Addictive Behaviors 92 (2019) 47–52

Contents lists available at ScienceDirect

Addictive Behaviors

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

The relationship between memory associations, gambling involvement, and problem gambling

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HIGHLIGHTS

- Data for 3078 Canadians, including 388 problem or pathological gamblers, was analyzed.
- Two 10-item measures of memory associations tested: behaviour and word associates
- Significant correlations for memory associations with gambling and problem gambling
- Behaviour associations tended to have a stronger relationship with gambling over words.

ARTICLE INFO

Keywords:
Implicit
Memory associations
Gambling
Problem gambling

ABSTRACT

The current study aimed to examine the relationship between implicit memory associations, gambling involvement, and problem gambling in a large representative group of Canadian adults. The sample consisted of 3078 (48.1% males, mean age 43.93, *SD* = 15.82) adult online panelists from across Canada that included 388 problem and pathological gamblers. Memory associations were assessed using a 10-item measure of word associations and a 10-item measure of behavioural associations. Gambling involvement was assessed via self-report of involvement, and problem gambling was assessed using the Problem and Pathological Gambling Measure (PPGM). Significant associations were found between measures of memory associations and both level of gambling involvement and problem gambling, with the magnitude of the correlations ranging from 0.262 to 0.388. Behavioural associations tended to have a stronger relationship with gambling involvement and problem gambling than word associations. The results of this study suggest that implicit associations may have utility in the assessment of problem gambling.

1. Introduction

Associations that people spontaneously report in response to certain words or phrases ('implicit memory associations') may provide information about their interest and engagement in certain activities that might not have been detected if they had been directly asked. These implicit associations may be particularly useful in the study of addictions, where social desirability, forgetting, and self-denial are known to compromise valid self-report.

The substance use literature has established the importance of implicit cognitions in predicting substance use and associated problems (Wiers & Stacy, 2006). A number of measures and approaches have been utilized including attentional bias (e.g., Bruce & Jones, 2004; Field & Cox, 2008; Mogg, Bradley, Field, & De Houwer, 2003), memory biases (e.g., De Houwer, 2003; Houben & Wiers, 2006; Krank & Goldstein, 2006; Stacy, 1995, 1997), and approach/avoidance tendencies (e.g., Wiers, Rinck, Kordts, Houben, & Strack, 2010). Rooke, Hine, and Thorsteinsson (2008) evaluated 89 studies with nearly 20,000 participants to estimate the magnitude of the relationship between substance-related implicit cognitions and the use of legal and illegal substances. The 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. Comparatively little research has been done in the field of gambling, and that which does exist has tended to utilize attentional bias (for a review see Hønsi, Mentzoni, Molde, & Pallesen, 2013) and more recent expansion into approach and avoidance tendencies (e.g., Boffo et al., 2018).

Approaches that assess memory associations obtain unique information about the structure of memory. The key with associative approaches is that these tests do not directly inquire about the target,

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https://doi.org/10.1016/j.addbeh.2018.12.015
Received 9 August 2018; Received in revised form 10 December 2018; Accepted 11 December 2018
Available online 14 December 2018

but rather provide an ambiguous cue and ask for a "top-of-mind" response. Two of the most predominant methods that have been used are ambiguous word associations and outcome-behaviour associations. Ambiguous word associations require the participant to list the first word that comes to mind in response to a cue word or phrase based on based on paraphernalia that are related to the behaviour or terminology often used to refer to the behaviour (Szalay, Carroll, & Tims, 1993). Outcome-behaviour associations are form of controlled word association that require a verb, action, or behaviour in response to a prompt. Prompts are often situational or emotional outcomes for a particular behaviour, and it is proposed that mere presentation of a written outcome can lead individuals to think about the target behaviour if it is the most salient response in memory (Stacy, Leigh, & Weingardt, 1994).

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. Russell, Williams, and Vokey (submitted) employed a sample of 494 university undergraduates to report 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 the relations 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 Russell, Williams, and Vokey (submitted) 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 Russell et al. (submitted) employed convenience samples from the local community (gamblers in the case of Stiles et al. (2016) and university students in the case of Russell et al. (submitted)). In addition, the sample size in Stiles et al. (2016) was fairly small, and the percentage of heavy and/or problem gamblers in Russell et al. (submitted) was very low. Furthermore, we endeavored to further examine differences between word and behavioural associates and whether there are differences in the relationships they have with measures of gambling involvement or problem gambling. In order to best achieve the study's goals we employed two short-form measures of word and behaviour associations to reduce participant burden. We also integrated the self-coding techniques developed by Frigon and Krank (2009) so as to reduce potential ambiguity in participant responses and as more a practical and efficient method of dealing with open-ended responses.

2. Methods

2.1. Participants

Between August and September 2016, 3176 English-speaking participants were recruited from the LegerWeb online panel, which is Canada's largest online panel. The panel is composed of thousands of Canadian adults who have been recruited to respond to regular survey requests in exchange for monetary compensation and recruitment is demographically structured to be representative of the general population. Data from 98 participants was subsequently 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 3078 individuals.

The sample was composed of 48.1% males and 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%).

2.2. Procedure

The present study was 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.

2.3. Measures

2.3.1. Behaviour associate task

Participants were given ten 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. The phrases utilized were a subset of phrases that had been successfully used in a previous study (Russell et al. (submitted)) 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. 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.

2.3.2. 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. All but one of the gambling-related words were a subset of words that had been successfully used in a previous study (Russell et al. (submitted)) 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. 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!"

2.3.3. Self-coding of associative measures

The self-coding procedures were adapted from those developed by Frigon and Krank (2009). Responses to all word and behaviour associates were presented with their original cues and participants were

Table 1
Means, Standard Deviations, and Kendall tau-b associations for associate measures, measures of gambling involvement, and PPGM classification.

			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	0.393**	–					
3. Gambling frequency[a]	2.37	1.59	0.287**	0.294**	–				
4. Number of formats	2.98	2.29	0.284**	0.279**	0.568**	–			
5. Average monthly spending[b]	1.19	0.92	0.292**	0.365**	0.635**	0.581**	–		
6. PPGM classification[c]	1.34	1.09	0.325**	0.388**	0.625**	0.565**	0.707**	–	
7. PPGM score	1.11	2.39	0.262**	0.365**	0.339**	0.325**	0.425**	0.753**	–

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.
** $p < .01$.

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).

2.3.4. 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 5 = 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, Volberg, Stevens, Williams, & Arthur, 2017). Composite measures were created reflecting a) total number of gambling formats engaged in (ranging from 0 to 11); 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 positive skew of expenditure value, this variable was subsequently recoded into four categories: 0 = $0, 1 = $1–100, 2 = $101–200, 3 = $201 + .

2.3.5. Problem and pathological gambling measure

The PPGM is a 14-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 discriminant validity, and excellent classification accuracy relative to clinical assessment for both treatment-seeking and non-treatment seeking problem gamblers (Back, Williams, & Lee, 2015; Williams & Volberg, 2010, 2014).

3. Results

3.1. 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 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 (52.0%, $n = 1599$) reported spending an average of $1–100 per month, 21.3% ($n = 656$) reported an average of $0 per month, 11.0% ($n = 339$) reported spending between $101–200 per month, and 15.7% ($n = 484$) spent $201 or more per month. The average number of gambling formats engaged in was 2.98 ($SD = 2.29$).

There were also high rates of problem gambling, with the sample consisting of 629 non-gamblers (20.4%), 1412 recreational gamblers (45.9%), 649 at-risk gamblers (21.1%), 151 problem gamblers (4.9%), and 237 pathological gamblers (7.7%).

3.2. Memory associations

The word associates items had a Cronbach alpha of 0.703, while the behaviour associates had a Cronbach alpha of 0.805. The Kendall tau-b association between the two implicit measures was 0.393 ($p < .01$).

3.3. 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 positive skew on the behaviour associates task, non-parametric Kendall's tau-b correlations were conducted. As seen in Table 1, 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 were medium in size (ranging from 0.262 to 0.388).

Comparison of the correlation coefficients using asymptotic z tests (1 tail) found the behaviour associate correlations to be significantly higher than the word associate correlations for average monthly spending ($p < .001$), PPGM classification ($p < .001$), and PPGM score ($p < .001$), but not gambling frequency ($p = .354$), or number of gambling formats ($p = .395$). Furthermore, the correlations between measures of implicit associations and PPGM classification (i.e., 0.325 for Word Associates and 0.388 for Behaviour Associates) were significantly larger than the comparable correlations between measures of implicit associations and measures of gambling involvement: Word Associates: average monthly spending ($p < .01$), gambling frequency ($p < .01$), number of formats ($p < .01$); Behaviour Associates: average monthly spending ($p < .05$), gambling frequency ($p < .001$), number of formats ($p < .001$).

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 2041 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 2041 non-gamblers and recreational gamblers was 0.31 (SD = 0.84; range of 0 to 9). Using a combined cut-off score of 1 on either the word associates or behaviour associates scale 349/388 (89.95%) of the problem and pathological gamblers would have been accurately classified and 755/2041 (36.99%) of non-gamblers and recreational gamblers would have been correctly classified. Using Cohen's kappa there was slight agreement between measures, $\kappa = 0.117$, $p < .001$. If the constraint is added that you must gamble at least 1–2 times per month (a requirement of the PPGM to be identified as a problem gambler) as well as have a score of 1 or more on either of the associate scales, 349/388 (89.95%) of the problem and pathological gamblers would have been accurately classified and 1256/2041 (61.54%) of non-gamblers and recreational gamblers would have been correctly classified. With this, Cohen's kappa improved to fair agreement between measures, $\kappa = 0.289$, $p < .001$.

A final analysis involved simultaneous multiple regressions to better establish the unique and relative contributions of different measures of gambling involvement and problem gambling to implicit associations. Word and behaviour associate scores were first screened for outliers and violations of normality to meet the assumptions of simultaneous multiple regression analysis. There was a severe positive skew on both variables that was corrected with an inverse transformation. These transformations brought the variables closer to normality, however, the skew could not be eliminated. Additionally, 17 multivariate outliers were eliminated from the analyses resulting in a final sample of 3061. Table 2 shows the results of the regression analysis for word associate scores and Table 3 shows the same results for behaviour associate scores. For word associate scores, R was significantly different from zero, $F(4, 3060) = 144.25$, $p < .001$, and three variables contributed significantly to the prediction of increased word associate score: PPGM classification ($sr_i^2 = 0.0123$), gambling frequency ($sr_i^2 = 0.0074$), and number of gambling formats ($sr_i^2 = 0.0092$). For the behaviour associate scores, R was also significantly different from zero, $F(4, 3060) = 246.31$, $p < .001$, and three variables contributed significantly to the prediction of increased behaviour associate score: gambling spending ($sr_i^2 = 0.0114$), number of gambling formats ($sr_i^2 = 0.0019$), and PPGM classification ($sr_i^2 = 0.0511$). Altogether, 15.8% of the variability in word associate scores and 24.3% of the variability in behaviour associate scores was predicted by knowing all four of the independent variables.

The results of these multiple regressions largely confirm the findings from the univariate analyses: that behavioural associates have a stronger relationship with the gambling outcomes relative to word associates and that measures of problem gambling tend to have somewhat stronger relationships than measures of gambling involvement.

4. 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 Russell et al. (submitted) 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 et al., 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 by Russell et al. (submitted). 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 with Russell et al. (submitted), implicit associations with problem gambling status were stronger than associations with level of gambling involvement. The basis for this is uncertain, but may be due to gambling-related cognitions being more pervasive and prominent among problem gamblers. In general, the ability of the implicit associations in the present study to discriminate between problem and non-problem gamblers was fair to excellent. Using a cutoff of 1 on either the word or behaviour associates had excellent sensitivity (90%) but very low specificity (37%). By adding the constraint that the participant must participate in gambling at least 1–2 times per month (an actual requirement of the PPGM to be identified as a potential problem gambler) as well as have cutoff of 1 on either of the associates resulted in excellent sensitivity (90%), and increased the specificity to 69%. This relatively low specificity may not be a concern, as future research may find that non-problem gamblers who were incorrectly identified as problem gamblers based on their implicit associations may be at greater risk for future problem gambling.

It is important to consider the limitations of this study. One is the issue of priming, as participants were informed that it was a study of gambling and video game play and the first section of the survey contained several questions on both gambling and video game play. We attempted to mitigate this issue by embedding the associative measures in the middle of the survey after a measure of mental health. Although priming is certainly a possibility in the present study it does not obviate the fact that heavier gamblers and problem gamblers nonetheless still

Table 2
Simultaneous multiple regression of word associate score with measures of problem gambling and gambling involvement.

	B	SE	β	sri^2
PPGM classification	−0.021	0.003	−0.168***	0.0123
Gambling frequency	−0.012	0.002	−0.138***	0.0074
Number of gambling formats	−0.008	0.001	−0.139***	0.0092
Average monthly spending	−0.002	0.004	−0.012	0.0000
Constant	0.403***	0.004		

$R = 0.399$; adjusted $R^2 = 0.158$; $^{**}p < .01$.
Note. An inverse transformation was applied to word associate scores prior to analysis, so β coefficients should be interpreted with caution.
*** $p < .001$.

Table 3
Simultaneous multiple regression of behaviour associate score with measures of problem gambling and gambling involvement.

	B	SE	β	sri^2
PPGM classification	−0.037	0.003	−0.343***	0.0511
Gambling frequency	0.003	0.002	0.036	0.0005
Number of gambling formats	−0.003	0.001	−0.064**	0.0019
Average monthly spending	−0.022	0.003	−0.169***	0.0114
Constant	0.507***	0.003		

$R = 0.494$; Adjusted $R^2 = 0.243$.
Note. An inverse transformation was applied to behaviour associate scores prior to analysis, so β coefficients should be interpreted with caution.
** $p < .01$.
*** $p < .001$.

reported significantly more gambling-related cognitions. Additionally, gambling was the first presented "optional" section (only presented to those who do gamble), subsequent sections addressed video games and collectible card play which were also related to many of the word associate cues and all of the behaviour associates. As well a section on substance use was included that is related to many of the behaviour associate cues that were originally developed for substance use research. 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. 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. Recently there has been research emerging testing the efficacy of targeting implicit associations to change gambling behaviours and problem gambling (Boffo, Willemen, Pronk, Wiers, & Dom, 2017). Future studies will need to look at the role of memory associations longitudinally in order to understand the temporal relationship between memory associations and problem gambling and gambling involvement and whether there could be any therapeutic or preventative benefits in experimentally targeting implicit memory associations.

Potential conflicts of interests

The authors have no financial or other conflict of interest associated with the present research. However, Dr. Williams has previously received a small amount of research funding from Unibet Ltd., an online gambling provider with headquarters in Malta.

Role of funding sources

This work was supported by funding provided by the Alberta Gambling Research Institute (AGRI)

Appendix A. Appendix

Word associates	
Gambling-related words	Control words
Game	Character
Twenty-one	Level
Ticket	Achievement
Money	
Streak	
Win	
Skill	

Behaviour associates	
Make money	Have fun
Short on cash	Feeling anxious
Do something thrilling	Feeling bored
Typical Friday or Saturday Night	Feel happy
Have a really good time	Pass the time

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