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Self-coded indirect memory associations and alcohol and marijuana use in college students

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Indirect memory associations for substance use predict both the concurrent and prospective levels of substance use. These methods assess spontaneous, possibly implicit, and easily accessible associations that predict substance use over direct (explicit) methods of assessment (e.g., outcome expectancies). The present study tested and expanded the application of a coding method for alcohol and marijuana associations on the basis of self-coding of indirect responses (Frigon & Krank, 2009). College students generated free associates to (1) ambiguous words (e.g., *draft* or *weed*), (2) situations (e.g., at a party, hanging out with friends), and (3) emotions (having fun, feeling dreamy). Later, participants were shown their responses and were asked to code their responses according to both nonrisk and risk activities, such as alcohol and marijuana use. Self-coded scores were higher than researcher-coded scores, captured the same variance, and improved the prediction of substance use. Self-coding of indirect memory associations provides accurate and efficient prediction of the level of alcohol and marijuana. Self-coding is efficient and may be useful for reducing ambiguities in coding of many different kinds of open-ended responses.

Some recent theoretical approaches to substance use have applied principles from cognitive psychology and associative learning (Goldman, Reich, & Darkes, 2006; Krank & Goldstein, 2006; Stacy, Ames, & Grenard, 2006; Stacy, Ames, Wiers, & Krank, 2010; Wiers et al., 2007). Examples of associative memory approaches include implicit memory associations (Ames et al., 2007; Krank & Goldstein, 2006; Stacy et al., 2006), automatic processes (Tiffany, 1990; Tiffany & Conklin, 2000), and attentional bias (Schoenmakers, Wiers, Jones, Bruce, & Jansen, 2007; Wiers et al., 2006). These approaches share the assumption that decisions to engage in substance use are influenced by substance-use cognitions. In particular, growing evidence suggests that both implicit and explicit measures of substance-use associations not only correlate with levels of substance use but also presage initiation and escalation of substance use (Kelly, Masterman, & Marlatt, 2005; Krank & Wall, 2006; Stacy et al., 2006).

Indirect cognitive methods obtain unique information about memory associations with substance use. Instead of asking about substance use directly, these methods use words, situations, or emotions commonly associated with substance use to cue open-ended responses. Responses are coded as related to substance use or not. The number of substance-use associations is used as an index of the strength or intensity of the behavioral associations. The method generates responses that are spontaneous, possibly implicit (Ames et al., 2007; Stacy et al., 2006), and accessible (Frigon & Krank, 2009). Importantly, these measures predict unique variance in substance use greater than is predicted by a variety of risk factors and explicit measures of association such as outcome expectancies (Ames et al., 2007; Krank & Goldstein, 2006; Stacy et al., 2006). Indirect word association tests are important because they capture accessible implicit memories that are relevant to substance use and that are not captured by direct methods.

Despite their potential value, indirect memory association measures can present practical problems. The coding procedures are labor intensive and require subjective coding. Most importantly, ambiguity in such associative responses often cannot be resolved even with strong training and multiple coders. Coding criteria change the signal detection properties of the measure by increasing either misses or false alarms, thus increasing measurement error and attenuating correlations with important variables (Cohen, Cohen, West, & Aiken, 2003).

Frigon and Krank (2009) recently reported a novel coding procedure in which associative responses are elicited in the typical indirect manner, but coding is done by the participants. The study confirmed the strong predictive relationship between indirect memory associations and substance use in high school students suspended for drug infractions. More importantly, self-coding not only captured the predictive value derived from either conservative or liberal coding methods but actually improved the prediction of alcohol and marijuana use.

Although similar to Frigon and Krank (2009), the present study extended the self-coding methodology to measures used with a general population of university

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students. This population is of interest because of the range of usage and the high levels of problem drinking and harmful substance use (Adlaf, Demers, & Gliksman, 2005; Adlaf, Gliksman, Demers, & Newton-Taylor, 2003; Ahmad, Flight, Singh, & Poole, 2008; Chan, Neighbors, Gilson, Larimer, & Marlatt, 2007; Flight, 2007; Leatherdale, Hammond, & Ahmed, 2008). The present study replicated the self-coding approach to behavioral associates in a nonclinical sample and extended the approach to the more sensitive ambiguous-word associates measure.

METHOD

Participants

One hundred thirty-two college students from the University of British Columbia (UBC) Okanagan participated and received partial credit in an introductory psychology course. The participants were 75% female and were distributed across school levels: first year (35.5%), second year (21.0%), third year (27.4%), fourth year (13.7%), and postgraduate (2.4%) (mean age = 21.0 years). All methods described here were approved by the Behavioral Research Ethics Board of UBC under the Canadian Tri-Council Guidelines.

Procedure

Participants were asked to complete a computer questionnaire about a variety of activities including, but not exclusively, risk-taking behaviors. Although the questionnaire contained instructions for each section, verbal instruction were provided if requested. Indirect-association measures were presented at the start of the session. After the answers for all indirect tasks were completed, the participants self-coded each response. Upon completion of self-coding, participants completed outcome expectancy, alcohol and drug use, and demographics sections in sequential order without returning to previous questions.

Measures

Ambiguous-word associations. Each ambiguous word was presented individually with instructions to type “the first word you think of.” The 13 ambiguous target probes used were *cooler*, *shot*, *bottle*, *screw*, *ice*, and *mug* for alcohol, and *bud*, *weed*, *pipe*, *pot*, *blunt*, *joint*, and *roach* for marijuana (Stacy, 1995, 1997).

Behavioral associates. The behavioral-associates stem phrases were presented with instructions to type “the first action or behavior that comes to mind.” The stem phrases were (1) *situational associates*—environments or times associated with marijuana or alcohol use in teens (e.g., *typical Friday or Saturday night*, *after school*, *at the mall*)—or (2) *emotion associates*—positive outcome expectancies (e.g., *feeling happy*, *having fun*) and negative emotional states associated with high-risk situations (e.g., *feeling upset*, *feeling bored*).

Substance use. Substance use was measured using 5-point recency scales for the last time the participant “drank alcohol,” “got drunk,” or “used marijuana.” The options were as follows: *past week*, *past month*, *past year*, *more than a year/ever*, and *never*. If participants were unsure of the meaning of the options, then the researcher explained them orally. For example, the option *more than a year/ever* was explained as “having used in the past, but not during the past year.” For alcohol, participants were asked their frequency (“How many days of the past 30 did you drink alcohol?”) and quantity (“Think of a typical drinking situation. How many drinks would you normally have?”). The participants were asked to respond on the basis of the definition of a *standard drink*, which was defined as one beer, one 5-ounce glass of wine, or one mixed drink.

Scoring

Researcher coding. Participants’ responses to the probes were coded by two raters who were blind to each other’s responses. Participants’ responses were coded using a conservative criterion; only unambiguous marijuana and alcohol responses were coded. Agreement was strong between coders (Cohen’s $\kappa < .90$ for ambiguous words; Cohen’s $\kappa < .81$ for behavioral associates), and disagreements were resolved by consensus. Totals for ambiguous-word associates ranged from 0 to 6 (alcohol) and 0 to 7 (marijuana), situation associates ranged from 0 to 10, and emotion associates ranged from 0 to 11.

Self-coding. Each phrase and the participants’ response were displayed individually on the computer screen with a list of categories: *marijuana*, *alcohol*, *other drugs*, *leisure*, *violence*, *friends/family*, *sex*, and *other*. The students were asked to check all applicable categories that applied to their response.

Data Analyses

We tested the hypothesis that self-coded cognitive measures would predict alcohol and marijuana use as well as or better than standard coding by a series of hierarchical regression analyses would. The variables were analyzed with a base Model 1 that included year in university and gender. Model 2 tested the added predictive value of researcher-coded substance use associates, and Model 3 further tested the added predictive value of self-coded substance use associates. These tests were designed to demonstrate whether self-coded responses added to and captured the predictive value of researcher-coded responses. Analyses were conducted using SPSS V17.0, and all significance tests were set at $p < .05$.

RESULTS

Alcohol and Marijuana Use

There was considerable alcohol and marijuana use in the participant sample. Most students had drunk in the past month, and only a few had never drunk alcohol. More than 50% also reported having been drunk in the past month. Over half had used marijuana, with about 25% using in the past month. The means for the recency measures of alcohol use and drunkenness are shown in Table 1. Table 1 also shows the mean number of days drinking in the past 30 and the mean reported number of drinks on a typical occasion. All alcohol use measures were moderately to strongly correlated. Mean marijuana use is shown in Table 2.

Coded Responses

Table 1 also shows the means for the researcher-coded and self-coded substance-use associates for alcohol and their intercorrelations. Self-coded scores were higher than researcher-coded scores for all measures. Self-coding and researcher coding were correlated for ambiguous-word associates, were correlated more moderately for the situation, and were not correlated for emotion associates. Researcher-coded alcohol associates were significantly correlated with all four alcohol-use measures except in the case of emotion associates, which was weakly correlated with only two of the four measures—days they drank in the past 30 days and the typical number of drinks. Self-coded alcohol associates were significantly correlated with all alcohol use measures except emotion behavior associates with the number of days they drank in the past 30.

Table 2 shows the marijuana use and coding measures. Self-coded scores were significantly higher than researcher-coded scores except for ambiguous words, where the difference was small and the correlation between scores was very high. Nevertheless, self-coded

Table 1
Means, Standard Deviations, and Correlations for Alcohol Use and Cognitive Measures

				Correlations								
	Measure	*M*	*SD*	1	2	3	4	5	6	7	8	9
Alcohol use	1. Recency: Drank alcohol†	4.05	1.19	–								
	2. Recency: Got drunk†	3.40	1.39	.745***	–							
	3. Days drank in past 30	3.55	3.51	.573***	.578***	–						
	4. Normal number of drinks	3.85	3.32	.450***	.612***	.291***	–					
Researcher coded	5. Ambiguous words	1.49	1.38	.261**	.371***	.279**	.357***	–				
	6. Situations	0.38	0.84	.240**	.335***	.358***	.261***	.249**	–			
	7. Emotions	0.07	0.28	.106	.047	.180*	.176*	.131	.313***	–		
Self-coded	8. Ambiguous words	3.13	2.43	.271**	.427***	.251**	.337***	.707***	.232**	.134	–	
	9. Situations	2.98	1.99	.402***	.525***	.378***	.387***	.230**	.260**	.002	.415***	–
	10. Emotions	1.19	1.57	.296***	.303***	.134	.256**	.039	.121	.144	.200*	.527***

Note—Numbers in the correlations columns correspond to the numbered measures. †Recency scale: 1 = *never*, 2 = *more than a year*, 3 = *past year*, 4 = *past month*, 5 = *past week*. *$p < .05$. **$p < .01$. ***$p < .001$.

scores for the ambiguous words were more strongly correlated with marijuana use. Researcher-coded situation and emotion associate means were very small, and these scores did not correlate with marijuana use. Self-coding and researcher coding of situation and emotion associates were significantly correlated.

The agreement between researcher-coded and self-coded measures was evident in the correlations. Closer inspection of data for specific cue words revealed that the self-coded scores were usually significantly associated with the researcher-coded scores (Cohen's κ, $p < .05$). Self-coding identified the alcohol or marijuana responses that researcher coding identified, but the reverse was not true. Occasionally, these scores were not associated, because self-coding identified many more responses than researcher-coding did.

Sequential Regression Analysis

The results of the three models in the sequential analysis for measures of alcohol use, drunkenness, and marijuana use are shown in Table 3. Table 4 shows the same models for quantity and frequency. The two demographic measures did not have a significant effect in Model 1.

Model 2 demonstrated the predictive value of researcher-coded responses for all use measures in the ΔR^2 scores. Researcher-coded scores added value in predicting alcohol use for all measures and in predicting marijuana use. The pattern of significant cognitive measures shows that ambiguous-word associates were the best unique predictor, with some unique predictions carried by the situational associates. The increase in the model fit was modest in the case of recency of drinking (7.7% of variance) but improved more for the other measures (from 13.4% to 18.5% of variance).

Despite the relative improvement in the model with the addition of researcher-coded variables, the added effect of self-coded variables was clearly evident in the ΔR^2 for all measures in Model 3. For all use measures, the significant B values shifted to the self-coded cognitive measures. In particular, the self-coded situational associates were the dominant predictor for all use measures. The only other unique predictors to emerge were for marijuana (self-coded ambiguous words) and for frequency of alcohol use in past 30 days (researcher-coded situational associates). Again, common variance was important, since all self-coded variables were individually predictive of use (Tables 1 and 2). The consistent improvement seen in Model 3 indicated that self-coding improved the prediction of recency of use, accounting for 22.1%, 38.9%, and 44.7% of the variance for alcohol use, drunkenness, and marijuana use, respectively. Improvements in the prediction of quantity and frequency of drinking were also evident, with Model 3 accounting for 29.2% and 26.0% of the variance, respectively.

DISCUSSION

The findings of the present study confirm that indirect measures of ambiguous-word associates and behavior as-

Table 2
Means, Standard Deviations, and Correlations for Marijuana Use and Cognitive Measures

				Correlations					
	Measure	*M*	*SD*	1	2	3	4	5	6
	1. Recency of use†	2.40	1.37	–					
Researcher coded	2. Ambiguous words	2.52	2.09	.340**	–				
	3. Situations	0.01	0.09	.166	.062	–			
	4. Emotions	0.04	0.29	.097	.145	−.012	–		
Self-coded	5. Ambiguous words	2.88	2.25	.471***	.831***	.121	.149	–	
	6. Situations	1.05	1.71	.596***	.207*	.357***	.059	.460***	–
	7. Emotions	0.52	1.17	.464***	.150	.411***	.327***	.369***	.715***

Note—Numbers in the correlations columns correspond to the numbered measures. †Recency scale: 1 = *never*, 2 = *more than a year*, 3 = *past year*, 4 = *past month*, 5 = *past week*. *$p < .05$. **$p < .01$. ***$p < .001$.

Table 3
Sequential Analysis of Three Recency Measures (Two Alcohol and One Marijuana) With Predictors Including Year and Gender (Models 1–3), Researcher-Coded Cognitive Measures (Models 2 and 3), and Self-Coded Cognitive Measures (Model 3)

Recency Measure	Year		Gender		Researcher Coded: Ambiguous Words		Researcher Coded: Situations		Researcher Coded: Emotions		Self-Coded: Ambiguous Words		Self-Coded: Situations		Self-Coded: Emotions		ΔR^2
	B	*SE*	B	*SE*	B	*SE*	B	*SE*	B	*SE*	B	*SE*	B	*SE*	B	*SE*	
Model 1																	
Alcohol use	0.119	0.092	−0.309	0.240													0.023
Drunkenness	0.050	0.108	−0.474	0.280													0.022
Marijuana use	−0.012	0.108	−0.251	0.281													0.006
Model 2																	
Alcohol use	0.074	0.091	−0.120	0.241	0.164*	0.076	0.232	0.132	0.108	0.374							0.077*
Drunkenness	−0.033	0.099	−0.157	0.264	0.308***	0.083	0.452**	0.144	−0.403	0.410							0.185***
Marijuana use	−0.016	0.102	−0.072	0.270	0.209***	0.056	2.345	1.307	0.239	0.400							0.134***
Model 3																	
Alcohol use	0.071	0.086	−0.115	0.229	0.127	0.116	0.121	0.129	0.153	0.361	−0.003	0.112	0.167***	0.061	0.095	0.074	0.121***
Drunkenness	−0.039	0.089	−0.195	0.237	0.093	0.120	0.252	0.134	−0.308	0.373	0.185	0.115	0.254***	0.063	0.070	0.076	0.182***
Marijuana use	0.062	0.083	−0.014	0.220	−0.134	0.113	−1.459	1.192	0.096	0.361	0.344**	0.126	0.376***	0.082	0.071	0.130	0.307***

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 4
Sequential Analysis of the Quantity and Frequency Measures of Alcohol Use With Predictors, Including Year and Gender (Models 1–3), Researcher-Coded Cognitive Measures (Models 2 and 3), and Self-Coded Cognitive Measures (Model 3)

Measure of Alcohol Use	Year		Gender		Researcher Coded: Ambiguous Words		Researcher Coded: Situations		Researcher Coded: Emotions		Self-Coded: Ambiguous Words		Self-Coded: Situations		Self-Coded: Emotions		ΔR^2
	B	*SE*	B	*SE*	B	*SE*	B	*SE*	B	*SE*	B	*SE*	B	*SE*	B	*SE*	
Model 1																	
Quantity	−0.231	0.254	−1.369*	0.662													0.041
Frequency in past 30 days	0.141	0.273	−0.891	0.712													0.013
Model 2																	
Quantity	−0.412	0.240	−0.702	0.637	0.745***	0.200	0.550	0.348	1.008	0.987							0.150***
Frequency in past 30 days	−0.023	0.258	−0.068	0.687	0.475*	0.216	1.173**	0.375	0.868	1.065							0.149***
Model 3																	
Quantity	−0.425	0.227	−0.750	0.608	0.379	0.308	0.205	0.343	1.135	0.959	0.317	0.296	0.429***	0.162	0.170	0.195	0.101***
Frequency in past 30 days	−0.024	0.246	−0.263	0.659	−0.060	0.334	0.755*	0.372	0.429***	0.162	0.170	0.195	0.575***	0.175	−0.189	0.211	0.098***

* $p < .05$. ** $p < .01$. *** $p < .001$.

sociates correlate with corresponding levels of alcohol and marijuana use in the population of college students. This relationship was present using standard conservative coding methods that code only clearly unambiguous responses. In addition, the present study replicated and extended the utility of self-coding these memory associations as a valid and practical approach to the use of these measures (Frigon & Krank, 2009). This is the first study to demonstrate the value of self-coding in a nonclinical population using methods appropriate for assessing these cognitions in a general population. Specifically, this study used cues (e.g., ambiguous words) and response specifications (first word or phrase) that were more appropriate for the college student population. This study demonstrated that self-coded responses not only provide accurate and efficient cognitive indicators for the level of alcohol and marijuana use in college students, but also improve the prediction over the traditional coding methods.

College students in this study reported a range of alcohol and marijuana use consistent with survey estimates of this population (Adlaf et al., 2005; Kuo et al., 2002). A few students reported little or no use, others reported casual use, and some reported binge drinking or regular marijuana use. The variance in levels of alcohol and marijuana use was significantly correlated with corresponding substance-use memory associations that were coded using standard procedures (Ames et al., 2005). These findings are consistent with many previous demonstrations of concurrent prediction of substance use (Ames et al., 2007; Krank & Goldstein, 2006; Krank & Wall, 2006; Rooke, Hine, & Thorsteinsson, 2008; Stacy, 1995, 1997; Stacy et al., 2006).

In addition to the usual method of coding, sequential multiple regressions in the present study revealed that self-coded association scores add significantly to the prediction of substance use when demographics and researcher-coded scores have already been included in the model. Further analysis of the memory associates and the self-coding responses confirmed the pattern found in our previous study with high-risk adolescents (Frigon & Krank, 2009): (1) very few alcohol or marijuana responses to non-target items, (2) virtually no researcher-coded responses that were not also self-coded, and (3) significantly more alcohol and marijuana self-coded responses to probe responses that were not coded by researchers.

Frigon and Krank (2009) offered two explanations for the better prediction with self-coding: enhanced retrieval and disambiguation. The first explanation is that self-coding improves the retrieval of substance-use associations (Krank & Wall, 2006; Krank, Wall, Stewart, Wiers, & Goldman, 2005). The retrieval explanation suggests that the increase in endorsement of substance-use associations improves the prediction of substance use by improving accessibility of memory associations. The second explanation is disambiguation of meaning (Bouton, 2002; Krank & Wall, 2006; Krank et al., 2005). Specifically, the self-coding procedure allows the individual to define the nature of the otherwise ambiguous response. Many items self-coded by individuals, like *party*, made sense to participants, but our coders could not differentiate whether the response meant alcohol, marijuana, neither, or both.

Limitations

The present study examined responses produced by indirect methods but did not clearly differentiate between implicit and explicit memory processes (Stacy et al., 2010; Wiers et al., 2007). The method used here generated associations indirectly, and possibly implicitly, but then used explicit evaluations of the response. Self-coded responses were confounded by direct reference to the target response. The self-coding process potentially introduced explicit expectations about drug use outcomes to these responses. Even more problematic is the possibility that responses could have been based on current use (Stacy, 1997). Nevertheless, the self-coding method is an improvement over more direct, explicit approaches, because it captures the variance in the independent prediction of substance use on the basis of indirect memory measures. Standard coding procedures of indirect associative measures have difficulty with ambiguity in some responses, but they do predict substance use independent of current explicit measures of association such as expectancies (Stacy, 1995, 1997). Indirect procedures generate spontaneous or top-of-mind associations and may uniquely tap implicit memory processes not typically assessed by the usual explicit methods. Self-coding may thus be, in part, more predictive because it adds an explicit component, but it is also useful because it includes the independent prediction from the implicit component. Indeed, to the extent that self-coding effectively disambiguates the meaning of implicit memory associations, this procedure may also more accurately measure implicit associations.

An unresolved issue is the test–retest reliability of this method. It is possible that the testing procedure itself may bias future associative responses. Only a design that provides a second test following a delay could answer whether bias is introduced and whether any such bias reduces the predictive value of the test. Such a study would be useful in determining the utility of this approach to longitudinal studies in which repeated measurements are taken.

Implications

The method of self-coding indirect memory associations has practical value for a wider range of research activities and applications. Automated self-coding scores do not limit the analysis of the detailed responses. Indeed, self-coding adds information and provides a composite and easy-to-use index of memory associations. Open-ended questions answer multiple questions at once and increase the richness of the data (King, 2004). They provide information about accessible and consequently relevant health cognitions. Such responses are useful for identifying personally relevant issues for qualitative analysis and have been used effectively in questionnaire development (Leigh & Stacy, 1993; Markland & Hardy, 1993; McCarthy, Pedersen, Thompsen, & Leuty, 2006). The present method provides a valid and efficient coding procedure that reduces ambiguity and solves a critical problem in coding open-ended assessments (Ames et al., 2005; Bornstein, 1999; King, 2004).

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