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Applying Self-Coding to the Measurement of Self-Generated Video Gaming and Gambling Memory Associations

Gillian E.H. Russell,[1] Autumn C. Puttick,[1] Damien T. Spilchen,[1] Robert Williams,[2] & James Sanders[2]

[1] Department of Psychology, University of Alberta, Lethbridge, AB, Canada
[2] Faculty of Health Sciences, Lethbridge, AB, Canada

Abstract

Recently the use of implicit memory associations has expanded in the addiction literature to include the assessment of video gaming and gambling. However, the issue with memory associations lies in the open-ended nature of the answers that must be coded, which is often labour-intensive, costly, and where the ambiguity cannot always be resolved. The present study evaluates participant self-coding of memory associations versus researcher coding in the assessment of memory associations for video gaming and gambling. A sample of 3,176 Canadian adults were asked to produce responses to ten ambiguous words and ten potential behavioural associations for engagement in video gaming or gambling. Participants were subsequently asked to classify what categories their responses belonged to, including video gaming and gambling. Consistent with the literature on alcohol and marijuana memory associations, self-coded scores for video gaming and gambling were significantly higher than scores coded by the researchers, had significantly higher correlations with self-reported behaviours, and significantly improved the prediction of video gaming and gambling behaviours.

Keywords: gambling, video gaming, memory associations, self-coding, implicit cognitions

Résumé

L'utilisation des associations de la mémoire implicite comprend depuis peu l'évaluation des jeux vidéo et des jeux de hasard dans le vocabulaire de la dépendance. Le problème des associations de la mémoire réside toutefois dans le caractère ouvert des réponses qui doivent être codées, ce qui est souvent à haute intensité de main-d'œuvre et coûteux. De plus, il est parfois impossible de résoudre l'ambiguïté. La présente étude évalue l'autocodage par les participants des associations de la mémoire par rapport au codage effectué par le chercheur dans le cadre des jeux vidéo et des jeux de hasard. On a demandé à un échantillon de 3 176 Canadiens d'âge adulte de répondre à dix mots ambigus et dix associations comportementales potentielles en rapport avec la participation à des jeux vidéo ou des jeux de hasard. On leur a ensuite demandé de classer leurs réponses dans différentes catégories, y compris les jeux vidéo et les jeux de hasard. Tout comme dans la documentation sur les associations de mémoire dans le domaine de l'alcool et de la marijuana, les pointages autocodés pour les jeux vidéo et les jeux de hasard étaient considérablement plus élevés que ceux codés par les chercheurs, faisaient l'objet d'une corrélation beaucoup plus élevée avec des comportements autodéclarés, et amélioraient considérablement la prédiction de comportements liés aux jeux vidéo et aux jeux de hasard.

Introduction

More recent cognitive approaches to the study of addictive behaviours have applied so called dual-process models of cognition that include both implicit, reflexive processes, and explicit, deliberative, processes (i.e., Evans & Coventry, 2006; Fleming, & Bartholow, 2014; Wiers et al., 2007). Measures of both processes not only correlate with addictive behaviours, but also suggest that addictions may be the result of an imbalance between these two competing systems. Indeed, one of the observed paradoxes of addictive behaviours is that often individuals will engage in a behaviour despite knowing the adverse consequences of engaging in such a behaviour. An example is the knowledge that smoking cigarettes is linked to the development of certain cancers and the decision to smoke despite this explicit knowledge because competing knowledge or implicit biases may favour cigarette consumption. While traditional explicit measures have been used more traditionally for assessment and research, implicit assessments may nevertheless provide insight about interest and engagement in certain activities, activities that may not be detected through this direct introspection because of issues such as social desirability, self-denial, or other issues in self-report may arise.

A number of approaches have been used to assess these implicit processes as they relate to addictive behaviours including methods that assess attentional bias (e.g., Bruce & Jones, 2004; Field & Cox, 2008; Mogg, Bradley, Field, & De Houwer, 2003), memory biases (e.g., De Houwer, 2003; Stacy, 1995, 1997; Stacy et al., 1994; Stiles et al., 2016), and approach/avoidance tendencies (e.g., Wiers et al., 2010). In particular, word associations, a measure of memory bias, have demonstrated to have the strongest effect sizes and predictive power of behaviours over other commonly used implicit measures such as the Implicit Association Test, Flicker Task, Addiction-Stroop, and Extrinsic Affective Simon Task (Rooke, Hine, & Thorsteinsson, 2008).

Tests that assess indirect memory associations using methods of word production are most often assessed using ambiguous word associations, which may in fact reflect understanding of semantic relationships, or outcome behaviour associations that may reflect actual behaviours. Ambiguous word associations, also referred to as free associations, require the participant to state the first word that comes to mind in response to a cue word or phrase (Szalay, Carroll, & Tims, 1993). Outcome-behaviour associations, a form of controlled word associations, require the participant to produce a verb, action or behaviour in response to an open-ended stem phrase. 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 et al., 1994). The key with both methods of assessment is that the prompts need to be ambiguous and not directly reference the target concept. Theoretically, because of the constraint placed on behaviour associations, these responses should have a greater relationship with actual behaviours than do word associations, as behaviour associations will tap into more than semantic knowledge. There has been conflicting evidence on whether word or behaviour associations are better predictive of behaviours. In a paper by Russell and colleagues (2020), word associations for video gaming enjoyed a greater relationship with video gaming and problem video gaming than did behaviour associations, a finding that conflicts with the literature on alcohol and cannabis (i.e., Krank et al., 2010) and gambling (i.e., Russell et al., 2019a) where behaviour associates had a greater relationship with behaviours than did word associates. Ultimately this finding may be down to the items selected for the given measures and a better subset of behaviour association prompts for video gaming may have altered these findings. With both measures it has been demonstrated that both correlate with current substance use as well as predicting future alcohol and marijuana use when demographic and other risk factors are controlled for (Krank & Goldstein, 2006; Stacy, 1997).

In the case of both word and behaviour associations, open-ended responses are subsequently coded as either belonging to the target category or not. The difficulty in assessing memory associations comes with the costly and labour-intensive process of categorizing participant responses that are often ambiguous. To interpret these responses, the researcher must select a particular coding method: liberal, conservative, or self-coded. With liberal coding procedures, all responses that are most likely to include the target are coded as such. In contrast, conservative coding procedures include only those responses that explicitly reference the target. Liberal coding often leads to a greater possibility of yielding a false positive, while conservative coding comes with the risk of false negatives. To maintain reliability both coding procedures require at least two coders, and even with strong training regimens, ambiguity of participant responses often cannot be fully resolved (Frigon & Krank, 2009). Self-coding procedures were developed as a resolution to the difficulties and labour demands of both liberal and conservative coding. Participants are presented a task involving two stages: first, participants self-generate associative responses to ambiguous cues; and, second, they are asked to classify their responses into a number of nonexclusive categories (Frigon & Krank, 2009; Krank et al., 2010).

In the present study, we evaluate the use of self-coding memory associations for both gambling and video gaming. Although self-coding has been used in studies of gambling and video gaming previously (e.g., Russell et al., 2019a; Russell et al., 2020), the methods have not been validated for behaviours beyond alcohol and marijuana use. Furthermore, in both Frigon and Krank's (2009) original study on behavioural associations and the subsequent expansion for use with word associations (Krank et al., 2010), self-coding was evaluated using relatively small samples (*N* = 132 and 126, respectively) restricted to high school and university students. Therefore, this study seeks not only to validate the use of self-coding for gambling and video gaming, but also for use with large samples that are more representative of the Canadian population and represent a broader range of behaviours.

Method

Participants

Three thousand one hundred and seventy-six English-speaking participants were recruited from the LegerWeb online panel during August and September of 2016. The panel comprises thousands of Canadian adults from all provinces and is structured to be demographically representative of the general population. LegerWeb recruits participants to respond to surveys in exchange for monetary compensation and entrance into regular prize draws. Data from 129 participants were subsequently eliminated because of incomplete or incorrect data (i.e., random letter sequences such as "asdf" on questions that required text entry). The final sample consisted of 3,047 participants.

The sample was approximately equal in ratio of males to females (51.8% female, 48% male, 0.2% refused to answer), and participants ranged from 18 to 91 years of age (M = 43.95, SD = 15.75). The sample was predominately from Ontario (43.3%), followed by British Columbia (14.2%), Alberta (13.4%), Quebec (9.1%), Manitoba (7.4%), Saskatchewan (4.3%), Nova Scotia (3.3%), Newfoundland and Labrador (2.2%), New Brunswick (1.6%), and Prince Edward Island (1.1%).

Procedure

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

The first part of the survey asked whether participants had engaged in collectible card play, gambling, and video game play in the past twelve months. Participants who indicated that they had engaged in any of the specific behaviours in the past year were then administered in-depth assessments of such behaviours, while those who did not were not required to complete these sections. Measures of substance use, and other addictions and mental health followed the sections gambling, video gaming, and collectible card play. Following these assessments, participants completed the associative measures and self-coded their responses. Questions about competitiveness, impulsivity, game play characteristics, personality, and social functioning were asked following to the self-coding task, although they were not included in the present study. The measures of relevance to the present study are described below and include the associative tasks, self-coding of responses, frequency of gambling and video game play, the Problem and Pathological Gambling Measure (PPGM; Williams & Volberg, 2010, 2014), and the Behavioural Addiction Measure for Video Gaming (BAM-VG; Sanders & Williams, 2016).

Measures

Word Associates

Participants were given a list of ten ambiguous words and 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!" The word list represented a subset of words used in a previous study that examined word associations for gambling alone (Russell et al., 2019a) and three additional words that were added to better assess word associations for video gaming. Four of the words could ambiguously be associated to either video gaming or gambling, three of the words could be associated with video gaming alone, and three of the words could be associated with gambling alone.

Behaviour Associates

Participants were given ten phrases that represented common motivational outcomes for gambling participation and video gaming (e.g., "have fun," "make money"). The phrases had been successfully used in a previous study of memory associations for gambling (Russell, et al., 2019a) and, through analysis of open-ended responses, it was then revealed that they also applied meaningfully to video gaming video. All ten of the phrases could be ambiguously related to gambling, whereas only eight of the phrases could be associated with video gaming. Similar to the word associates, for each phrase, participants were instructed to write down the first the *behaviour* or *action* that came to mind and to work quickly.

Self-Coding of Associative Measures

Upon completion of the associative tasks participants were asked to self-code their responses using the procedure employed in research on alcohol- and marijuana-related memory associations (Frigon & Krank, 2009; Krank et al., 2010) that was later adapted for use for gambling (Russell et al., 2019a; Russell et al., 2019b) and video gaming (Russell et al., submitted). As with the original procedure for self-coding, participants were prevented from returning to previous sections of the survey to modify their responses. The initial word and behaviour association prompts were displayed alongside the participant's responses. Participants were asked to select all of the categories that related to their response from the following options: recreation/leisure, gambling, alcohol, family/friends, video gaming, food, collectible card play, and other. Responses that were self-coded as relating to gambling and/or video games were assigned a score of one, whereas all other responses were assigned a score of zero (it should be noted that in certain cases a response was coded as both video gaming and gambling and subsequent composite scores reflect this). For each participant, separate composite scores were created for both gambling and video gaming. Composite scores for the behaviour associates ranged from 0–10 for gambling and 0–8 for video gaming, and composite scores for the word associates ranged from 0–7 for both gambling and video gaming.

Frequency of Gambling and Video Game Involvement

As part of larger measures of gambling and video gaming involvement (including measures of spending, number of formats, and hours of engagement) participants were asked about the frequency in which they engaged in specific formats of gambling and video gaming in the past 12 months. Participants were asked about their frequency of engagement across 11 types of gambling, including: 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, and purchasing high-risk stocks. In addition, participants were asked about their frequency of engagement in 18 genres of video games: action/adventure, Facebook/browser, fighting, first-person shooter, gambling (non-monetary), massive multi-player online role-playing games (MMORPG), multiplayer online battle arena, platform games, puzzle, racing, role playing, rhythm/music, sandbox, simulation, sports, strategy, traditional, and other. Frequency of engagement was assessed for each format of gambling and video gaming with the use of a 6-point Likert scale (0 = never to 5 = daily or almost daily). The wording of the questions and the response options used in this study have demonstrated reliability and validity in the assessment of gambling participation (Williams et al., 2017). Independent composite scores were calculated for both gambling and video gaming, reflecting the maximum frequency of engagement.

Behavioural Addiction Measure for Video Gaming (BAM-VG)

The BAM-VG is a 19-item yes-or-no measure that assesses the severity of video gaming involvement over the past 12 months and demonstrates exceptionally good internal consistency, construct and criterion validity, as well as good test-retest reliability (Sanders & Williams, 2016). Individuals that indicate they have played video games at least once a month over the past 12 months are classified into one of three categories: recreational, at-risk, or problem video gamer. Those that have not played video games over the past 12 months are classified as non-video gamers and those that play less than once a month are recreational video gamers.

Problem and Pathological Gambling Measure

The PPGM is a 14-item, yes or no measure designed to assess the severity of gambling involvement in the past year and identifies different patterns of gambling behaviour that demonstrates good internal consistency, test-retest reliability, and discriminant and convergent validity (Back, Williams, & Lee, 2015; Williams & Volberg, 2010, 2014). Individuals who indicate they have gambled at least monthly over the past year are assessed and classified as either a recreational, at-risk, problem, or pathological gambler. The accuracy of these classifications has been demonstrated for both treatment- and non-treatment-seeking problem gamblers (Williams & Volberg, 2014). Those respondents who had not gambled over the past 12 months were classified as non-gamblers and those that gamble less than once a month were classified as recreational gamblers.

Researcher Coding of Association Responses

Participant responses to the behaviour and word associates were coded by two independent raters. Participant responses were coded both with a conservative criterion and a liberal criterion. The conservative criterion required the response to be unambiguously associated with video games or gambling (i.e., responses specifically state "play video games" or "go to the casino" for behaviour associations or simply "video games" or "poker" for word associations), whereas the liberal criterion allowed for responses that were likely to be associated with video games or gambling (i.e., responses such as "play" or "cards" for behavioural associations for the cue "want to have fun" or "unlocked" for the cue word "achievement" or "off" for the cue word "ticket"). Responses that met the criteria were coded as 1, and those that did not were coded as 0. Cohen's kappa coefficient (k) was calculated to assess inter-rater reliability for both conservative and liberal coding. Gambling-related behaviour associates yielded excellent agreement for both conservative ($k = .949$) and liberal ($k = .885$) coding, and the word associates ranged from substantial to excellent agreement ($k = .798$ for conservative coding; $k = .865$ for liberal coding). Video gaming-related behaviour associates demonstrated moderate agreement for conservative coding ($k = .498$) and substantial agreement for liberal coding ($k = .742$). There was also moderate agreement for the video gaming word associates ($k = .513$ for conservative coding; $k = .547$ for liberal coding). Disagreement between the coders was subsequently reconciled and total scores for word and behaviour associates (conservative and liberal) for gambling and video gaming were tabulated for analyses.

Results

Levels of Gambling and Video Gaming

For video gaming, the majority of participants participated in some form of video gaming at least once per week (N = 1661; 54.5%). Only 750 participants reported not playing video games at a-ll over the past 12 months (24.6%), while 126 participants reported playing video games less than once a month (4.1%), 237 participants reported playing video games 1–2 times a month (7.8%), 273 participants reported playing video games 3–4 times a month (9.0%), 625 participants reported playing video games a few times a week (20.5%), and 1036 participants reported playing video games daily or almost daily (34.0%). Using the BAM-VG, 750 participants were classified as non-video gamers (24.6%), 1,756 participants were classified as recreational video gamers (57.6%), 375 participants were classified as at-risk video gamers (12.3%), and 166 participants were classified as problem video gamers (5.4%).

The majority of the sample (N = 2426; 79.6%) reported gambling over the previous 12 months; 621 participants reported not gambling at all (20.4%), 309 participants reported gambling less than once a month (10.1%), 543 participants reported gambling 1–2 times a month (17.8%), 720 participants reported gambling 3–4 times a month (23.6%), 612 participants reported gambling a few times a week (20.1%), and 242 participants reported gambling daily or almost daily (7.9%). In terms of problem gambling status, according to the PPGM, 621 participants were classified as non-gamblers (20.4%), 1399 participants were classified as recreational gamblers (45.9%), 644 participants were classified as problem gamblers (21.1%), 150 participants were classified as problem gamblers (4.9%), and 233 participants were classified as pathological gamblers (7.6%).

Coded Associations

Mean word and behaviour associate scores, both researcher and self-coded, and Kendall tau-b analyses for video gaming are presented in Table 1. Friedman tests were used to determine whether associate scores significantly differed as a result of the three coding procedures (self-coding, conservative researcher coding, and liberal researcher coding). Results indicated that total scores differed based on coding type for both behaviour associates (χ^2 = 1523.7, $p < 0.001$) and word associates (χ^2 = 2080.2, $p < 0.001$). Follow-up Wilcoxon Signed Rank tests revealed that self-coded word and behaviour associate scores were significantly higher than both liberal and conservative coded scores ($p < .0001$). Frequency of video gaming and BAM-VG classification demonstrated significant positive correlations (ranging from .166 - .400) with both researcher and self-coded behaviour and word associates. Comparison of correlation coefficients using asymptotic Z-tests (1-tailed) revealed that correlations between self-coded word and behaviour associate responses with video gaming frequency and BAM-VG classification proved larger than those with conservative and liberal coding ($p < .0001$).

Table 1

Mean, Standard Deviation, and Kendall Tau-b Associations for Associate Measures, Video Game Frequency of Use, and BAM-VG Scores.

			Correlations							
Measure	*M*	*SD*	1.	2.	3.	4.	5.	6.	7.	8.
1. Frequency[a]	2.99	2.01	-							
2. BAM-VG Classification[b]	0.99	0.77	.694***	-						
3. BA Conservative	0.18	0.57	.196***	.256***	-					
4. WA Conservative	0.48	0.81	.198***	.250***	.210***	-				
5. BA Liberal	0.63	1.01	.202***	.253***	.467***	.199***	-			
6. WA Liberal	1.34	1.26	.166***	.218***	.174***	.568***	.223***	-		
7. BA Self-Coded	1.08	1.53	.297***	.373***	.295***	.217***	.387***	.211***	-	
8. WA Self-Coded	1.95	2.14	.318***	.400***	.193***	.385***	.214***	.415***	.447***	-

Note. Numbers in the correlations columns correspond to the numbered measures. B.A. = Behaviour Associate; W.A. = Word Associate. [a]Frequency Scale: 0 = never, 1 = less than once a month, 2 = 1–2 times a month, 3 = 3–4 times a month, 4 = a few times a week, 5 = daily or almost daily. [b]BAM-VG Classification: 0 = non-video gamer, 1 = recreational video gamer, 2 = at-risk video gamer, 3 = problem video gamer, *** = $p < 0.001$.

Mean word and behaviour associate scores, both researcher and self-coded, and Kendall tau-b analyses for gambling are presented in Table 2. Friedman tests were again used to determine whether self-coding, conservative researcher coding, and liberal researcher coding produced significantly different associate scores. Results confirmed that total scores differed based on the three coding types for both behaviour associates ($\chi^2 = 1070.7$, $p < 0.001$) and word associates ($\chi^2 = 1541.5$, $p < 0.001$). Follow-up Wilcoxon Signed Rank tests revealed that self-coded word and behaviour associate scores were significantly higher than both liberal and conservative coded scores ($p < .0001$). Gambling frequency and PPGM classification demonstrated significant positive correlations (ranging from .200–.381) with both researcher and self-coded behaviour and word associates. Follow-up asymptotic Z-tests revealed that self-coded word and behaviour associate scores had significantly larger correlations with gambling frequency and PPGM classification than did both conservative or liberal coding types ($p < .01$ - $p < .0001$).

Sequential Regression Analyses

All dependent variables were screened for violations of normality and outliers. There was a significant positive skew in BAM-VG classification, PPGM classification, and video gaming frequency. Both BAM-VG classification and PPGM classification were transformed using a logarithmic transformation and video gaming frequency had an inverse transformation applied. Despite these transformations improving the normality of the distribution, normality was still violated, so the results need to be interpreted with caution. Gambling frequency was not skewed; however, normality was still violated and transformation did not improve its distribution. After screening for outliers, there were 114 multivariate outliers for the video gaming analyses and for gambling there were 119 multivariate outliers that were removed. It should be noted that the final analyses were also performed including the multivariate outliers and there were no substantial differences in the results, however, the reported results do not include multivariate outliers.

Table 3 shows the results of the sequential regression analyses using video gaming frequency and BAM-VG classification as the dependent variables. For video gaming frequency, conservative researcher coded word and behaviour associates alone (Model 1) predicted 7.4% of the variance in frequency of video gaming. Adding in liberal researcher coded scores (Model 2) significantly increased the model fit compared to Model 1, capturing an additional 1.7% of variance. Adding self-coded scores into the analysis (Model 3) predicted significantly more variance than Model 2, adding an additional 8.9% of predicted variance in video gaming frequency, predicting a total of 18.0% of the variance in the frequency of video game engagement. For BAM-VG classification, Model 1 predicted 10.0% of the variance, Model 2 predicted significantly more variance than Model 1, adding an additional 2.5% of predicted variance. Model 3 predicted significantly more variance than Model 2, adding 11.6% of predicted variance, predicting a total of 24.1% of the variance for BAM-VG classification.

Table 2

Mean, Standard Deviation, and Kendall Tau-b Associations for Associate Measures, Gambling Frequency, and PPGM Scores.

			Correlations							
Measure	*M*	*SD*	1.	2.	3.	4.	5.	6.	7.	8.
1. Frequency[a]	2.37	1.59	-							
2. PPGM Classification[b]	1.34	1.09	.626***	-						
3. B.A. Conservative	0.17	0.65	.215***	.246***	-					
4. W.A. Conservative	0.86	1.00	.235***	.228***	.217***	-				
5. B.A. Liberal	0.21	0.73	.226***	.248***	.873***	.212***	-			
6. W.A. Liberal	1.45	1.25	.216***	.200***	.201***	.746***	.209***	-		
7. B.A. Self-Coded	0.71	1.49	.291***	.381***	.409***	.172***	.417***	.165***	-	
8. W.A. Self-Coded	1.85	1.79	.290***	.325***	.237***	.426***	.241***	.444***	.393***	-

Note. Numbers in the correlations columns correspond to the numbered measures. B.A. = Behaviour Associate; W.A. = Word Associate. [a]Frequency Scale: 0 = never, 1 = less than once a month, 2 = 1-2 times a month, 3 = 3–4 times a month, 4 = a few times a week, 5 = daily or almost daily. [b]PPGM Classification: 0 = non-gambler, 1 = recreational gambler, 2 = at-risk gambler, 3 = problem gambler, 4 = pathological gambler, *** = $p < 0.001$.

Table 3
Sequential Regression of Coding Method on Video Game Frequency and BAM-VG Classification.

	Video Game Frequency				BAM-VG Classification			
	B	*(SE)*	*R*	Δr^2	*B*	*(SE)*	*R*	Δr^2
Model 1			.274	.074***			.317	.100***
Constant	2.604***	.043			0.820***	.016		
B.A. Conservative	0.833***	.092			0.196***	.019		
W.A. Conservative	0.540***	.052			0.423***	.034		
Model 2			.304	.017***			.356	.025***
Constant	2.374***	.055			0.720***	.020		
B.A. Conservative	0.552***	.102			0.289***	.037		
W.A. Conservative	0.352***	.068			0.119***	.025		
B.A. Liberal	0.305***	.051			0.147***	.019		
W.A. Liberal	0.144***	.041			0.056***	.015		
Model 3			.427	.089***			.492	.116***
Constant	2.121***	.054			0.612***	.019		
B.A. Conservative	0.411***	.097			0.227***	.035		
W.A. Conservative	0.220**	.065			0.065**	.023		
B.A. Liberal	0.124*	.051			0.067***	.018		
W.A. Liberal	-0.060	.041			-0.027	.015		
B.A. Self-Coded	0.203***	.031			0.095***	.011		
W.A. Self-Coded	0.266***	.022			0.107***	.008		

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$. *Note:* B.A. = Behaviour Associate; W.A. = Word Associate. Note: All models were run including the multivariate outliers. There were no substantial differences in the results.

Table 4 shows the results of the sequential regression analyses using gambling frequency and PPGM classification as the dependent variables. For gambling frequency, conservative researcher coded word and behaviour associates alone (Model 1) predicted 9.5% of the variance. Adding in liberal researcher coded associations (Model 2) predicted significantly more variance than Model 1, capturing an additional 0.5% of the variance. Adding self-coding into the analysis (Model 3) predicted significantly more variance than Model 2, adding an additional 6.5% predicted variance, predicting a total of 16.5% of the variance in the frequency of gambling. For PPGM classification, Model 1 predicted 8.4% of the variance. Model 2, predicted significantly predicted 0.1% more variance than Model 1. Model 3 predicted significantly more variance than Model 2, adding 11.6% of predicted variance, predicting a total of 20.1% of the variance in PPGM classification.

Discussion

Recently the use of implicit memory associations in the addiction literature has expanded to include the assessment of memory associations related to video gaming and gambling (e.g., Russell et al., submitted; Stiles et al., 2016). As with the assessment of memory associations for alcohol and cannabis, memory associations for

Table 4
Sequential Regression of Coding Method on Video Game Frequency and BAM-VG Classification.

	Gambling Frequency				PPGM Classification			
	B	*(SE)*	*R*	Δr^2	*B*	*(SE)*	*R*	Δr^2
Model 1			.309	.095***			.291	.084***
Constant	1.921***	.037			1.061***	.024		
B.A. Conservative	0.667***	.078			0.554***	.051		
W.A. Conservative	0.398***	.031			0.196***	.020		
Model 2			.318	.005***			.292	.001***
Constant	1.847***	.043			1.054***	.029		
B.A. Conservative	0.029	.208			0.346	.138		
W.A. Conservative	0.276***	.054			0.189***	.036		
B.A. Liberal	0.625**	.192			0.206*	.127		
W.A. Liberal	0.114**	.042			0.006	.028		
Model 3			.406	.065***			.450	.116***
Constant	1.643***	.044			0.887***	.028		
B.A. Conservative	-0.201	.201			0.127	.129		
W.A. Conservative	0.225***	.052			0.154***	.033		
B.A. Liberal	0.481**	.185			0.058	.119		
W.A. Liberal	0.007	.042			-0.065*	.027		
B.A. Self-Coded	0.233***	.029			0.266***	.019		
W.A. Self-Coded	0.179***	.021			0.110***	.013		

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$. *Note:* B.A. = Behaviour Associate; W.A. = Word Associate. Note: All models were run including the multivariate outliers, there were no substantial differences in the results.

both video gaming and gambling must be coded in order for responses to be classified, a process that is often labour intensive and costly, with ambiguity not always being able to be resolved. The purpose of the present study was to determine whether the method of self-coding of memory associations that was developed by Frigon and Krank (2009) is valid for application to the assessment of gambling and video gaming, as well as the use of self-coding with large population-based samples. The results revealed that self-coding is a practical and valid approach for coding memory associations for application of video gaming and gambling, as has been previously found for alcohol and cannabis use.

There were significant levels of both video gaming and gambling in the sample, including a large number of problem video gamers and pathological and problem gamblers. As with both Frigon and Krank (2009) and Krank and colleagues (2010), a significant number of responses emerged to the target items that were categorized as either video gaming or gambling during self-coding that were not included in either form of researcher coding. Correlations between researcher and self-coded responses with measures of video gaming and gambling frequency and problems were all significant. Correlations for self-coded responses with both frequency and problems compared to both forms of researchers coding enjoyed a larger magnitude as demonstrated using the asymptotic *Z*-tests. Sequential regression analyses for both video gaming and gambling revealed that self-coding significantly improved the prediction of video gaming and gambling frequency and problems when added to regression analyses using typical coding methods (Model 3 in both Tables 3 and 4).

Frigon and Krank (2009) posed that two explanations as to why self-coding may better predict behaviours over researcher coding: (1) it may enhance the retrieval of responses; and (2) disambiguation. In terms of enhanced retrieval, self-coding may present the opportunity for participants to provide new information that was not thought of during the initial assessment by improving the accessibility of memories (Krank & Wall, 2006). Unlike other studies of memory associations for addictive behaviours (e.g., Stiles et al. 2016), inter-rater reliability of coded responses was an issue, in particular for video gaming associations. because of both the ambiguity in participant responses and the differing experiences with video games of the independent coders. Despite reconciling differences in the coding of the two raters, it is nevertheless likely that responses were miscategorized both conservatively and liberally because of the extensive range of stimuli associated with video gaming. Self-coding scores were more than four times as large as conservatively coded scores for word associates for video gaming, a difference that was significant. The ambiguous cue word *character,* for example, offered a wide variety of responses, many of which *could* be characters from a video game, however the name may have been common and refer to other characters in other popular media or characters that have appeared in both other media and video games (e.g., Mickey Mouse in the Kingdom Hearts video games). Furthermore, with the vast number of video games that exist, responses may refer to elements of a specific game that the coders were unaware—such as specific characters, items, achievements, etc.

There were several limitations to the current study. First, the sample consists of English-speaking Canadians. There are potential issues in translation for the word associates in particular, where words may not have similar ambiguity as they do in English. Furthermore, colloquial usage of words, which can be unique to specific regions or countries, may affect the range of responses that each word can provide. Thus, we should use caution when extending these results to other populations.

Second, potential priming of responses could have also been an issue in the open-ended responses as participants were informed during the recruitment phase of the study that the study was examining the relationship between gambling, video gaming, and collectible card play. This solicitation paired with the optional sections on each behaviour were included in the survey prior to the section on memory associations, and this may have served as a prime for responses. However, optional sections were only presented to those that actually engaged in the behaviours and sections on substance use and other addictions were presented to all participants that may have also served as a potential prime for responses for the behaviour associates in particular and the priming from the optional sections.

Third, there were a number of participants that indicated that either they had not played video games or had not gambled in the previous 12 months. As we did not inquire about lifetime engagement it is unclear whether these individuals had never engaged in the behaviour or had instead just abstained in the previous 12 months so it is unclear whether these associations were based on personal experience with the behaviour, or whether they had been learned via alternative means (i.e., media exposure, personal contacts, work, education, etc.). This learning could also indicate individuals in a state of contemplating engagement in the behaviours. Longitudinal research is required to evaluate better the development of these associations.

Finally, as with the studies by Frigon and Krank (2009) and Krank and colleagues (2010), self-coding of responses may present a confound by directly presenting the target categories. However, Frigon and Krank (2009) pose that this direct reference to the target behaviours may cause self-coded scores to be more predictive of behaviour compared to researcher-coded scores, because it combines the influence of both implicit and explicit memory processes. Additionally, the original open-ended responses were presented separate from the self-coding and participants were prevented from changing their original response based on the presentation of the coding categories to prevent potential influence on responses through potential priming or demand characteristics.

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For correspondence: Gillian E.H. Russell, Ph.D. Candidate, Department of Psychology, University of Lethbridge, 4401 University Drive W., Lethbridge, Alberta, Canada, T1K 3M4.
E-mail: g.russell@uleth.ca

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