-class solution was found to be best. The three latent classes shared important similarities with the pathways model typologies. There was a group of otherwise normal gamblers resembling the Behaviourally Conditioned typology, a class of gamblers with elevated antisociality and impulsivity resembling the Anti-social Impulsivist gambler, and a class that shared consistencies, although to a lesser extent than the previous classes, with the Emotionally Vulnerable gambler. Despite these consistencies with the model, anxiety and depression were not found to be significant class predictors. The Behaviourally Conditioned gambler and the Emotionally Vulnerable gambler classes did not appear to be as well differentiated as would be expected given the model's suppositions. This appears to be the first study to assess if problem gamblers can be grouped based on the presence of pathways model typological traits predating aberrant gambling behaviour. The findings provide preliminary support that problem gamblers can be grouped based on the presence of pre-problem gambling traits. The study's findings also provide further evidence for aspects of the Blaszczynski and Nower's (2002) problem gambling subtypes. These subtypes may be ultimately used to develop subtype specific intervention and prevention strategies.

Acknowledgements

I would like to express my sincerest gratitude and respect to my thesis supervisor, Dr. Darren Christensen, for his ongoing support and mentorship. His commitment to this project and to the scholarly development of his students is inspiring. His continued encouragement despite many setbacks was integral to the completion of this project and to my success as a graduate student.

I would also like to thank both my committee members, Dr. Robert Williams and Dr. Brenda Leung for their intellectual contributions to the project. A special thanks to Dr. Robert Williams for his suggestion and permission to use the Quinte Longitudinal Dataset. I would also like Dr. Lia Nower for reviewing the preliminary results of the project. Finally, I would like to extend thanks to Dr. Paul Delfabbro and Dr. Alex Blaszczynski for their review and comments of an earlier draft of the project.

Table of Contents

List of Tables

viii

List of Figures

Introduction

The prevalence of problem gambling worldwide has been found to range from 0.5% to 7.6% depending on country and time of measurement (Williams, Volberg & Stevens, 2012). A problem gambler has been described as an individual who presents with difficulties in controlling or managing gambling behaviour, subsequently resulting in adverse consequences for either the gambler, the gambler's family and/or other members of society (Neal, Delfabbro & O'Neil, 2005). Problem gambling can be further understood as a continuum, with the most severe form of problem gambling referred to as pathological gambling (Williams, et al., 2015). Individuals who are suffering from pathological gambling (recently re-categorized as gambling disorder in the DSM-5), suffer from a number of symptoms including, but not limited to, preoccupation with gambling, chasing losses, lying to conceal gambling and failed attempts to cut down (American Psychiatric Association, 2013). Problem gamblers also commonly suffer from a variety of concurrent disorders including substance use disorder, mood disorders and personality disorders (Lorains, Cowlishaw & Thomas, 2011; Petry, Stinson & Grant, 2005). The degrees of severity and various subpopulations of problem gamblers with co-morbid psychiatric illnesses demonstrate that problem gamblers are a heterogeneous population.

Trajectory and Stability of Problem Gambling

Prior to the DSM-5, the American Psychiatric Association has historically characterized pathological gambling behavior as being both chronic and progressive if left untreated (Slutske, 2006). However, in contrast to these early clinical assumptions, several longitudinal and cross-sectional studies have demonstrated that for some

individuals, problem gambling is neither a chronic nor progressive condition. This is made particularly apparent in cases of natural recovery. Natural recovery refers to the phenomenon whereby a problem gambler recovers without seeking formal help or intervention (Hodgins, Wynne & Makarchuck, 1999). Research has demonstrated that natural recovery commonly occurs amongst problem gamblers. In an analysis of two US national survey studies (Gambling Impact and Behaviour Study and National Epidemiologic Survey on Alcohol and Related Conditions Survey), Slutske (2006) found that approximately one-third of individuals who met the lifetime criteria for pathological gambling did not experience any past-year gambling related problems. Notably, only 7-12% of the pathological gamblers from the two samples had sought out treatment for their gambling problems or attended a Gamblers Anonymous meeting (Slutske, 2006). Thus, the majority of pathological gamblers who recovered did so without seeking assistance from professionals or from self-help groups.

Longitudinal gambling studies have provided further evidence for the commonality of recovery in problem gamblers and for the instability of problem gambling related symptoms in individuals suffering from aberrant gambling behaviour. Longitudinal studies on problem gambling have consistently demonstrated that the condition is rarely stable or chronic (Williams et al., 2015). For example, in a large five-year prospective study completed by Williams et al. (2015), it was found that approximately 80% of individuals who had met the criteria for problem gambling had demonstrated at least one year without experiencing gambling related problems over the course of the study. Interestingly, more severe problem gamblers (pathological gamblers) demonstrated similar instability in their problem gambling symptomatology. That is,

severe problem gamblers tended to demonstrate reductions in the severity of their gambling problem. However, Williams et al. (2015) note that when recovery from problem gambling was defined as the absence of gambling related problems, the pathological gamblers of their sample demonstrated a more stable and chronic trajectory. Further supporting heterogeneity in problem gambling chronicity, Luce, Louise and Kairouz (2016) observed different problem gambling trajectories for subgroups of gamblers based on problem gambling severity over a two year period. That is, the general trend of problem gamblers in Luce, Louise and Kairouz's (2016) sample showed a reduction in problem gambling severity over time, with a portion of problem gamblers demonstrating a non-linear or fluid trajectory regarding their problem gambling status and another portion of their sample presenting with a more chronic course.

Relapse has also been found to be a relatively common phenomenon experienced by problem gamblers in recovery (Williams et al., 2015). Of the problem gamblers who had experienced one year of recovery from problem gambling, 25% had relapsed in the following year. The rate of relapse steadily increased for each consecutive year of recovery up to 40% at three years. Other evidence from longitudinal studies has provided further support for the high frequency of relapse amongst problem gamblers in recovery. For example, in another longitudinal study completed by Hodgins and el-Guebaly (2004), it was found that in a sample of 101 pathological gamblers who had recently quit gambling, only 8% had successfully maintained abstinence from gambling at 12 months. So although recovery from problem gambling may be a common occurrence, so too is relapse.

To summarize, investigations on the trajectory of problem gambling have demonstrated problem gamblers typically show high rates of natural recovery followed by frequent relapse. Thus, the condition appears to be a relatively unstable with a large portion of problem gamblers demonstrating fluctuations in their gambling and problem gambling status over time.

The Pathways Model

The etiology of problem gambling appears to be as complex as the population that suffers from it; it has been theorized to be multifaceted, with a number of factors which may influence the course and development of problematic gambling behaviour (Delfabbro, 2013a; Shaffer & Martin, 2011; Williams et al., 2015). Despite the growing number of empirical studies that have attempted to elucidate the etiology of problem gambling, the exact causality of aberrant gambling behaviour still remains unknown. Consequently, a number of researchers have proposed theoretical etiological models that attempt to account for how problematic gambling behaviour develops (Shaffer & Martin, 2011). However, few of these proposed models are empirically derived and even fewer have investigated the supposed variables implicated in the development of problematic gambling (Casey et al., 2011). Establishing an empirically valid etiological model of problem gambling is of great importance as it is both clinically relevant and necessary for effective prevention.

Of the etiological models that exist, one has become increasingly influential in the problem gambling literature, and that is the pathways model proposed by Blaszczynski and Nower (2002). The pathways model is a conceptually driven, theoretical model that attempts to account for the heterogeneous nature of problem gamblers by theorizing that

aberrant gambling behaviour can result from three related but distinguishable etiological paths (Blaszczynski & Nower, 2002). The three paths, or subtypes, proposed by the model will now be presented along with some relevant research findings that have provided support for the problem gambling correlates on which each of the paths are premised.

Behaviourally Conditioned Pathway

Behaviourally conditioned (BC) gamblers are suggested to engage in problematic gambling behaviour primarily because of erroneous gambling cognitions (i.e. misunderstandings of randomness) and conditioning. Gamblers fitting of this typology are differentiated by the absence of any pre-existing clinically significant psychopathology (Blaszczynski & Nower, 2002). However, it is suggested that BC gamblers can develop co-morbid psychiatric illness such as depression and anxiety, but such disorders are a consequence of problematic gambling rather than being contributing factors. It is also suggested that BC gamblers may demonstrate instability, fluctuating between heavy gambling and pathological gambling (Blaszczynski & Nower, 2002).

Consistent with Blaszczynski and Nower's (2002) description of the BC pathway, many problem gamblers are sensitive to structural characteristics of gambling and the association between gambling behaviour and winning. For example, the immediacy of winning (Choliz, 2010), and the visual similarity between wins and near-misses (Sharman et al., 2015) encourage persistent gambling behavior. Moreover, gamblers typically receive wins in highly variable patterns (Browne, Rockloff, Blaszczynski, Allcock, & Windross, 2013), and it has been theorized that variable reinforcement schedules are a powerful environmental factor that maintain gambling behaviour (Hurlburt, Knapp &

Knowles, 1980). For example, variable reinforcement ratios (VR) have been shown to produce high response rates and persistent responses during extinction of behaviour when responses are no longer reinforced (Mazur, 2006), as subjects who experience partial reinforcement initially appear to conflate reinforcing and non-reinforcing trials (Capaldi, 1966). Moreover, gambling has been suggested to be a particular type of VR that has been termed random ratios (RR; Hurlburt et al., 1980). The difference between VR and RR is that in a RR, the probability of being rewarded is independent of the outcomes of previous events, while in a VR, the probability of reinforcement becomes greater with each previously failed attempt (Hurlburt et al., 1980).

RR have been proposed to result in a number of invalid cognitions regarding randomness such as the belief in hot and cold streaks (Delfabbro, 2013b). There is strong evidence that problem gamblers demonstrate more gambling related cognitive distortions, or gambling fallacies, in comparison to non-problem gamblers (Myrseth, Brunbord & Eidem, 2010; Williams et al., 2015). Such findings are consistent with Blaszczynski and Nower's (2002) proposal that conditioning and erroneous gambling cognitions may contribute to the development of problematic gambling behaviour.

Emotionally Vulnerable Pathway

As with the BC subtype, Emotionally Vulnerable (EV) gamblers are believed to suffer from a variety of distorted gambling cognitions and conditioning. Unlike BC gamblers, EV gamblers are believed to have pre-existing depression and anxiety. EV gamblers are further differentiated by greater dysfunction within their family histories, deleterious life experiences, psychosocial problems, neurobiological irregularities and poor coping skills (Blaszczynski & Nower, 2002). Additionally, the model postulates that

EV gamblers primarily gamble as a means of escaping or modulating negative affective states.

Supportive of Blaszczynski and Nower's (2002) depiction of the EV pathway, cross-sectional research has shown that some problem gamblers demonstrate adverse childhood histories. For example, Petry and Steinberg (2005) found that a sample of 149 treatment-seeking pathological gamblers presented with overall scores that placed them in the moderate to severe range on the Childhood Trauma Questionnaire (CTQ) (Bernstein & Fink, 1998) when compared to the norms of the general population. Higher scores on the CTQ were related to earlier onset of problem gambling, more severe gambling related problems and greater frequency of gambling behaviour (Petry & Steinberg, 2005). Furthermore, Hodgins et al. (2010) investigated if a relationship existed between childhood maltreatment and problem gambling in a community sample of problem gamblers. Consistent with Petry and Steinberg's (2005) findings, Hodgins et al. (2010) found that approximately one-third of problem gamblers in their sample reported to have experienced at least one form of childhood abuse or neglect. Additionally, it was found that experiencing at least one instance of childhood abuse or neglect was associated with greater frequency of gambling behaviour and a greater likelihood of having experienced gambling related problems (Hodgins et al., 2010). Several other studies have provided further support for the relationship between early childhood adversity and problem gambling (Black, Shaw, McCormick, & Allen, 2012; Sharma & Sacco, 2015; Felsher, Derevensky & Gupta, 2010).

Cross-sectional research has also demonstrated that the motive of gambling to escape, the primary motive of EV gamblers as specified by the pathways model, is an

important problem gambling correlate. For example, in a qualitative grounded theory study completed by Wood and Griffiths (2007), it was found that the majority of problem gamblers included in the study reported to be motivated to gamble as a means of modulating negative effective states or as a method of escaping problems. Consistent with Wood and Griffiths' (2007) findings, a number of other cross-sectional quantitative studies have demonstrated that gambling as a method of escape, or as a method of regulating emotional states, are important gambling motives related to problematic gambling behaviour (Flack & Morris, 2014; Tomas, Allen & Phillips, 2009).

Anti-Social Impulsivist Pathway

Finally, the third pathway outlined by the pathways model, the Anti-Social Impulsivist (AI) gambler, is suggested to be comprised of individuals who suffer from the most severely disordered psychopathology (Blaszczynski & Nower, 2002). As with the EV gamblers, AI gamblers suffer from emotional vulnerabilities, gambling related cognitive distortions, neurobiological dysfunction and psychosocial difficulties. What distinguishes these gamblers from the other subtypes is that they are believed to suffer from high levels of impulsivity, premorbid attention deficit disorder and antisocial personality disorder (ASPD) (Blaszczynski & Nower, 2002). Consequently, AI gamblers are also suggested to struggle with boredom, suicidal thoughts and substance abuse (Blaszczynski & Nower, 2002). AI gamblers are theorized to initiate gambling behaviour at an earlier age in comparison to the other two typologies, and gamblers consistent with this subtype are suggested to be the least responsive to treatment interventions because of their clinical profile (Blaszczynski & Nower, 2002).

In line with Blaszczynski and Nower's (2002) theoretical supposition, age has been found to be a significant correlate associated with problematic gambling behaviour. For example, Huang and Boyer (2007) found that Canadian youth (15-24) experienced higher rates of problem gambling in comparison to adults. In a Swedish national study of problem gambling, Volberg, Abbott, Rönnberg and Munck (2001) found that individuals who were under the age of 25, particularly males, were more likely to have experienced problem gambling over their lifetime in comparison to individuals who were over the age of 25. Furthermore, earlier age of initiation has been found to be associated with greater pathological gambling severity (Jimenez-Murcia et al., 2010). Jimenez-Murcia et al.'s (2010) finding is consistent with Blaszczynski and Nower's (2002) proposal that problem gamblers who initiate gambling behaviour at an earlier age in life present with the most severe gambling related problems.

Another important distinguishing characteristic of the AI pathway that has been found to be elevated in problem gamblers is impulsivity. For instance, Alessi and Petry (2003), found that pathological gamblers demonstrated steeper discounting rates on a temporal discounting task in comparison to healthy controls; steeper discounting rates were also found to be associated with greater severity of gambling problems (Alessi & Petry, 2003). The rate by which an individual discounts the value of a reward based on temporality is believed to be a measure of impulsivity and self-control (Dixon, Rehfeldt & Randich, 2003). That is, the more an individual discounts the value of a reward based on the delay of the reward, the steeper their discounting rate and the more impulsive he or she is believed to be. In a more recent study completed by Brevers et al. (2012), it was also found that both problem and pathological gamblers demonstrated steeper discounting

rates in comparison to controls. However, in contradiction to Alessi and Petry's (2003) findings, problem and pathological gamblers in Brevers et al.'s (2012) study demonstrated similar rates of discounting. Moreover, in a comprehensive meta-analysis of the studies that have investigated personality correlates and pathological gambling, it was found that pathological gamblers report significant elevations in propensity to take emotionally motivated, impetuous action and are more likely to act without consideration of consequences when compared to controls (Maclaren, Fugelsang, Harrigan & Dixon, 2011).

An etiological factor specified by the model previously described that is believed to contribute to the development of problem gambling in both EV and AI pathways is neurobiological dysfunction. There is a growing body of evidence from studies that have investigated neurobiological factors and problem gambling that would support such a proposal. For instance, there are several neurotransmitters that have been linked to problematic gambling behaviour. Some of these neurotransmitters include serotonin, glutamate, noradrenalin, dopamine and endorphins (Potenza, 2008). Evidence supporting the role of these various neurotransmitters comes from a number of studies that have investigated the efficacy of psychopharmacological interventions for the treatment of pathological gambling. For example, it has been found that opioid antagonists are an effective treatment for reducing problematic gambling related symptoms for some pathological gamblers (Grant et al., 2006; Kim, Grant, Adson & Shin, 2001). Further evidence for the role of neurotransmitters in the development and sustainment of problematic gambling has come from studies that have investigated dopamine agonists in the treatment of individuals suffering from Parkinson's disease and restless leg syndrome

(Potenza, 2008). More specifically, it has been demonstrated that a minority of individuals who are treated with dopamine agonists may begin to exhibit aberrant gambling behaviour despite reporting no prior history of problem gambling (Bostwick, Hecksel, Stevens, Bower, & Ahlskog, 2009; Dodd et al., 2005; Driver-Dunckley, Samanta & Stacy, 2003; Singh, Kandimala, Dewey & O'Suilleabhain, 2007; Voon et al., 2007; Wientraub et al., 2006).

Finally, it should be specified that the pathways to problem gambling are unidirectional in nature, as the traits that differentiate each of the typologies are suggested to predate and influence the development of problematic gambling behaviour rather than forming a cyclical pattern of causality (i.e. where problem gambling contributes to a factor, and this factor then further contributes to problem gambling). This is of particular importance because as mentioned, BC gamblers may develop anxiety, depression or disordered substance use. However, these disorders are suggested to be a consequence of aberrant gambling behaviour for this typology. Furthermore, the presence of psychiatric illness is suggested to not influence the developmental course or trajectory of problematic gambling behavior for BC gamblers. Thus, some BC gamblers may present phenomenologically consistent with the EV subtype (i.e. with depression and/or anxiety), but would still be typified as a BC gambler if the co-morbid psychiatric illness did not predate the initiation of problematic gambling behaviour.

Ecological and the Pathways Model

In addition to the subtypes sharing the commonality of conditioning and erroneous gambling beliefs, Blaszczynski and Nower (2002) suggest that the typologies are undifferentiated by ecological factors. That is, environmental factors may contribute

to the development of problem gambling for all of the pathways model subtypes. Some of these ecological factors specified in the model include accessibility and availability of gambling opportunities. Correlational studies have consistently demonstrated that the propinquity of gambling activities is a significant risk factor for problem gambling (Welte, Wieczorek, Barnes & Tidwell, 2006; & Welte, Wieczorek, Barnes, Tidwell & Hoffman, 2004). Social gambling norms and values have also been suggested to be important ecological factors common to the pathways model subtypes (Blaszczynski & Nower, 2002), although, gambling norms and values have been found to be more predictive of whether or not an individual will choose to gamble, and appear to share a limited relationship with problematic gambling behaviour (Welte et al., 2006). It has also been found that populations from disadvantaged neighbourhoods (i.e. neighbourhoods with poor economic conditions and lower quality education) exhibit abnormally high rates of problem gambling (Barnes, Welte, Tidwell & Hoffman, 2013; Welte et al., 2004). Additionally, minority and low socioeconomic status have both been found to be correlated with higher rates of problematic gambling behaviour (Barnes et al., 2013; Welte et al., 2006; Welte et al., 2004).

Substance Abuse Typologies and the Pathways Model

The biopsychosocial model of substance addiction is a metatheory that attempts to integrate and synthesize theories as well as empirical findings from a range of scientific disciplines (i.e. sociology, biology and psychology) to account for the etiology of substance addiction (Kumpfer, Tunnerll & Whiteside, 1990). Similar to substance addiction, other behavioural addictions, such as gambling, have been suggested to result from a complex combination of social, psychological and cultural factors (Marlatt, Baer,

Donovan & Kivlahan, 1988; Griffiths, 2005). The similarities between substance addiction and disordered gambling are made further apparent by common theorized addictive components or phenomenological experiences such as withdrawal and tolerance (Griffiths, 2005), as well as similarities in suggested phases of development (Marlatt et al., 1988). There is evidence to support such commonalities, for example, Christensen, Jackson, Dowling, Volberg and Tomas (2014) demonstrated that problem gamblers can be subdivided into progressive phases of severity, similar to substance addiction, based on the presence of specific disordered gambling symptoms.

Given that both addictions are believed to have commonalities in their theorized etiologies, it is plausible that similarities may also exist in the structure and differentiating features of problem gambling and substance addiction typologies. Consistent with such reasoning, one would expect the pathways model subtypes to share important overlap with substance addiction typologies. In a comprehensive review of the typological research on alcohol dependence along with their implications for pharmacological interventions, Leggio, Kenna, Fenton, Bonenant & Swift (2009) discuss a number of typological models ranging from two to five subtypes. Notably, in an earlier review on the typologies of alcohol dependence, Hesselbrock and Hesselbrock (2006) argue that important commonalities exist across the proposed alcohol and substance use addiction typological models. More specifically, Hesselbrock and Hesselbrock (2006) suggest that there appear to be four reoccurring subtypes in the literature: a mild course subtype; an anxiety/depressive subtype; an anti-social subtype and a chronic or severe subtype. Some of these alcohol typologies appear to share important similarities with the pathways to problem gambling proposed by Blaszczynski and Nower (2002).

For instance, Windle and Scheidt (2004), using a cluster analysis, found that four subtypes best accounted for their sample of alcohol dependents. One cluster was differentiated by polysubstance use and may be an alcohol specific typology. As for the other three subtypes, they appeared to share some striking commonalities with the pathways model typologies. One subtype presented with a similar clinical profile to BC gamblers, as the individuals fitting with this typology presented with the least severe alcohol consumption and alcohol related problems, had a later onset of alcohol use, and demonstrated the least number of childhood conduct problems. Another cluster shared some important commonalties with the EV gambler as two of its defining characteristics included high depressive and generalized anxiety symptomology. Finally, the last subtype was consistent with aspects of the AI pathway, as this cluster of problematic substance users were differentiated by the most severe alcohol related impairment and highest levels of antisociality.

Consistent with Windle and Scheidt's (2004) typological model, Del Boca and Hesselbrock (1996) also presented a four subtype model. Once more, the typologies outlined by Del Boca and Hesselbrock (1996) demonstrate important similarities with the pathways model subtypes. These similarities include a typology that is characterized by low levels of co-morbid psychiatric illness; a subtype that is differentiated by depressive symptomology and anxiety; a subtype that is characterized by the presence of ASPD. Finally, the fourth subtype described by Del Boca and Hesselbrock (1996) was characterized by high levels of co-morbid anxiety, depression and antisociality. In addition, this subtype had the most severe family histories of alcohol addiction and had the earliest age of initiation of alcohol use. This typology would also be consistent with

the AI pathway, as Blaszczynski and Nower (2002) suggest that AI gamblers can present with co-morbid depression and anxiety in addition to antisociality. Another shared similarity between the proposed AI subtype and this subgroup of alcohol dependents is that AI gamblers are also suggested to initiate gambling behaviour at an earlier age in comparison to the other pathways model typologies. Thus, it appears that the pathways model subtypes share some important commonalities with other empirically derived typological models of substance addiction. This may provide further support for the pathways model subtypes because, as mentioned, both problematic substance use and disordered gambling are suggested to share a number of important etiological and phenomenological similarities. It is also possible that both disorders may share common etiological paths to addiction, and that the pathways model may be able to account for such paths.

Cross-Sectional Analyses of the Pathways Model

There is an emerging body of cross-sectional research that has provided support for the existence of the pathways model typologies. A succinct review of these studies and their findings will now be presented. Turner, Umesh, Warren and Masood (2008) completed a study that investigated if the pathways model could successfully account for a sample of 141 gamblers and problem gamblers. A number of pathways model typological characteristics were assessed such as depression, anxiety and attention deficit hyperactivity disorder and a principle component analysis was used to analyze the data. The authors found that four distinct components existed, and two of these components were consistent with the BC pathway. One of these components was heavily loaded on erroneous gambling cognitions, the other component was heavily loaded on having

experienced a substantial win streak as well as having received a large win shortly after the initiation of gambling. The third component was consistent with the EV subtype, and this component was heavily loaded on social anxiety, depression and harm avoidance. Finally, the fourth component was consistent with the AI profile, and this component had strong loadings on impulsivity, attention deficit hyperactivity disorder symptoms, boredom susceptibility and novelty seeking. Turner et al. (2008) conclude that their findings are consistent with the pathways model typologies, however, they suggest that the BC pathway may be further subdivided into two additional paths or subtypes; one path consisting of gamblers who engage in problematic gambling as a result of having experienced early wins in their gambling career, and the other subgroup consisting of gamblers who primarily develop aberrant gambling behaviour because of gambling related fallacies.

Turner et al.'s (2008) findings have since been further supported by a study completed by Ledgerwood and Petry (2010). The study investigated if the pathways model typologies were predictive of treatment outcomes for a sample of 229 treatment-seeking pathological gamblers. Consistent with both the pathways model and with Turner et al.'s (2008) findings, Ledgerwood and Petry (2010) found that their sample could successfully be sub-grouped into the three pathways model taxonomies. That is, their sample of problem gamblers were able to be classified into three subgroups using pathways model defining typological traits. Moreover, Ledgerwood and Petry's (2010) findings supported Blaszczynski and Nower's (2002) conceptual profile of the AI subtype, as problem gamblers in their sample who scored high on both the measures of impulsivity and ASPD also presented with the most severe gambling problems as

measured by the gambling version of the addictions severity index (Lesieur & Blume, 1992). Furthermore, gamblers fitting of the AI subtype also presented with the most severe psychosocial problems.

The pathways model has also been tested for its ability to account for problem gambling youth. Gupta et al. (2013) assessed a number of distinguishing pathways model typological characteristics in a sample of 109 problem gambling adolescents between the ages of 14 – 18. A latent class analysis (LCA) was then performed in order to determine how many classes best accounted for their sample. It was found that five distinct classes based on psychopathology best accounted for participants, and that three of the five classes were consistent with the pathways model typologies. As for the other two classes, Gupta et al. (2013) suggest that one of the classes may be youth specific, and that the other class may represent an intermediate group of problem gamblers who possess both AI and EV typological traits. However, it is also possible that a major limitation of the study may have also affected the number of latent classes; the authors included adolescents who scored three on the Diagnostic Statistical Manual Fourth Edition Multiple Response Junior (DSM-IV-MR-J; Fisher, 2000) and considered them to be at risk for developing problem gambling. Although, a score of four or more on the DSM-IV-MR-J is generally believed to be indicative of problem gambling in youth (Fisher, 2000). This is a significant limitation, as there is no research to substantiate the authors' at-risk claim. Consequently, Gupta et al. (2013) may have falsely included adolescents in their study that may have not been problem gamblers, and this may have influenced the LCA.

Nower, Martins, Lin and Blanco (2013) tested the pathways model by completing a LCA using a nationally representative sample of 581 adult disordered gamblers. Disordered gamblers in the study were defined as those individuals who met at least three of the DSM-IV diagnostic criteria for pathological gambling. A total of 22 variables (17 dichotomous and 5 continuous) were included in the analysis as class indicators. These variables measured a number of important pathways model typological traits including ASPD, anxiety, depression, and familial dysfunction.

Consistent with the pathways model, the authors found that a three-class solution best accounted for their sample. In further support of the model, the three latent classes identified shared important similarities with the pathways model typologies. The first and largest class (n=295) presented with a profile consistent with the BC subtype, with problem gamblers in this class demonstrating the lowest probabilities of meeting the criteria for mood or personality disorders and the lowest mean score on a variable that assessed problem gambling severity. The second latent class observed (n = 117) was argued to be in line with the EV pathway. Problem gamblers in this class had the highest probability of having met the criteria for past-year depression and anxiety. These gamblers also held an intermediate position in terms of parental alcohol/drug problems and parental divorce. The third class (n = 169) demonstrated important similarities with the AI subtype, and problem gamblers in this class presented with the highest probabilities of having met the criteria for ASPD, past-year substance use disorder, parental divorce and parental drug/alcohol problems. Nower and colleagues note that although a three-class solution was the best fitting model, it is plausible that two groups of problem gamblers may exist; one group with no concurrent psychopathology predating

problematic gambling or personality disorders and another group of problem gamblers who present with serious psychopathology and biological vulnerabilities (i.e. class 3 and class 2 may in fact be one group, with class 2 being the less severe variant).

Although Nower et al.'s study had a number of strengths which included a large sample size and the inclusion of a comprehensive list of variables that assessed the majority of pathways model typological traits as class indicators in the analysis, it failed to include measures of chronology of psychopathology. This is a major limitation, as problem gamblers in Nower et al.'s analysis were grouped based on the presence of concurrent psychiatric illness which may have occurred after the onset of problem gambling. Thus, the latent classes identified in the analysis may better describe how problem gamblers may be grouped based on symptomologies and such groups may not be representative of etiological paths.

Finally, a recent study completed by Valleur et al. (2016) has provided further evidence for the existence of the pathways model subtypes. The authors categorized 374 problem gamblers into the pathways model typologies using a number of instruments that assess co-morbid psychiatric disorders (i.e. depression, ASPD and anxiety) as well as other typologically distinguishing traits such as impulsivity. As with the aforementioned studies, it was demonstrated that problem gamblers in their sample could be predominately accounted for by the three pathways model typologies. Participants' preferred gambling activities were also assessed and notably, AI gamblers tended to prefer semi-skilled games such as betting on sports and horse racing, whereas EV gamblers demonstrated a greater preference for more luck based games such as slot machines and scratch tickets. Valluer et al. (2016) argue that BC gamblers were the least

distinguishable group in their sample and that these gamblers appeared to hold an intermediate position between AI and EV gamblers in terms of their gambling preference and symptomology. That is, participants who presented with phenomenologies consistent with the BC subtype also presented as more heterogeneous in their preference for gambling activities.

Although many of the findings from the reviewed studies have provided further evidence for the pathways model subtypes, some of the findings from the aforementioned studies proved to be discrepant with aspects of the model. Some of these findings included similar rates of responsiveness to treatment regardless of subtype (Ledgerwood & Petry, 2010), common age of initiation of gambling behaviour (Tuner et al., 2008; Ledgerwood & Petry, 2010) and problem gamblers being best accounted for by five subgroups (Gupta et al., 2012) or four subtypes (Tuner et al., 2008) as opposed to three. Despite these inconsistencies, it does appear that there are subgroups of problem gamblers who present with phenomenologies that are consistent with the pathways model typologies. However, these findings do not confirm the etiological suppositions in which the model is founded upon as none of the studies have focused exclusively on if problem gamblers can be sub-grouped based on their presentation of pathways model traits prior to the onset of problem gambling. For example, Gupta et al. (2013) and Nower et al.'s (2013) latent class analyses did not include class indicators that assessed depression, anxiety or substance use prior to the onset of problem gambling. Instead, these studies included class indicators that assessed concurrent psychopathology

This limitation is made more apparent when considering that only one of the reviewed studies included an assessment of chronology of co-morbid psychopathology,

(Valleur et al., 2016) and this was assessed using a retrospective self-report. Consequently, it still remains unclear as to whether or not the pathways model subtypes reflect etiological paths to problem gambling or if the putative pathways model typologies represent clusters of individuals who present with similar symptomologies after the initiation of problematic gambling behaviour. Thus, addressing this limitation is the primary objective of the study and this will be accomplished by competing a LCA using a longitudinal archival dataset.

Summary

To summarize, problem gamblers are a heterogeneous population, and this heterogeneity has been demonstrated in studies that have investigated co-morbid psychopathology in samples of problem gamblers. The pathways model, a prominent etiological model in the literature that attempts to account for the various risk factors associated with problem gambling and the heterogeneity of problem gamblers, was then reviewed. The pathways model typologies were then compared to substance addiction typologies and important similarities were identified. Following, cross-sectional evidence for the pathways model was discussed, and a significant limitation in the research literature on the model was identified; this limitation being that no studies to date have empirically tested if problem gamblers can be grouped exclusively using the presence of traits predating problem gambling.

Research Questions and Hypotheses

The primary research question that this study seeks to answer is, does the pathways model meaningfully account for individuals who present with problematic gambling behaviour for the first time? That is, do problem gamblers cluster into groups as

predicted by the model based on the presence of traits that pre-date their problematic gambling behaviour? If the model is correct, one would predict that three distinct, but related groups of problem gamblers exist. More specifically, there should exist one group of first-time problem gamblers who present with no pre-existing psychopathology prior to the initiation of their gambling behaviour (i.e. BC gamblers). There should also be a group of first-time problem gamblers who demonstrate clinically significant depression and anxiety predating their problematic gambling (i.e. EV gamblers). Finally, there should be a group of first-time problem gamblers who present with elevated impulsivity and antisociality prior to the initiation of problematic gambling (i.e. AI gamblers).

The study will also seek to answer the question, is age of onset of gambling related to pathways model status? As discussed earlier, several studies have provided evidence inconsistent with Blaszczynski and Nower's (2002) theory that AI gamblers initiate gambling behaviour at an earlier age in comparison to the other two typologies. Thus, the study will seek to provide further clarification regarding this supposition by investigating if initial age of gambling behaviour is a significant predictor of class membership.

Methods

In order to answer the primary and secondary research questions, the study employed a LCA on an archival dataset. In this section, the archival data set will be reviewed and the sample included in the present analysis will be described. Following, the variables included as class indicators will be presented along with their relevancy in testing the pathways model. How each of these variables were measured in the QLS will then be discussed and when applicable, the psychometric properties for the instruments

used to measure the manifest variables will be reviewed. The analytical technique will then be presented and rationale will be given for its suitability in testing the pathways model subtypes. A detailed overview of the procedures for assessing model fit is specified. Finally, a number of post-hoc tests were completed to test if the latent groups differed on select variables. The variables selected to be included in the post-hoc tests were chosen with the aim of better describing the latent classes and to determine if the classes significantly differed in regards to their demographics.

Quinte Longitudinal Study (QLS)

The QLS was a longitudinal study that was completed in Quinte Ontario, Canada by Williams et al. (2015) that investigated gambling and problem gambling. A total of 4,121 participants were recruited and assessed annually for a period of five years (2006 – 2011). The QLS cohort was made up of two samples, which included a general population sample and an at-risk sample. The general population sample consisted of 3,065 individuals making up the majority of the QLS cohort. Eligible participants included in this sample were those who were 18 years of age and older, who lived within 70 kilometers of the city of Bellville and who had confirmed that they would be residing in the Belleville area for at least another year. The at-risk sample included 1056 individuals who were recruited at the same time as the general population sample. The purpose of the at-risk sample was to ensure that there was a sufficient representation of gamblers and problem gamblers in the cohort. Eligibility criteria for the at-risk sample were the same as the general population sample (i.e. same age requirements, geographic location, etc.), with one exception; to be included in the at-risk cohort, individuals must have endorsed at least one of the following:

"Spending $10 or more per month on lottery and instant win tickets in a

typical month; spending $10 or more a month on bingo, casino table

games, or games of skill against other people in a typical month; playing

either slot machines or betting on horse racing in the past year; or an

intention to gamble at the new QER-II when it eventually opened"

(Williams et al., 2015, p.31).

Participants were first contacted as part of a four-minute survey that was

administered at random over the phone. Following the completion of the survey, eligible

participants were then asked if they would like to participate in the QLS. The initial

response rate was 21.3% and the study had an impressive overall retention rate of 93.9%.

Of the total 4,121 participants included in the QLS, 1.2% were classified as pathological

gamblers at first assessment. Another 2.1% of participants were classified as problem

gamblers and 13.7% were classified as at-risk gamblers. The remaining participants were

classified as either recreational gamblers, (75.5%, respectively) or non-gamblers (7.5%,

respectively).

The QLS data set is particularly well suited for the purposes of testing the

pathways model's proposed etiological paths to problem gambling, as it measures 4,121

individuals across five waves. Consequently, individuals who developed problem

gambling for the first time during the QLS were tested on a number of measures that

assessed pathways model typological traits prior to the initiation of problematic gambling

behaviour. These typological traits include impulsivity, co-morbid psychiatric disorders

(i.e. depression and anxiety), antisociality and gambling intensity. Consequently, the QLS

data set provides a unique opportunity to test the pathways model.

Participants

There was a total of 125 first-time problem gamblers included in the LCA. First-time problem gamblers were operationally defined as those cases in the QLS who did not endorse the wave one item "do you have any lifetime history of problem gambling" and who met the criteria for problem or pathological gambling in at least one wave over the course of the study. It was decided that first-time problem gamblers at wave one would not be included in the LCA, as assessments prior to the onset of problem gambling were not available for these cases. Cases who presented with problem gambling after wave one had been assessed using a comprehensive battery of instruments in prior wave(s) and thus, such information could be included in the LCA to determine if, and how, problem gamblers may cluster based on traits, behaviours and psychological disorders that pre-dated their problematic gambling. Of the first-time problem gamblers included in the analysis, 47 first engaged in problematic gambling at wave two, 39 at wave three, 27 at wave four and 12 at wave five.

Class Indicators

The QLS included variables that assessed the majority of the pathways model typological traits, however, not all of these variables could be included as indicators in the LCA given the sample size. Consequently, only a select number of QLS variables related to the pathways model were included as class indicators in the LCA. These indicators included five continuous variables, retrospective age of initiation of gambling behaviour, impulsivity, social functioning, antisociality and total number of days gambled in the year prior to the onset of problem gambling. There were also three dichotomous variables included as indicators in the analysis; depression prior to onset of problem

gambling, problematic substance use prior to the onset of problem gambling and generalized anxiety prior to the onset of problem gambling.

The aforementioned variables were selected as class indicators because of their relevancy to the pathways model typologies. As reviewed, impulsivity, antisociality, social dysfunction, earlier onset of gambling behaviour and psychopathology predating problematic gambling are all important defining features of the AI subtype. Thus, if the model is correct, responses to these variables should result in the clustering of gamblers who resemble the AI profile. Similarly, EV gamblers are said to be characterized by the presence of depression and anxiety predating their problem gambling, but are differentiated from AI gamblers as they do not present with elevated impulsivity and antisociality. Again, if the model is accurate, a group of cases resembling the EV subtype should cluster given their responses to the variables included in the analysis. Finally, given the description of the BC gambler, the variables included as class predictors should also result in the clustering of problem gamblers who do not present with any psychopathology predating problem gambling; non-elevated antisociality, social dysfunction, or impulsivity. Gamblers fitting of this subtype may also be clustered by greater gambling intensity prior to onset of problem gambling, as exposure to conditioning is said to be a primary etiological factor for gamblers fitting of the BC subtype.

Variables were created for depression and anxiety prior to the onset of problem gambling. To meet the criteria for either depression or anxiety prior to the onset of problem gambling, a participant must have met the criteria for such disorders in at least one wave before their engagement of problematic gambling or reported that they had

suffered from these disorders in their lifetime preceding their participation in the QLS. Lifetime assessment of participants' mental illness consisted of two items. The first item asked participants if they had any significant history of mental health problems and the second was an open-ended question which asked participants to specify their problem(s). Participants' answers where then coded based on their responses (i.e. if a participant responded with depression, they would then meet the criteria for depression prior to onset of problem gambling).

Given such an approach, wave five first-time problem gamblers had four previous assessments which were used in determining their pre-existing depression and/or anxiety. Whereas only one assessment could be included in determining prior anxiety and/or depression for wave two first time problem gamblers. An alternative method would have been to only include the assessment of such disorders in the wave prior to the onset of problem gambling. Despite this method having the advantage of each case having an equal number of assessments regardless of what wave that they presented with problem gambling, it was felt that this approach would have resulted in important information being dropped from the analysis. For example, a first-time problem gambler at wave five who presented with depression in wave 1, 2 and 3, but not in wave 4 would have not met the criteria for depression prior to the onset of problem gambling if the latter approach was applied. Such a method would have failed to appropriately represent a participants' historic experience of depression and consequently, the first approach outlined was chosen in spite of the unequal number of assessments being used to determine the presence of pre-existing depression and/or anxiety.

It should also be mentioned that in some cases where participants had equal number of assessments, (i.e. they developed problem gambling in the same wave) they did not necessarily have the name number of positive screens for depression or anxiety. For example, a participant in wave three who presented with problem gambling may have only been positively screened for depression in wave 1, while another participant who presented with problem gambling in wave 3 may have been positively screened for depression in both waves 1 and 2. In both cases, participants would have met the endorsement criteria for depression prior to problem gambling and were treated equally despite having an unequal number of positive screens.

A similar method was applied in creating the variable substance problems prior to the onset of problem gambling. Participants' substance use in the wave(s) prior to their initiation of problem gambling and a QLS variable that assessed participants' retrospective lifetime problematic substance use in wave one of the study was used to determine if participants met the endorsement criteria for this variable. To have problematic substance use prior to problem gambling, participants must have been assessed as having alcohol or substance abuse/dependence in at least one wave before the onset of problem gambling or reported having experienced problems with alcohol or drugs at least once in their lifetime.

Measures

Problem gambling. Problem gambling was assessed by the Problem and Pathological Gambling Measure (PPGM; Williams & Volberg, 2013). The PPGM classifies individuals into one of five categories based on their responses. These categories include non-gambler, recreational gambler, at-risk gambler, problem gambler

and pathological gambler. The PPGM has been demonstrated to have good test-retest reliability (r = 0.78) and good internal consistency (Cronbach alpha = 0.76 - 0.81; Williams & Volberg, 2010, 2014). The classification accuracy of the PPGM has been shown to be excellent when compared to a clinical assessment with 99.7% sensitivity and 98.9% specificity, respectively (Williams & Volberg, 2014).

Gambling intensity. Past year gambling frequency was used as a measure of gambling intensity and exposure to gambling. Although there were several other QLS variables that could have been used as measures of gambling intensity such as gambling expenditure, it was felt that gambling frequency would be the best measure of intensity, as it would not be as influenced by confounding variables such as participants' annual income. Past-year gambling frequency was a composite variable that was created by adding the past-month frequency for each form of gambling measured in the QLS to a maximum of 30, and multiplying by 12 (Williams et al., 2015).

Anti-sociality and social functioning. The Antisocial Feature Scale from the Personality Assessment Inventory (PAI; Morey, 2007) was used to measure participants' antisociality. Participants' responses on the Nonsupport Scale from the PAI (Morey & Boggs, 1991) were used to measure their social functioning, with high scores indicating poorer social support. The PAI's three to four week test-retest reliability has demonstrated to range from r = 0.32 - 0.92 (with a median r = 0.82) (Boyle, 1995). The internal consistency for PAI's 22 scales have also demonstrated variance ranging from α = 0.45 - 0.90 (with a median α = 0.81) in a normative sample (Kavan, 1995). It should be noted that PAI's Antisocial Feature Scale was only administered at wave 1 of the study, whereas the Nonsupport subscale was administered to participants at each wave.

Impulsivity. Participants' impulsivity was measured by the Impulsiveness Subscale of the NEO Personality Inventory – Revised (NEO PI-R; Costa & McCrae, 1992). The NEO PI-R's test-retest reliability has been found to be good for all domains ranging from r = 0.79 to 0.83 (Costa & McCrae, 1992). The internal consistency of the NEO PI-R's scales used to measure personality facets have been found to be adequate ranging from α = 0.56 to 0.81 (Costa & McCrae, 1992). As with the participants' assessment of antisociality, the Impulsiveness Subscale of the NEO Personality Inventory was administered only once at wave 1 of the study.

Depression and anxiety. The Composite International Diagnostic Interview Short-Form (CIDI-SF; Kessler, Andrews, Mroczek, Ustun & Wittchen, 1998) is a screening instrument used to assess the presence of a number of frequently occurring psychiatric disorders including generalized anxiety disorder, major depressive disorder and alcohol dependence (Kessler, Andrews, Mroczek, Ustun, & Wittchen, 1998). The QLS included a number of items from the CIDI-SF that were used to assess the presence of several psychiatric disorders. The analysis included participants' scores on CIDI-SF items used to measure major depressive disorder and generalized anxiety disorder. To meet the criteria for depression, a participant must have endorsed five out of the ten CIDI-SF items used to measure depressive symptomology, and endorsed an item that asked if these symptoms adversely impacted their life. To be diagnosed with generalized anxiety disorder, participants must have endorsed a total of six CIDI-SF items. Three of those six items must have included excessive worry/anxiety on most days for six months, worry that is unspecific to one domain and difficulties inhibiting worry. The CIDI-SF has

been demonstrated have exceptional categorization accuracy when compared to the full CIDI and range from 93% - 99% (Kessler et al., 1998).

Problematic substance use. Participants' substance use was assessed using an adapted version of the World Health Organization Alcohol, Smoking and Substance Involvement Screening Test (ASSIST; WHO54 ASSIST Working Group, 2002). The ASSIST was adapted to include items from the PPGM that were reworded to assess problematic substance use as opposed to gambling. Participants in the QLS were classified as substance abusers if they, or someone close to them, would say they had experienced or reported to have experienced significant adverse consequences because of their substance use. Participants were classified as substance dependent if they endorsed four or more of the 14 items, with at least one of those items being one that assessed addictive phenomenological experiences such as loss of control, withdrawal and tolerance. For the purposes of the analysis, substance abuse and substance dependence were collapsed into one category, problematic substance use.

Childhood trauma. The experience of childhood trauma was assessed using a retrospective nominal variable. Participants were asked at wave 1 of the study if they had endured sexual, physical or emotional abuse as a child growing up. Participants were able to provide one of three responses to the item including yes, no, or prefer not to say.

Gambling to escape. Participants reported main reason for gambling was assessed at each wave of the QLS. One of these motives was gambling as a method of escape. This was assessed using a dichotomous item where participants were asked if they primarily gambled as a way of distracting or escaping.

Demographic. Descriptive statistics for the sample of first-time problem gamblers are presented in Table 1. There were two missing values for the variable that assessed participants' income. One of the missing values was replaced with the participant's reported income from the prior wave. The other value was replaced using the series mean, as this value could not be replaced with the participant's income in the prior wave because this information was also missing.

Table 1

Descriptive statistics for first time problem gamblers (n =125)

Variable	N	%
No. of Females	70	56
Education (n, %)		
Some high school	14	11.2
Completed high school	33	26.4
Some technical school, college or university	33	26.4
Completed technical school	9	7.2
Completed college or university	35	28.0
Professional degree	1	0.8
Ethnicity (n, %)		
Aboriginal	5	4
African	1	.8
Asian	1	.8
European (Eastern)	5	4
European (Western)	95	76
Latin American	2	1.6
Other	16	12.8
PPGM Category (n, %)		
Problem Gambler	104	83.2
Pathological Gambler	21	16.8
Income		
< $20,000	11	8.8
$20,000 - $29,999	13	10.4
$30,000 – $39,999	15	12.0
$40,000 - $49,999	17	13.6
$50,000 - $ 59,999	17	13.6
$60,000 - $69,999	12	9.6
$70,000 - $79,999	12	9.6
$80,000 – $89,999	4	3.2
$90,000 - $99,999	4	3.2
$100,000 - $119,999	14	11.2
$120,000 - $149,999	4	3.2
> $150,000	2	1.6
	Mean	SD
Mean age of first onset of problem gambling (*SD*)	48.09	13.65

Statistical Analysis

A LCA was chosen as the analytical technique because it can be employed to determine if latent or unobserved groups may exist based upon observable responses (Magidson & Vermunt, 2007). Given that the etiological paths specified by the pathways model cannot be directly observed, LCA is a well-suited analytical technique to test the model. LCA can be used to determine if problem gamblers can be grouped into latent classes, and if so, the profiles of these latent classes can then be compared to the pathways model typologies. A basic assumption of LCA is that each case included in the analysis can only belong to one latent class (Magidson & Vermunt, 2007). Latent class membership is probabilistic, meaning that for each case, "posterior class-membership probabilities are computed from the estimated model parameters and [each case's] observed scores" (Vermunt & Magidson, 2002, p. 90). Thus, latent class membership is assigned based on the highest estimated probability of a case belonging to a class. The ultimate goal of LCA is to explain correlations between observed variables with as few latent classes as possible (Magidson & Vermunt, 2007). Latent models are compared starting with the most parsimonious model or a one-class solution. Models with increasing numbers of classes are then compared using model fit statistics until an optimal solution is achieved.

The LCA was completed using the program Latent Gold 5.1 (Vermunt & Magidson, 2015). Class solutions ranging from 1 to 5 were compared using several fit statistics to determine the best fitting model. These statistics included the Akaike Information Criterion (AIC; Akaike, 1974) and the Bayesian Information Criterion (BIC; Schwarz, 1978). Both statistics assess model solutions by balancing model fit with model

complexity (i.e., the number of parameters). A conditional bootstrap test (-2LL Diff; Vermunt & Magidson, 2005) was performed to test if significant improvement was observed between k versus k -1; where k represents the number of latent classes or the number of parameters. In other words, the bootstrap -2LL Diff tests if a model with more restrictions (i.e. more classes, parameters etc.) is a significantly better-fitting model in comparison to a less restricted model. In order for this test to be valid, the less restricted model must be nested within the model with the greater number of restrictions (Vermunt & Magidson, 2005). If the test is non-significant, the model with greater restrictions is rejected in favour of the less restrictive model (Vermunt & Magidson, 2005).

In addition to considering the outlined global measures of model fit, a local measure of model fit and local independence, an important assumption of LCA (Vermunt & Magidson, 2016), was considered in selecting the best model. This can be done in the Latent Gold program by investigating the bivariate residual statistic (BVR) for each variable pairing included in the analysis. The BVR statistic assesses to what degree the model is able to reproduce the association between two variables (Vermunt & Magidson, 2005). "Each BVR corresponds to a Pearson X^2 statistic (divided by the degrees of freedom) where the observed frequencies in a 2-way cross-tabulation of the variables are contrasted with those expected counts estimated under the corresponding LC model" (Magidson & Vermunt, 2004 p.18). A BVR statistic greater than 3.84 is considered significant ($p < .05$, df = 1) (Vermunt & Magidson, 2016), indicating that the model does not sufficiently estimate the observed association and that the condition of local independence has not been met (Vermunt & Magidson, 2005). There are several methods that can be used to address issues of local dependence, and the method opted for in the

present LCA was the addition of a direct effect (Hagenaars, 1988). Adding a direct effect allows the model to account for a large correlation between two variables that would otherwise not be able to be accounted for by relaxing the assumption of local independence for this variable pairing (Magidson & Vermunt, 2004). This method is well suited in circumstances when there are only a few substantially large BVRs, and such was the case with the present LCA.

<div align="center">

Results

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A 3-class solution was ultimately determined to be the best fitting model for the sample. There were discrepancies observed between the fit statistics, with the AIC continuing to decline with each additional class and the BIC being lowest for the 3 class solution. The bootstrap -2LL diff test also indicated that there was a significant improvement between 3 classes when compared to a 2 class solution, but 4 classes were not significantly better than 3. The BIC statistic and the bootstrap -2LL diff test have been shown to outperform the AIC in a simulation study that was completed by Nylund, Asparouhov and Muthen (2007) and the findings from both of these statistics provided support for the 3-class solution as the overall best fitting solution.

The BVRs were also considered when determining the best fitting model. There was a large BVR observed between anxiety prior to the onset of problem gambling and depression prior to the onset of problem gambling for all of the class solutions. In order to address this issue, a direct effect was added to the model. 1-5 class solutions were rerun with the direct effect added and the 3 class solution emerged again as the model with the lowest BIC statistic. A bootstrap -2LL diff test confirmed that the 3-class solution with the direct effect was a significantly better fit when compared to a 3-class solution without

the direct effect (p < .001). The BVRs were reviewed after the direct effect was added

and none were greater than 3.84 for the 3-class solution, thus no further direct effects

were added to the model.

Table 2 provides the fit statistics for the 1-5 class solutions with the post-hoc

direct effect added. As can be seen, the 3-class model continued to be the solution with

the lowest BIC (4983.98, respectively). As with the solutions without the direct effect

added, the AIC continued to decline with each additional class. The AIC for the 3 class

solution was found to be 4865.10, respectively. The bootstrap -2LL diff test also found

that the 3-class solution was significantly better fitting than the 2 class solution (p <

.001), but again, the 4-class solution was not significantly better than the 3-class (p

=.216). Moreover, the 2-class solution demonstrated additional problems with local

dependencies, with another variable pairing having a BVR greater than 3.84. Although

the bootsrap -2LL diff test showed that there was a significant improvement between the

5-class solution and the 4-class solution (p < .001), the 3-class model demonstrated a

lower BIC score in comparison to the 5-class solution.

Table 2
Latent class solutions with post-hoc direct effect added

Classes	Log-likelihood	BIC	AIC	Bootstrap – 2LL Diff	Entropy r^2	# BVRs > 3.84
1 class	-2515.38	5098.36	5058.76	-	-	11
2 class	-2424.69	4984.58	4905.38	P < .001	.78	1
3 class	**-2390.55**	**4983.89**	**4865.10**	**P < .001**	**.82**	**0**
4 class	-2376.59	5023.58	4865.19	P = .216	.81	1
5 class	-2338.58	5015.15	4817.16	P < .001	.86	0

To ensure stability of the class solutions, the LCA was rerun ten times using

random start seeds. Random start seeds are random integers used as a starting number

when bootstrapping. Although some variation was observed between the solutions, for the majority of the random seeds, the 3-class model continued to emerge as the most parsimonious. Given all of the findings presented, it was decided that the 3- class solution was the most accurate, and for purposes of clarity, it will be the only model that will be discussed in further detail.

Figure 1 is a Prf-plot of the model and provides a graphical representation of the profiles for each of the three classes. The Prf-plot illustrates the conditional probabilities for the nominal variables and the means for the continuous variables which have been rescaled to range between 0-1 (Vermunt & Magidson, 2005). "Scaling of these 0-1 means is accomplished by subtracting the lowest observed value from the class-specific means and dividing the results by the range, which is simply the difference between the highest and the lowest observed value" (Vemunt & Magidson, 2005, p. 117). In doing so, both the nominal and continuous variables are able to be compared on the same scale

Figure 1

Prf-plot for the three class solution
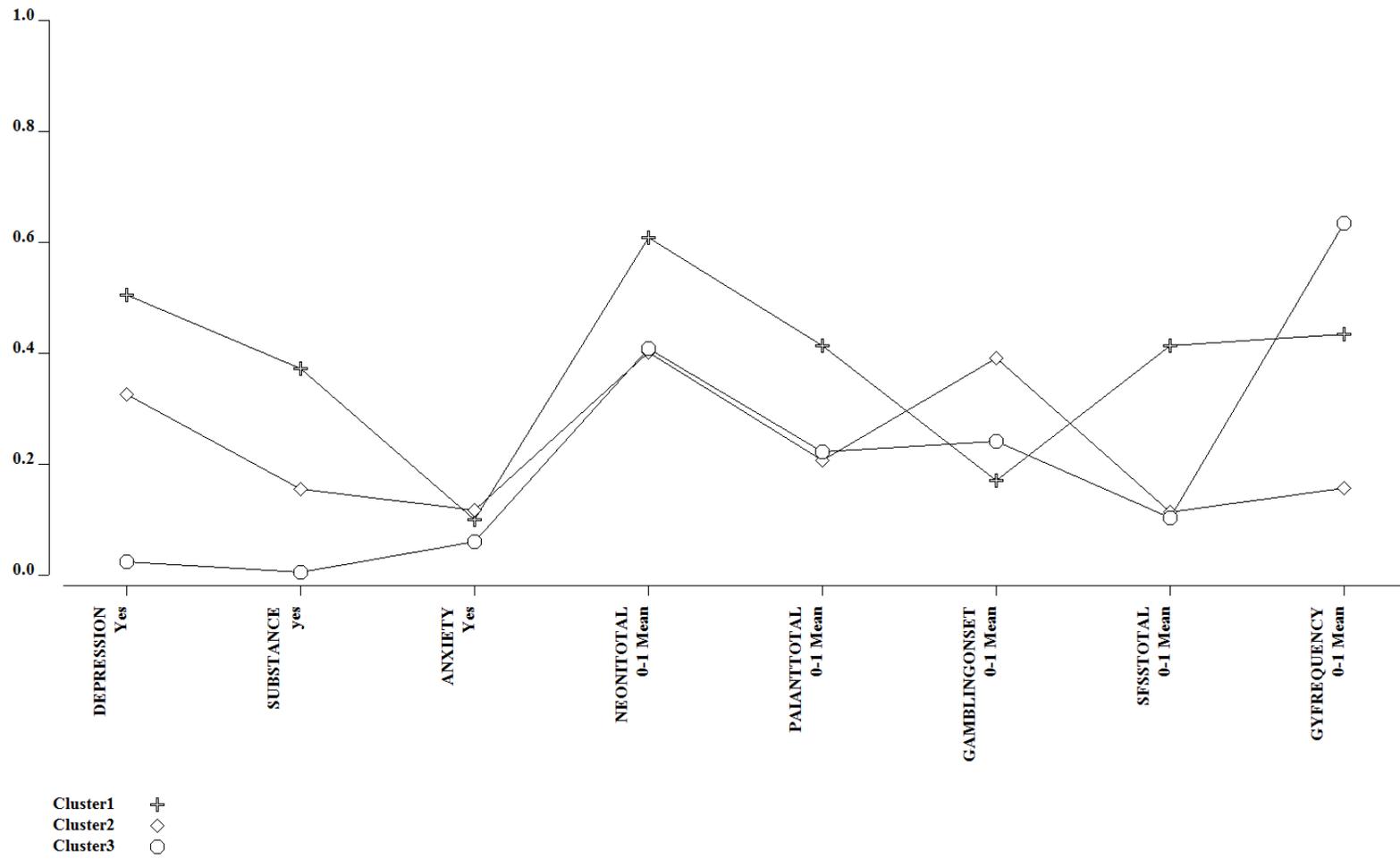
Given the model classification, the largest class was class 1, with 53.25% (n = 66) of the cases being grouped into this class. The second largest class was class 2, with 26.73% (n = 35) of the cases being grouped into this class. Finally, class 3 was the smallest class, with 20.02% (n = 24) of the cases being grouped into this class. It should be noted there is a small discrepancy between the size of the classes as estimated by the model and the number of cases that are assigned to each latent class. This is because Latent Gold assigns cases into classes based on the modal probability of class membership which may result in some classification error. The estimated classification error for the 3-class solution with the direct effect added was .07 respectively, meaning that approximately 7% of cases are estimated to be misclassified by the model.

Table 3

Latent Class Profiles

Indicators	Class 1	Class 2	Class3
Gambling frequency prior to onset of problem gambling	155.80[2]	56.11[1,3]	228.14[2]
Social support total	7.43[2,3]	2.04[1]	1.84[1]
NEO PR-R impulsivity total	17.34[2,3]	13.81[1]	13.94[1]
PAI Anti-sociality total	16.53[2,3]	8.24[1]	8.86[1]
Age of initiation of gambling behaviour	17.33[2]	26.83[1]	20.35
Generalized anxiety prior to onset of problem gambling	.10	.12	.06
Depression prior to onset of problem gambling	.50	.33	.02
Substance problems prior to onset of problem gambling	.37	.15	.00

1,2 and 3 indicate significant pairwise differences between classes with the Bonferroni correction applied (α = .05/3).

Table 3 provides the means for the continuous indicators for each class along with the conditional probabilities for each of the nominal indicators that were included in the

analysis. The Latent Gold 5.1 also allows for pairwise comparisons to be made between the classes for each of the indicators included in the model. This is accomplished through paired Wald tests, where a significant p-value indicates that the classes differ significantly on that indicator (Vermunt & Magidson, 2015). The results of the pairwise comparisons with the Bonferroni correction ($\alpha = .05/3$; 3 given that there is 3 latent classes being compared) are also provided in Table 3.

As can be seen in Table 3, class 1 had the second highest average number of days gambled in the year prior to onset of problem gambling, the highest mean score on the Nonsupport Scale[1], the highest mean on the Antisocial Feature Subscale, the highest average impulsivity score and the lowest average age of onset of gambling behavior. Problem gamblers in this class had a low probability of meeting the criteria of anxiety prior to onset of problem gambling (~10%). Gamblers in this class also had the highest probability of having had depression prior to onset problem gambling (~50%) as well as the highest probability of having met the criteria for problematic substance use prior to their problematic gambling behaviour (~37%).

Problem gamblers in class 2 had the lowest average number of days spent gambling in the year prior to onset of problem gambling. This class held an intermediate position in regards to their average Nonsupport score, the lowest impulsivity score and the lowest score on the Antisocial Feature Subscale; although the differences between class 2 and 3 on these measures were marginal. This class had the highest average age of initiation of gambling behaviour and the highest conditional probability for meeting the criteria for anxiety pre-problem gambling (~12%). Class 2 problem gamblers also had the

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[1] Higher scores on this subscale indicate poorer social support.

second highest probabilities of having been depressed (~33%) and for having experienced

problematic substance use (15%) prior to the onset of problem gambling.

Class 3 had the highest average of days gambled in the year prior to problem

gambling and they had the lowest average on the Nonsupport scale. The class held an

intermediate position in terms of their average impulsivity score, their average age of

onset of gambling and their score on the Antisocial Feature subscale. Gamblers in this

class also had low probabilities for meeting the criteria for depression (~6%), anxiety

(~2%) and problematic substance use (~0%) prior to the onset of problem gambling.

Modal assignment was used to classify each case to a corresponding class and the

classes were then compared on a number of demographic variables in SPSS. The

demographic information for each of the classes is presented in Table 4. As can be seen,

class 1 problem gamblers had the lowest proportion of females (47%), the highest

proportion of pathological gamblers as assessed by the PPGM (18.2%), the highest

proportion of cases who reported having experienced childhood abuse (28.8%), the

earliest average age of onset of problem gambling (44.27 years), held an intermediate

position in regards to the proportion of cases who endorsed gambling to escape (13.6%)

and held an intermediate position in terms of their average delay between onset of

gambling and onset of problem gambling (26.86 years). Class 2 had the highest

proportion of females (71.4%), the second highest proportion of pathological gamblers

(17.1%), the highest proportion of cases who endorsed gambling mainly to escape at

onset of problem gambling (31.4%), the second highest rates of cases who reported

having experienced childhood abuse (17.1%) the second highest average age of onset of

problem gambling (51.25 years) and the shortest average delay between onset of

gambling and onset of problem gambling (24.94 years). Finally, class 3 demonstrated the second highest proportion of women (58.3%), lowest proportion of pathological gamblers (12.5%), the low proportion of cases who endorsed gambling to escape at onset of problem gambling (12.5%), the lowest proportion of cases that reported having been abused in childhood (12.5%) the latest average onset of problem gambling (53.98 years) and the largest delay between onset of gambling and onset of problem gambling (33.65 year).

Table 4

Demographic information for the three classes based on modal assignment

Variable	Class 1 (n = 66)	Class 2 (n = 35)	Class 3 (n = 24)
No. of Women	31 (47%)	25 (71.4%)	14 (58.3%)
Education (n, %)			
Some high school	5 (7.6)	4 (11.4)	5 (20.8)
Completed high school	20 (30.3)	7 (20.0)	6 (25.0)
Some technical school, college or university	16 (24.2)	12 (34.3)	5 (20.8)
Completed technical school	7 (10.6)	-	2 (8.3)
Completed college or university	17 (25.8)	12 (34.3)	6 (25)
Professional degree	1 (1.5)	-	-
Ethnicity (n, %)			
Aboriginal	2 (3)	3 (8.6)	-
African	1 (1.5)	-	-
Asian	1 (1.5)	-	-
European (Eastern)	4 (6.1)	1 (2.9)	-
European (Western)	50 (75.8)	24 (68.6)	21 (87.5)
Latin American	1 (1.5)	-	1 (4.2)
Other	7 (10.6)	7 (20.0)	2 (8.3)
Income			
< $20,000	7 (10.6)	4 (8.3)	-
$20,000 - $29,999	10 (15.2)	1 (2.9)	2 (8.3)
$30,000 – $39,999	6 (9.1)	4 (11.4)	5 (20.8)
$40,000 - $49,999	9 (13.6)	4 (11.4)	4 (16.7)
$50,000 - $ 59,999	7 (10.6)	7 (20.0)	3 (12.5)
$60,000 - $69,999	6 (9.1)	3 (8.6)	3 (12.5)
$70,000 - $79,999	6 (9.1)	2 (5.7)	4 (16.7)
$80,000 – $89,999	1 (1.5)	2 (5.7)	1 (4.2)
$90,000 - $99,999	3 (4.5)	1 (2.9)	-
$100,000 - $119,999	7 (10.6)	6 (17.1)	1 (4.2)
$120,000 - $149,999	3 (4.5)	-	1 (4.2)
> $150,000	1 (1.5)	1 (2.9)	-
Gambling to escape (n, %)	9 (13.6)	11 (31.4)	3 (12.5)
Childhood abuse (n, %)			
No	42 (63.6)	27 (81.8)	21 (87.5)
Yes	19 (28.8)	6 (17.1)	3 (12.5)
Prefer not to say	5 (7.6)	2 (5.7)	-
PPGM Category			
Problem gambler	54 (81.8)	29 (82.9)	21 (87.5)
Pathological gambler	12 (18.2)	6 (17.1)	3 (12.5)
Mean age of first onset of problem gambling (*SD*)	44.27 (14.66)	51.25 (12.44)	53.98 (8.66)
Mean age difference between first gamble and onset of problem gambling (*SD*)	26.86 (13.95)	24.94 (13.52)	33.65 (8.37)

Post Hoc Tests

Post-hoc tests were completed to determine if the latent groups demonstrated significant between-group differences on any of the variables listed in Table 4. A Chi-square test was completed to determine if the groups differed significantly in regards to gender proportions. A non-significant Chi-square statistic was obtained, X^2 (2, n = 125) = 5.62, p = .06, indicating that the classes did not differ significantly on gender. A Chi-square test was conducted to evaluate if the class differed significantly in regards to ethnicity. The Chi-square test was not significant, X^2 (12, n = 125) = 10.770, p = .549, indicating that the classes did not differ significantly on ethnicity. A Chi-square test was completed in order to determine if the classes differed on the severity of problem gambling at onset as measured by the PPGM. A non-significant Chi-square statistic was obtained, X^2 (2, n=125) = .411, p = .814, indicating that the classes did not differ significantly in regards to their severity of problem gambling at first year of onset.

Post-hoc tests were also completed to determine if the classes differed significantly on the proportions of cases who had experienced childhood abuse and gambling as a method of escape at onset of problem gambling. Seven cases were removed from the Chi-square analysis for childhood abuse as these cases had provided the response "prefer not to say". Five of these cases were from class 1 and two cases were from class 2. This left a total of 118 cases to be included in the analysis. A non-significant Chi-square statistic was obtained, X^2 (2, n = 118) = 4.088, p = .130, indicating that the groups did not differ significantly on the proportion of cases who had reported to have experienced childhood abuse. A Chi-square test was also completed to test if the groups differed significantly on the variable that assessed gambling as a method of escape

at onset of problem gambling. A non-significant Chi-square statistic was obtained, X^2 (2, n = 125) = 5.511, p = .064, indicating that the groups were not significantly different in regards to the proportion of participants who gambled to escape at onset of problem gambling.

Kruskal-Wallis tests were conducted to test if the latent groups differed significantly on income and on education. The Kruskal-Wallis found non-significant differences in the mean rank between groups X^2 (2, N = 125) = .648, p = .723 for income. The Kruskal-Wallis test for education also found that the rank means between groups were not significantly different X^2 (2, N = 125) = 1.08, p = .583.

A one-way analysis of variance (ANOVA) was completed to determine if the classes differed with respect to their average age of onset of problem gambling. The independent variable was the latent class membership and the dependent variable was age of onset of problem gambling. Equal variance could not be assumed, as the Levene's test was found to be significant (p = .014). Consequently, the Brown-Forsythe statistic is reported. The ANOVA was significant, F (2, 109.5) = 7.84, p = .001, indicating that the classes differed significantly on age of onset of problem gambling. Post-hoc Dunnett's C tests revealed that class 1 had a significantly earlier onset of problem gambling when compared to class 2 and class 3.

An ANOVA was also completed to evaluate if the classes differed significantly in regards to the delay between onset of gambling and onset of problem gambling. The dependent variable was delay between onset of gambling and onset of problem gambling in years, and the independent variable was modal latent class assignment. The Levene's test was significant (p = .043) indicating that equal variances could not be assumed. As a

result, the Brown-Forsythe statistic is reported. The ANOVA was found to be significant, F (2, 100.7) = 4.15, p = .019, indicating that the groups differed significantly on their average delay between onset of gambling and of problem gambling. Post-hoc Dunnett's C tests found that class 3 gamblers demonstrated the greatest average delay between onset of gambling behaviour and onset of problematic gambling in comparison to classes 1 and 2.

Discussion

The current findings provide support for aspects of the pathways model. Most importantly, the findings support the theory that problem gamblers can be subdivided into three classes based on the presence of traits and characteristics that predate their problematic gambling behaviour (Blaszczynski & Nower, 2002). These findings are also consistent with other studies that found problem gamblers can be divided into three groups based on the presence of defining pathways model typological traits (Nower et al., 2012; Ledgerwood & Petry, 2010 & Valleur et al., 2016). Furthermore, the latent classes found in the LCA share important similarities with the pathways model typologies. This is particularly apparent when comparing class 1 with Blaszczynski and Nower's (2002) theorized profile of the AI gambler. Consistent with the AI profile, gamblers in this class were differentiated by higher levels of trait impulsivity and antisociality. Moreover, these gamblers presented with poorer social support prior to onset of problem gambling and had the earliest onset of gambling behavior. Gamblers in this class also demonstrated a greater psychopathological dysfunction as evidenced by higher rates of pre-problem gambling depression and problematic substance use.

Class 1 gamblers also shared important similarities with the findings from several studies that have investigated the pathways model typologies. As reviewed, Turner et al. (2008) found a latent component that had a strong loading on impulsivity. Similarly, impulsivity in the present study was found to be a significant class 1 predictor. Also in line with previous investigations of the pathways model, class 1 gamblers in the study were differentiated by higher antisociality (Gupta et al., 2012; Nower et al., 2012; Ledgerwood & Petry, 2010; Valluer et al., 2016). Such consistency across studies suggests that there is a subgroup of problem gamblers who may be both highly antisocial and impulsive. Future studies should aim to determine if this subgroup of problem gamblers present with a more chronic or treatment-resistant condition as speculated by the model.

Also in line with Blaszczynski and Nower's (2002) model, there was a class of problem gamblers that presented phenomenologically consistent with the BC gambler. As with the BC subtype, class 3 gamblers had low rates of psychiatric disorders predating problem gambling. Notably, problem gamblers in this class demonstrated the most intensive gambling prior to the onset of problem gambling. High gambling frequency would effectively expose gamblers in this class to regular operant and classical conditioning. Longitudinal studies have found that gambling intensity (i.e. frequency and expenditure) is an important predictor of problem gambling onset (el-Guebaly et al., 2015; William et al., 2015). It is plausible that regular exposure to gambling could explain why these otherwise normal gamblers escalate the intensity of their gambling behaviour to where they may begin to experience gambling related problems. Such a finding lends further support to Blaszczynski and Nower's (2002) suggestion that

exposure to operant and classical conditioning is a primary factor that contributes to the development of problem gambling for a subset of gamblers.

Class 3 gamblers shared important consistencies with other studies that have investigated the model. As reviewed, the majority of the studies that have investigated the model have found a subgroup of problem gamblers who are devoid of severe co-morbid psychological illness or adverse developmental backgrounds (Gupta et al., 2012; Nower et al., 2012; Ledgerwood & Petry, 2010; Valluer et al., 2016). Such findings lend further support to the possibility that exposure to conditioning and ecological factors, such as gambling venue proximity, may be sufficient for some gamblers to go on to develop gambling related problems. Further investigations should aim to determine if gamblers fitting of this subtype demonstrate greater fluctuations in their problematic gambling status or higher rates of natural recovery as suggested by the pathways model (Blaszczynski & Nower, 2002).

As for the second class found in the LCA, it did share some similarities with the EV pathway, however, in comparison to the other two classes this class was the least consistent in terms of the model's tenets. In saying that, gamblers fitting of this subtype demonstrated marginally higher rates of depression predating their problem gambling when compared to class 3, although not as high as class 1. Also consistent with the EV subtype, problem gamblers in this class held an intermediate position in terms of their probability of having met the criteria for problematic substance use prior to the engagement of problem gambling. Class 2 also resembled aspects of EV gamblers in Ledgerwood and Petry's (2010) study, as EV gamblers in their study also had the latest onset of gambling behaviour. Class 2 gamblers in the present study also shared

similarities with the EV gamblers in Nower et al.'s (2013) study, in that EV gamblers in their study held an intermediate position on a number of important typological variables including past year problematic substance use and depression. This class also had the highest proportion of cases that were motivated to gamble as a method of escape, however, this proportion was not found to be significantly different than the other groups.

In terms of the class sizes, only one of the studies reviewed shared similarities in regards to the present studies class proportions. As discussed earlier, class 1, the class that was most consistent with AI gamblers was comprised of 66 cases. 35 of the cases were classified into class 2, the class that most resembled EV gamblers. Finally, 24 cases were classified into class 3, the class most consistent with the BC profile. As with Ledgerwood and Petry (2010), the AI class was the largest group and the EV class was found to be the second largest. This was inconsistent with Nower et al. (2013) findings, who found that the class of problem gamblers who most resembled BC gamblers was the largest, followed by AI gamblers. Consistent with Nower et al. (2013), Valleur et al. (2016) found that BC gamblers were the largest group in their sample, however, the second largest group was found to be EV gamblers as opposed to AI gamblers. Consequently, there appears to be large variation in terms of proportion of class sizes across studies. The present study's sample size was relatively small in comparison to Nower et al.'s (2012) sample and as a result, it is plausible that with a larger sample size the class sizes observed in this present study may have been more in line with their findings.

Discrepancies with the Pathways model

Despite the latent classes sharing similarities with the pathways model, there were also some important discrepancies observed. The classes were not well distinguished

based on the presence of psychopathology predating problem gambling. More specifically, the variables that assessed mental illness prior to onset of problem gambling were not found to be significant indicators of class membership. Also, the presence of anxiety prior to problem gambling was a particularly poor indicator, with all of the latent classes demonstrating low probabilities of endorsement. Such findings are inconsistent with previous investigations of the model that have employed similar analytical techniques (Gupta et al., 2012; Nower et al., 2013). A possible explanation for the divergence in findings is that the two aforementioned studies included assessments of concurrent psychopathology as class indicators, where the present study only included participants' psychopathology prior to the onset of problem gambling. Thus, the presence of co-occurring disordered psychopathology may better differentiate problem gamblers into subgroups in comparison to the presence of disorders that precede the commencement of problem gambling.

Another notable inconsistency that was found is in regards to Blaszczynski and Nower's (2002) supposition that AI gamblers demonstrate the shortest delay between onset of gambling and problem gambling. Class 1 gamblers did present with a significantly earlier onset of problem gambling, but did not demonstrate a more rapid onset of problem gambling in comparison to the other two classes. In fact, it was the gamblers who most resembled the EV subtype who demonstrated the shortest delay between first gamble and commencement of problem gambling.

The classes were not found to differ significantly on the proportion of cases who reported having experienced childhood abuse or on the motive of gambling to escape at onset of problem gambling. Both of these variables are theorized to represent important

defining traits for both the EV and AI paths. As reviewed, EV gamblers are believed to be characterized by gambling primarily to escape, and both EV and AI gamblers are believed to characterized by higher rates of adverse childhood experiences such as abuse. Although class 1 gamblers did present with highest proportion of cases who reported having experienced childhood abuse, this difference was not found to be significant. Similarly, class 2 gamblers presented with the highest proportion of cases who reported having gambled primarily to escape or distract, but again, this difference was not found to be significant.

There was also a large amount of overlap observed between class 2 and class 3, with gambling frequency prior to onset being the only significant indicator that separated these two groups. This is marked by the non-significant pair-wise comparisons found for important theoretical class indicators such as depression and anxiety. Overlap, although less extreme than the findings of the current study, was observed in Gupta et al.'s (2012) LCA of youth problem gamblers. The pathways model does account for commonalities between the subtypes (Blaszczynski and Nower, 2002), however, the differences between class 2 and 3 in the present study do not appear to be as pronounced as would be expected given the tenets of the model. For example, one would have estimated given the model's description of the EV subtype, that gamblers fitting with this typology would have been better differentiated based on their scores on the Nonsupport scale. This is because nearly half of the items on this scale are related to familial relationships. Given that the EV gamblers are suggested to be characterized by difficult family histories, but do not present with the same social dysfunction as the AI gamblers (Blaszczynski & Nower,

2002), one would have expected class 2 gamblers to have held an intermediate position between class 1 and class 3 in terms of their non-support scale scores.

Instead of these two classes being well differentiated, it appears that the differences between these groups of gamblers may to be somewhat arbitrary in nature, with subtle differences separating gamblers who have similar personality profiles. Such a view would stand in contention with the pathways model, which suggests that gamblers can be meaningfully grouped based on etiological and personality differences. It may also be plausible that problem gamblers may be better differentiated based on their symptomology and phenomenologies after the onset of problem gambling rather than before. This would imply that the pathways model may better serve as a typological model of problem gambling rather than an etiological model. This again, would explain why previous studies have found problem gamblers to be better differentiated based on the pathway model traits in comparison to the findings of the present study.

Gender differences and the Classes

Problem gamblers in class 2, the class that most resembled EV gamblers in the present study, had the highest proportion of female gamblers with approximately 71.4% of cases in this class being female. This finding is relatively consistent with other studies that have investigated the model in that the subgroup of problem gamblers who resemble the EV profile typically demonstrate the highest proportion of female gamblers (Gupta et al., 2012; Ledgerwood & Petry, 2010; Nower et al., 2012). Consequently, it is plausible that the EV pathway might represent a more female-typical developmental path to problematic gambling. Such a position is further supported by the findings from studies that have investigated gender differences between male and female problem gamblers.

For example, it has been found that female problem gamblers typically have a later onset of gambling behaviour than male problem gamblers, and female problem gamblers also demonstrate a shorter delay between onset of gambling and onset of problematic gambling when compared to males (Grant & Kim, 2001; Grant & Kim, 2002; Ladd & Petry, 2002; Potenza, Steinberg, Wu, Rounsaville & O'Malley, 2006). In addition, female problem gamblers have been found to have a later onset of problem gambling in comparison to males (Grant, Kim, Odlaug, Buchanan & Potenza, 2009).

Class 2 problem gamblers in the present study demonstrated the latest onset of problem gambling and the shortest delay between onset of gambling and onset of problematic gambling. These findings are congruent with the previous gender differences reviewed. Thus, it is possible that the differences observed between the classes in the present LCA may be partly explained by differences in gender. Such a position is further supported by two studies that found that high trait impulsivity is only predictive of problem gambling for males and not females (Echeburúa, González-Ortega, de Corral, & Polo-López, 2013; González-Ortega, Echeburúa, Corral, Polo-López, & Alberich, 2013). Notably, in the present study, the latent class characterized by impulsivity had the greatest proportion of male gamblers. Thus, it possible that gender might be another important typological trait, with greater proportions female gamblers presenting as EV gamblers and greater proportions of male gamblers presenting with profiles consistent with AI gamblers. It is suggested that future longitudinal studies should aim to investigate if the genders differ in terms of problem gambling predictors and if these predictors share overlap with pathways typological specific etiological factors. For example, if there are found to be gender specific predictors, do problem gambling predictors for female

problem gamblers share resemblance with the etiological factors specified by the model for the EV subtype?

Latent class and Alcohol Subtypes

As reviewed, problem gambling and problematic substance use have been theorized to share similar biopsychosocial etiologies. Given such etiological overlap, the argument was presented that there may also exist commonalities in problem gambling subtypes and problematic substance use subtypes. As speculated, important similarities were found to exist between the classes observed in the present study and some of the research that has investigated problematic alcohol subtypes. For instance, aspects of the classes found in the present LCA were consistent with some of the defining features of the clusters of problematic substance users found in both Windle & Scheidt's (2004) and Del Boca and Hesselbrock's (1996) studies. As with Windle and Scheidt's (2004) Chronic/ASP subtype, class 1 gamblers were characterized by elevated antisociality. Class 3 gamblers also shared important similarities with Windle and Scheidt's (2004) Mild Course cluster of substance users, as both subgroups demonstrated the latest onset of problematic gambling/alcohol use. Furthermore, both class 3 and the Mild Course subtype demonstrated relatively low rates of co-occurring psychiatric illness.

As with class 3 gamblers, Del Boca and Hesselbrock's (1996) Low Risk-Low Severity subtype of problematic substance users also showed low rates of depression, antisociality and anxiety. Class 1 gamblers also appeared to be phenomenologically consistent with Del Boca and Hesselbrock's (1996) High Risk-High Severity subtype, as problematic substance users in this cluster demonstrated high rates of ASPD, depression and anxiety. Finally, class 2 did share some features with the Internalizer cluster of

substance users found in Del Boca and Hesselbrock's (1996) cluster analysis, as both class 2 and Internalizer substance users had the greatest proportion of females and the highest rates of anxiety when compared to the other classes/clusters.

Despite these similarities, there were some important discrepancies observed between the classes in the present study and the problematic substance use subtypes discussed. For example, class 1 gamblers demonstrated the highest probability of depression prior to onset of problem gambling, whereas the Chronic/ASP subtype observed in Windle and Scheidt's (2004) study demonstrated relatively low rates of co-morbid depression. Furthermore, there was no class found in the present study that resembled the Negative Affect cluster of problematic substance users observed in Windle and Scheidt's (2004) study. That is, there was no class of problem gamblers who were significantly differentiated based on the presence of depression and anxiety. Although class 2 gamblers did have elevated probabilities of depression/anxiety when compared to class 3 gamblers, these were not found to be significant class predictors and their probabilities of endorsing these disorders were not greater than the probabilities for class 1 gamblers. Negative affect substance users on the other hand were found to be significantly different from the other clusters of problematic substance users based on their depressive and anxious symptomology (Windle & Scheidt, 2004). There was also no class that resembled Del Boca and Hesselbrock's (1996) Externalizer subtype of problematic substance users. Substance users in this subtype were characterized by high rates of ASPD and demonstrated low rates of depression and anxiety. This cluster of problematic alcohol users were almost exclusively comprised of males. No class

observed in the present LCA resembled this exclusively antisocial group of problematic alcohol using males.

It is plausible that these differences could be explained by the fact that the present LCA included only pre-problem gambling traits, whereas the two alcohol subtypes previously discussed focused on co-occurring mental illness. It is also possible that there may be similar subtypes of substance users and problem gamblers, but that certain subtypes of problematic substance users may be alcohol specific. Irregardless of the discrepancies, there does appear to be similarities that exist between alcohol subtypes and subtypes of problem gamblers. For example, there appears to be a group of otherwise normal problem gamblers and otherwise normal problematic substance users. There also appears to be a group gamblers and substance users who are differentiated by elevated levels of antisociality. Given such similarities, it is recommended that future studies aim to investigate problematic substance users can be subgrouped into similar typologies using pathways model defining traits and features.

Treatment and Prevention Implications

A number of researchers have already speculated that the pathways model subtypes may be used to devise subtype specific treatment interventions and prevention efforts (Allami & Vitaro, 2015; Blaszczynski & Nower, 2002; Milosevic & Ledgerwood, 2010). More specifically, Blaszczynski and Nower (2002) suggest that AI gamblers may benefit from more intensive psychotherapeutic interventions in conjunction with pharmacological treatment. Gamblers fitting of this profile are also suggested to present as the least responsive to treatment due to their impulsive, antisocial nature (Blaszczynski & Nower, 2002). As discussed, class 1 gamblers, the class most consistent with the AI

subtype, were differentiated by elevated impulsivity and antisociality. Subsequently, the inclusion of a behavioral treatment modality, such as Contingency Management, may prove to be particularly effective for gamblers fitting of the AI subtype, as such an intervention includes regular rewards for treatment participation, compliance and gambling abstinence (Christensen, 2015). Creating a greater incentive to participate in treatment may aid in addressing the speculated low treatment responsivity of AI gamblers, potentially improving treatment retention and outcomes.

In contrast, it has been suggested that BC gamblers may require less intensive treatment interventions when compared to the other two typologies, and that controlled gambling may be an achievable treatment goal for this subpopulation (Blaszczynski & Nower, 2002). Addressing gambling-related cognitive distortions through brief outpatient cognitive behavioural therapy may prove to be sufficient for addressing problematic gambling for individuals fitting of this subtype. BC gamblers may also stand to benefit the most from prevention efforts that aim to interrupt or limit exposure to conditioning and educate gamblers on concepts such as gambling odds and randomness. Given that class 3 gamblers, the gamblers most fitting of the BC subtype, demonstrated the greatest frequency of problem gambling before onset, disrupting or reducing escalation through prevention efforts may prove to be a particularly effective preventative measure for such a population. It is recommended that future studies aim to investigate if the subtypes may demonstrate greater responsivity to subtype specific treatment interventions. It is also suggested that future studies investigate if prevention efforts targeting the pathways model typologies can be developed, and if such efforts demonstrate different efficacy based on the presence of typologically defining factors.

Limitations

The study had a number of limitations that should be considered when reviewing the results. First, the predictors included in the latent class analysis were not an exhaustive assessment of the pathways model typological traits specified by the model. Some of the traits not included as class predictors in the analysis but described as being defining features of the typologies by Blaszczynski and Nower (2002) include: EV gamblers being motivated to gamble to escape negative emotional states, higher frequencies of having endured adverse childhood experiences for both EV and AI gamblers, AI gamblers being further characterized by co-morbid attention deficit hyperactivity disorder and BC gamblers being more responsive to treatment intervention. Although some of the variables were included in post-hoc analyses (i.e. gambling to escape and childhood abuse) not all of these variables could be included as class predictors given the sample size, and in some cases, these variables were not available (i.e. attention deficit hyperactivity disorder was not assessed in the QLS). Thus, the present study is not a full test of the model and the inclusion of these additional variables as class predictors may have influenced the number of latent classes observed. It is also equally plausible that the inclusion of these variables may have affected the profiles of the latent classes described in this study. As a result, it is suggested that future studies should aim to test the existence of the subtypes using all of the typologically defining traits specified by the model.

Another important limitation of the present study is that not all problem gamblers included in the sample were assessed for the same number of waves. As mentioned earlier, some problem gamblers had been assessed four times prior to the onset of

problem gambling, while participants who demonstrated problem gambling in wave two were only assessed one time. This resulted in some of the participants having a more comprehensive historical account when determining the presence of pre-problem gambling psychiatric illness. The study attempted to compensate for this by including a self-report item that asked participants if they had experienced any serious lifetime mental illness before beginning the QLS study.

Although the study used a longitudinal archival dataset, the LCA analysis was ultimately cross-sectional. As a result, it is unclear as to whether or not the classes might differ in regards to problem gambling trajectories, natural recovery rates or chronicity. This is an important limitation of the study's intent to test the model, as BC gamblers are suggested to fluctuate between heavy and problematic gambling (Blaszczynski and Nower, 2002). Furthermore, the present study is unable to determine if pathways model typological status changes over time (i.e. can an individual who presents as a BC gambler become increasingly impulsive or anti-social because of continued engagement of problem gambling resulting in a profile more consistent with the AI subtype?). Consequently, it is suggested that future studies should aim to investigate if the pathways model typological traits can be used to group gamblers who demonstrate different problem gambling trajectories and if typological status may change over time.

Finally, the sample size and the inclusion of a post-hoc direct effect should be considered when interpreting the study's results. As discussed earlier, a direct effect can be added when a latent class model fails to explain significant associations between variable pairings. In this case, the latent class model failed to account for the association between depression and anxiety. By adding a direct effect the basic assumption of local

independence was relaxed. Although this resulted in the analysis meeting the basic assumptions of the analytical technique, the 3-class solution obtained is unable to explain the observed association between depression and anxiety. Thus, the 3-class solution that was presented is unable to sufficiently explain the association between all of the indicators that were entered into the model.

The sample size of the present study was relatively small given the analytical technique employed. There is still debate as to what is an ideal sample size for LCA, with some authors suggesting a minimum sample size ranging between 300-1000 (Tueller & Lubke, 2011), and others suggesting a minimum sample of 500 (Steinley & Brusco, 2011). In a more recent simulation study, Wurpts and Geisser (2014) found that having larger sample size resulted in more consistent and accurate LCA results. Wurpts and Geisser (2014) go on to suggest that given their findings, LCA should not be completed with sample sizes of less than 100. Although the present study did have a greater sample than 100, satisfying Wurpts and Geisser's (2014) minimum criteria, the results should be interpreted with caution given that greater consistency is observed in LCA solutions with larger samples. Nevertheless, the study did place primacy on BIC and conditional bootstrap test when determining the best latent class solution. Both techniques have been found in a simulation study completed by Nylund et al. (2007) to be best suited when assessing LCA models with small sample sizes. Thus, the appropriate methods were employed when testing the LCA solutions, and as a result, the findings from the present study are believed to be important preliminary findings, warranting further testing using larger sample sizes.

Conclusion

To the author's knowledge, this was the first study that aimed to test the pathways model typologies using the presence of pre-problem gambling typological traits in a sample of first-time problem gamblers. The study's results provide further empirical support for the heterogeneity of problematic gamblers as well as further evidence for the existence of at least two of the pathway model subtypes. There was clearly one group of first-time problem gamblers who presented as otherwise normal, fitting with Blaszczynski and Nower's (2002) description of the BC gambler. There was also a subgroup of problem gamblers observed in the study who were differentiated by higher antisociality, impulsivity and co-morbid psychopathology prior to onset of problem gambling. These gamblers appeared to be largely consistent with Blaszczynski and Nower's (2002) AI gambler. In contradiction to previous findings and the model, depression and anxiety were not found to be significant class predictors. Additionally, the distinction between two of the classes appeared to be somewhat arbitrary, as evidenced by nonsignificant differences for all but one of the class predictors included in the analysis. Despite these noted divergences with the model, the findings of the present study do provide preliminary support that problem gamblers may be grouped based on the existence of traits predating problem gambling. The study's results should be replicated using larger sample sizes and future longitudinal studies are needed that investigate if these subgroups of gamblers demonstrate differences in chronicity or problem gambling instability over time.

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