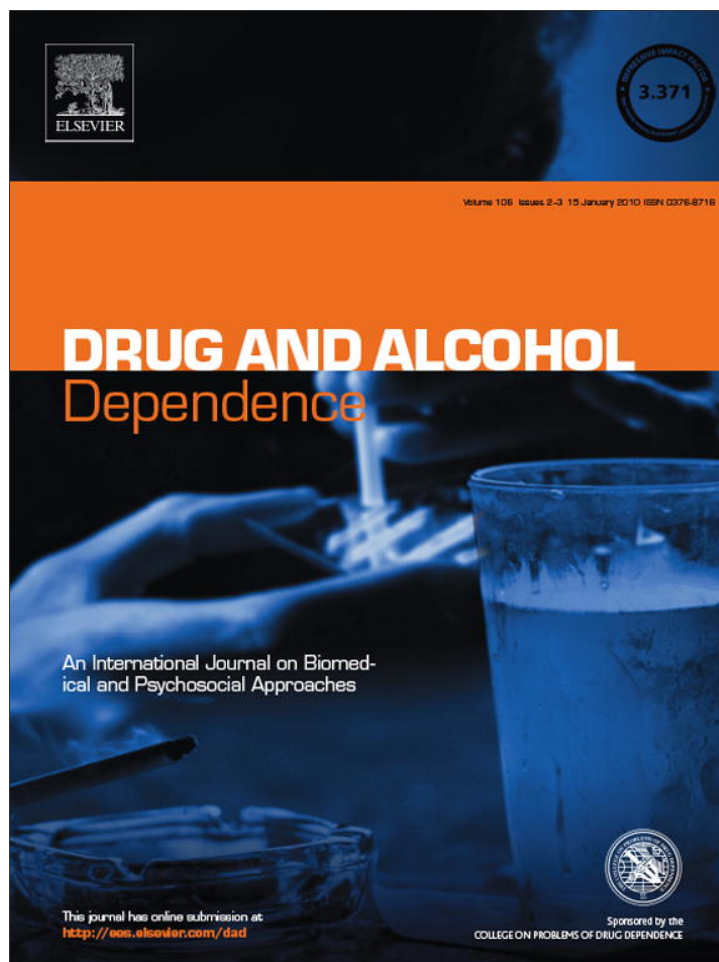


Provided for non-commercial research and education use.
Not for reproduction, distribution or commercial use.



This article appeared in a journal published by Elsevier. The attached copy is furnished to the author for internal non-commercial research and education use, including for instruction at the authors institution and sharing with colleagues.

Other uses, including reproduction and distribution, or selling or licensing copies, or posting to personal, institutional or third party websites are prohibited.

In most cases authors are permitted to post their version of the article (e.g. in Word or Tex form) to their personal website or institutional repository. Authors requiring further information regarding Elsevier's archiving and manuscript policies are encouraged to visit:

<http://www.elsevier.com/copyright>



Contents lists available at ScienceDirect

Drug and Alcohol Dependence

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

Seeing the forest through the trees: A comparison of different IAT variants measuring implicit alcohol associations

Katrijn Houben^{a,*}, Brian A. Nosek^b, Reinout W. Wiers^c

^a Clinical Psychological Science, Maastricht University, PO Box 616, 6200 MD Maastricht, The Netherlands

^b Department of Psychology, University of Virginia, Charlottesville, USA

^c Department of Psychology, University of Amsterdam, Amsterdam, The Netherlands

ARTICLE INFO

Article history:

Received 9 October 2008

Received in revised form 11 August 2009

Accepted 27 August 2009

Available online 24 September 2009

Keywords:

Implicit cognition

Implicit Association Test

Alcohol use

ABSTRACT

Dual-process models propose that addictive behaviors are determined by an implicit, impulsive system and an explicit, reflective system. Consistent with these models, research has demonstrated implicit affective associations with alcohol, using the Implicit Association Test (IAT), that predict unique variance in drinking behavior above explicit cognitions. However, different IAT versions have been used to measure implicit affective associations with alcohol, and the present study sought to determine which of these IAT variants showed the highest validity and internal consistencies. In total, 4800 participants completed one of six IAT versions via the Internet: a bipolar IAT (i.e., positive vs. negative), a unipolar positive IAT (i.e., positive vs. neutral), or a unipolar negative IAT (i.e., negative vs. neutral) with general positive and negative stimuli or with positive and negative alcohol-related affective states. While the alcohol-related affective bipolar and unipolar positive IAT versions and the general affective bipolar and unipolar positive IAT versions showed comparable internal consistencies, somewhat lower internal consistencies were found for the unipolar negative IAT versions. Further, alcohol-related affective IAT variants were more strongly related to explicit measures than general affective IAT versions. Also, alcohol-related and general affective bipolar and unipolar positive IAT variants were related to drinking behavior, but not unipolar negative IAT variants. Finally, the bipolar alcohol-related affective IAT, the unipolar alcohol-related positive IAT and the unipolar general positive IAT predicted drinking behavior above explicit measures. Overall, the bipolar alcohol-related affective IAT outperformed all other IAT variants with respect to its relationship with explicit measures and drinking behavior.

© 2009 Elsevier Ireland Ltd. All rights reserved.

1. Introduction

Contemporary dual-process theories propose that addictive behaviors like alcohol misuse and abuse, are determined by the dynamic interplay of two qualitatively different systems: a fast, associative, implicit, *impulsive* system, which includes automatic appraisal of stimuli in terms of their affective and motivational significance, and a slower, rule-based, explicit, *reflective* system, which includes controlled processes related to conscious deliberations, emotion regulation and expected outcomes (e.g., [Deutsch and Strack, 2006](#); [Evans, 2003](#); [Evans and Coventry, 2006](#); [Strack and Deutsch, 2004](#); [Wiers et al., 2007](#)). According to these models, the impulsive system consists of an associative network in which frequently co-occurring representations of perceptual features, affect, and behavioral schemata form associative clusters. Importantly, activation spreads between the elements of associative clusters

and activates behavioral schemata automatically. The reflective system also uses information retrieved from the associative network that resides in the impulsive system, but operates by very different principles. Specifically, reflective processes depend on symbolic and propositional representations and determine behavior through conscious deliberation. Further, the impulsive system and the reflective system can trigger simultaneous, conflicting signals, but ultimately, behavior is determined by the relative strengths of impulsive and reflective processes so that stronger processes gain advantage over weaker ones ([Deutsch and Strack, 2006](#); [Strack and Deutsch, 2004](#)).

From this perspective it follows that, in order to understand the processes underlying alcohol use, it is necessary to assess both impulsive and reflective processes related to alcohol use. While reflective processes can be easily measured using direct self-report measures, impulsive processes are more appropriately measured indirectly. Indirect measures, like the Implicit Association Test (IAT; [Greenwald et al., 1998](#)), do not rely on self-report, but instead infer processes from performance on reaction-time tasks. In line with previous research, we will refer to automatically activated

* Corresponding author. Tel.: +31 433881953.

E-mail address: K.Houben@psychology.unimaas.nl (K. Houben).

impulsive processes measured with the IAT as implicit associations or implicit cognitions, and to reflective processes measured with self-report measures as explicit cognitions (cf. De Houwer, 2006).

The IAT is a computerized sorting task that infers implicit associations from the simultaneous classification of two target categories, for example “alcohol” versus “soft drinks”, and two affective attribute categories, for example “positive” versus “negative”. Items representing all four categorized are presented one at a time, and participants must categorize them as quickly as possible. In one of the two key conditions, items representing alcohol or positive are categorized with one response (a key press), and items representing soft drinks or negative are categorized with an alternative response. In the other condition, alcohol and negative items are categorized with one response, and soft drinks and positive items with the other. The difference in average categorization latency between these two conditions reflects the strength of association between the target and attribute concepts (see Nosek et al., 2007a for a review).

1.1. Overview of findings with different IAT versions

In the past decade, many studies have used the IAT to examine the nature of implicit affective associations with alcohol and their relationship with drinking behavior (see Rooke et al., 2008). However, the substantial variability in the findings across studies could be due to different operationalizations of the IAT and related implicit measures. For example, some studies have used a bipolar affective dimension in which positive affect is contrasted with negative affect (e.g., De Houwer et al., 2004; Wiers et al., 2002). However, such bipolar IAT variants cannot assess implicit alcohol associations with positive affect and negative affect separately (Nosek et al., 2007a). This could be problematic given that ambivalence – both positive and negative feelings – toward alcohol can be quite high (Conner and Sparks, 2002). Other studies have examined positive and negative implicit alcohol associations separately with unipolar IAT versions, one contrasting positive affect with neutral and another contrasting negative affect with neutral (e.g., Houben and Wiers, 2008a; Jajodia and Earleywine, 2003; McCarthy and Thompson, 2006). While promising, no study has yet compared bipolar and unipolar IAT versions with respect to internal consistency or validity for predicting alcohol-related cognitions and drinking behavior. Such comparisons are resource intensive, usually requiring more participants and power than feasible in a laboratory setting.

Another possible reason for the unexplained variability in findings linking implicit alcohol cognitions with drinking behavior is that some studies operationalized attribute categories with positive and negative alcohol-related affective states (i.e., positive and negative mood states that are related to drinking alcohol; e.g., happy, excited, depressed, sad; e.g., Jajodia and Earleywine, 2003; Wiers et al., 2002), and others used general positive and negative affective stimuli (i.e., love, peace, war, disease; e.g., Houben and Wiers, 2006a, 2007). We refer to the first type as alcohol-related affective IATs, and to the latter type as general affective IATs.

According to the dual-process perspective on addictive behaviors (e.g., Deutsch and Strack, 2006; Wiers et al., 2007), the associative network that resides in the impulsive system consists of associated perceptual cues, affect, and behavioral schemata that frequently occur together. From this perspective, we expect that alcohol-related cues are more strongly associated with alcohol-related affective states that often co-occur with drinking, than with general affective concepts. Moreover, alcohol-related affective states are probably also more strongly associated with behavioral schemata of drinking alcohol than general affective concepts. This suggests that alcohol-related affective IAT variants are better suited as measures of implicit alcohol associations

that steer drinking behavior compared to general affective IAT variants.

In line with this hypothesis, previous findings are suggestive of stronger validity for alcohol-related affective IAT variants than for general affective IAT variants, regardless of whether the attribute dimension was presented in a bipolar or a unipolar format. Studies using bipolar IATs show that alcohol is associated more strongly with negative affect than with positive affect, regardless of whether general or alcohol-related attributes are used (alcohol-related: Houben and Wiers, 2006b; Wiers et al., 2002, 2005; general affective: De Houwer et al., 2004; Houben and Wiers, 2007, 2008b). Further, the bipolar alcohol-related affective IAT has consistently shown a moderate to strong relationship with drinking behavior, with weaker negative implicit associations with alcohol predicting elevated levels of drinking (Houben and Wiers, 2006b; Wiers et al., 2002, 2005), and more positive explicit alcohol-related cognitions (Houben and Wiers, 2006b; Wiers et al., 2002). In contrast, the bipolar general affective IAT has shown mixed results with respect to its relationship with explicit measures and drinking behavior (Houben and Wiers, 2007, 2008b).

Similarly, the general and alcohol-related unipolar IAT variants elicit similar IAT effects: alcohol is associated with both negative affect and positive affect (Houben and Wiers, 2006a, 2008a; Jajodia and Earleywine, 2003; McCarthy and Thompson, 2006). Further, no studies have demonstrated a relationship between negative implicit alcohol associations and drinking levels, whether using alcohol-related or general affective unipolar negative IAT versions (Houben and Wiers, 2006a, 2008a; Jajodia and Earleywine, 2003; McCarthy and Thompson, 2006). In contrast, more positive implicit alcohol associations are consistently related to increased drinking behavior, but only with unipolar alcohol-related positive IAT versions (Houben and Wiers, 2008a; Jajodia and Earleywine, 2003; McCarthy and Thompson, 2006), and not with unipolar general positive IAT variants (Houben and Wiers, 2006a). Finally, except for one study (McCarthy and Thompson, 2006), no significant correlations have been reported between unipolar IAT variants and explicit cognitions (Houben and Wiers, 2006a, 2008a; Jajodia and Earleywine, 2003).

1.2. Present study

This review suggests stronger validity for alcohol-related affective IAT versions than for general affective IAT versions (with respect to both bipolar and unipolar IAT variants). Further, while different IAT effects have been demonstrated with unipolar IAT variants compared to bipolar IAT variants, it is unclear whether there are also differences in validity between bipolar and unipolar IAT versions. Finally, it is unclear whether all these different IAT variants show comparable internal consistencies. Since these IAT versions were all developed to measure the same underlying construct, namely implicit affective associations with the concept alcohol, it would be useful to determine which yields the highest incremental validity and internal consistencies.

This has both practical and theoretical implications. First, based on contemporary dual-process models of addictive behaviors, both impulsive and reflective processes are important for understanding the mechanisms that steer alcohol use and abuse. Hence, reliable and valid indirect measures that tap impulsive processes are essential complements to already established direct measures of reflective processes. Second, to reduce alcohol misuse and abuse, interventions need to influence both impulsive and reflective processes (e.g., Wiers et al., 2006, 2008). The success of these and other interventions will be facilitated with reliable and valid indirect measures of their effect on impulsive processes.

In order to achieve high power and detect differences among IAT variants, we leveraged a virtual laboratory infrastructure

(<https://implicit.harvard.edu/>) to recruit a large and heterogeneous sample. This virtual laboratory, and web-based methods in general, have proven useful for measuring implicit cognitions for a variety of topics (Nosek, 2005; Nosek et al., 2007b) and for implicit alcohol associations in particular (Houben and Wiers, 2008b). Participants were randomly assigned to one of six IAT versions: participants either performed a bipolar IAT (i.e., positive vs. negative), a unipolar positive IAT (i.e., positive vs. neutral), or a unipolar negative IAT (i.e., negative vs. neutral). Further, the IAT attribute categories either consisted of general positive and negative stimuli or of positive and negative alcohol-related affective states. Participants also reported explicit alcohol-related cognitions and alcohol use.

2. Method

2.1. Participants

A total of 4800 volunteers at the Dutch Project Implicit research site (<https://implicit.harvard.edu/implicit/netherlands/>; see also Nosek, 2005; Nosek and Hansen, 2008) initiated a study session. Following data cleaning (i.e., dropping participants with missing data, with >10% of response latencies shorter than 300 ms, or with >40% errors in any of the four combined sorting blocks; see also Greenwald et al., 2003; Nosek, 2005; Nosek and Hansen, 2008; Nosek et al., 2007a), a total of 3169 participants were retained.¹ Finally, participants who reported that they did not drink alcohol were excluded. The final sample consisted of 2868 participants (57% male; mean age = 34.20 years, $SD = 12.28$). On average, participants consumed 11.43 ($SD = 9.78$; range 1–56), Dutch standard alcoholic drinks containing 10 g of alcohol.

2.2. Materials and measures

2.2.1. Implicit Association Test. Participants were randomly assigned to one of the six possible IAT conditions resulting from crossing the polarity of the attribute dimension (i.e., bipolar positive vs. negative, unipolar positive vs. neutral, or unipolar negative vs. neutral) with the type of attribute stimuli (i.e., general positive/negative attributes or positive/negative alcohol-related affective states). IATs were presented with a Flash applet administered by the Project Implicit study management infrastructure (see Nosek, 2005; Nosek et al., 2007a). In all six IAT versions, the target categories were 'alcohol' (stimulus items: wine, beer, pint, vodka, whiskey, and breezer) and 'soft drink' (stimulus items: coca cola, fanta, orange soda, sparkling water, juice, cassis). In the bipolar alcohol-related affective IAT, a positive attribute category consisting of six positive affective states related to drinking alcohol (i.e., talkative, excited, cheerful, happy, funny, lively; label 'pleasant') was paired with a negative attribute category that consisted of six negative affective states related to drinking alcohol (nauseous, listless, awful, miserable, sad, annoying; label 'unpleasant').² The same 'pleasant' and 'unpleasant' attribute categories were used in the unipolar alcohol-related positive IAT and the unipolar alcohol-related negative IAT, respectively, where they were paired with a neutral attribute category (stimulus items: average, undefined, general, normal, usual, everyday; label 'neutral'). In the bipolar general affective IAT, a positive attribute category consisting of six general positive words (i.e., love, sunshine, warmth, peace, hug, rainbow; label 'pleasant') was paired with a negative attribute category that consisted of six general negative words (sorrow, war, depression, pain, fight, disease; label 'unpleasant'). The same general 'pleasant' and 'unpleasant' attribute categories were used in the unipolar general positive IAT and the unipolar general negative IAT, respectively, where they were paired with a neutral attribute category that consisted of six general neutral words (i.e., letter, appliance, ballpoint, circle, square, page; label 'neutral').

All six IAT versions followed the standard IAT procedure (Nosek et al., 2007a). Participants completed seven response blocks. First, participants sorted affective attributes for 24 trials into two attribute categories (i.e., pleasant vs. unpleasant

¹ From the total sample of 4800 participants, 1371 participants failed to complete the IAT (28.57%), and an additional 180 participants did not complete the self-report measures (2.5% did not fill out the drinking measures, and 1.25% did not fill out the explicit measures). Further, 80 participants were removed due to their task performance in the IAT.

² For the positive alcohol-related attribute category, we selected six attributes with a positive affective value that also scored high on arousal. Conversely, for the negative alcohol-related attribute category, we selected six attributes with a negative affective value that also scored low on arousal. Thus, these two alcohol-related affective attribute categories represent positive arousal and negative sedation, respectively, which are the two affective dimensions that have been demonstrated to be important positive and negative predictors of drinking behavior, respectively (cf. Wiers, 2008).

for the two bipolar IAT versions, pleasant vs. neutral for the two unipolar positive IAT versions, and unpleasant vs. neutral for the two unipolar negative IAT versions) using left ('e') and right ('i') response keys on the keyboard. Second, participants sorted alcoholic drinks and soft drinks using the same two response keys for 24 trials into the two target categories (i.e., alcohol vs. soft drink). Third, participants sorted stimuli for all four categories for 24 trials using the two response keys. During this combined sorting block, participants sorted items of one attribute category and one target category with one response key, and the other key was used to categorize items from the other attribute category and target category (e.g., pleasant + alcohol vs. unpleasant + soft drink for the two bipolar IAT versions, pleasant + alcohol vs. neutral + soft drink for the two unipolar positive IAT versions, and unpleasant + soft drink vs. neutral + alcohol for the two unipolar negative IAT versions). Fourth, the same response mapping was repeated for 48 more trials. Fifth, participants sorted alcoholic drinks and soft drinks again for 48 trials with the reversed response mapping (i.e., if alcohol was previously sorted using the left response key, it now had to be sorted using the right response key). Sixth, participants again sorted stimuli from all four categories for 24 trials, but now with the reversed response mappings for the target categories (e.g., pleasant + soft drink vs. unpleasant + alcohol for the two bipolar IAT versions, pleasant + soft drink vs. neutral + alcohol for the two unipolar positive IAT versions, and unpleasant + alcohol vs. neutral + soft drink for the two unipolar negative IAT versions). Seventh, participants repeated the sorting conditions from the sixth block for 48 more trials.

Target and attribute stimuli were always presented in the middle of the computer screen. In blocks with four categories, trials alternated between presenting target items and attribute items. During the task, the labels of the categories assigned to the left and right response key were presented in the corresponding upper corners of the computer screen. To emphasize the distinction between the target dimension and the attribute dimension, labels and items for the two target categories were presented in white, while labels and items for the attribute categories appeared in green against a black background. Categorization errors were signaled with a red "X" beneath the stimulus item and participants had to correct the response before continuing to the next trial. The intertrial interval was 150 ms. Finally, the order of the combined sorting conditions (blocks 3, 4 and blocks 6, 7) was randomized across participants so that half of the participants categorized alcohol with pleasant first and the other half categorizes alcohol with unpleasant first (and likewise for the other IAT versions).

2.2.2. Explicit expectancies and attitudes. Explicit alcohol-related expectancies were measured with a 12-item expectancy questionnaire. Each question asked participants to indicate on a 7-point Likert scale how much they agreed (1 = completely disagree; 7 = completely agree) with the statement: "After drinking alcohol, I feel ..." which was completed with the following words: Nauseous, listless, miserable, depressed, sad, uncomfortable, talkative, excited, cheerful, happy, funny, and lively (i.e., the same words that were used as attribute stimuli in the alcohol-related affective IAT versions). Explicit attitudes toward alcohol were assessed with an attitude questionnaire which consisted of 2 semantic differentials. Participants indicated on a 7-point Likert scale how much they considered drinking alcohol to be unpleasant (1) versus pleasant (7), and bad (1) versus good (7).

2.2.3. Alcohol use. Alcohol use was measured through a self-report questionnaire (Wiers et al., 1997) based on the timeline follow-back method (TLFB; Sobell and Sobell, 1990). Participants were asked to indicate how many drinks of different types of alcoholic beverages they consumed during each day of the past week.

2.3. Design and procedure

Participants were randomly assigned to one of six possible IAT versions: a bipolar IAT with general positive and negative attributes ($n = 493$; 56.2% male; mean age = 34.86 years, $SD = 11.93$; average alcohol use = 11.26 glasses per week, $SD = 9.95$), a bipolar IAT with positive and negative alcohol-related affective states ($n = 414$; 60.4% male; mean age = 33.7 years, $SD = 12.47$; average alcohol use = 11.75 glasses per week, $SD = 9.59$), a unipolar IAT with general positive and neutral attributes ($n = 485$; 59% male; mean age = 34.70 years, $SD = 11.92$; average alcohol use = 11.10 glasses per week, $SD = 9.56$), a unipolar IAT with positive alcohol-related affective states and neutral affective states ($n = 477$; 56.2% male; mean age = 33.98 years, $SD = 12.17$; average alcohol use = 11.14 glasses per week, $SD = 9.46$), a unipolar IAT with general negative and neutral attributes ($n = 484$; 57.6% male; mean age = 34.36 years, $SD = 12.59$; average alcohol use = 11.24 glasses per week, $SD = 9.70$), or a unipolar IAT with negative alcohol-related affective states and neutral affective states ($n = 515$; 53% male; mean age = 33.52 years, $SD = 12.58$; average alcohol use = 12.07 glasses per week, $SD = 10.34$). About half of the participants first completed the IAT ($n = 1510$), followed by the expectancy questionnaire, the attitude questionnaire and the alcohol use questionnaire, in this order. The participants ($n = 1358$) half received the self-report measures before they performed the IAT.

Table 1
Mean IAT effects (D600 effect measure), *t*-value, and effect size (*r*) per IAT version.

	<i>M</i>	<i>SD</i>	<i>t</i> (<i>df</i>)	<i>r</i>
Bipolar alcohol-related affective IAT	-.47	.48	-19.91 (413)**	.70
Bipolar general affective IAT	-.70	.44	-35.33 (492)**	.85
Unipolar alcohol-related positive IAT	.31	.46	14.61 (476)**	.56
Unipolar general positive IAT	.17	.51	7.31 (484)**	.32
Unipolar alcohol-related negative IAT	-.61	.38	-36.24 (514)**	.85
Unipolar general negative IAT	-.76	.38	-44.18 (483)**	.90

** *t*-value is significant at the .05 level (2-tailed).

3. Results

3.1. Implicit attitudes toward alcohol

IAT effects were calculated with the D600 scoring algorithm. Following the formula presented by Greenwald et al. (2003), practice trials were retained, latencies of error trials were replaced with the mean of the correct responses in the block plus a 600 ms penalty, and the difference between the average response latency between the two blocks was divided by the standard deviation of all trials between the two response blocks. The D600 measure was coded so that positive values indicate more positive implicit attitudes toward alcohol (for the bipolar IAT versions and the unipolar positive IAT versions) or less negative implicit attitudes toward alcohol (for the unipolar negative IAT).

Internal consistencies were calculated for each IAT version by correlating the D600 measure calculated for the practice trials with the IAT effect measure calculated for the test trials (cf. Greenwald et al., 2003). However, dividing a measure into halves underestimates the reliability of the entire measure, and therefore we applied the Spearman–Brown correction which compensates for this underestimate of the true internal consistency (cf. Karpinski and Steinman, 2006). Internal consistencies for the bipolar alcohol-related affective IAT and the bipolar general affective IAT were .79 and .76, respectively. For the unipolar positive IATs, the internal consistencies were .78 and .81 for the alcohol-related affective version and the general affective version, respectively. Finally, internal consistencies for the unipolar alcohol-related negative IAT and the unipolar general negative IAT were .68 and .69, respectively. Thus, while the alcohol-related affective IAT versions and the general affective IAT versions showed comparable internal consistencies, results did demonstrate somewhat lower internal consistencies for the unipolar negative IAT versions as compared to the bipolar IAT versions and the unipolar positive IAT versions.

To examine whether the size of IAT effects differed between the six IAT versions, we performed a 2 (attribute stimuli: general affective or alcohol-related affective attributes) by 3 (polarity: bipolar positive vs. negative, unipolar positive vs. neutral, or unipolar negative vs. neutral) ANOVA on the D600 measure. Results showed a significant effect of polarity, $F(2, 2862) = 1260.44, p < .001, r = .68$, as well as a significant effect of attribute stimuli, $F(1, 2862) = 110.71, p < .001, r = .19$. Further, the interaction effect was very small, $F(2, 2862) = 2.87, p = .06, r = .05$. It reflected the fact that differences between the alcohol-related affective IATs and general affective IATs was largest with the bipolar IAT ($r = .24$) and smallest with the unipolar positive IAT ($r = .14$), with the unipolar negative IAT in between ($r = .20$; see effects in Table 1).

3.2. Predictive and incremental validity

A mean score was calculated for positive items of the expectancy questionnaire, $M = 4.92, SD = 1.07$, and for negative items of the expectancy questionnaire, $M = 2.64, SD = 1.13$. Similarly, a mean

score was calculated from the two items of the attitude questionnaire, $M = 4.89, SD = .87$. Correlations of these explicit expectancies and attitudes with the different IAT versions are shown in Table 2. Results showed that the bipolar alcohol-related affective IAT was significantly more strongly correlated with negative explicit expectancies than the bipolar general affective IAT, $z = -2.57, p = .005$, while there was a trend indicating that the bipolar alcohol-related affective IAT was more strongly correlated with positive explicit expectancies, $z = 1.35, p = .08$, and explicit attitudes, $z = 1.58, p = .06$, than the bipolar general affective IAT. No differences with respect to correlations with explicit measures were found between the unipolar alcohol-related positive IAT and the unipolar general positive IAT ($p > .10$). However, results did indicate that the unipolar alcohol-related negative IAT was significantly more strongly correlated with positive expectancies than the unipolar general negative IAT, $z = 2.07, p = .02$, while correlations with negative expectancies and with attitudes did not differ significantly between the two unipolar negative IAT versions ($p > .10$). Further, the bipolar alcohol-related affective IAT was significantly more strongly correlated with explicit attitudes than the unipolar alcohol-related positive IAT, $z = 2.18, p = .02$, and significantly more strongly related to negative expectancies, $z = -1.69, p = .04$, and to explicit attitudes, $z = 2.06, p = .02$, than the unipolar alcohol-related negative IAT. No other differences in correlations with explicit measures between bipolar and unipolar alcohol-related affective IAT versions reached significance ($p > .10$). Finally, the bipolar and unipolar general affective IAT versions did not differ significantly with respect to their correlations with explicit measures ($p > .10$).

Further, an estimate of alcohol use was calculated from the TLFB questionnaire as the sum score of alcohol consumption on each day of the past week. The alcohol use estimate was log-transformed before it was entered in the correlational analyses to achieve a normal distribution for this variable. As can be seen in Table 2, the bipolar IAT versions and the unipolar positive IAT versions were significantly related to alcohol use, whereas the unipolar negative IAT versions did not show a significant relationship with drinking behavior. Results further indicated that the bipolar alcohol-related affective IAT was significantly more strongly related to alcohol use than the bipolar general affective IAT, $z = 2.65, p = .004$, while no differences in correlations with alcohol use emerged between the unipolar alcohol-related positive IAT and the unipolar general positive IAT, or between the unipolar alcohol-related negative IAT and the unipolar general negative IAT ($p > .10$). Further, the bipolar alcohol-related affective IAT was also more strongly related to alcohol use than the unipolar alcohol-related positive IAT, $z = 2.03, p = .02$, and the unipolar alcohol-related negative IAT, $z = 3.59, p < .001$. In addition, the unipolar alcohol-related positive IAT was also more strongly related to alcohol use than the unipolar alcohol-related negative IAT, $z = 1.59, p = .05$. Finally, with respect to the general affective IAT versions, results showed that the unipolar general positive IAT was more strongly correlated with alcohol use than the unipolar general negative IAT, $z = 2.52, p = .01$, while no other differences between the bipolar and unipolar general affective IAT versions reached significance ($p > .10$).

Next, we tested the predictive validity of the explicit measures and the incremental validity of the IAT versions using hierarchical regression analysis. Since the unipolar negative IAT versions did not show a relationship with drinking behavior in the correlational analyses, we included only the bipolar IAT versions and the unipolar positive IAT versions in the regression analysis ($n = 1869$). Further, the explicit measures, the D600 IAT measure and the log-transformed alcohol use estimate were standardized before they were entered in the regression analysis and interactions were calculated using these standardized variables. Explicit alcohol-related

Table 2
Correlations of the IAT, explicit alcohol-related cognitions and alcohol use, separately for each of the six conditions.

Condition		Positive expectancies	Negative expectancies	Attitude	Alcohol use
Bipolar alcohol-related affective	IAT	.10*	-.18**	.28**	.28**
	Positive expectancies	-	-.04	.36**	.11*
	Negative expectancies	-	-	-.29**	-.10*
	Attitude	-	-	-	.21**
Bipolar general affective	IAT	.01	-.01	.18**	.11*
	Positive expectancies	-	-.20**	.29**	.19**
	Negative expectancies	-	-	-.35**	-.16**
	Attitude	-	-	-	.39**
Unipolar alcohol-related positive	IAT	.10*	-.12**	.14**	.15**
	Positive expectancies	-	-.17**	.35**	.16**
	Negative expectancies	-	-	-.37**	-.11*
	Attitude	-	-	-	.29**
Unipolar general positive	IAT	.10*	-.06	.15**	.19**
	Positive expectancies	-	-.13**	.30**	.04
	Negative expectancies	-	-	-.39**	-.23**
	Attitude	-	-	-	.39**
Unipolar alcohol-related negative	IAT	.16**	-.07	.15**	.05
	Positive expectancies	-	-.23**	.35**	.12**
	Negative expectancies	-	-	-.31**	-.11*
	Attitude	-	-	-	.28**
Unipolar general negative	IAT	.03	-.06	.10*	.03
	Positive expectancies	-	-.26**	.33**	.13**
	Negative expectancies	-	-	-.34**	-.21**
	Attitude	-	-	-	.37**

* Correlation is significant at the .05 level (2-tailed).

** Correlation is significant at the .01 level (2-tailed).

expectancies and attitudes toward alcohol were entered in step 1. Here, only attitudes toward alcohol significantly predicted alcohol use, $\beta = .30, p < .001$. The D600 IAT effect measure and two dummy variables for polarity and for attribute stimuli were entered in step 2. Only the D600 IAT effect significantly predicted alcohol use above explicit alcohol-related cognitions, $\beta = .12, p < .001$. In step 3, we entered the two-way interactions of the dummy variables and the D600 measure, which did not significantly increase the variance explained. Finally, in step 4, we entered the three-way interaction between the D600 measure, polarity and type of attribute stimuli to examine whether there were differences between the IAT versions with respect to incremental validity. The three-way interaction between the D600 IAT measure, type of attribute stimuli and polarity significantly predicted alcohol use.³ The final model of the hierarchical regression analysis predicting alcohol use (step 4) is shown in Table 3.

Thus, the relationship between the IAT effect and alcohol use varied significantly across the four IAT versions. The simple slopes for each IAT version are shown in Fig. 1. As can be seen in Fig. 1, the bipolar alcohol-related affective IAT showed the best prediction of alcohol use above the variance explained by explicit measures, compared to the other three IAT versions. The three-way interaction was further examined by testing for simple slope differences (Dawson and Richter, 2006). While the difference between the simple slope for the bipolar alcohol-related affective IAT and the simple slope for the bipolar general affective IAT was significant, $t(1858) = 2.22, p = .03$, none of the other simple slope differences reached statistical significance ($p > .10$). Finally, except for the bipolar general affective IAT, all simple slopes were significantly

Table 3
Final model of the hierarchical regression analysis predicting alcohol use.

Variable	β	SE β	t	p
Positive alcohol expectancies	.02	.02	0.92	0.36
Negative alcohol expectancies	-.04	.02	-1.60	0.11
Attitude toward alcohol	.28	.03	11.45	<0.001
IAT	.06	.04	1.37	0.17
Polarity	.00	.03	0.00	1.00
Type of attribute stimuli	.00	.03	0.00	1.00
IAT \times polarity	.06	.04	1.36	0.18
IAT \times type of attribute stimuli	.10	.04	2.22	0.03
Polarity \times type of attribute stimuli	.00	.04	0.00	1.00
IAT \times polarity \times type of attribute stimuli	-.10	.04	-2.06	0.04

Note: Explicit expectancies and attitudes were entered in step 1, $F(3, 1865) = 75.32, p < .001, R^2 = .11$; The D600 IAT measure as well as the two dummies for polarity and type of attribute stimuli were entered in step 2, $F_{change}(3, 1862) = 9.81, p = .01, R^2_{change} = .01$; The two-way interactions between the two dummy variables and the D600 measure were entered in step 3, $F_{change}(3, 1859) = .38, p = .77, R^2_{change} = .00$; In step 4, the three-way interaction between the dummy variables and the D600 measure was added to the regression model, $F_{change}(1, 1858) = 4.23, p = .04, R^2_{change} = .01$. Final model: $R^2 = .13, R^2_{adjusted} = .12, F(10, 1858) = 26.41, p < .001$.

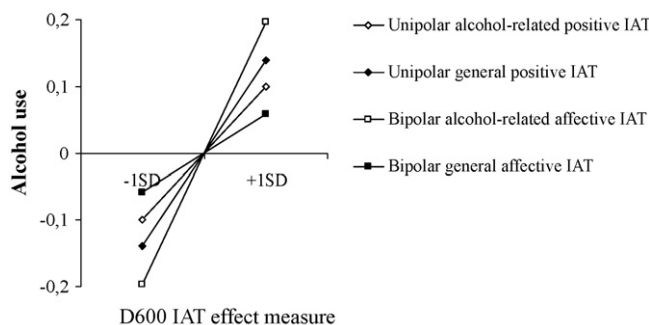


Fig. 1. A three-way interaction plot illustrating the simple slopes for the prediction of alcohol use (standardized, log-transformed estimate) by implicit alcohol attitudes (D600 IAT effect measure) separately for the different IAT versions.

³ When sex was entered in the regression analysis, sex significantly explained about 6% of variance in alcohol use, $\beta = -.24, p < .001, R^2 = .06$. Importantly, entering sex in the regression analysis did not change the pattern of results. Further, none of the interactions between sex, the D600 measure, and the dummies for polarity and type of attribute stimuli reached significance.

different from zero, $t(1858)=1.37$, $p=.17$ for the bipolar general affective IAT, $t(1858)=4.23$, $p<.001$ for the bipolar alcohol-related affective IAT, $t(1858)=3.26$, $p=.001$ for the unipolar general positive IAT, and $t(1858)=2.30$, $p=.02$ for the unipolar alcohol-related positive IAT. These results indicate that the bipolar alcohol-related affective IAT and both the unipolar alcohol-related positive IAT and the unipolar general positive IAT significantly predicted alcohol use above the variance explained by explicit measures.

4. Discussion

4.1. Overview of the present findings

The aim of the present study was to compare bipolar and unipolar IAT versions that have been used in previous studies to examine implicit affective associations with alcohol, with respect to their internal consistency, IAT effects, their relationship with explicit measures and drinking behavior, and their incremental validity. While the bipolar and unipolar positive IAT variants showed comparable good internal consistencies, the internal consistency for the unipolar negative IAT variants was somewhat lower but still acceptable. Findings with both the alcohol-related affective and general affective IAT versions were consistent with previous findings, demonstrating overall negative implicit associations with alcohol in the bipolar IAT versions (cf. De Houwer et al., 2004; Houben and Wiers, 2006b, 2007, 2008b; Wiers et al., 2002, 2005) and in the unipolar negative IAT versions (cf. Houben and Wiers, 2006a, 2008a; Jajodia and Earleywine, 2003; McCarthy and Thompson, 2006), but positive implicit alcohol associations in the unipolar positive IAT variants (cf. Houben and Wiers, 2006a; Jajodia and Earleywine, 2003; McCarthy and Thompson, 2006). Further, the present findings indicated that, for both the bipolar and unipolar negative IAT variants, IAT effects were less negative in the alcohol-related affective IAT versions than in the general affective IAT versions. Effects in the unipolar alcohol-related positive IAT were more positive compared to the unipolar general positive IAT. Thus, when attribute categories in the IAT are operationalized using alcohol-related affective states, the IAT yields less negative or more positive implicit affective associations with alcohol than when attribute categories consist of general affective stimuli.

In the present study, all IAT versions showed a relationship with explicit attitudes toward alcohol with the bipolar alcohol-related affective IAT showing the strongest correlation. Further, all alcohol-related affective IAT versions showed a relationship with explicit positive expectancies while, of the general affective IAT versions, only the unipolar positive IAT was related to explicit positive expectancies. Only the bipolar alcohol-related affective IAT and the unipolar alcohol-related positive IAT showed a relationship with explicit negative expectancies. Tests confirmed that there were some indications that the alcohol-related affective IAT versions were more strongly related to explicit expectancies than the general affective IAT versions. However, one possible explanation for this finding is that the correlations between the alcohol-related affective IAT versions and explicit expectancies were inflated because these measures used the same stimuli. Nevertheless, this cannot account for the present differences between the alcohol-related affective IAT versions and the general affective IAT versions regarding their correlations with explicit attitudes.

Further, consistent with previous findings, the bipolar IAT versions and the unipolar positive IAT versions were related to alcohol use, while the unipolar negative IAT versions did not show a relationship with drinking behavior (cf. Houben and Wiers, 2006b, 2007, 2008a; Jajodia and Earleywine, 2003; McCarthy and Thompson, 2006; Wiers et al., 2002, 2005). Similar to what was found with respect to the relationship between IAT effects and

explicit measures, the strongest correlation with drinking behavior was obtained with the bipolar alcohol-related affective IAT. The bipolar alcohol-related affective IAT, as well as the unipolar alcohol-related positive IAT also predicted alcohol use above the variance explained by explicit measures, which is consistent with previous studies using these IAT variants (cf. Houben and Wiers, 2006b, 2008a; Jajodia and Earleywine, 2003; McCarthy and Thompson, 2006; Wiers et al., 2002). In addition, unlike the study by Houben and Wiers (2006a), the present findings also demonstrated incremental validity for the unipolar general positive IAT. Further, no significant difference was demonstrated between the predictive validity of these three IAT variants. Finally, the bipolar general affective IAT did not show incremental validity which is consistent with findings reported by Houben and Wiers (2008b; but see Houben and Wiers, 2007).

In sum, alcohol-related IAT versions in general demonstrated higher validity, in terms of correlations with explicit measures and prediction of drinking behavior, than general affective IAT versions. Probably, alcohol-related affect is more strongly linked to alcohol-related cues and behavioral schemata related to drinking alcohol than general affective concepts because they more often co-occur with drinking. Further, the present findings also seem to suggest higher validity for bipolar IAT versions than for unipolar positive IAT variants. However, this was only the case for the alcohol-related affective IAT versions, while no difference in validity was found between the general affective bipolar IAT and the general positive unipolar IAT. One possible explanation is that the bipolar alcohol-related was conceptually more similar to the (bipolar) explicit attitude measure than the unipolar alcohol-related positive IAT. This may not only have inflated the relationship of the bipolar alcohol-related affective IAT with explicit attitudes but also its relationship with drinking behavior due to shared variance with explicit attitudes. When controlling for the prediction by explicit measures, the bipolar and unipolar affective IAT versions showed comparable incremental validity.

It should be noted that all IAT versions used in the present study contrasted the concept alcohol with the concept soft drinks and are therefore limited to measuring the relative strengths of pairs of implicit associations. This relative nature of the IAT may complicate the interpretation of the present IAT effects since they can reflect both implicit associations with alcohol and/or implicit associations with soft drinks. Recent research, however, has demonstrated a similar pattern of results when alcohol was contrasted with a different contrast category than soft drinks in the IAT (Houben and Wiers, 2006a), and with a non-relative variant of the IAT, the Single-Category IAT (SC-IAT; Karpinski and Steinman, 2006), that does not require a contrast category (Friese et al., 2008; Houben and Wiers, 2008a; Thush and Wiers, 2007). These findings, thus, indicate that the relativity of the IAT probably does not pose a threat to the interpretation of IAT effects in terms of implicit associations with alcohol or to its validity as predictor of drinking behavior. At this time, however, it remains unclear how the present findings regarding polarity and type of attribute stimuli generalize to SC-IAT versions, although Houben and Wiers (2008a) did demonstrate superior predictive and incremental validity for the unipolar alcohol-related affective IAT compared to the unipolar alcohol-related affective SC-IAT. Thus, the IAT versions tested in the present study may be more valid measures of implicit alcohol associations than the SC-IAT. However, this conclusion may be premature and future research needs to further examine the reliability and validity of the SC-IAT as a measure of implicit alcohol associations.

Finally, there are some limitations to the present study that need to be noted. First, it could be argued that some of the general affective attributes could also be interpreted as alcohol-related affective (e.g., "depression", "sorrow"), which could have caused some overlap between the general affective IAT versions and the

alcohol-related affective IAT versions. Nevertheless, the present findings demonstrated superior validity for the alcohol-related IAT versions as compared to the general affective IAT versions. Therefore, this potential conceptual overlap between the attribute categories cannot account for the present findings, and preventing such overlap in the future will likely even increase the validity of alcohol-related IAT versions as measures of implicit alcohol associations compared to general affective IAT versions. Second, the alcohol-related affective attributes were all adjectives while the general affective attributes were nouns. The reason for this discrepancy is that we aimed to keep the attribute categories as similar as possible to previous research. It is, however, unclear at this time whether this may have influenced the present findings and future research could compare findings with alcohol-related affective attributes and general affective attributes that are all nouns or adjectives. Third, it should be noted that the IAT cannot differentiate between alcohol-affective outcome associations and alcohol-affective antecedent trigger associations. Consequently, correlations between the alcohol-related affective IAT versions and explicit expectancies should increase to the extent that participants interpret affective attributes as consequences from drinking alcohol rather than as antecedent mood states for drinking alcohol. However, as has been argued by Wiers (2008), there are three main types of alcohol-related mood states: positive reinforcement (i.e., positive consequences due to drinking), negative expectancies (i.e., negative consequences due to drinking), and negative reinforcement (i.e., drinking to relief negative antecedent mood state). Importantly, the alcohol-related IAT versions in this study were designed to assess only the first types of alcohol-related affect which can be measured using single adjectives, unlike negative reinforcement for which time is crucial (Wiers, 2008). Fourth, the differences in incremental validity between the IAT versions were very small but still significant due to the large sample in this study, which permitted us to find such small effects. Thus, one could wonder about the practical implications of such small effects. However, the implications were certainly not negligible, since results indicated similar incremental validity for the bipolar alcohol-related affective IAT and both the alcohol-related positive unipolar IAT and the general positive unipolar IAT, while the bipolar general affective IAT did not predict drinking behavior above explicit measures, even in this large sample.

4.2. *Dual-process view of alcohol use and abuse*

From the perspective of dual-process models, alcohol use is determined by a complex interplay between the impulsive system and the reflective system. Therefore, in order to fully understand the mechanisms underlying alcohol use, it is important to examine impulsive processes and reflective processes. The present findings demonstrate that the IAT can be useful tool for investigating impulsive processes. Moreover, the present findings lend further support for the presence of an associative cluster in the impulsive system, in which alcohol is associated with both negative affect and positive affect. However, even though the present findings suggest that alcohol is more strongly associated with negative affect than with positive affect, only the strength of implicit associations between alcohol and positive affect is related to drinking levels. Specifically, more positive implicit affective associations with alcohol (measured with bipolar or unipolar positive IAT versions) predict increased drinking levels.

It should be noted that implicit affective associations with alcohol have also been measured using other indirect measures than IAT, including the Extrinsic Affective Simon Task (EAST; De Houwer, 2003). Consistent with the present findings, studies using variants of the EAST have also demonstrated that stronger positive implicit associations with alcohol predict higher levels of drinking behav-

ior (De Houwer and De Bruycker, 2007; de Jong et al., 2007). In contrast, implicit associations between alcohol and negative affect (measured with negative unipolar IAT versions) appear unrelated to drinking behavior. A possible explanation for this finding is that representations of immediate alcohol effects (e.g., pleasure, arousal) automatically become part of the associative cluster representing the concept alcohol. Less proximate alcohol effects (e.g., health problems), in contrast, may not be integrated via automatic learning. Instead, establishing such relations may depend on reflective processes (Deutsch and Strack, 2006). This could explain why measures that rely more strongly on reflective processes have demonstrated a relationship between negative outcome expectancies and drinking behavior (e.g., Leigh and Stacy, 1998; Reich and Goldman, 2005). In contrast, negative implicit associations may be more abstract, and less accessible in routine drinking situations compared to positive associations, which may explain why they are not related to drinking behavior. It is also interesting to note that other studies have also reported greater validity and internal consistencies for implicit associations with positive affect than for associations with negative affect, across a range of topics and with different indirect tasks (Bar-Anan et al., 2009; Sriram and Greenwald, 2009). Hence, this finding appears to be robust and further investigations will be needed to clarify this good primacy effect.

Further, the impulsive system not only automatically appraises stimuli in terms of their affective value but also in terms of their motivational significance (Bechara et al., 2006; Deutsch and Strack, 2006). The importance of motivational significance is also stressed in other influential models of addictive behaviors, such as the incentive-sensitization theory (Robinson and Berridge, 1993, 2003), and a tight link between affect and motivation is also suggested in theories of normal appetitive behavior (Bradley, 2000). Consistent with these models, studies using the IAT have found support for a motivational cluster, including implicit arousal associations (De Houwer et al., 2004; Houben and Wiers, 2006a; Wiers et al., 2002, 2005) and implicit approach associations (Ostafin and Palfai, 2006; Palfai and Ostafin, 2003), involving the concept alcohol, that predict drinking behavior above explicit measures. With respect to the scope of the present study, it should be noted that implicit arousal associations with alcohol and implicit approach tendencies towards alcohol have been examined using only alcohol-related affective IAT variants.

Hence, together, results with the IAT suggest that appetitive reactions to alcohol cues, including positive affect and increased levels of arousal, are an integral part of the associative cluster representing the concept alcohol in the impulsive system. Moreover, these appetitive reactions appear to have strong associative links to behavior and thereby instigate further drinking through automatic activation of behavioral approach schemata. While these findings provide better insight into the impulsive processes that guide alcohol use, it should be noted that these findings do not clarify whether reflective or impulsive processes will dominate when the opportunity to drink presents itself. This dynamic interaction between impulsive and reflective processes needs to be further examined in future research. Further, it should be noted that these conclusions are mostly based on research that, like the present study, measured alcohol use only over a relatively short time-frame, which is a limitation to previous findings as well as to the present results. Therefore, it would be interesting for future research to measure alcohol consumption over a longer period, and to examine the validity of implicit alcohol associations with positive affect, arousal, and approach tendencies as predictors of prospective alcohol use. Further, in order to gain a better understanding of the processes underlying alcohol use, future research should also include abstainers so that impulsive processes can be examined for the full range of drinkers.

4.3. Conclusion

To summarize, the present findings demonstrate (1) that alcohol-related affective IAT variants are more strongly related to explicit measures than general affective IAT versions, (2) that both alcohol-related and general affective bipolar and unipolar positive IAT variants, but not unipolar negative IAT variants, are related to drinking behavior, and (3) that the bipolar alcohol-related affective, the unipolar alcohol-related positive IAT, and the unipolar general positive IAT predict drinking behavior above explicit measures. Further, the overall pattern of results suggests that the bipolar alcohol-related affective IAT outperforms all other IAT variants with respect to its relationship with explicit measures and drinking behavior.

Role of the funding source

Funding for this study was provided by a grant from the Technology Foundation STW to the last author, and by NIH R01 MH68447 to the second author; the sponsors had no further role in study design; in the collection, analysis and interpretation of data; in the writing of the report; or in the decision to submit the paper for publication.

Contributors

Katrijn Houben and Reinout W. Wiers designed the study. Katrijn Houben performed the statistical analysis, and wrote the first draft of the manuscript. All authors contributed to and have approved the final manuscript.

Conflict of interest

All other authors declare that they have no conflicts of interest.

References

- Bar-Anan, Y., Nosek, B.A., Vianello, M., 2009. The sorting paired features task: a measure of association strengths. *Exp. Psychol.* 56, 329–343.
- Bechara, A., Noel, X., Crone, E.A., 2006. Loss of willpower: abnormal neural mechanisms of impulse control and decision making in addiction. In: Wiers, R.W., Stacy, A.W. (Eds.), *Handbook of Implicit Cognition and Addiction*. SAGE Publishers, Thousand Oaks, pp. 215–232.
- Bradley, M.M., 2000. Emotion and motivation. In: Cacioppo, J.T., Tassinary, L.G., Berntson, G.G. (Eds.), *Handbook of Psychophysiology*, 2nd ed. Cambridge University Press, New York, pp. 602–642.
- Conner, M., Sparks, P., 2002. Ambivalence and attitudes. *Eur. Rev. Social Psychol.* 12, 37–70.
- Dawson, J.F., Richter, A.W., 2006. Probing three-way interactions in moderated multiple regression: development and application of a slope difference test. *J. Appl. Psychol.* 91, 917–926.
- De Houwer, J., 2003. The Extrinsic Affective Simon Task. *Exp. Psychol.* 50, 77–85.
- De Houwer, J., 2006. What are implicit measures and why are we using them? In: Wiers, R.W., Stacy, A.W. (Eds.), *Handbook of Implicit Cognition and Addiction*. SAGE Publishers, Thousand Oaks, pp. 11–28.
- De Houwer, J., Crombez, G., Koster, E.H.W., De Beul, N., 2004. Implicit alcohol-related cognitions in a clinical sample of heavy drinkers. *J. Behav. Ther. Exp. Psychiatry* 35, 275–286.
- De Houwer, J., De Bruycker, E., 2007. The identification-EAST as a valid measure of implicit attitudes toward alcohol-related stimuli. *J. Behav. Ther. Exp. Psychiatry* 38, 133–143.
- de Jong, P.J., Wiers, R.W., van de Braak, M., Huijding, J., 2007. Using the Extrinsic Affective Simon Test as a measure of implicit attitudes toward alcohol: relationship with drinking behavior and alcohol problems. *Addict. Behav.* 32, 881–887.
- Deutsch, R., Strack, F., 2006. Reflective and impulsive determinants of addictive behavior. In: Wiers, R.W., Stacy, A.W. (Eds.), *Handbook of Implicit Cognition and Addiction*. SAGE Publishers, Thousand Oaks, pp. 45–57.
- Evans, J.S.B.T., 2003. In two minds: dual-process accounts of reasoning. *Trends Cogn. Sci.* 7, 454–459.
- Evans, J.S.B.T., Coventry, K., 2006. A dual process approach to behavioural addiction: the case of gambling. In: Wiers, R.W., Stacy, A.W. (Eds.), *Handbook of Implicit Cognition and Addiction*. SAGE Publishers, Thousand Oaks, pp. 29–43.
- Friese, M., Hofmann, W., Wänke, M., 2008. When impulses take over: moderated predictive validity of explicit and implicit attitude measures in predicting food choice and consumption behaviour. *Br. J. Soc. Psychol.* 47, 397–419.
- Greenwald, A.G., McGhee, D.E., Schwartz, J.L.K., 1998. Measuring individual differences in implicit cognition: the Implicit Association Test. *J. Pers. Soc. Psychol.* 74, 1464–1480.
- Greenwald, A.G., Nosek, B.A., Banaji, M.R., 2003. Understanding and using the implicit association test. I. An improved scoring algorithm. *J. Pers. Soc. Psychol.* 85, 197–216.
- Houben, K., Wiers, R.W., 2006a. Assessing implicit alcohol associations with the Implicit Association Test: fact or artifact? *Addict. Behav.* 31, 1346–1362.
- Houben, K., Wiers, R.W., 2006b. A test of the salience asymmetry interpretation of the alcohol-IAT. *Exp. Psychol.* 53, 292–300.
- Houben, K., Wiers, R.W., 2007. Personalizing the alcohol-IAT with individualized stimuli: relationship with drinking behavior and drinking-related problems. *Addict. Behav.* 32, 2852–2864.
- Houben, K., Wiers, R.W., 2008a. Implicitly positive about alcohol? Implicit positive associations predict drinking behavior. *Addict. Behav.* 33, 979–986.
- Houben, K., Wiers, R.W., 2008b. Measuring implicit alcohol associations via the Internet: validation of web-based implicit association tests. *Behav. Res. Methods* 40, 1134–1143.
- Jajodia, A., Earleywine, M., 2003. Measuring alcohol expectancies with the implicit association test. *Psychol. Addict. Behav.* 17, 126–133.
- Karpinski, A., Steinman, R.B., 2006. The single-category implicit association test as a measure of implicit social cognition. *J. Pers. Soc. Psychol.* 91, 16–32.
- Leigh, B.C., Stacy, A.W., 1998. Individual differences in memory associations involving the positive and negative outcomes of alcohol use. *Psychol. Addict. Behav.* 12, 39–46.
- McCarthy, D.M., Thompsen, D.M., 2006. Implicit and explicit measures of alcohol and smoking cognitions. *Psychol. Addict. Behav.* 20, 436–444.
- Nosek, B.A., 2005. Moderators of the relationship between implicit and explicit evaluation. *J. Exp. Psychol. Gen.* 134, 565–584.
- Nosek, B.A., Greenwald, A.G., Banaji, M.R., 2007a. The Implicit Association Test at age 7: a methodological and conceptual review. In: Bargh, J.A. (Ed.), *Social Psychology and the Unconscious: The Automaticity of Higher Mental Processes*. Psychology Press, pp. 265–292.
- Nosek, B.A., Smyth, F.L., Hansen, J.J., Devos, T., Lindner, N.M., Ranganath, K.A., Smith, C.T., Olson, K.R., Chugh, D., Greenwald, A.G., Banaji, M.R., 2007b. Pervasiveness and correlates of implicit attitudes and stereotypes. *Eur. Rev. Soc. Psychol.* 18, 36–88.
- Nosek, B.A., Hansen, J., 2008. The associations in our heads belong to us: searching for attitudes and knowledge in implicit evaluation. *Cogn. Emotion* 22, 553–594.
- Ostafin, B., Palfai, T.P., 2006. Compelled to consume: the Implicit Association Test and automatic alcohol motivation. *Psychol. Addict. Behav.* 20, 322–327.
- Palfai, T.P., Ostafin, B.D., 2003. Alcohol-related motivational tendencies in hazardous drinkers: assessing implicit response tendencies using the modified-IAT. *Behav. Res. Ther.* 41, 1149–1162.
- Reich, R.R., Goldman, M.S., 2005. Exploring the alcohol expectancy memory network: the utility of free associates. *Psychol. Addict. Behav.* 19, 317–325.
- Robinson, T.E., Berridge, K.C., 1993. The neural basis of drug craving: an incentive-sensitization theory of addiction. *Brain Res. Rev.* 18, 247–291.
- Robinson, T.E., Berridge, K.C., 2003. Addiction. *Annu. Rev. Psychol.* 54, 25–53.
- Rooke, S.E., Hine, D.W., Thorsteinsson, E.B., 2008. Implicit cognition and substance use: a meta-analysis. *Addict. Behav.* 33, 1314–1328.
- Sobell, L.C., Sobell, M.B., 1990. Self-report issues in alcohol abuse: state of the art and future directions. *Behav. Assess.* 12, 77–90.
- Sriram, N., Greenwald, A.G., 2009. The brief Implicit Association Test. *Exp. Psychol.* 56, 283–294.
- Strack, F., Deutsch, R., 2004. Reflective and impulsive determinants of social behavior. *Pers. Soc. Psychol. Rev.* 8, 220–247.
- Thush, C., Wiers, R.W., 2007. Explicit and implicit alcohol-related cognitions and the prediction of future drinking in adolescents. *Addict. Behav.* 32, 1367–1383.
- Wiers, R.W., 2008. Alcohol and drug expectancies as anticipated changes in affect: negative reinforcement is not sedation. *Subst. Use Misuse* 43, 501–516.
- Wiers, R.W., Bartholow, B.D., van den Wildenberg, E., Thush, C., Engels, R.C.M.E., Sher, K.J., Grenard, J.L., Ames, S.L., Stacy, A.W., 2007. Automatic and controlled processes and the development of addictive behaviors in adolescents: a review and a model. *Pharmacol. Biochem. Behav.* 86, 263–283.
- Wiers, R.W., Cox, W.M., Field, M., Fadardi, J.S., Palfai, T.P., Schoenmakers, T., Stacy, A.W., 2006. The search for new ways to change implicit alcohol-related cognitions in heavy drinkers. *Alcohol. Clin. Exp. Res.* 30, 1–12.
- Wiers, R.W., Hoogveen, K.-J., Sergeant, J.A., Gunning, W.B., 1997. High- and low-dose alcohol-related expectancies and the differential associations with drinking in male and female adolescents and young adults. *Addiction* 92, 871–888.
- Wiers, R.W., Schoenmakers, T., Houben, K., Thush, C., Fadardi, J.S., Cox, W.M., 2008. Can problematic alcohol use be trained away? New behavioural treatments aimed at changing and moderating implicit cognitive processes in alcohol abuse. In: Martin, C.R. (Ed.), *Identification and Treatment of Alcohol Dependency*. M&K Publishing, Keswick, UK, pp. 185–205.
- Wiers, R.W., van de Luitgaarden, J., van den Wildenberg, E., Smulders, F.T.Y., 2005. Challenging implicit and explicit alcohol-related cognitions in young heavy drinkers. *Addiction* 100, 806–819.
- Wiers, R.W., van Woerden, N., Smulders, F.T.Y., de Jong, P.J., 2002. Implicit and explicit alcohol-related cognitions in heavy and light drinkers. *J. Abnorm. Psychol.* 111, 648–658.