Available online at www.sciencedirect.com
ScienceDirect
Drug and Alcohol Dependence 94 (2008) 116–124
DRUG and ALCOHOL DEPENDENCE
www.elsevier.com/locate/drugalcdep

Interactions between implicit and explicit cognition and working memory capacity in the prediction of alcohol use in at-risk adolescents

Carolien Thush [a,*], Reinout W. Wiers [a,1], Susan L. Ames [b], Jerry L. Grenard [b], Steve Sussman [b], Alan W. Stacy [b]

[a] *Clinical Psychological Science, Maastricht University, Maastricht, The Netherlands*
[b] *Institute for Health Promotion and Disease Prevention Research, University of Southern California, Los Angeles, USA*

Received 16 March 2007; received in revised form 23 October 2007; accepted 23 October 2007
Available online 26 December 2007

Abstract

Dual process models of addiction suggest that the influence of alcohol-related cognition might be dependent on the level of executive functioning. This study investigated if the interaction between implicit and explicit alcohol-related cognitions and working memory capacity predicted alcohol use after 1 month in at-risk youth. Implicit and explicit alcohol-related cognitions were assessed in 88 Dutch at-risk adolescents ranging in age from 14 to 20 (51 males) with an adapted version of the Implicit Association Test (IAT) and an expectancy questionnaire. Working memory capacity was assessed using the computer-based version of the Self-Ordered Pointing Task (SOPT). Alcohol use and alcohol-related problems were measured at baseline and after 1 month with self-report questionnaires. The hierarchical regression analysis showed that both the interaction between implicit positive-arousal cognitions and working memory capacity and the interaction between explicit positive-arousal cognitions and working memory capacity predicted unique variance in alcohol use after 1 month. Implicit positive-arousal cognitions predicted alcohol use after 1 month more strongly in students with lower levels of working memory capacity, whereas explicit positive-arousal cognitions predicted 1-month follow-up alcohol use more strongly in students with higher levels of working memory capacity. This could imply that different intervention methods could be effective for different subgroups of at-risk youth.

Keywords: Implicit cognition; Explicit cognition; Executive functioning; IAT; Adolescence; Alcohol use

1. Introduction

Several dual process models predict that both more reflective explicit and more impulsive implicit cognitive processes influence behavior (e.g. Fazio and Towles-Schwen, 1999; Kahneman, 2003; Strack and Deutsch, 2004). Implicit cognitions represent more automatic underlying motivational processes, whereas explicit cognitions are related to more deliberate thought processes (Greenwald and Banaji, 1995; Kahneman, 2003). Recently, there has been increased interest in the role of implicit cognitions in the development of addictive behaviors. These implicit alcohol-related cognitions represent individual differences in memory associations between alcohol-related cues (e.g. presence of alcohol), outcomes (e.g. excitement), and behaviors (e.g. drinking). These associations if strengthened over time become motivationally significant and guide behavior relatively automatically (Stacy, 1997). The mesolimbic dopamine reward system has been associated with these relatively automatic motivational processes, which are believed to play an important role in the development of addictive behavior (e.g. Bechara, 2005; Kalivas and Volkow, 2005). Implicit cognitions have been shown to predict unique variance in current and prospective alcohol use after controlling for explicit cognitions (e.g. Jajodia and

* Corresponding author at: Clinical Psychological Science, University of Maastricht, Universiteitssingel 40, PO Box 616, 6200 MD Maastricht, The Netherlands. Tel.: +31 43 388 1927/1908; fax: +31 43 388 4196.
E-mail address: c.thush@psychology.unimaas.nl (C. Thush).
[1] Present address: Radboud University, Nijmegen, The Netherlands; The Dutch Addiction Research Institute (IVO), Rotterdam, The Netherlands.

0376-8716/$ – see front matter © 2007 Elsevier Ireland Ltd. All rights reserved.
doi:10.1016/j.drugalcdep.2007.10.019

Earleywine, 2003; Palfai and Wood, 2001; Stacy, 1997; Thush and Wiers, 2007; Wiers et al., 2002).

A second assumption of several dual process models is that the influence of implicit processes on subsequent behavior is moderated by explicit processes if motivation and the opportunity to do so are present (e.g. Fazio and Towles-Schwen, 1999; Kahneman, 2003; Strack and Deutsch, 2004). Indeed, neurobiological addiction research has shown that the prefrontal cortex and associated areas are involved in more reflective decision making and in the moderation of impulses (e.g. Bechara, 2005; Kalivas and Volkow, 2005; Wilson et al., 2004). Dual process models of addiction specifically predict that the influence of implicit appetitive cognitions on subsequent addictive behavior might be dependent on the level of executive functioning (e.g. Stacy et al., 2004; Wiers et al., 2007).

Executive functions can be described as a set of cognitive skills relevant to goal-directed behavior involving different abilities such as shifting, updating and inhibition (Miyake et al., 2000). Working memory capacity has been proposed to be a central construct that possibly binds these different but related executive functions (Kane and Engle, 2002). The relationship between executive functions and alcohol use has been shown to be bidirectional. Poorer executive functioning can be considered a risk factor for developing addictive behaviors such as drinking alcohol (e.g. Finn and Hall, 2004; Peterson et al., 1992; Tapert et al., 2002). Additionally, alcohol abuse has been shown to negatively affect the maturation of brain regions (e.g., De Bellis et al., 2000), to impair neuropsychological functioning (e.g., Brown et al., 2000) and to alter processing on executive functioning tasks (Tapert et al., 2004). During adolescence, when executive functions and associated brain regions are still developing, alcohol induced damage in the prefrontal cortex can lead to inhibitory and attentional control problems which, in turn, may influence continued alcohol use (Crews et al., 2000; Wiers et al., 2007). This bidirectional nature might be more apparent in at-risk adolescents. It is also possible that these at-risk adolescents may start with poorer executive functions and begin drinking at earlier ages, which, in turn, further interferes with their ability to control their drinking behavior.

Prior research has suggested that the influence of implicit automatic processes, on other behaviors, indeed, is moderated by executive control (e.g. Feldman-Barrett et al., 2004; Payne, 2005), as has also been proposed for addictive behaviors (e.g. Stacy et al., 2004; Wiers et al., 2007). Grenard et al. (manuscript under review) evaluated the interaction between working memory capacity and spontaneous memory associations assessed with word association tasks (an alternative indirect assessment of implicit cognitive processes) among at-risk youth and found evidence that drug-relevant associations were stronger predictors of alcohol and cigarette use among those with lower working memory capacity than among those with higher working memory capacity. Finn and Hall (2004) proposed that two mechanisms might be responsible for the moderating influence of executive functioning on the implicit processes-behavior relationship. First, low activating capacity of working memory makes it difficult to shift attention away from highly activated stimuli to stimuli that are less salient. Second, short term positive associations with behavior tend to be highly activated (salient), whereas the long term negative associations with behavior are usually weakly activated. Consequently, in high-risk situations, such as being at a party where alcohol is readily available, an individual needs to be able to switch to less immediately salient goals and attend to them – such as the intention to not drink large amounts of alcohol or binge drink – while distracting salient information in the current high-risk situation is more automatically activated (e.g., the urge to feel intoxicated or to give in to peer pressure). This relationship between executive functioning and behavior suggests that adolescents who are less able to actively manage less salient but adaptive goals when faced with distracting information are more likely to let their behavior be influenced by distracting salient information that is triggered in the current situation (e.g. Stacy et al., 2004; Wiers et al., 2007).

Conversely, research suggests that explicit positive expectancies might be moderated by executive functioning in the opposite direction. In addiction research, alcohol expectancies have been shown to be good predictors of concurrent and, to a lesser extent, prospective alcohol use (e.g., Goldman and Darkes, 2004; Jones et al., 2001; Sher et al., 1996; Stacy et al., 1991). Tapert et al. (2003) showed that explicit positive alcohol expectancies predicted alcohol use in substance use disorder adolescents with good verbal skills, but not in substance use disorder adolescents with poor verbal skills. Verbal skills are needed for developing internal language-based reasoning skills (Luria, 1961) and predictive of positive alcohol expectancies (Deckel et al., 1995). Verbal skill tasks such as the verbal fluency task are commonly regarded as measuring frontal-lobe processing (Deckel et al., 1995) and verbal executive functioning (Tapert et al., 2003). Tapert et al. (2003) concluded that positive alcohol expectancies require encoding and deep processing in order for them to affect decision making and thus drinking. However, other studies have found that adolescents who show good executive functioning (e.g. good inhibitory neural processing) generally had fewer positive and more negative outcome alcohol expectancies (Anderson et al., 2005) and that verbal skills sometimes are also negatively predictive of positive expectancies (Deckel et al., 1995). Thus, there are still some questions about whether positive alcohol expectancies might be moderated by executive functioning in the opposite direction than implicit appetitive associations.

Hence, from a dual process perspective we hypothesized that the influence of implicit appetitive associations (both positive-arousal and positive-sedation) on subsequent drinking behavior is stronger in adolescents with low working memory capacity than in adolescents with high working memory capacity. Conversely, the influence of explicit positive-arousal alcohol-related processes on subsequent drinking behavior is hypothesized to be stronger in adolescents with high working memory capacity compared with adolescents with low working memory capacity. The current study investigated these two interactions between alcohol-related cognition and working memory capacity in the prediction of alcohol use after 1 month in at-risk youth.