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# Apples and Oranges? Comparing Indirect Measures of Alcohol-Related Cognition Predicting Alcohol Use in At-Risk Adolescents

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Recently, there has been increased interest in the role of implicit cognitive processes in the development of addictive behaviors. In this study, the authors compared 3 indirect measures of alcohol-related cognitions in the prospective prediction of alcohol use in at-risk adolescents. Implicit alcohol-related cognitions were assessed in 88 Dutch at-risk adolescents ranging in age from 14 to 20 years (51 males, 37 females) by means of varieties of word association tasks, Implicit Association Tests, and Extrinsic Affective Simon Tasks adapted for alcohol use. Alcohol use and alcohol-related problems were measured with self-report questionnaires at baseline and after 1 month. Results showed that the indirect measures predicted unique variance in prospective alcohol use after controlling for the direct measure of alcohol-related cognitions and background variables. The results indicate that the word association tasks were the best indirect measure of alcohol-related cognitions. These indirect measures appear to assess cognitive motivational processes that affect behavior in ways not reflected by direct measures of alcohol-related cognitions.

*Keywords:* adolescent alcohol use, EAST, IAT, implicit cognition, word association

Dual process models predict that both explicit and implicit cognitive processes influence behavior (e.g., Fazio & Towles-Schwen, 1999; Strack & Deutsch, 2004). Implicit cognitive processes represent more automatic underlying motivational processes, whereas explicit cognitions are related to slower deliberate thought processes that may inhibit more automatic, impulsive thinking and behavior (Greenwald & Banaji, 1995; Kahneman, 2003). Early experiences with alcohol could result in alcohol-related cues (e.g., presence of alcohol), outcomes (e.g., excitement), and behaviors (e.g., drinking) to become associated in memory. These associations may become strengthened over time and guide behavior relatively automatically (Stacy, 1997).

Implicit alcohol-related cognitions have been shown to predict unique variance in current and prospective alcohol use after controlling for explicit alcohol-related cognitions (e.g., Jajodia & Earleywine, 2003; Palfai & Wood, 2001; Stacy, 1997; Thush & Wiers, 2007; Wiers, van Woerden, Smulders, & De Jong, 2002). Implicit cognitions can be measured with various indirect tasks derived from different research paradigms. Throughout this article, we use the terms *implicit* and *explicit cognitive processes* or *cognitions* when referring to the processes evaluated, and we use the terms *direct* or *indirect measures* when referring to the assessment procedures. Various indirect word association tasks have been derived from basic memory research and have been found to predict substance use among college students (e.g., Kelly, Masterman, & Marlatt, 2005; Palfai & Wood, 2001; Stacy, 1995), community samples (e.g., Stacy & Newcomb, 1998), drug offenders (e.g., Ames, Zogg, & Stacy, 2002), and at-risk youth (e.g., Ames, Sussman, Dent, & Stacy, 2005). In addition, various reaction time paradigms have been adapted to assess automatic alcohol-related cognitions. Among the most commonly researched are variants of the Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998) and the Extrinsic Affective Simon Task (EAST; De Houwer, 2003). Both have been found to predict alcohol use and alcohol-related problems among college students (e.g., IAT: Jajodia & Earleywine, 2003; Wiers et al., 2002; EAST: De Houwer, Crombez, Koster, & De Beul, 2004; De Jong, Wiers, van den Braak, & Huijding, 2007). For example, with the use of the IAT, Wiers et al. (2002) found that heavy drinkers associated alcohol more strongly with arousal than with sedation, whereas light drinkers did not, and arousal associations predicted prospective alcohol use. To our knowledge, however, these indirect measures have not been compared directly in the prediction of alcohol use within one study among at-risk youth.

In this study, therefore, we compared these three indirect measures of alcohol-related cognitions in the prediction of prospective alcohol use in at-risk adolescents while controlling for a variety of

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other variables. Determining the predictive value of these measures can help shed some light on which measures are best in predicting future alcohol use among at-risk adolescents. This could benefit our understanding of underlying processes in the development of addictive behaviors and the program effectiveness of targeted interventions among at-risk youth. We hypothesized that the indirect measures would predict a unique part of the variance in adolescent drinking while controlling for confounding and demographic variables (impulsivity, sensation seeking, explicit alcohol-related cognitions, gender, age, and school attended). These possible effects were investigated in an exploratory manner without specific hypotheses.

# Method

## *Participants*

A total of 88 Dutch adolescents (51 males, 37 females) in the age range of 14 to 20 years ($M$ = 16.34 years, $SD$ = 1.34) were recruited from four low-level vocational schools. Out of the 88 participants, 68 (77.27%) indicated having one or more binge drinking episodes (five or more Dutch standard alcoholic drinks on one occasion) in the past 2 weeks.

## *Measures*

### *Alcohol Use*

Alcohol use was assessed with a Dutch version of the alcohol use questionnaires as described in Ames et al. (2007). Self-report questionnaires have been proven to be reliable and valid if participant sobriety and confidentiality of data are assured (Sobell & Sobell, 1990). Both requirements were fulfilled in this study.

### *Alcohol-Related Problems*

An index of alcohol-related problems was assessed using an 18-item version of the Rutgers Alcohol Problems Index (White & Labouvie, 1989). Participants were asked to indicate on a 5-point Likert scale how many times they had experienced certain problems within the past months because of their alcohol use. The items were summed to create an index of alcohol-related problems (Cronbach's alpha = .87).

### *Indirect Measures of Alcohol-Related Cognitions*

*Word association measures.* Three types of associative memory tasks were used in which participants were presented with written verbal cues and were instructed to write down the first word it made them think of. In the cue–behavior association task, participants responded to 24 Dutch homographs (ambiguous words), including 6 words related to alcohol (an English example is *pitcher*; Stacy, 1995, 1997). The outcome–behavior association task consisted of 13 Dutch affective outcomes, of which 6 were positive anticipated consequences of alcohol use (e.g., *feeling relaxed*; Stacy, 1995, 1997). The compound cues were 9 Dutch phrases that consisted of a location and an affective outcome, out of which 6 consisted of a high-risk global situation item and a high-risk affective outcome item (e.g., *friend's house, feeling good*; Stacy, Galaif, Sussman, & Dent, 1996; Sussman, Stacy, Ames, & Freedman, 1998). The responses to each cue were coded as being related to alcohol by two independent judges (kappas ranged from .72 to .82). A final consensus coding was mediated by a third judge. A mean score was calculated across the alcohol-related cues to provide an indication of the activation of alcohol-related associations to the verbal cues. The scores were combined to form a single composite word association index.

*IAT.* In the IAT, participants categorize four categories of stimuli as quickly as possible while using only a left or right response key (see Greenwald et al., 1998). Because prior studies have shown that people can be ambivalent toward alcohol (Houben & Wiers, 2006), we decided to use three unipolar IATs to obtain the association between alcohol and a single attribute. One IAT assessed the association between "active" positive arousal words (e.g., *excited* and *energetic*) versus "neutral" words (e.g., *historical* and *digital*) with photos of objects related to alcohol (e.g., a beer bottle) or objects not related to alcohol (e.g., a ketchup bottle). Another IAT assessed the association between "relaxed" positive sedation words (e.g., *chill* and *calm*) versus neutral words with objects related or not related to alcohol. Finally, one IAT assessed the association between "miserable" negative words (e.g., *sad* and *nauseous*) versus neutral words with objects related or not related to alcohol. These attribute categories were chosen because they represent the three main categories of alcohol expectancies (Goldman & Darkes, 2004). The D-2SD penalty score for practice and test was chosen as the main reaction time measure (see Greenwald, Nosek, & Banaji, 2003).

*EAST.* In the EAST, participants categorize attribute words in terms of the attribute categories as quickly as possible by using two response keys. These response keys acquire an affective meaning. Subsequently, participants categorize colored target words as quickly as possible with respect to their color categories while ignoring their meaning by using the same response buttons. This way, one can assess whether the compatible target words (e.g., when the color of the target word is on the same response key as the associated meaning) will be classified faster than the incompatible target words (e.g., when the color of the target word is on a different response key as the associated meaning; see De Houwer, 2003). In this study, two unipolar versions of the EAST were used; one EAST assessed the association between positive arousal words versus neutral words with different substances (e.g., *beer* and *marihuana*); the other EAST assessed the association between positive sedation words versus neutral words with different substances. The same attribute words were used as in the two similar IATs. The EAST scores were obtained by calculating the difference in response latency between the incompatible and compatible target words.

Detailed instructions on the indirect measures (and other measures) are available from Carolien Thush on request.

### *Other Measures*

*Direct measure of alcohol-related cognitions.* The direct measure of alcohol-related cognitions included 18 items representing an explicit version of the IAT attribute words (as in Wiers et al., 2002). Participants indicated on a 6-point Likert-type scale the extent to which they (dis)agreed with an item consisting of a statement on drinking alcohol (e.g., "Drinking alcohol makes me feel energetic"). The questionnaire consisted of three scales: positive arousal, positive sedation, and negative outcome (Cronbach's alphas ranged from .73 to .84).

*Impulsivity and sensation-seeking scale.* Impulsivity and sensation seeking were assessed with the 18 items from the Zuckerman–Kuhlman Personality Questionnaire (Zuckerman, Kuhlman, Thornquist, & Kiers, 1991). Participants were asked to indicate whether they thought a statement describing them was true or false. For the two subscales, a continuous sum score was calculated (Cronbach's alphas = .67 and .65, respectively).

### Procedure

After obtaining active consent from both the participants and parents, we tested participants in groups of four at school in a separate test room during school time. The word association tasks were administered first to ensure that the free associative nature of the task would not be affected by other assessments. Subsequently, the EAST and the IAT were administered on a laptop computer with a separate response device. The order of tasks within each reaction time paradigm was partially counterbalanced. Next, the participants filled out the direct measure of alcohol-related cognitions. The alcohol use questionnaire was administered last to avoid any interference between having to report one's alcohol use and the measures of implicit and explicit alcohol-related cognitions. The total testing sessions took approximately 90 min for each participant. One month later, we asked the participants to fill out the alcohol use and alcohol-related problems questionnaire. All 88 participants were present at follow-up.

### Data Reduction

To obtain a normally distributed dependent variable and to reduce the chances of a Type I error by multiple testing, we computed a log transformed standardized alcohol use index score. First, $z$ scores were calculated for eight correlating outcome measures, namely, the number of times alcohol used in lifetime, number of times alcohol used in the past month, the number of standard drinks on a weekend day, the number of standard drinks on a weekday, number of times drunk in the past year, frequency of binges per 2 weeks, the number of binges in the past week, and the sum score on the Rutgers Alcohol Problems Index. Subsequently, the alcohol use index score was computed by log transforming the mean of these eight $z$ scores to obtain a normally distributed dependent variable.

## Results

### Outliers

Two participants who reported that they had never consumed alcohol were eliminated from further analyses. In addition, 5 participants were excluded from further analyses because they exceeded the mean error scores in a reaction time task, with more than 3 standard deviations (see Greenwald et al., 2003). The analytic sample was 81.

### Multiple Regression Analyses

Multiple regression models for the alcohol use index were evaluated on the basis of the results of the bivariate analyses; only the variables that were (borderline) significantly correlated with the alcohol use index were included in the multiple regression (see Table 1). By using this procedure, we ensured an optimal trade off between statistical power (including all variables reduces power) and completeness (not leaving out important variables). A setwise hierarchical procedure was used for the multiple regression analyses (Cohen & Cohen, 1983). In Step 1, we entered gender and school attended into the regression equation as background variables. In Step 2, we added sensation seeking and impulsivity to the regression equation. In Step 3, we added the three direct measures of alcohol-related cognition to the model. In Step 4, we added three indirect measures of alcohol-related cognition to the regression model. The hierarchical regression model revealed that overall as a set the indirect measures added significantly to the prediction of prospective drinking ($\Delta R^2 = .06$, $p < .05$) above and beyond the background variables and direct measures (see Table

Table 1
*Pearson Correlations for Explicit and Implicit Cognitions and Alcohol Use*

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Expl Active | — | | | | | | | | | |
| 2. Expl Relaxed | .01 | — | | | | | | | | |
| 3. Expl Miserable | −.11 | −.45** | — | | | | | | | |
| 4. IAT Active | −.12 | −.02 | .13 | — | | | | | | |
| 5. IAT Relaxed | −.03 | .13 | −.06 | .21# | — | | | | | |
| 6. IAT Miserable | −.05 | −.09 | .06 | .27* | −.11 | — | | | | |
| 7. EAST Active | .05 | .12 | .04 | −.19# | −.15 | −.17 | — | | | |
| 8. EAST Relaxed | −.08 | .30** | −.23* | .16 | −.04 | −.12 | −.08 | — | | |
| 9. Word association index | −.04 | .40** | −.30** | .10 | .11 | −.10 | −.02 | .22* | — | |
| 10. Alcohol use index | .22# | .44** | −.46** | .01 | −.02 | −.23* | −.01 | .26* | .43** | — |

*Note.* Expl Active = explicit positive-arousal alcohol cognitions; Expl Relaxed = explicit positive-sedation alcohol cognitions; Expl Miserable = explicit negative alcohol cognitions; IAT = Implicit Association Tests; IAT Active = D (standardized difference score) − 2*SD* score for the positive-arousal IAT; IAT Relaxed = D − 2*SD* score for the positive-sedation IAT; IAT Miserable = D − 2*SD* score for the negative IAT; EAST = Extrinsic Affective Simon Tasks; EAST Active = mean reaction time difference score for positive-arousal EAST; EAST Relaxed = mean reaction time difference score for positive-sedation EAST; Word association index = mean score of alcohol cues, alcohol outcomes, and compound cues; Alcohol use index = log transformed standardized sum score of eight outcome variables.
# $p \leq .10$. * $p < .05$. ** $p < .01$.

2). Overall, the full model explained 54% of the variance in the alcohol use index, $R^2$ adjusted = .46, $F(12, 67) = 6.56$, $p < .001$. A trimmed model was obtained by removing all variables that were not significant from the regression equation. The final trimmed model revealed that the word associations ($\beta = .30$, $p < .01$) predicted the alcohol use index after 1 month, adjusting for other predictors that were also significant, including school ($\beta = .30$, $p < .01$), impulsivity ($\beta = .21$, $p < .05$), explicit positive-arousal alcohol-related cognitions ($\beta = .20$, $p < .05$), and explicit negative alcohol-related cognitions ($\beta = -.40$, $p < .001$). Overall, the trimmed model explained 49% of the variance, $R^2$ adjusted = .44, $F(7, 73) = 10.08$, $p < .001$.

## Discussion

In this study, we compared three indirect measures of alcohol-related cognitions that were used to predict prospective alcohol use in at-risk adolescents. The multiple regression analysis showed that the indirect measures predicted unique variance in prospective alcohol use after controlling for explicit alcohol-related cognitions and background variables. This is in line with previous research on implicit and explicit alcohol-related cognitive processes in young adults and adolescents (e.g., Palfai & Wood, 2001; Stacy, 1997; Thush & Wiers, 2007; Wiers et al., 2002). In addition, the trimmed model showed that the word association tests were the strongest predictor among the group of indirect measures of alcohol use. Similar findings were reported in a comparison of word association, IAT, and EAST in the prediction of marijuana use among at-risk youth in the United States (Ames et al., 2007). Thus, the same pattern of results arises across different countries, languages, and substances.

Table 2
*Summary of Multiple Regression Analysis for Variables Predicting Alcohol Use After 1 Month (n = 81)*

| Variable | Cumulative | | Simultaneous | | |
|---|---|---|---|---|---|
| | $R^2$ | $\Delta R^2$ | *B* | *SE B* | β |
| Gender | | | 0.13 | 0.15 | .09 |
| School 1 | | | 0.10 | 0.31 | .03 |
| School 3 | | | 0.37 | 0.18 | .21* |
| School 4 | .12 | | −0.14 | 0.16 | −.09 |
| Sensation seeking | | | 0.28 | 0.37 | .08 |
| Impulsivity | .17 | .06 | 0.55 | 0.31 | .19 |
| Expl Active | | | 0.17 | 0.07 | .22* |
| Expl Relaxed | | | 0.11 | 0.09 | .14 |
| Expl Miserable | .48 | .31** | −0.26 | 0.08 | −.32** |
| IAT Miserable | | | −0.17 | 0.11 | −.14 |
| EAST Relaxed | | | 0.00 | 0.00 | .08 |
| Word association index | .54 | .06* | 1.70 | 0.82 | .20* |

*Note.* $R^2$ and $\Delta R^2$ are from hierarchical models in which preceding effects were entered first; the *B, SE B,* and β are from a simultaneous model. Sensation seeking = summed mean sensation-seeking score; Impulsivity = summed mean impulsivity score; Expl Active = explicit positive-arousal alcohol cognitions; Expl Relaxed = explicit positive-sedation alcohol cognitions; Expl Miserable = explicit negative alcohol cognitions; IAT = Implicit Association Tests; IAT Miserable = D (standardized difference score) − 2*SD* score for the negative IAT; EAST = Extrinsic Affective Simon Tasks; EAST Relaxed = mean reaction time difference score for the positive-sedation EAST; Word association index = mean score of alcohol cues, alcohol outcomes, and compound cues.
* $p < .05$. ** $p < .01$.

One possible explanation for the current pattern of results is that the IAT measures relative associations between predefined categories. In contrast, word association allows for free competition among associates to be generated in response to a variety of cues. Because these word association tasks do not impose categorical constraints on the individual, they increase the likelihood of tapping into individual differences in underlying motivational associative structures. On the one hand, the reaction time measures seem to be limited in the sense that they place categorical constraints on the activation of associative structures, whereas these categorical constraints could be helpful when specific hypotheses about the content of alcohol-related associations are being assessed. In sum, comparing these tasks is like comparing apples and oranges; both types of indirect measures (word association tasks and reaction time measures) have their own unique strengths for which they can be used in addiction research.

Given several limitations, the results presented in this study should be interpreted with some caution. First, although we screened for schools with a high proportion of at-risk adolescents, we did not use a probability sampling strategy at an individual level; therefore, we might not be able to generalize these results to other at-risk adolescent populations. Second, we did not have the statistical power to adequately look at possible interactions with other background variables, such as gender. It could be that the results would have been different for specific subgroups of at-risk adolescents. Third, because the word association tests, EAST, and IAT were performed in a fixed order, it is possible that order effects could have played a role in the current results. However, this fixed sequence was chosen as the most optimal procedure to minimize method-related variance in a study focusing on individual differences (cf. Asendorpf, Banse, & Mücke, 2002). Fourth, although measuring implicit associations in a unipolar fashion may have a better construct validity given that people can be ambivalent toward alcohol (Houben & Wiers, 2006), measuring associations in a bipolar fashion could provide better power because it allows a more natural competition between several associations that exist side by side (e.g., the competition between a positive and a negative association with alcohol). This could partly explain why both the IAT and EAST were not more predictive and were sometimes significant correlates only in the bivariate analysis. Finally, it is possible that assessing too many drugs in one unipolar EAST is problematic, minimizing activation of associative structures and, thus, the EAST effects in this study.

In sum, both explicit and implicit alcohol-related cognitions seem to predict drinking behavior in at-risk adolescents. Overall, the indirect measures added significantly to the prediction of prospective drinking while controlling for background variables and direct measures. More specifically, word associations predicted drinking after 1 month, adjusting for school, impulsivity, and explicit positive-arousal and negative alcohol cognitions. Although the reaction time measures place categorical constraints on the activation of an associative network, these categorical constraints could still be helpful when specific hypotheses are being assessed. Thus, depending on the nature of the hypotheses to be assessed, both word association tasks and reaction time measures have their own unique strengths for which they can be used in addiction research.

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