INVESTIGATING THE RELATIONSHIP BETWEEN IMPLICIT MEMORY ASSOCIATIONS AND GAMBLING

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Abstract

The purpose of this thesis was to a) develop measures to capture and quantify implicit memory associations in gambling, and b) identify the presence and magnitude of these implicit associations as it relates to a person's level of gambling involvement and problem gambling. Study 1 involved the development and evaluation of two measures assessing different aspects of implicit memory in a sample of 494 University of Lethbridge undergraduate students. The first measure was a 'word associates' task involving people's immediate word associations for specific words, and the second measure was a 'behaviour associates' task in which people indicate the automatic behaviours or actions that come to mind with a certain word or phrase. In both situations many of the words and phrases presented had potential gambling connotations. An analysis of the performance of individual items in Study 1 helped guide the creation of two shorter measures for Study 2. In Study 2 these shortened measures were administered to a more nationally representative online panel sample of 3,078 Canadians (oversampled for gambling involvement) and the results re-analyzed. The findings of these two studies confirm that the presence and frequency of implicit gambling-related associations increases to a significant degree as a person's level of gambling involvement and problem gambling increases. Future research is needed to better understand a) whether these implicit associations precede gambling involvement or whether they are a result of gambling involvement; b) their utility in helping identify problem gamblers in denial; and c) their utility in both preventing problem gambling and predicting relapse.

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APA	American Psychiatric Association
DSM	Diagnostic and Statistical Manual of Mental Disorders
EAST	Extrinsic Affective Simon Task
IAT	Implicit Association Task
M	Mean
N	Total sample size
n	Sub-sample size
p	Statistical p-value
PPGM	Problem and Pathological Gambling Measure
SD	Standard Deviation

CHAPTER 1: GENERAL INTRODUCTION

Gambling is defined as "betting money or material goods on an event with an uncertain outcome in the hopes of winning additional money or material goods" (Williams, et al., 2017). This is a broad concept that includes a diverse range of activities including: bingo, sports betting, charity raffles or fundraiser tickets, electronic or video gambling machines, table games at a casino, poker, betting on games of skill such as pool or darts, lottery tickets, scratch tickets, and online gambling.

For most people gambling is engaged in solely for entertainment. However, for others, gambling fulfills other motives such as socialization, to increase pleasant feelings, to cope with unpleasant feelings, or for monetary gain (Dechant & Ellery, 2011; Stewart & Zack, 2008). So the question becomes: at what point does gambling become problematic, and how can we separate the recreational gambler from the pathological?

There are a number of different accepted terms and definitions used to describe excessive gambling including "problem gambling", "pathological gambling," "disordered gambling," and "compulsive gambling". The most commonly used term in the scholarly literature is "problem gambling". The most widely accepted definition of problem gambling comes from Neal, Delfabbro, and O'Neil (2005), who describe it as "difficulties in limiting money and/or time spent on gambling which leads to adverse consequences for the gambler, others, or for the community".

There are several instruments used to assess problem gambling, with the most commonly used ones being the Problem Gambling Severity Index (Ferris & Wynne, 2001), the South Oaks Gambling Screen – Revised (Abbott & Volberg, 1996), and the Diagnostic and Statistical Manual of Mental Disorders (5th edition) criteria for disordered gambling (APA, 2013). These instruments have well established internal consistency, test-retest reliability, convergent validity, discriminant validity, and classification accuracy for treatment-seeking problem gamblers (see Stinchfield, 2014 and Stinchfield, Govoni & Frisch, 2007 for a review).

However, these instruments only have modest classification accuracy for problem gamblers in the general population who have not sought treatment (Williams & Volberg, 2010, 2014). This was one of the deficiencies that led to the development of the Problem and Pathological Gambling Measure (PPGM), which endeavours to minimize the false positives and false negatives that occur in these traditional instruments (Williams & Volberg, 2010, 2014). One way in which the PPGM endeavours to minimize false negatives is allowing for problem gambling designation of individuals reporting sub-threshold levels of symptomatology if their gambling expenditure and frequency are equal to those of unambiguously identified problem gamblers. Denial is a common feature of people with addictions and yet the PPGM is the only instrument that attempts to address this (the other instruments require a degree of insight and willingness to report problem gambling symptomatology). An important impetus for the present thesis was the possibility that people's automatic or implicit associations may be an additional and/or alternative way of helping to identify addicts in denial.

Implicit Assessment in Addictions

Research on implicit assessment methods takes a contemporary approach to addiction by assuming that not all behaviours are the result of reflective decision-making that takes into account the informed choice of the individual (Stacy & Wiers, 2010). Instead, implicit cognitive theory assumes that behaviours are spontaneous and the result of unconscious processing activated by contextual triggers; processes that have consistently been found to correlate with and predict addictive behaviours. By measuring these underlying processes we can better understand associations that have been learned through experience, and tap into the knowledge that is unavailable to more traditional introspective, self-reflective measures. Including these types of measures in an assessment instrument would help capture the non-reflective side of problem gambling, and help to circumvent the issues of deception and recall bias.

It wasn't until the late 1980s and early 1990s that research on addictions began to address automatic processes (e.g., Tiffany, 1990), however it is only in the last 10 years that the field has gained substantial momentum. At its core, addiction is a problem of self-control (McClure & Bickel, 2014). An individual's intentions are overcome by compulsions associated with their addiction. Despite having intentions to discontinue the addictive behaviour and knowing that continuation is harmful, the individual is unable to quit – they lack the control processes to do so. Self-control of addictive behaviours requires the individual to refrain from pursuing a valued incentive even though pursuing that incentive is supported by the immediate context (Metcalfe & Mischel, 1999). Because craving and wanting are more salient processes, and activation of the implicit system is greater than that of the explicit system, control of addictive behaviour is handed over to these automatic processes.

Over the past decade there has been a growing body of evidence on implicit attitudes and stimuli that appear to operate outside of conscious awareness and the effects that they have on addictive behaviours (e.g., Stacy & Wiers, 2010; Wiers et al., 2002). Research has determined that implicit memory and cognition have clear dissociations with explicit memory. For example, multiple studies have noted that amnesic patients possess normal levels of memory on many indirect assessments, but exhibit impaired performance on explicit recall tests (e.g. Ames et al., 2007). By recognizing that the two can potentially operate independently of one another we can see how accessing the information available to the implicit system may offer unique information.

In their comprehensive review of the issue, Wiers and Stacy (2006) establish that three key benefits of assessing implicit cognitions are: (1) implicit assessments may evaluate processes that may be unavailable to introspection; (2) implicit assessments are less susceptible to self-justification and social desirability; and (3) implicit assessments may explain unique variance or different aspects of behaviour. By tapping into the implicit processes we are able to tap into associations that are not necessarily analogous to explicit expectancies, and each association may play a role in exacerbating or perpetuating addictive behaviours (e.g., Krank, 2010; Stacy, 1997).

Even when controlling for other predictive variables (e.g., gender, acculturation) memory associations have consistently been found to be correlated with current levels of substance use, (e.g., Rooke, Hine, & Thorsteinsson, 2008; Stacy, 1995, 1997). Because the implicit system is thought to be evolutionarily old, and found in both humans and animals, we can see how learning of cues and contexts of drug availability occurs rapidly. Once learned, these cues and contexts become associated with craving and drug seeking and are difficult to extinguish. Early research by Stacy (1997) has demonstrated that apart from previous substance use, memory associations are among the strongest predictors of future alcohol and marijuana use when compared to other factors such as outcome expectancies, impulsive sensation seeking and gender.

Krank (2010) tracked subsequent alcohol use trajectories over a five year period. In this study the number of memory associations at the initial testing phase was positively correlated with subsequent alcohol use. What was particularly interesting and important with this study was the ability to predict future alcohol consumption *even among those who had never consumed alcohol*. An explanation for the findings of Krank's (2010) study is that experiences from media exposure, discussion among peers, or being in a setting in which drugs are available may cause certain substances to become highly associated in memory (Stacy, Ames, & Leigh, 2004). What this result suggests is that a transition state from non-user to user, or from one addiction to another, can be explained by these connectionist theories (e.g., Queller & Smith, 2002). Measuring these associations provides a way to study these dynamic processes that link a substance to memory; something unlikely to be uncovered using traditional assessment methods.

Measurement Techniques

A number of methods exist for assessing implicit cognition. In general, these methods can be grouped into measures that evaluate reaction time, and indirect measures that assess word production. The term 'implicit measure' is used frequently, but what exactly does it mean to say that a measure is implicit or indirect? In a review by De Houwer (2006), three functional properties of implicit measures are described: (1) participants have no control of the measurement outcome; (2) participants do not have conscious access to the attitude or cognition; and, (3) participants are not aware of the fact that the target attitude or cognition is being measured. It is important that the literature describe exactly which functional property the measure is using as a definition of being implicit; that is to say, not simply stating a measure is implicit, but rather implicit in the sense that participants do not have conscious access to the attitude or cognition. The following will provide a brief survey of commonly used methods of evaluating implicit cognition in the study of addictions.

Measures of Reaction Time. Over the past two decades, there has been an abundance of research using different measures of reaction time to assess the cognitive processes that underlie addiction. These measures have been theorized to assess three broad categories of cognitive processes: memory associations related to the substance or behaviour; action tendencies triggered by the substance or behaviour; and, attentional bias for a substance or behaviour (Stacy & Wiers, 2010).

The Implicit Association Test (IAT) is the most frequently used test of implicit attitudes and memory associations (Greenwald, McGhee, & Schwartz, 1998). It was designed to measure differences in association of two target stimuli (e.g., alcohol vs. soda) with an attribute (e.g., pleasant vs. unpleasant). Participants are asked to categorize various stimuli by pressing one of two response keys. The principle of this task is that if an individual implicitly evaluates alcohol as more positive than negative, then response time will be shorter when the task involves two highly associated categories (e.g., alcohol + pleasant) than when it involves two categories with weaker associations (e.g., alcohol + unpleasant) (Stacy & Wiers, 2010). The difference in performance is assumed to reflect the strength of the implicit associations between the target and attribute categories; this is known as the IAT effect (Greenwald, McGhee, & Schwartz, 1998). A variant of the IAT is used to measure approach versus avoidance (Ostafin & Palfai, 2006; Wiers, Rinck, Kordts, Houben, & Strack, 2010). It involves using a joystick to push or pull an image; when the image is pulled with the joystick, its size increases and when the image is pushed away, its size decreases (Rinck & Becker, 2007). Within a population of hazardous drinkers it has been found that reaction times are faster in pulling alcohol-related pictures than they are in pushing alcohol pictures (e.g., Rinck & Becker, 2007; Wiers, Rinck, Dictus, & Wildenberg, 2009).

The Extrinsic Affective Simon Task (EAST) is a categorization task that measures single target associations within one task (De Houwer, 2003). This task is similar to the IAT in that participants must classify stimuli with two response keys. With the EAST, attribute words (e.g., positive and negative) are typically assigned with two response keys while target words (e.g., alcohol, soda) are classified with an irrelevant stimulus property (i.e., colour) using the same two response keys. For example, participants may be instructed to respond with one key to words with a positive meaning and no colour or to words presented in red (regardless of meaning) and to respond with the other key to words with a negative meaning and no colour or to targets presented in green. Thus, implicit associations between the target and attribute are defined as the reaction time performance difference between giving an extrinsically positive response to a (red) target and giving an extrinsically negative response to a (green) target. A positive score implies that participant has a positive implicit attitude for the target. In general the IAT is used much more often than the EAST, which may perhaps be due to the smaller effect sizes found with the EAST relative to the IAT (De Houwer, 2003).

Attentional bias is another approach. Attentional bias is thought to be a product of motivational state, with the strength of this motivational state being affected by environmental and internal factors (Christiansen, Schoenmakers, & Field, 2015). Individuals may be more or less likely to have their attentional focus automatically captured by cues in the environment due to natural predispositions and/or past learning experiences. Once attention is captured, these cues are assumed to exert influence on behaviour. Although there are a number of measures used to assess attentional bias for addictive behaviours, variations of the addiction Stroop and the visual probe task are the most frequently used (for review, see Field & Cox, 2008; Field, Munafò, & Franken, 2009; Christiansen, Schoenmakers, & Field, 2015).

With the addiction Stroop, participants are required to identify the colour of a stimulus (typically a word) as fast as possible. Stimuli are either neutral (e.g. “soda”) or target-related (e.g. “beer”) and selective processing of target-related stimuli is reflected in the slowing of colour naming reaction time when compared to neutral stimuli. A variation of this task uses images instead of words and participants are instructed to name the colour of the frame surrounding the image (Bruce & Jones, 2004). With the visual probe task, two words or images, one target (e.g., “beer”) and one matched control (e.g., “soda”), are presented simultaneously on a computer screen, and one of these words/images is subsequently replaced by a symbol. It is the participant’s task to indicate where the symbol appeared as quickly as possible. Attentional bias scores are derived by comparing reaction times when the symbol replaced the target stimuli versus when it replaced the control stimuli, with the assumption being that response time should be shorter when the symbol replaced the target stimuli. Both the Stroop and visual probe task have consistently shown evidence of attentional bias in heavy substance users (Field & Cox, 2008).

Other measures used to assess attentional bias include variations of the change-detection paradigm and tasks that track eye-movements. With change-detection paradigms, a single feature in a complex visual scene is altered (back and forth) through successive presentations. Often this change is not detected immediately, despite the individual being told that one will occur. In studies of substance use there have been four key findings: (1) heavier users detect substance related changes quicker than light users and non-users; (2) light users and non-users detect changes to neutral stimuli faster than heavy users; (3) heavy users detect changes in substance-related stimuli quicker than they do in neutral stimuli; and, (4) light users and non-users detect changes to neutral stimuli quicker than they do for substance-related stimuli (Jones et al., 2003). Similarly, Yaxley & Zwaan (2005) showed that change detection times were shortest for changes in smoking-related objects and change-detection times were longest when a smoking-related object was present but did not undergo change.

Eye Tracking. Eye-tracking is used to measure exactly what individuals are paying attention to in a visual scene and the amount of time spent paying attention to each element (Balcetis & Dunning, 2006; Wadlinger & Isaacowitz, 2008). Areas within each picture containing relevant cues (e.g., drug or alcohol related stimuli) are defined as 'look-zones'. Attentional bias is assessed by comparing time spent attending to one cue versus another or comparing time spent within the look-zone versus outside of the look-zone. What these studies show is that individuals with heavy drug use spend significantly longer attending to the look-zone than individuals without heavy drug use (Balcetis & Dunning, 2006; Field, Mogg, & Bradley, 2005; Mogg, Bradley, Field, & De Houwer, 2003; Wadlinger & Isaacowitz, 2008).

Indirect Measures of Word Production

Indirect testing procedures probe memory associations primarily using word production methods. These tests do not directly inquire about the target behaviour/stimulus but rather its associations. By measuring these associations without explicit awareness we may overcome resistance in the assessment process (Stacy, 1997), access memories that are outside conscious awareness (e.g., Stacy & Wiers, 2010), and reveal unconscious influences on behaviour.

Approaches that evaluate memory associations for drug outcomes presume that individuals differ in the strength of their associations between certain behaviours and certain outcomes (Stacy, 1997). For example, individuals with strong associations between a particular behaviour, such as marijuana use, and a particular outcome, such as increased ability to sleep, will more likely report marijuana as a response when sleep is used as a prompt. Memory associations are typically formed as a result of behaviour. However, these memory associations will often operate to facilitate future behaviour. This process can work to strengthen these associations and make it difficult to break them (e.g., Stacy, 1997; Thush & Wiers, 2007).

In addiction research, measures of cognitive association have been limited to studies of alcohol and drug-use, and are based on the following key concepts: (1) that links can be developed between cognitive representations of stimuli related to drug use and drug-related concepts (particularly as a result of drug use); (2) activation of one representation can spread to another; and, (3) activation of a particular drug-related concept is related to actual drug use (Glautier & Spencer, 1999). The explanation for this phenomenon is based on the theory of spreading activation and the work of Collins & Loftus (1975). The theory proposes that human memory may be thought of as a network of connected units, and when one is activated this spreads to other linked units. Thus, we assume that the strongest associates of the cue are automatically activated, but that many other items are more weakly associated with the stimulus are also activated but have not met the threshold for conscious expression. However, this activation results in priming such that these other related stimuli will be more easily recognized.

Word Associations. Addiction research began using word association methods with the work of Szalay and colleagues (1992). These early investigations revealed that the associative structures of drug users versus non-drug users are significantly different. Tests of word association use words commonly associated with a particular behaviour or target to cue an open-ended response. There are two primary methods of assessing word associations: 'ambiguous' and 'continued', with ambiguous being the most common (Stacy, 1995, 1997). Also known as the free-association method, tests of ambiguous word associates require participants to write down the first word that "pops to mind" for each word in a list of ambiguous cue words. Cue words may be situations associated with the behaviour, outcomes of a particular behaviour, or synonyms.

Tests of 'continued association' ask participants to come up with multiple responses for the same cue, which are repeated in a column. For example, the word fun is listed 10 times on a page and participants respond with the first word each instance makes them think of, with the requirement that they try to think of a different response each time (Stacy, Ames, & Grenard, 2006). Another variation of continued associations is where participants are asked to write down as many words as they can that are associated with a particular cue over a given period of time (typically one minute). It has been found that repeated responses to the same cue yields variation in responses and may more readily produce clinically relevant responses than other methods. However, there is the risk of response chaining, whereby the previous response affects subsequent responses due to priming and spreading activation (Glautier & Spencer, 1999). These methods reflect more than just lexical knowledge, as they do not depend on the function of the hippocampus or declarative cognition. Evidence has demonstrated that amnesic patients with severely impaired explicit memory demonstrate no impairments on tests of implicit memory using word association tests (Levy, Stark, & Squire, 2004).

Outcome-Behaviour Associations. Tests of outcome-behaviour associations, also referred to as controlled word associates, are a specific form of word association. With these measures, participants are given a word or open-ended stem phrases and are asked to provide the first behaviour, action, or verb that "pops to mind." These tests operate on the principle that mere presentation of a written outcome can lead individuals to think about a specific behaviour if the behaviour is sufficiently associated with that outcome in memory (Stacy, 1997). Stem phrases are particular situations or emotions that are often associated with the target behaviour but do not explicitly mention the behaviour or its symptoms (e.g., Frigon & Krank, 2009; Stacy, Leigh, & Weingardt, 1994). Situational probes indicate places or times that a behaviour is likely to occur (e.g., "If I am at a party, then I will…") and emotional probes are either conditions under which a behaviour is more likely (e.g., "If I have trouble sleeping, then I will…") or motives an individual cites for engaging in that behaviour (e.g., "If I want to feel happy, then I will…").

In the first study to apply these methods to addiction, Stacy, Leigh, & Weingardt (1994), primed non-alcohol-dependent subjects by having them read through phrases that were either behavioural outcomes of alcohol consumption (i.e. have a good time) or phrases that included behavioural outcomes that had no relation to alcohol consumption (i.e. feeling thrifty). Findings demonstrated that, despite not being asked about alcohol consumption until after completing the behavioural associations task, strong correlations existed between the generation of alcohol responses and reported alcohol consumption.

A variation of the behavioural associates is the event-completion task. With this task participants are provided with a list of phrases or contexts about some ambiguous other people that they must complete with a top-of-mind response (Stacy, Ames, & Leigh, 2004). The phrases and contexts are either the antecedents or outcomes associated with the target. The event-completion task items are useful when addressing risky behaviours because they may spontaneously activate associations without being threatening or being influenced by social desirability as they refer to ambiguous other people, rather than the person themselves. The advantage of assessing behavioral associates over word association is that they tap into more than lexical knowledge and provide greater information regarding the underlying associative processes that shape addictive behaviour (Stacy, Ames, & Grenard, 2006).

Potential Limitations of Implicit Assessment

There are some limitations to the assessments described above. One of these limitations is theoretical. It concerns the fact that the correlation between measures of implicit association and subjective craving (r = 0.20) is relatively weak; whereas theoretical models suggest that these variables should be closely related (Field et al., 2009).

Other limitations are methodological. Noise is an issue with all the reaction time tasks, as reaction time involves multiple cognitive and motor processes, some of which are unrelated to the task. (Based on this fact, Ataya and colleagues (2012) suggest that the degree of inter-item correlation (e.g., Cronbach's alpha) can be interpreted as an estimate of the amount of noise interfering with the measurement of cognitive bias).

As the Implicit Association Test and its variants are the most frequency used measures of implicit cognition and assessment (Rooke, Hine, & Thorsteinsson, 2008), it is no surprise that they have been subject to the most scrutiny. One issue is that the IAT and visual probe tasks are quite complex. Further research is needed to examine whether this complexity represents a significant compromise to their reliability and validity. Another issue is that the IAT assumes a bipolar model of implicit attitudes, meaning that attitudes can be assessed on a single continuum ranging from positive to negative. However, new variations of the original task have been developed to assess unipolar attitudes (e.g., Thush et al, 2007). Another potential problem with the IAT is that implicit attitudes can only be assessed in relation to a contrast or control category. This can be problematic when the target stimulus (e.g., heroin) does not have an obvious contrast. In addition, IAT effects appear to be susceptible to contamination by culturally shared associative knowledge that is not necessarily personally endorsed (Karpinski & Hilton, 2001; Olson & Fazio, 2004).

A limitation that applies to the indirect measures of word production is that the items are open-ended, and provide qualitative data that is often ambiguous. In order to interpret these responses, a coding method for these responses must be selected: liberal, conservative, or self-coded. With liberal coding, all responses that are most likely to include the target are coded as such. For instance, if a participant responds with "go to the bar" it is liberally coded as including the target of alcohol, whereas if that individual had actually meant they would go dancing at the bar, or eating at the bar, this response would have been incorrectly classified. In contrast, conservative coding include only those responses that explicitly reference the target; a response would have to explicitly state "have a drink" or "go for a beer" to be included as an alcohol related response. Both coding procedures require at least two coders to ensure reliability, making the process very labor intensive. In addition, even with rigorous training the ambiguity of some participant responses cannot be resolved (Frigon & Krank, 2009). Self-coding is a relatively new method that presents a resolution to this problem whereby participants are presented with the original testing cues and their responses, and then asked to identify themselves which target category their response relates to (Frigon & Krank, 2009; Krank, Schoenfeld, & Frigon, 2010). One potential problem with this technique is that participant coding may be influenced by being made aware of the target category (Frigon & Krank, 2009). Nonetheless, in general, research shows that self-coding has a stronger association with behaviours than either liberal or conservative coding (Frigon & Krank, 2009; Krank, Schoenfeld, & Frigon, 2010).

Implicit Assessment in Gambling and Problem Gambling

In contrast to the extensive body of literature regarding how implicit processes influence alcohol and other substance use, researchers have only recently turned their attention to investigating this relationship for gambling and problem gambling. Most of this research has involved attentional bias, with several studies employing variants of the addiction Stroop task (e.g.,Boyer & Dickerson, 2003; McCusker & Gettings, 1997; Molde et al, 2010) (for a comprehensive review see Hønsi, Mentzoni, Molde, & Pallesen, 2013). Findings from these studies have demonstrated the presence of an attentional bias among problem gamblers. More specifically, problem gamblers are more likely to make errors and take significantly longer to name the colour of words when a gambling stimulus is presented compared to a control stimulus. In addition, the visual probe task has been used to demonstrate that problem gamblers have an attentional bias for gambling related cues versus healthy controls (Vizcaino et al., 2013).

Brevers and colleagues (2011) sought to investigate initial orienting for a stimulus by using a change detection task. Findings revealed that problem gamblers were quicker to detect changes to gambling-related stimuli than change to a neutral stimulus when compared to healthy controls. Eye-tracking further revealed that with the problem gambler, the percentage of first eye movements and number of fixations (which also lasted longer) towards the gambling stimuli was greater than that for neutral images, a pattern that was not demonstrated among controls.

Other reaction time measures, outside of attentional bias, have assessed implicit outcome expectancies and implicit attitudes. Several studies have investigated implicit outcome expectancies using an adaptation of the affective priming task (Stewart, Stewart, Yi, & Ellery, 2015; Stewart, Yi, & Stewart, 2014; Yi, Stewart, Collins, & Stewart, 2015). The task is designed to measure reaction time for positive and negative gambling outcome expectancy words, with results demonstrating a significant positive relationship between reaction time for positive outcome expectancies and measures of gambling behaviour and problem gambling severity. Variants of the IAT for implicit attitudes have also been used (Brevers et al., 2013; Flórez et al., 2016; Plotka, et al., 2013; Yi & Kantekar, 2010). Results from all studies revealed that many problem gamblers, despite experiencing deleterious effects related to gambling, tended to display positive implicit attitudes towards gambling.

Measures of word production have been used less frequently in the gambling literature. To date, only one study has investigated the role of implicit memory associations and gambling. Stiles and colleagues (2016) used a modified version of the BOAT (Behaviour Association Task; a task developed for alcohol associations; Stacy, Leigh, & Weingardt, 1994), called the G-BOAT (Gambling Behaviour Outcome Association Task). Like the BOAT, the G-BOAT involves a series of outcome phrases that the participant is instructed to complete with the first behaviour or action that comes to mind. Results demonstrated that among a sample of 96 gamblers (66 men and 30 women) with relatively high levels of gambling involvement and problem gambling, those who spent more time and money gambling and those with more problematic gambling responded with more gambling related responses.

In summary, the majority of these studies have employed attentional bias measures or other differences in reaction time. The findings to date have been consistent with what has been found in the substance use literature, which is not surprising given the commonalities between substance and gambling addictions (APA, 2013; Grant, Potenza, Weinstein, & Gorelick, 2010; Petry, 2005; Potenza, 2006). However, there is a paucity of research with implicit memory association tasks, which potentially have more logistical utility (as described below).

Study Goals

Given that there are issues with existing problem gambling assessment, and a need to better understand how implicit processes are related to addictions that are not related to substance use, the purpose of this thesis is to a) identify the presence and magnitude of implicit memory associations as it relates to a person's level of gambling involvement and problem gambling, and b) to develop measures to capture and quantify these associations. In this thesis, I specifically investigate the role of implicit memory associations and gambling, an area of which to date there is only one published article (Stiles et al., 2016).

Measures of memory associations have two distinct advantages over measures of reaction time: (1) their ease of application, as they can be administered in a variety of formats (i.e. digital, paper, phone, and face-to-face), relatively quickly making them ideal for population research and/or clinical assessment settings; and (2) the strongest effect sizes and predictive power for implicit assessment in addiction have been found with tests of memory associations over measures of both implicit attitudes and attentional bias (Rooke et al., 2008).

As this is research is among the first to approach problem gambling assessment from the perspective of implicit memory associations, the first part of this thesis was focused on creating methods of measuring these processes. In Chapter 2 (Study 1) I develop two new measures for assessing memory associations and evaluate them in a sample of University of Lethbridge undergraduates. The first measure assesses ambiguous word associations for gambling that are both format-specific and related to gambling as a whole. In the work by Stiles and colleagues (2016), these types of associations were not assessed. The second measure evaluates outcome-behaviour associations for gambling. Outcome phrases were adapted from work on alcohol and marijuana used by Frigon & Krank (2009) and Stacy, Leigh, and Weingardt (1994) as well as what is known about common motives for engaging in gambling (Dechant & Ellery, 2011; Stewart & Zack, 2008). Chapter 3 involves an analysis of the performance of individual items in Study 1 for the purposes of creating two shorter measures for Study 2. In Chapter 4 (Study 2) these shorter measures are administered to several thousand Canadian online panelists (oversampled for gamblers) to evaluate their performance across a more representative sample of the population as well as a more diverse range of gamblers.

CHAPTER 2. STUDY 1: DEVELOPMENT AND EVALUATION OF TWO MEASURES OF IMPLICIT ASSOCIATIONS FOR GAMBLING

Abstract

The present study looked at the development of two ways of measuring implicit associations for gambling and problem gambling. The first was a ‘word associates’ task whereby university undergraduate participants (*N* = 494) reported the first word that came to mind for 33 words that were ambiguously related to gambling as well as 5 control words. The second was a ‘behaviour associates’ task whereby participants reported the first behaviour or action that came to mind, again using 21 phrases that had potential gambling-related connotations. Consistent with the hypothesis of this study, there was a significant positive relationship between number of memory associations and reported level of gambling involvement as well as problem gambling status. Behaviour associations were stronger than word associations, suggesting that each type of association may tap into a different facet of associative memory. Associations with problem gambling status were also stronger than associations with level of gambling involvement.

Introduction

Research on implicit processes has been influential in the field of alcohol and other substance related addictions as it assumes that not all behaviours are the result of reflective decision-making (Krank, 2010; Stacy, 1997; Stacy, Ames, & Grenard, 2006; Stacy, Ames, Wiers, & Krank, 2010). Instead, implicit cognitive theory assumes that some behaviours are the result of unconscious and reactive processing activated by contextual triggers. Because they are unavailable to conscious introspection and filtering, examining implicit cognitions can help to explain the intention-behaviour gap; individuals engage in behaviours that they know are harmful and do not consciously intend to perform because they are influenced by a subset of associations in memory that become spontaneously activated under various conditions (Stacy & Wiers, 2010).

Given the similarities between problem gambling and substance related addictions (APA, 2013; Grant, Potenza, Weinstein, & Gorelick, 2010; Potenza, 2006), implicit processes may also play an important role in explaining problem gambling. In the field of gambling research, measures that tap into implicit processes have primarily focused on attentional bias (for a review see Hønsi, Mentzoni, Molde, & Pallesen, 2013). Because these types of measures are largely reaction time based, noise is an issue, as reaction time requires multiple cognitive and motor processes that may not be relevant to what is being assessed (Ataya et al, 2012). Furthermore, Rooke and colleagues (2008) completed a comprehensive meta-analysis that evaluated 89 effect sizes of nearly 20,000 participants to estimate the magnitude of the relationship between substance-related implicit cognitions and the use of legal and illegal substances. Results demonstrated that the strongest effect sizes and predictive power were found with tests of memory associations over measures of implicit attitudes and attentional bias.

Tests of implicit memory associations allow us to better understand associations that have been learned through experience, and tap into the knowledge that is unavailable to more traditional introspective, self-reflective measures. In the substance use field, approaches that evaluate memory associations for drug outcomes presume that individuals differ in the strength of their associations between outcomes and behaviours (Stacy, 1995, 1997; Stacy, Leigh, & Weingardt, 1994). Such tests do not directly inquire about the target behaviour or stimulus but rather measure associations and access memories that are outside conscious awareness. The more accessible these associations are, the more it is expected that they are both reflective of current behaviour and have a potential influence of future behaviour.

There are several methods of assessing activation of implicit memory associations, however ambiguous word associations and outcome-behaviour associations have been demonstrated to be the strongest correlates of actual behaviour (Stacy, 1997). Ambiguous word associations require the participant to list the first word that comes to mind in response to a cue word or phrase (Szalay, Carroll, & Tims, 1993). Outcome-behaviour associations ask the participant to produce a verb, action or behaviour in response to a prompt. These measures operate on the principle that mere presentation of a written outcome can lead individuals to think about a specific behaviour if the behaviour is sufficiently associated with that outcome in memory (Stacy, Leigh, & Weingardt, 1994). The key with both methods of assessment is that the prompts need to be ambiguous and not directly reference the target concept. In both cases, open-ended responses are subsequently coded as either belonging to the target category or not. Importantly, these measures have been demonstrated to correlate with current, and predict future alcohol and marijuana use when demographic and other risk factors such as impulsive sensation seeking and acculturation, as well as explicit measures of cognition such as outcome expectancies are controlled for (Krank & Goldstein, 2006; Stacy, 1997). By adapting these measures for gambling, we may assess the non-reflective side of problem gambling, and help to circumvent the issues of deception and recall bias.

In accordance with memory association approaches for substance use, the current study serves to evaluate two new tests of memory associations for gambling: a measure of ambiguous word associates and a measure of outcome-behaviour associates. It was hypothesized that positive associations would exist for both ambiguous word associations and outcome-behaviour associations with concurrent gambling involvement and level of problem gambling. However, what was uncertain is the magnitude of these associations; the utility of each of the individual items in showing these associations; whether they would be differences in the size of the correlations for behavioural associates compared to word associates; and whether they would be differences in the magnitude of correlations for level of gambling involvement compared with level of problem gambling.

Methods

Participants

From January to December 2016, 626 students from the University of Lethbridge were recruited for the study. A total of 132 participants were subsequently excluded from the analysis due to incomplete or inaccurate data (i.e. participants that did not complete the survey appropriately, such as participants who input random letter sequences or single-letter responses on the associative measures) on the variables of interest. After exclusion, the final sample consisted of 494 participants. The final sample was predominantly female (360 females, 131 males, and 3 prefer not to answer). The average

age was 21.28 years (*SD* = 4.12) and the range was 17-62 years. The sample was primarily Caucasian (85.8%), followed by Asian (6.1%), African (4%), Metis (2.4%), Middle Eastern (2%), Indigenous Canadian (1%) and Other (2.8%).

Procedure

Participants were recruited through the University of Lethbridge online subject pool whereby students receive course credit in psychology for participation. The solicitation indicated their participation was being sought for two investigations examining: (1) the individual characteristics associated with decision making biases and errors, and (2) an investigation into implicit cognition and gambling. The first study made no mention of gambling in recruitment advertisements, however the second study explicitly indicated that gambling would be assessed. The study was conducted either on a desktop computer in a laboratory in the psychology department, or at the person's home on their own computer or mobile device (38% completed in the lab, 62.1% at their home). After obtaining consent, participants completed a number of self-report measures and cognitive tasks. For the present study, the measures involved the word association task, behaviour association task, measures of gambling involvement, and the Problem and Pathological Gambling Measure (PPGM) (Williams & Volberg, 2010, 2014). With both of the studies, the associative tasks were the first to be completed in order to reduce any potential priming effects from other items in the surveys.

Measures

Word Associate Task. As seen in Table 1, there were 33 words that were likely to be associated with gambling and five ambiguous control words with no obvious relationship to gambling. The gambling-related words were chosen to represent a broad range of both format specific associations (e.g., cherry, twenty-one, spread) and words more generically related to gambling (e.g., game, win, money). Participants were provided with the following instructions: “For the following set of words, please write down the VERY FIRST word or phrase that comes to mind after reading each word. For example: salt: pepper. Remember to respond with the FIRST word or phrase that "pops to mind." Work quickly!”

Table 1. Word Associates.

Gambling-Related Words					Control Words
draw	wheel	Book	horse	cherry	tree
chips	hit	Dice	track	line	bird
deck	nine	Streak	hall	slot	sand
black	pit	Sports	money	credits	pillow
hand	spin	Table	seven	twenty-one	flower
win	pull	Ticket	spread		
green	scratch	Red	game		

Behaviour Associate Task. Prompts were developed using common motives for gambling participation (Dechant & Ellery, 2011; Stewart & Zack, 2008) and adapted from those used in Frigon and Krank’s (2009) work on alcohol and marijuana memory associations. As seen in Table 2, participants were given 21 statements that cover both situations (e.g., short on cash) and feelings (e.g., feel happy) that could potentially be associated with gambling. Instructions for the task were as follows: “For the following phrases, write down the first behaviour that comes to mind; do not think about your responses, write down the very first thought that comes to you. Example: Feeling hungry: have a snack. Please keep your answer short; limit yourself to a single word or phrase. Remember to respond with the FIRST action or behaviour that "pops to mind." Work Quickly!”

Table 2. Behaviour Associates.

After work or school	Feeling bored	Feel happy
Short on cash	Feeling anxious	Trouble sleeping
Make money	Have fun	Pass the time
Go on vacation	Do something thrilling	Forget worries
In a bad mood	Feel self-confident	Get lucky
Stressed out	Feel like celebrating	Feeling lonely
Have a really good time	Feeling upset or depressed	Typical Friday or Saturday night

Self-Coding of Associative Measures. Self-coding procedures were adapted from Frigon & Krank (2009). Self-coding was used as it has been found to have a stronger association with actual behaviour compared to researcher-coded methods (Frigon & Krank, 2009; Krank, Schoenfeld, & Frigon, 2010). The person's responses to all word and behaviour associates were shown to them along with the original cues. Participants were then asked to select the category or categories to which their response belonged, with the choices being: recreation/leisure, gambling, food, alcohol, family/friends, and other. Responses for the target category (gambling) were summed, which produced a score for both the word associates (possible range of 0-33) and the behaviour associates (possible range of 0-21).

Level of Gambling Involvement. Participants were asked about their frequency and expenditure on each of 11 different types of gambling in the past 12 months (i.e., lottery and raffle tickets, instant lottery tickets (scratchcards), electronic gambling machines (e.g., slots, video lottery terminals), casino table games, poker, sports betting, horse or dog race betting, bingo, private games for money, financial indices betting on a gambling website, other). Response options were provided for frequency (ranging from 0 = never, to 6 = daily or almost daily), whereas the response for expenditure was open-ended. The specific question wordings and response options employed have been demonstrated to be both reliable and valid in the assessment of gambling participation

(Williams et al., 2017). Composite measures were created reflecting a) total number of gambling formats engaged in (ranging from 0 – 11); b) maximum frequency of gambling reported for any format; and c) average net monthly spending on all forms of gambling. Due to the significant skew in the distribution of expenditure values, this variable was subsequently recoded into four categories: 0 = $0, 1 = $1-100, 2 = $101-200, 3 = $201+.

Problem and Pathological Gambling Measure (PPGM). The PPGM is a 17-item instrument that assesses past year problem gambling symptomatology and classifies people into one of four categories: recreational gambler, at-risk gambler, problem gambler, or pathological gambler (Williams & Volberg, 2010, 2014). It has very good internal consistency, test-retest reliability, convergent and discriminative validity, and excellent classification accuracy relative to clinical assessment for both treatment-seeking and non-treatment seeking problem gamblers (Back et al., 2015; Williams & Volberg, 2010, 2014).

Results

Priming

Mann Whitney U tests were conducted to determine whether there was a difference between the two studies based on study advertisement (i.e., gambling or non-gambling). There were no significant differences in the number of either word associates (p = .876) or behaviour associates (p = .425), indicating that the different descriptions of the studies did not serve as a prime for responses. Consequently, both groups were combined for subsequent analyses.

Level of Gambling and Problem Gambling

A total of 78.5% of the sample reported having gambled on some type of gambling at least once in the past 12 months. There were relatively few regular gamblers, with only 12.8% reporting gambling once a month or more in the past 12 months. The average number of formats engaged in was 1.88 (*SD* = 1.72). According to the PPGM, the sample consisted of 106 non-gamblers, 358 recreational gamblers, 19 at-risk gamblers, 8 problem gamblers, and 3 pathological gamblers. Due to the small number of both problem and pathological gamblers these groups were collapsed to 11 problem/pathological gamblers. The prevalence rate of both gambling (78.5%) and problem gambling (2.2%) in this sample is roughly equivalent to what is typically seen within the populations of most western countries (Williams, Volberg, & Stevens, 2012), albeit lower than what is typically seen in university samples (e.g., Williams et al., 2006; Wong, Zane, Saw, & Chan, 2013). In the present study this may be attributable to 72.9% of the sample being female, as females are known to have lower levels of gambling involvement and problem gambling than do men (e.g., Merkouris et al., 2016; Williams, Volberg, & Stevens, 2012).

Memory Associations

One item from the behaviour associates scale, "get lucky," was found to have an unusually high frequency of categorization as being related to gambling (37%) compared to an average endorsement of 2% for all other items. After reviewing the range of qualitative responses, it was determined that the item was not sufficiently ambiguous and it was removed from further analyses, reducing the total possible scoring for the behaviour associates scale to 0-20. No other items were found to be problematic. The word associates items had a Cronbach alpha of .758 and the behaviour associate items had a Cronbach alpha of .521. The Kendall tau-b association between the two implicit measures was .282 ($p < .01$).

Relationship between Implicit Memory Associations and Gambling

Correlational analyses were conducted to assess the relationship between the associative measures and the measures of gambling involvement as well as PPGM classification and total score. Due to the presence of large and significant skew for the word associates scores and behaviour associates scores, non-parametric Kendall's tau-b correlations were conducted. As seen in Table 3, significant positive correlations were found between both of the associative measures and all measures of gambling involvement as well as with PPGM classification and score. In all cases, the magnitude of the correlations was fairly modest (ranging from .175 to .350). [Note: for illustrative purposes and comparisons to Stiles et al. (2016), Pearson r correlations are also presented. Also, for illustrative purposes the correlations between the associates and PPGM total score is presented. As can be seen, they are consistently lower than PPGM classification, which is why the latter is used exclusively in the other analyses.]

Tau correlation coefficients were converted to r according to Walker (2003) for pairwise comparison of the correlation coefficients using asymptotic z tests. Behaviour associate correlations were found to be significantly higher than word associate correlations for all measures of gambling involvement (gambling frequency $p <.001$, 1-tailed; number of gambling formats $p <.01$ 1-tailed; gambling expenditure $p <.05$ 1-tailed) and problem gambling (PPGM) classification $p <.001$, 1-tailed; PPGM score $p <.05$ 1-tailed).

Table 3. Descriptive Statistics and Kendall tau-b Correlations in Study 1.

Measure	*M*	*SD*	Correlations 1.	2.	3.	4.	5.	6.	7.
1. Word Associate Score	5.66	3.53	-						
2. Behaviour Associate Score	0.47	0.95	.282**	-					
3. Gambling Frequency[a]	1.01	0.86	.235**	.334**	-				
4. Number of Formats	1.88	1.72	.175**	.259**	.652**	-			
5. Average Monthly Spending[b]	0.72	0.52	.194**	.257**	.665**	.641**	-		
6. PPGM Classification[c]	0.87	0.57	.255**	.350**	.877**	.672**	.728**	-	
7. PPGM Total Score	0.15	0.76	.178**	.230**	.409**	.267**	.215**	.518**	-

Descriptive Statistics and Pearson r Correlations in Study 1.

Measure	*M*	*SD*	Correlations 1.	2.	3.	4.	5.	6.	7.
1. Word Associate Score	5.66	3.53	-						
2. Behaviour Associate Score	0.47	0.95	.349**	-					
3. Gambling Frequency[a]	1.01	0.86	.275**	.350**	-				
4. Number of Formats	1.88	1.72	.241**	.312**	.557**	-			
5. Average Monthly Spending[b]	0.72	0.52	.219**	.287**	.525**	.615**	-		
6. PPGM Classification[c]	0.87	0.57	.318**	.378**	.751**	.648**	.672**	-	
7. PPGM Total Score	0.15	0.76	.188**	.246**	.438**	.340**	.236**	.614**	-

Note. Numbers in the correlations columns correspond to the numbered measures. [a]Frequency Scale: 0 = never, 1 = less than monthly, 2 = once a month, 3 = 2-3 times per month, 4 = once a week, 5 = several times per week, 6 = daily or almost daily. [b]Spending: 0 = \$0, 1 = \$1-100, 2 = \$101-200, 3 = \$201+. [c]PPGM Classification: 0 = non-gambler, 1 = recreational gambler, 2 = at-risk gambler, 3 = problem gambler. ** $p < .01$.

Within the word associates, the correlation with PPGM classification was significantly higher than the correlation for level of gambling involvement as represented by gambling spending ($p < .001$, 1 tail), number of formats ($p <.001$, 1 tail), and gambling frequency ($p <.001$, 1 tail). Within the behaviour associates, the correlation with PPGM classification was also significantly higher than the correlation for gambling spending ($p <.001$, 1 tail), number of formats ($p <.001$, 1 tail), and gambling frequency ($p <.001$, 1 tail).

The average word associate score for the 11 problem gamblers was 10.27 (*SD* = 4.61; range of 6 to 20) whereas the average word associate score for the 464 non-gamblers and recreational gamblers was 5.47 (*SD* = 3.41; range of 0 to 23). The average behaviour associate score for the 11 problem gamblers was 1.91 (*SD* = 2.17; range of 0 to 6) whereas the average behaviour associate score for the 464 non-gamblers and recreational gamblers was 0.39 (*SD* = 0.82; range of 0 to 4). Using a cut score of 6 on the word associates, 11/11 (100%) problem gamblers would have been accurately classified and 268/464 (57.8%) of non-gamblers and recreational gamblers correctly classified. For the behaviour associates, using a cut score of 1, 7/11 (63.6%) of problem gamblers would have been accurately classified and 349/464 (75.2%) of non-gamblers and recreational gamblers would have been correctly classified. (Note that the cut-off score should optimally be situated so that it captures almost all of the unambiguous problem gamblers, with the non-problem gamblers who still fall in that range potentially being people at-risk of becoming problem gamblers or potentially problem gamblers in denial).

Discussion

The purpose of this study was to develop two different measures of implicit memory associations for gambling and then to evaluate their association with level of gambling involvement and problem gambling. The results demonstrated that both word associates and behaviour associates have a significant positive relationship with both gambling involvement and problem gambling, as was predicted. In other words, participants with lower numbers of both word and behaviour associates tended to gamble less intensely and were more likely to fall into the non-gambler and recreational gambler categories, whereas those who endorsed greater numbers of associations were more likely to gamble intensely and belong in the at-risk and problem gambler categories. These findings are by and large consistent with those obtained among substance-using populations, but are important nonetheless, as this is one of the few studies that has demonstrated implicit word and behavioural associations in gambling.

There are several other important findings of this study. For one, these results confirm the utility of the actual items chosen for the word and behavioural associate lists. For another, the magnitude for the correlations between the behaviour associates and the target variables was consistently and significantly larger than those with the word associates and the target variables. This finding is consistent with research in non-gambling areas. It reaffirms that behaviour associations tap into more than lexical knowledge and provide a more accurate picture of the underlying associative processes (Stacy, Ames, & Grenard, 2006). Analysis revealed that the word associates items had an acceptable Cronbach alpha while the behaviour associate items exhibited a poor Cronbach alpha. This was not a concern as both measures, like problem gambling, are multidimensional (Nower, Martins, Lin, & Blanco, 2013).

Another important finding was that the correlations with PPGM classification were significantly higher than the correlations for level of gambling involvement. This is also consistent with what was found in Stiles et al. (2016). PPGM classification and gambling involvement were strongly correlated in the present study (.67 for number of formats, .73 for spending, .88 for frequency). Nonetheless, what this result implies is that implicit associations for gambling tend to be stronger for problem gamblers compared to just intensive gamblers. That being said, even the strongest Kendall tau-b correlation was rather modest in magnitude (.350), similar to what was found in Stiles et al. (2016) [i.e., Pearson *r* correlations between behavioural associates and gambling expenditure being .35, .36 for time spent gambling, and .51 for total score on the Problem Gambling Severity Index (Ferris & Wynne, 2001)]. In general, the ability of the implicit associations in the present study to discriminate between unambiguous problem and non-problem gamblers was fair to good. With the cut-offs chosen, the word associations had a high sensitivity (100%) and low specificity (58%), while the behaviour associates had modest sensitivity (64%) and specificity (75%). That being said, further research might indicate that the non-problem gamblers who fell above the cut range may be at risk for future problem gambling or potentially be problem gamblers in denial.

There are several limitations to the present study, one of which concerns the sample. The sample was composed of relatively light-gamblers, likely due to fact that the majority of participants were female. Furthermore, only 11 people (2.2% of the sample) were problem gamblers. In addition, the sample was very circumscribed and homogenous in terms of age, the fact that they were all university students, and the fact they all lived in Lethbridge. This limits the generalizability of the findings to clinical samples and the general population. Investigating the relationship between memory associations and gambling in a sample that is more representative of the general population, and with a greater level of gambling involvement and problem gambling will be instructive.

A second issue concerns the item choices for both the word associates and the behaviour associates. These choices were made after an extensive study of potential gambling-related words and phrases, in consultation with researchers (e.g., RW) quite familiar with gambling. Nonetheless, a different choice of items would have affected the magnitude of the correlation coefficients to some extent.

Another limitation is that the word association task was always administered before the behaviour associate task. It is possible that this may have served as a prime for the behaviour associate task; however, the low number of gambling-related responses suggests that this was perhaps not an issue.

A final issue is that the cross-sectional design of this study limits our ability to draw causal inferences. This study established that there is a relationship between memory associations and both gambling involvement and problem gambling status. What this study failed to do, however, is establish the directionality of this relationship; are memory associations a cause or a consequence of increased gambling involvement and problem gambling symptomatology? In the field of alcohol, Krank (2010) studied the effects of word associations on adolescent alcohol consumption over a five-year period beginning in grade seven. The findings revealed that those who had more than two alcohol-related implicit cognitions in grade seven subsequently consumed more alcohol at one, two, three and four-year follow-ups than those with either one to two or no alcohol-related memory associations. This result is particularly interesting given that many of the participants indicated at time 1 they had never consumed alcohol, implying that the associations existed before the behaviours.

Findings from this study confirm that implicit associations bear a relationship with level of gambling and problem gambling, and thus, potentially have important implications for assessment, prevention and treatment. In terms of assessment, the present study confirms that implicit associations are significantly related to problem gambling status and may have some utility as an adjunct measure in assessment. In terms of prevention, if these implicit gambling associations are predictive of future gambling behaviour (as seen in Krank, 2010), then breaking, weakening, or changing these associations might have beneficial preventative effects. In terms of treatment, it may be that the presence and strength of implicit associations is predictive of relapse. All of these issues merit further research, especially in a longitudinal context.

CHAPTER 3. ITEM-ANALYSIS OF ASSOCIATE ITEMS FOR STUDY 2

Results of Study 1 showed that an increased number of ambiguous word associations and outcome-behaviour associations were related to level of gambling involvement and problem gambling status. Although these results were significant, the generalizability of these results is uncertain due to a very circumscribed sample. Specifically, the sample had a disproportionate number of females (72.9%) and the participants were all university students who lived in Lethbridge, Alberta. They also had relatively little gambling involvement. To investigate the generalizability of these findings and whether these issues in sampling may have influenced the results of Study 1, in Study 2 the aim was to investigate the relationship between implicit memory associations and gambling in a much larger and diverse sample of the general Canadian population that was over sampled for gambling involvement.

Several things both constrained and influenced the choice of word associates and behavioural associates for Study 2. One was the fact that these items were added to a larger study whose primary focus was on investigating factors that differentiated problem gamblers from problem video game players, along with a secondary focus on collective card players. Because this study was assessing multiple behavioural addictions, it was of some interest to use items that may evaluate all three types, rather than being specific to only gambling. The second issue was the need for the list of associates to be much shorter than used in Study 1, due to time and space limitations on the online survey. This required the items to be more generic, rather than more specific to a particular type of gambling. Thus, the chosen items were not always the ones with the strongest individual correlations with gambling and problem gambling, but rather the items that were more generically related to gambling. A final issue was that the choice of items had to be made prior to the results of Study 1 being fully analyzed (i.e., choices were made on the basis of data collected up to April 14, 2016, which only included 299/494 participants).

Table 4 illustrates the correlation of each word associate item in Study 1 against the various measures of gambling involvement and problem gambling. The items ultimately chosen for Study 2 are within boxes. As mentioned, item selection was based on the magnitude of the correlation and whether the item could ambiguously cover more than one gambling format or behavioural addiction. The word "win" was also included in the final measure due to its relevance to all three target behaviours, despite not reaching statistical significance with any of the measures of involvement or PPGM classification. Four additional new items were also added to the short-screen that better characterized video game play: skill, character, level, and achievement.

Table 4. Pearson Correlations between Individual Word Associate Items and Measures of Gambling Involvement and Problem Gambling in Study 1.

	PPGM Classification	Gambling Frequency	Number of Gambling Formats	Gambling Spending
Scratch	.216**	.126*	.146*	.155**
Credits	.208**	.149**	.149*	-
Black	.190**	-	-	-
Chips	.178*	-	-	.089*
Game	.158**	-	-	-
Dice	.154**	-	-	.116*
Line	.152**	.119*	.126*	-
Spin	.142*	-	-	.156**
Horse	.137*	-	.116*	-
Twenty-one	.126**	.119**	-	-
Hit	.126*	.129*	-	.149**
Ticket	.122*	-	-	-
Wheel	.118**	-	-	-
Money	.118*	.123*	-	-
Seven	-	-	.173**	.126*
Streak	-	-	.137*	-
Cherry	-	-	.129*	-
Deck	-	-	.125**	-
Red	-	-	.119**	-
Win[a]	-	-	-	-
Track	-	-	-	-
Table	-	-	-	-
Spread	-	-	-	-
Sports	-	-	-	-
Slot	-	-	-	-
Pull	-	-	-	.130*
Pit	-	.115*	-	-
Nine	-	-	-	-
Hand	-	-	-	-
Hall	-	-	-	.119*
Green	-	-	-	-
Draw	-	-	-	-
Book	-	-	-	-
Tree	-	-	-	-
Bird	-	-	-	-
Sand	-	-	-	-
Pillow	-	-	-	-
Flower	-	-	-	-.118*

Note. **. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed). Non-significant correlations suppressed. Items included in the short screen for Study 2 are within the boxes. [a]This item was included in the short-screen due to its relationship with video games (a separate study).

As the motives to engage in gambling overlap with the motives to engage in other addictive behaviours (Stewart & Zack, 2008) all 10 short-screen behavioural associate items for Study 2 were drawn from the existing pool from Study 1. Table 5 illustrates the correlation of each behaviour associate item in Study 1 against the various measures of gambling involvement and problem gambling. The 10 items selected for Study 2 are enclosed in boxes. Despite having the strongest correlations with PPGM classification, the items "feel lonely" and "feel self-confident" were not included in the final measure. Rather, it was felt that the items "feeling bored", "feel happy", and "pass the time", although not significant, would have a greater relationship with video game play.

Table 5. Pearson Correlations between Individual Behaviour Associate Items and Measures of Gambling Involvement and Problem Gambling in Study 1.

	PPGM Classification	Gambling Frequency	Number of Gambling Formats	Gambling Spending
Feel lonely	$.294^{**}$	-	-	$.142^{*}$
Feel self-confident	$.215^{**}$	-	$.183^{**}$	-
Make money	$.186^{**}$	$.162^{**}$	$.153^{*}$	-
Short on cash	$.168^{**}$	$.192^{**}$	$.179^{**}$	$.187^{**}$
Do something thrilling	$.167^{**}$	$.119^{*}$	$.137^{*}$	$.169^{**}$
Typical Friday or Saturday night	$.163^{**}$	$.151^{**}$	$.187^{**}$	-
Have a really good time	$.163^{**}$	-	$.150^{**}$	-
Have fun	$.114^{*}$	$.146^{*}$	$.173^{**}$	-
Feeling anxious	-	-	$.129^{*}$	$.119^{*}$
Feel like celebrating	-	-	$.127^{*}$	$.115^{*}$
Forget worries	-	-	-	-
Feeling bored[a]	-	-	-	-
Feel happy[a]	-	-	-	-
Pass the time[a]	-	-	-	-
In a bad mood	-	-	-	-
Go on vacation	-	$.152^{**}$	-	-
Stressed out	-	-	-	-
Trouble sleeping	-	-	-	$.181^{**}$
After work or school	-	-	-	-
Feeling upset or depressed	-	-	-	-

Note. ** $p < 0.01$ level (2-tailed). $^{*}p < .05$ level (2-tailed). Non-significant correlations suppressed. Items included in the short screen for Study 2 are within the boxes. [a]These items were included in the short-screen due to their relationship with video games (a separate study).

CHAPTER 4. STUDY 2: CANADIAN ONLINE PANEL INVESTIGATING MEMORY ASSOCIATIONS AND GAMBLING

Abstract

Automatic or implicit associations have shown value in being able to predict concurrent and future substance use. Research on gambling is much more limited. That which does exist has tended to utilize attention bias as a measure, and has usually employed small unrepresentative samples. The present study investigated implicit word associations and behavioural associations for 10 words and 10 phrases having ambiguous gambling-related connotations to 3,078 adult online panelists from across Canada that included 388 problem and pathological gamblers. As was found in two prior laboratory-based studies, both implicit measures were significantly and positively related to level of gambling involvement and problem gambling in the general population of Canadians. Also as was found in these prior studies, behaviour associations tended to be stronger than word associations, and association with problem gambling status was stronger than association with level of gambling involvement. This study confirms the potential utility of implicit associations in the assessment, prevention, and treatment of problem gambling.

Introduction

Prevailing cognitive theory assumes that humans are rational decision makers who systematically evaluate possible positive and negative consequences of behaviour. More recent cognitive approaches acknowledge that behaviours may be the result of interaction between two competing cognitive systems: (1) the unconscious and automatic implicit system; and, (2) the conscious and deliberative explicit system (Tversky & Kahneman, 1974; Metcalfe & Mischel, 1999; Stanovich & West, 1997). This implicit system is the "default system" for human decisions, particularly those governing risky judgments.

During the past few decades, major developments in the study of addiction have been made by introducing measures of these implicit processes. A number of measures and approaches have been utilized to assess these processes through implicit memory associations (e.g., Krank & Goldstein, 2006; Rooke, Hine, & Thorsteinsson, 2008; Stacy, 1995, 1997), attentional biases (e.g., Bruce & Jones, 2004; Field & Cox, 2008; Mogg, Bradley, Field, & De Houwer, 2003; Ostafin & Palfai, 2006), and implicit attitudes (e.g., De Houwer, 2003; Houben & Weirs, 2006).

Approaches that assess memory associations obtain unique information about the structure of memory. The key with associative approaches is that the tests do not directly inquire about the target, but rather participants are provided with an ambiguous cue and asked to provide a "top-of-mind" response. These associations are typically measured using word production. Addiction research began using word association methods with the work of Szalay and colleagues (1992) in the early 1990s. These early investigations revealed that the associative structures of drug users versus non-drug users are significantly different.

Memory associations between a behaviour or object and its cues increase in strength with repetition, and it is theorized that this is reflected in implicit associative responses (Stacy, 1995; Stacy, Leigh, & Weingardt, 1994; Szalay, et al., 1993). Cues must be experienced often enough to be encoded, but this need not be first-hand engagement. This experience may be from media exposure, discussion among peers, or being in a setting in which a particular behaviour is performed (Grenard, Dent, & Stacy, 2013; Stacy, Ames, & Leigh, 2004). The key is that repetitions of the same or similar experiences lead to a consistent pattern of activation during those experiences. Subsequent presentation of cues that approximate memories of the previous experiences may then lead to activation of those memories if they are sufficiently encoded in memory (Stacy, 1997) and this activation of one representation can spread to another (Glautier & Spencer, 1999). Collins and Loftus (1975) describe this phenomenon as spreading activation whereby human memory may be thought of as being represented by a network of connected units, and when one is activated this spreads to other linked units. With measures of implicit memory associations we assume that the strongest associates of the cue are picked up, and that memories that are more weakly associated with the stimulus are also activated but have not met the threshold for conscious expression.

Despite findings from the substance use literature pointing to the importance of implicit cognitions in substance use and associated problems (Weirs & Stacy, 2006), their utilization for other behavioural addictions such as problem gambling have not be thoroughly studied. Most of the gambling-related research that does exist has involved attentional bias, with several studies employing variants of the addiction Stroop task (e.g.,Boyer & Dickerson, 2002; McCusker & Gettings, 1997; Molde et al, 2010) (for a comprehensive review see Hønsi, Mentzoni, Molde, & Pallesen, 2013).

To date, only two studies have examined implicit *memory associations* and their relationship to gambling involvement. Stiles et al. (2016) asked 96 adult gamblers recruited from the local community to identify the behaviours or actions that immediately came to mind following a phrase (e.g., "I feel relaxed" or "I have fun"). Individuals who spent more time and money gambling and those with more problematic gambling were found to respond with significantly more gambling-related responses. The second study was Study 1 of the present thesis whereby 494 university undergraduates reported the first word that came to mind for words that were ambiguously related to gambling (e.g., "scratch", "credits") as well as the first behaviour or action that came to mind for various phrases (e.g., "feel lonely", "make money"). A significant positive relationship between number of memory associations and reported level of gambling involvement as well as problem gambling status was found, with behaviour associations being stronger than word associations, and the relationship with problem gambling status being stronger than the relationship with level of gambling involvement.

The present study is an effort to extend and replicate the findings from Stiles et al. (2016) and Study 1 to a larger, more representative sample and to a sample with a greater proportion of heavy gamblers and problem gamblers. Both Stiles et al. (2016) and Study 1 employed convenience samples from the local community (gamblers in the case of Stiles et al. (2016) and university students in the case of Study 1). In addition, the sample size in Stiles et al. (2016) was fairly small, and the percentage of heavy and/or problem gamblers in Study 1 was very low.

Methods

Participants

Between August and September 2016, 4,006 participants were recruited from the LegerWeb online panel, which is Canada's largest online panel. Data from 830 participants were subsequently eliminated as they completed the survey in French. (Although the survey was professionally translated into French, it appears that some of the nuances may have been lost, as the correlations between the word and behavioural associates and levels of gambling and problem gambling were significantly lower in the French sample than among participants who took the survey in English). An additional 98 individuals were eliminated due to incomplete or inaccurate data (i.e., participants that did not complete the survey appropriately, such as inputting random letter sequences or single-letter responses on the associative measures). Thus, the final sample consisted of 3,078 individuals.

The final sample was composed of 48.1% males 51.7% females (0.2% refused to answer). The mean age was 43.93 (SD = 15.82) with a range of 18 to 91. The sample was predominantly from Ontario (43.2%) followed by British Columbia (14.4%), Alberta (13.5%), Quebec (9.0%), Manitoba (7.5%), Saskatchewan (4.2%), Nova Scotia (3.3%), Newfoundland and Labrador (2.2%), New Brunswick (1.6%), and PEI (1.1%).

Procedure

The present study is part of a larger study on the differences and similarities between problem gamblers, problem video game players, and collectible card players. Thus, panelists were sent an e-mail solicitation asking "Do you regularly gamble, play video games, or play collectible card games (e.g., Magic the Gathering; Hearthstone)?" Those who answered affirmatively were then invited to participate in the survey in exchange for monetary compensation and entrance into a monthly prize draw (i.e., the normal rewards offered by LegerWeb).

The survey began with three optional sections assessing gambling, video game play and collectible card play that were only presented to those who had participated in the activity in the past twelve months. These sections were followed by a section on substance and other addictions and a measure of mental health. Next were the behaviour associates and then the word associates and self-coding of responses. (They were placed in the middle of the survey to mitigate against priming effects of the recruitment solicitation). Following the associative tasks were measures on competitiveness, impulsivity, game play characteristics, personality, and social functioning. For the present study, the measures of relevance were the word and behaviour association short screens, measures of gambling involvement (frequency, number of formats engaged in, and spending), and the Problem and Pathological Gambling Measure (Williams & Volberg, 2010, 2014). These measures are described below.

Measures

Behaviour Associate Task. Participants were given 10 phrases that cover common motivational outcomes (e.g. 'have fun', 'make money') for gambling participation (Dechant & Ellery, 2011; Stewart & Zack, 2008) as well as phrases adapted from those used in Frigon and Krank's (2009) work on alcohol and marijuana memory associations. These phrases are contained in Table 6. The phrases utilized were a subset of phrases that had been successfully used in a previous study (Study 1), and were chosen so as to be broadly representative of the larger range of motivational outcomes for both gambling and video gaming and/or their established empirical relationship with gambling and problem gambling in Study 1. Participants were instructed that for each phrase they were to write down the first behaviour or action that came to mind and to work quickly.

Word Associate Task. Participants were given seven words that could be associated with gambling and three words that were not likely to be highly related to gambling. These words are listed in Table 6. All but one of the gambling-related words were a subset of words that had been successfully used in a previous study (Study 1), and were chosen so as to be generically related to all types of gambling and/or their established empirical relationship with gambling and problem gambling in Study 1. Participants were provided with the prompt: “For the following set of words, please write down the VERY FIRST word or phrase that comes to mind after reading each word. For example: salt: pepper. Remember to respond with the FIRST word or phrase that "pops to mind." Work quickly!”

Table 6. Word and Behaviour Associates Selected for Study 2.

Word Associates	
Gambling-Related Words	Control Words
Game	Character
Twenty-one	Level
Ticket	Achievement
Money	
Streak	
Win	
Skill	
Behaviour Associates	
Make money	
Short on cash	
Do something thrilling	
Typical Friday or Saturday Night	
Have a really good time	
Have fun	
Feeling anxious	
Feeling bored	
Feel happy	
Pass the time	

Note: some of these 'control words' were words thought to be more related to video game play than gambling.

Self-Coding of Associative Measures. The self-coding procedures were adapted from those developed by Frigon & Krank (2009). Responses to all word and behaviour associates were presented with their original cues and participants were asked to select all those categories associated with their response, with the choices being: recreation/leisure, gambling, food, alcohol, family/friends, video games, collectible cards, and other. If a response was coded as including gambling it was assigned a score of one, otherwise it was assigned a zero. A composite score was then created for both the word associates (possible range of 0-7) and behaviour associates (possible range of 0-10).

Level of Gambling Involvement. Participants were asked about their frequency and expenditure on each of 11 different types of gambling in the past 12 months (raffle and fundraising tickets, instant lottery tickets (scratch cards), lottery tickets, sports betting, horse race betting, casino table games, bingo, slot machines or video lottery terminals, social betting on games of skill, internet gambling, purchasing high-risk stocks). Response options were provided for frequency (ranging from 0 = never, to 6 = daily or almost daily), whereas the response for expenditure was open-ended. The specific question wordings and response options employed have been demonstrated to be both reliable and valid in the assessment of gambling participation (Williams et al., 2017). Composite measures were created reflecting a) total number of gambling formats engaged in (ranging from 0 – 10; b) maximum frequency of gambling reported for any format; and c) average net monthly spending on all forms of gambling. Due to the large and significant skew of expenditure value, this variable was subsequently recoded into four categories: 0 = $0, 1 = $1-100, 2 = $101-200, 3 = $201+.

Problem and Pathological Gambling Measure. The PPGM is a 17-item instrument that assesses past year problem gambling symptomatology and classifies people into one of four categories: recreational gambler, at-risk gambler, problem gambler, or pathological gambler (Williams & Volberg, 2010, 2014). It has very good internal consistency, test-retest reliability, convergent and discriminative validity, and excellent classification accuracy relative to clinical assessment for both treatment-seeking and non-treatment seeking problem gamblers (Back et al., 2015; Williams & Volberg, 2010, 2014).

Results

Level of Gambling and Problem Gambling

There was considerable gambling involvement with 79.6% of the sample having gambled at least once over the past 12 months and 69.6% reported gambling regularly (once a month or more). More specifically, a total of 20.4% (n = 629) reported having not gambled in the past year, 10% (n = 309) gambled less than monthly, 17.7% (n = 544) 1 to 2 times per month, 23.7% (n = 728) 3 to 4 times per month, 20.2% (n = 623) a few times per week, and 8.0% (n = 245) daily or almost daily over the past 12 months. The majority of the sample (51.9%, n = 1599) reported spending an average of $1-100 per month, 21.3% ($n$ = 656) reported an average of $0 per month, 11% ($n$ = 339) reported spending between $101-200 per month, and 15.7% (n = 484) spent $201 or more per month. The average number of formats engaged in averaged 2.98 (*SD* = 2.29).

There were also high rates of problem gambling, with the sample consisting of 629 non-gamblers, 1412 recreational gamblers, 649 at-risk gamblers, 151 problem gamblers, and 237 pathological gamblers.

Memory Associations

The word associates items had a Cronbach alpha of .703, while the behaviour associates had a Cronbach alpha of .805. The Kendall tau-b association between the two implicit measures was .393 ($p < .01$).

Relationship between Implicit Memory Associations and Gambling

Correlational analyses were conducted to assess the relationship between the associative measures and the measures of gambling involvement and PPGM classification. Due to the presence of a large and significant skew on the behaviour associates task, non-parametric Kendall's tau-b correlations were conducted. As seen in Table 7, significant positive correlations were found between both of the associative measures and all measures of gambling involvement as well as with PPGM classification and score. In all cases, the magnitude of the correlations was fairly modest (ranging from

.279 to .388). [Note: for illustrative purposes and comparisons to Stiles et al. (2016) Pearson r correlations are also presented. Also, for illustrative purposes the correlations between the associates and PPGM total score is presented. As can be seen, they tend to be lower than the PPGM classification correlations, which is why the latter is used exclusively in the other analyses.]

Table 7. Means, Standard Deviations, and Kendall tau-b Associations for Associate Measures, Measures of Gambling Involvement, and PPGM Classification in Study 2.

			Correlations						
Measure	*M*	*SD*	1.	2.	3.	4.	5.	6.	7.
1. Word Associate Score	1.83	1.79	-						
2. Behaviour Associate Score	0.70	1.47	.393**	-					
3. Gambling Frequency[a]	2.37	1.59	.287**	.294**	-				
4. Number of Formats	2.98	2.29	.284**	.279**	.568**	-			
5. Average Monthly Spending[b]	1.21	0.95	.286**	.364**	.638**	.572**	-		
6. PPGM Classification[c]	1.34	1.09	.325**	.388**	.625**	.565**	.702**	-	
7. PPGM Score	1.11	2.39	.262**	.365**	.339**	.325**	.424**	.753**	-

Means, Standard Deviations, and Pearson r Associations for Associate Measures, Measures of Gambling Involvement, and PPGM Classification in Study 2.

			Correlations						
Measure	*M*	*SD*	1.	2.	3.	4.	5.	6.	7.
1. Word Associate Score	1.83	1.79	-						
2. Behaviour Associate Score	0.70	1.47	.493**	-					
3. Gambling Frequency[a]	2.37	1.59	.369**	.316**	-				
4. Number of Formats	2.98	2.29	.361**	.318**	.682**	-			
5. Average Monthly Spending[b]	1.21	0.95	.341**	.387**	.691**	.611**	-		
6. PPGM Classification[c]	1.34	1.09	.391**	.457**	.659**	.583**	.680**	-	
7. PPGM Score	1.11	2.39	.280**	.471**	.345**	.319**	.435**	.805**	-

Note. Numbers in the correlations columns correspond to the numbered measures. [a]Frequency Scale: 0 = never, 1 = less than once a month, 2 = 1-2 times a month, 3 = 3-4 times per month, 4 = a few times a week, 5 = daily or almost daily. [b]Spending: 0 = \$0, 1 = \$1-100, 2 = \$101-200, 3 = \$201+. [c]PPGM Classification: 0 = non-gambler, 1 = recreational gambler, 2 = at-risk gambler, 3 = problem gambler, 4 = pathological gambler. $^{**}p < .01$.

Tau correlation coefficients were converted to *r* according to Walker (2003). Comparison of the correlation coefficients using asymptotic z tests found the behaviour associate correlations to be significantly higher than the word associate correlations for average monthly spending (p <.001, 1 tail), PPGM classification (p <.001., 1 tail), and PPGM score (p <.001., 1 tail), but not gambling frequency (p = .245, 1 tail), or number of gambling formats (p = .479, 1 tail).

Within the word associates the correlation with PPGM classification was significantly higher than the correlation for gambling frequency (p <.001, 1 tail), number of formats (p <.001, 1 tail), and gambling spending (p <.001, 1 tail). Within the behaviour associates, the correlation with PPGM classification was also significantly higher than the correlation for gambling frequency (p < .001, 1 tail), number of formats (p < .001, 1 tail), and gambling spending (p < .001, 1 tail).

Tables 8 and 9 show the individual item correlations with level of gambling involvement and problem gambling.

Table 8. Pearson Correlations between Individual Behaviour Associate Items and Measures of Gambling Involvement and Problem Gambling in Study 2.

	PPGM Classification	Gambling Frequency	Number of Gambling Formats	Gambling Spending
Feeling bored[a]	.328**	.224**	.212**	.270**
Make money	.308**	.240**	.192**	.238**
Have fun	.298**	.232**	.241**	.264**
Short on cash	.294**	.189**	.182**	.241**
Feel happy[a]	.284**	.177**	.147**	.224**
Pass the time[a]	.277**	.187**	.191**	.235**
Have a really good time	.266**	.205**	.219**	.237**
Do something thrilling	.265**	.184**	.210**	.240**
Feeling anxious	.257**	.140**	.138**	.182**
Typical Friday or Saturday night	.249**	.192**	.197**	.231**

Note. **. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed). Non-significant correlations suppressed. [a]These items were included due to their relationship with video games (a separate study).

Table 9. Pearson Correlations between Individual Word Associate Items and Measures of Gambling Involvement and Problem Gambling in Study 2.

	PPGM Classification	Gambling Frequency	Number of Gambling Formats	Gambling Spending
Money	.314**	.228**	.228**	.240**
Game	.289**	.268**	.240**	.272**
Win[a]	.277**	.277**	.251**	.248**
Achievement[a]	.265**	.177**	.198**	.194**
Streak	.238**	.235**	.233**	.211**
Ticket	.214**	.255**	.212**	.184**
Skill[a]	.211**	.155**	.187**	.164**
Level[a]	.176**	.132**	.111**	.129**
Character[a]	.153**	.101**	.103**	.108**
Twenty-one	.131**	.135**	.178**	.132**

Note. **. Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed). Non-significant correlations suppressed. [a]These items were included due to their relationship with video games (a separate study).

The average word associate score for the 388 problem and pathological gamblers was 3.03 (*SD* = 2.11; range of 0 to 7) whereas the average word associate score for the 2051 non-gamblers and recreational gamblers was 1.39 (*SD* =1.51; range of 0 to 7). The average behaviour associate score for the 388 problem and pathological gamblers was 2.22 (*SD* = 2.41; range of 0 to 9) whereas the average behaviour associate score for the 2051 non-gamblers and recreational gamblers was 0.31 (*SD* = 0.84; range of 0 to 9). Using a cut score of 2 on the word associates 276/388 (71.1%) of problem and pathological gamblers would have been accurately classified and 1254/2041 (61.4%) of non-gamblers and recreational gamblers. Using a cut score of 1 on the behaviour associates, 265/388 (68.3%) of problem and pathological gamblers would have been accurately classified and 1687/2041 (82.7%) of non-gamblers and recreational gamblers would have been correctly classified.

Discussion

Research has increasingly used associative memory concepts and measures when investigating addictive behaviours (Kelly, Masterman, & Marlatt, 2005; Krank, Schoenfeld, & Frigon, 2010). Recent lines of inquiry have sought to determine whether associative memory processes are also present and influence problem gambling behaviours. This study adapted measures from Study 1 in order to develop two brief screening instruments for a national online panel of the Canadian population. Self-coding procedures were utilized in order to disambiguate responses and based on findings that this process demonstrates greater correlations with behaviour when compared to researcher coding methods (Frigon & Krank, 2009; Krank, Shoenfeld, & Frigon, 2010). Self-coding also had the added benefit of saving considerable time and resources over traditional coding with two independent raters.

The findings of this study reaffirm that measures of implicit memory associations positively and robustly correlate with gambling involvement and problem gambling status in the general Canadian population. These relationships were significant across all measures of gambling involvement and problem gambling status and were evidenced with a much shorter list of items than employed in Study 1. Importantly, when examining the concurrent relationship between memory associations and problem gambling there was a greater correlation with behaviour associates over word associates. A likely explanation for this result is that word associations tap into the lexical facets of implicit memory, while behaviour associations tap into the actual underlying associations that shape behaviour (Stacy, Ames, & Grenard, 2006).

Similarly, as was found in Study 1, implicit associations with problem gambling status were stronger than associations with level of gambling involvement. That being said, in general, the ability of the implicit associations in the present study to discriminate between problem and non-problem gamblers was fair to good. Using a cutoff of 2, the word associates had a fair degree of sensitivity (68%) but very good specificity (83%). Using a cutoff of 1, the behaviour associates had a fair degree of sensitivity (72%), but relatively low specificity (61%). Nonetheless, further research might indicate that the non-problem gamblers who fell above the cut range may be at risk for future problem gambling or potentially be problem gamblers in denial.

It is important to consider the limitations of this study for future research. One is the issue of priming, as participants were informed that it was a study of gambling and video game play. Furthermore, the first section of the survey contained several questions on both gambling and video game play. Although priming is certainly a possibility in the present study, it was constant across all participants and does not obviate the fact that heavier gamblers and problem gamblers nonetheless still reported significantly more gambling-related cognitions. It is possible that the number and frequency of gambling-related cognitions may have been somewhat less without priming. However, what this study illustrates is that priming does not interfere with this relationship, and may be a procedure that could be utilized to *enhance* it.

A second issue concerns the item choices for both the word associates and the behaviour associates. As was the case with Study 1, a different choice of items would likely have affected the magnitude of the correlation coefficients to some extent.

Finally, this study only examined concurrent relationships, which limits our ability to draw causal inferences. Future studies will need to look at the role of memory associations longitudinally in order to understand whether memory associations are a cause or a consequence of problem gambling.

CHAPTER 5: GENERAL DISCUSSION AND CONCLUSIONS

The purpose of this thesis was to a) develop measures to capture and quantify implicit memory associations in gambling, and b) identify the presence and magnitude of these implicit associations as it relates to a person's level of gambling involvement and problem gambling. In contrast to the well-established importance of implicit associations with substance-related addictions, there is much less literature with respect to gambling, and only one prior study specifically investigating implicit memory associations (i.e., Stiles et al., 2016). To enhance the understanding of these implicit processes as they relate to gambling, the studies contained in this research were designed to develop methods of measuring memory associations for gambling.

Summary of Findings

Study 1: Development of Two Measures of Implicit Associations for Gambling

In the first study, methods were developed to tap into two different facets of associative memory by assessing ambiguous word associations and outcome-behaviour associations. A 38 measure of word associates was developed to assess both format specific associations (e.g., cherry → slot machine; scratch → instant lottery tickets) and more generally related to gambling (e.g., game, win). A total of 21 behaviour associates were developed using common motives for engaging in gambling (e.g., have fun, make money). These measures were administered to a convenience sample of 494 university students to examine the relationship between reporting gambling-related implicit associations and the person's level of gambling involvement and problem gambling. Consistent with the hypothesis, there was a significant positive relationship between number of word and behaviour associations reported and level of gambling involvement as well as problem gambling status. Behaviour associations were stronger than word associations, and associations with problem gambling status were also stronger than associations with level of gambling involvement. The ability of both the word and behavioural associates to distinguish between PPGM identified problem versus non-problem gamblers was fair to good.

Study 2: Canadian Online Panel Investigating Memory Associations and Gambling

Study 2 endeavoured to replicate the findings of Study 1 with shorter measures (10 word associates and 10 behaviour associates) and on a more representative national sample of 3,078 Canadians that included a higher proportion of heavy gamblers and problem gamblers. Items were chosen largely from the original pool of items used in Study 1. Participants were given the two 10 item screening measures in the middle of a larger study/survey looking at the relationship between problem gambling, problem video game playing, and collectible card play. All of the findings in Study 1 were replicated in Study 2.

Integration of Study Findings

Taken together, the results of the two studies confirm that implicit memory associations exist with gamblers and are present to a greater degree in heavier gamblers and problem gamblers. Not surprisingly, behaviour associations had a stronger relationship with level of gambling and problem gambling status than did word associations. This is likely due to the fact that many people (including non-gamblers) will have automatic word associations to words with potential gambling-related connotations (e.g., scratch, chips). On the other hand, it is more likely to be regular gamblers who spontaneously report gambling-related behaviours in response to generic phrases such as ‘make money’, and ‘have a really good time’. It is also interesting and important to note that gambling-related associations were more likely to be reported by problem gamblers compared to people with high levels of gambling involvement. The basis for this result is uncertain, but it does reaffirm the potential utility of these implicit associations being used in the assessment of problem gambling. Of final note, implicit memory associations show some ability to discriminate between problem gamblers and non-problem gamblers and thus may have some utility in assessment.

Limitations

There are several important limitations to the studies included in this thesis, some of which have already been addressed. First, both studies were cross-sectional in nature, meaning only concurrent relationships could be analyzed. No study to date has established that implicit memory associations have a causal role for gambling, so it is unclear if they are a cause or a consequence of increased gambling involvement.

A second limitation is that it is impossible to guarantee that participants were responding with top-of-mind responses. It is quite possible that some participants may have filtered their responses due to social desirability biasing (Stacy, 1997; Stacy, Leigh, & Weingardt, 1997) or alternatively, may have produce words and behaviour that were congruent with the perceived demand characteristics of the task.

A third limitation is that priming may have inflated the number of gambling responses, and potentially to a greater degree in gamblers relative to non-gamblers. Both studies made efforts to reduce or avoid priming, but it still may have occurred to some extent.

A fourth limitation is that these measures are based on word production, meaning that language must be taken into account. For both studies participants who did not indicate English as their first language were excluded. This is because, with the word associates in particular, cues are developed based on ambiguity. Those who are not familiar with English language, and colloquial or "slang" usage of words may not view the cues as ambiguous. Because of this, it limits these results to those who speak English and potentially just to Canadians to some extent, as slang and colloquial usage can vary by region.

A fourth limitation concerns the implication that word and behaviour associations tap into unconscious processing. It would have been useful to include explicit cognitive measures of gambling such as outcome expectancies (Gillespie, Derevensky, & Gupta, 2007; Stewart & Wall, 2005) or motives (Dechant & Ellery, 2011; Stewart & Zack, 2008) in order to evaluate whether there is any mismatch between responses.

A fifth limitation involves the theoretical framework that both studies are based upon. Both studies are based on theories that behaviours may be the result of interaction between competing conscious and unconscious cognitive systems (Tversky & Kahneman, 1974; Metcalfe & Mischel, 1999; Stanovich & West, 1997). While this framework is widely endorsed, there is some debate as to whether memory can be conceptualized using a two-system framework (e.g. Evans, 2008, 2012). In particular it has been argued that a two system framework may be over simplifying memory and lead to fallacies surrounding how memory systems function.

A final issue concerns the use of self-coding. Although the original presentation of both measures is indirect, with no mention of the target (i.e., gambling), the coding procedures require explicit evaluations with reference to the target (Frigon & Krank, 2009; Krank, Schoenfeld, & Frigon, 2010). This reference to the target may in turn have primed participant's responses to favor gambling categorizations when they were ambiguous.

Implications and Future Directions

The findings from the studies included in this thesis have a number of important implications. First, the present findings provide additional evidence for the application of the theory of dual-processes to the understanding of gambling behaviour and gambling problems, a line of inquiry that has only recently been suggested among addiction researchers (see Evans & Coventry, 2006). Previous research has already demonstrated that explicit cognitions have an important role in gambling by assessing such factors as motives (Dechant & Ellery, 2011; Stewart & Zack, 2008) and outcome expectancies (Gillespie, Derevensky, & Gupta, 2007; Stewart & Wall, 2005). The studies contained in this thesis provide support for the role of the implicit cognitions. Indeed, in both studies memory associations were found to significantly correlate with both gambling behaviours (frequency, spending, and formats) and problem gambling status. Given the paucity of research on implicit cognitions and gambling in general and implicit memory associations and gambling more specifically, the results of this thesis provide an important framework for future research investigating the role of implicit memory associations in gambling.

Second, based on the findings from both studies, it appears word and behaviour associations may tap into different forms of associative memory that differentially affect problem gambling. Specifically, behaviour associations appear to be more common with problem gamblers than word associations. Given that this was found using both the short-screen and the full inventory of items, it seems to lend support to the idea that word associations tap into more of the lexical stream of memory while behaviour associations give insight to the associations that underlie behaviours (Stacy, Ames, & Grenard, 2006).

Third, implicit associations may be a viable target for both prevention and treatment. In a study by Krank (2010), youth were assessed over a five-year period beginning in grade seven. Participants were divided into groups based on the number of alcohol-related word associations they had at initial assessment. The findings revealed that those who had more than two alcohol-related cognitions in grade seven subsequently consumed more alcohol at one, two, three and four-year follow-ups than those with either one to two or no alcohol-related memory associations. So far, no study has longitudinally assessed associations for gambling and the potential for predicting future gambling engagement, however the findings of the studies contained in this thesis suggest that a similar relationship may exist. In particular, with the results of Study 1, despite there being a significant number of non-gamblers and relatively light gambling engagement, there was significant endorsement of ambiguous word associations for gambling (M = 5.66, SD = 3.53). This result demonstrates that ambiguous word associations for gambling can exist in the absence of gambling engagement and may be indicative of a potential risk factor for future gambling problems.

In a similar way, longitudinal research has shown that problem gambling has a high risk of relapse (Williams, Hann et al., 2015). The factors that promote relapse are not entirely clear, but it seems plausible that having implicit behavioural associations would likely be a risk factor and therefore a target for intervention.

Indeed, Stacy, Ames & Leigh (2004) and Ames et al. (2007) suggest that there may be significant benefit in trying to create different implicit associations in order for it to compete with the strong previously learned associations and habits. Cues can bring to mind any number of behaviours. However, if alcohol use is what immediately comes to mind when presented with a cue, then researchers, in conducting an intervention, might want to target and change these associations so that alternative behaviours spontaneously come to mind. Recently there has been growing attention to the utility of developing 'implementation intentions' to influence subsequent drinking patterns and on preventing uptake of smoking (e.g., Armitage, 2009; Hagger et al. 2012). Implementation intentions are used to help with the execution of goal intentions through the selection of specific situational cues (e.g., "On a Friday night") and developing pre-determined actions (e.g., "I will order pop") for those cues (Gollwitzer, 1999). Conner and Higgins (2010) were able to demonstrate that a short intervention performed every 4 months over a 2-year period, implementation intentions significantly reduced self-reported smoking behaviour. These studies demonstrate the utility of implanting new associations into memory so that they may be enacted through the reactive system. Despite attempts to directly influence implicit processes being in their infancy, the outlook is promising and is implicated to making major improvements to existing prevention and treatment programming. Stacy, Ames, & Grenard (2006) suggest that if an intervention is able to influence these implicit associations, they may more readily transfer to everyday life, and influence behaviour relatively spontaneously.

A fourth implication concerns assessment. Traditional assessment typically employs techniques of free recall, cued recall, and recognition by talking and asking questions; the key feature being that they all rely on conscious recollection. However, this does not take into account the fact that some individuals are unable to explain their uncontrollable behaviours because they are unaware of their implicit response (Yen et al., 2011). By measuring implicit processes there are a number benefits that may enhance traditional assessments. First, implicit measures reveal stable attitudes and cognitions regarding the target behaviour (Preece, 1978; Schnabel & Asendorpf, 2013; Szalay & Deese, 1978). Because the implicit system is derived from learning, and responds automatically, these processes are less likely to be disrupted, and thus allow us to tap into these underlying stable structures. Second, because there is a degree of stigma attached to addictive behaviours, we cannot be certain that participants are not being deceptive in order to appear more socially desirable with traditional methods of evaluation (Brown, Kranzler, & Del Boca, 1992; Williams & Nowatzki, 2005). Third, traditional measurement often requires much insight about behaviour, something that is lacking in many addicts (Martínez-González, Vilar López, Becoña Iglesias, & Verdejo-García, 2016). Finally, assessment of these processes may provide the opportunity to monitor treatment progress and outcomes (Szalay, et al., 1993). Because of the stable nature of implicit processes, they may provide insight into those most at risk of relapse and be an ideal target for future therapeutic advancements. Measurement of these processes within clinical settings would enhance the understanding of the non-reflective side of cognition and addiction.

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