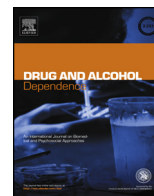




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Attentional bias and executive control in treatment-seeking substance-dependent adolescents: A cross-sectional and follow-up study

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ABSTRACT

Background: Research in adults shows that substance dependent individuals demonstrate attentional bias (AB) for substance-related stimuli. This study investigated the role of AB in adolescents diagnosed with alcohol, cannabis, amphetamine or GHB dependency on entering therapy and six months later, and the role of executive control (EC) as a moderator of the relationship between problem severity and AB.

Methods: Seventy-eight young substance-dependent (SD) patients (mean age = 19.5), and 64 healthy controls (HC; mean age = 19.0) were tested. Thirty-eight SD patients took part at 6-month follow-up (FU). AB was indexed by a visual probe task, EC by the attention network task, problem severity by the short alcohol (or drug) use disorder identification test and the severity of dependence questionnaire.

Results: SD patients demonstrated an AB for substance stimuli presented for 500 ms and 1250 ms, with the latter related to severity of dependence. There was a nonsignificant tendency indicating that EC was higher in HC than SD participants, but EC did not moderate the relationship between AB and dependency. Substance use, dependency, EC and AB remained unchanged in the 6 month FU period.

Conclusions: Young SD patients showed a stronger relatively early as well as maintained AB toward substance cues. A stronger maintained attention was related to higher severity of dependence. Further, there were some indications that EC might play a role in adolescent substance use. The finding that at FU AB and problem severity were not decreased, and EC was not increased underlines the persistent character of addiction.

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1. Introduction

Addiction is a serious problem worldwide, both at the individual and the societal level. Epidemiologic studies have demonstrated that the prevalence of alcohol and drug use and abuse increases with age during adolescence and peaks in young adulthood (Hibell et al., 2012; Johnston et al., 2014; SAMHSA, 2014; van Laar et al., 2014). Therefore, it is important to increase knowledge of factors that contribute to the development of alcohol and drug use problems.

Current models of addictive behavior propose that attentional bias (AB) plays a central role in the persistence of substance (ab)

use (e.g., Franken, 2003; Wiers et al., 2007, 2013). In line with this, there is considerable evidence supporting the view that substance-related stimuli capture the attention of individuals who (ab) use these addictive substances (Field and Cox, 2008). The selective attention for alcohol or drug-related stimuli is assumed to activate the feeling of craving, which further promotes AB for the substance and subsequent drug-seeking behavior (Franken, 2003). Further, research has shown that substance abusers' executive functioning is affected (e.g., Cox and Klinger, 2004; Lubman et al., 2004; Wiers et al., 2007; but see Boelema et al., 2015; Wiers et al., 2015), and it has been argued that substance users with reduced Executive Control (EC) are especially susceptible to the attention-grabbing properties of substance-related stimuli (Field and Cox, 2008), because they are less able to regulate their attention (Fazio and Towles-Schwen, 1999; Wiers et al., 2007).

Thus far, research on substance-related AB has focused on adult populations. Using various paradigms, these studies have demon-

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strated AB in non-clinical and clinical alcohol and drug users (see for review, [Field and Cox, 2008](#); [Sinclair et al., 2010](#)). AB for substance cues has been linked to craving (see for meta-analysis, [Field et al., 2009](#)), relapse, and to the escalation of drug problems ([Garland et al., 2012](#); [Marhe et al., 2013](#); [Waters et al., 2012](#)). However, recent critical reviews demonstrate that there is inconsistent evidence regarding the predictive relationship between AB assessed in clinical settings and subsequent relapse ([Christiansen et al., 2015](#); [Field et al., 2014](#)).

For a proper appreciation of the role of AB in the development of addictive behaviors, it is important to investigate the role of AB in the early stages of substance (ab) use. There are only a few studies that have examined AB for substance-related stimuli in younger age groups, and all of them focused on alcohol use in nonclinical settings. These studies found evidence for an AB in heavy drinking adolescents (16–18 years: [Field et al., 2007](#)), and high-risk adolescents (12–16 years: [Pieters et al., 2011](#); 15–20 years: [Zetteler et al., 2006](#)), but not in unselected groups of adolescents (12–18 years: [van Hemel-Ruiter et al., 2015](#); 15–21 years [Willem et al., 2013](#); see for review: [Wiers et al., 2015](#)). However, a recent longitudinal study in a normative sample of young adolescents showed that alcohol AB predicted adolescent alcohol use later on (12–18 years: [Janssen et al., 2015](#)). Only one study investigated the role of attentional bias in relatively young (adolescent/early adult) cannabis users, demonstrating an AB for cannabis cues in heavy users, which was strongest in cannabis dependent individuals (18–30 years: [Cousijn et al., 2013](#)).

The present study aimed to extend this research, by investigating substance-related AB in adolescents and young adult (“young”, 12–25 year-olds) substance-dependent (SD) patients. The large majority of youth enrolling in addiction therapy are abusers of cannabis or alcohol. This applies both to the U.S. ([SAMHSA, 2014](#); [Johnston et al., 2014](#)) as well as for Europe ([EMCDDA, 2015](#); [van Laar et al., 2014](#)). Given the relatively high prevalence of adolescent alcohol, cannabis, amphetamine, and GHB abusers in The Netherlands ([Wisselink et al., 2013](#)), we decided to focus on these groups for the current study.

The major aim of this study was to test if young SD patients diagnosed with alcohol, cannabis, amphetamine, or GHB abuse or dependency are characterized by an AB for personally relevant substance stimuli. To index substance-specific AB we used a visual probe task (VPT) similar to the VPT designed by [Field et al. \(2004\)](#). To investigate the time-course of AB, different exposure durations (SOA, stimulus onset asynchrony) were used in this task. In the present study we used an SOA of 500 ms, which is found to be a robust condition demonstrating AB (e.g., [Cisler and Koster, 2010](#); [Mogg and Bradley, 1998](#)), and is thought to reflect relative early attentional processes. We further used a longer SOA of 1250 ms, as a reflection of maintained attention, as previous studies have shown that especially biases in maintained attention are relevant in substance use problems (e.g., [Field and Cox, 2008](#)).

Cognitive models of addiction further propose that individual differences in cognitive control will modulate the relationship between automatically triggered appetitive processes (e.g., AB) and problem severity ([Field and Cox, 2008](#)). However, there are some inconsistencies in previous research with some studies showing that indeed the predictive validity of automatically triggered appetitive processes (e.g., AB) toward alcohol was restricted to individuals with relatively weak executive functions ([Grenard et al., 2008](#); [Houben and Wiers, 2009](#); [Peeters et al., 2012, 2013](#); [Thush et al., 2008](#); [van Hemel-Ruiter et al., 2015](#)), and some studies that did not find such a moderating influence of executive functioning on automatic processes ([Christiansen et al., 2012](#); [Cousijn et al., 2013](#); [Pieters et al., 2012](#); [van Hemel-Ruiter et al., 2011](#)).

The second aim of the current study was therefore to test whether young SD patients are characterized by a relatively weak

EC, and whether the relationship between substance-specific AB and problem severity is moderated by EC. To assess individual differences in EC, we used the attention network task ([Fan et al., 2002](#)). Recent studies using the ANT to measure EC within undergraduate samples showed that AB for alcohol stimuli was related to alcohol use only in weak EC adolescents ([van Hemel-Ruiter et al., 2015](#)), and that there was a relationship between fear-level and heightened threat-related AB only in weak EC individuals ([Hou et al., 2014](#); [Reinholdt-Dunne et al., 2009](#)).

The last aim of this study was to investigate whether substance-related AB and EC change during therapy. There is some evidence that AB is reversed in abstinent smokers ([Peuker and Bizarro, 2014](#)), reversed or decreased in abstinent alcoholics ([Noël et al., 2006](#); [Townshend and Duka, 2007](#); [Vollstädt-Klein et al., 2009](#)), and decreased in treated cocaine and heroin abusers ([Gardini et al., 2009](#)). In this study we therefore also included a follow-up assessment for the SD group, to investigate whether AB and EC had changed six months after entering treatment, and if so, whether this change was related to changes in problem severity.

In short, the present study was designed to investigate AB and EC in young SD patients. Healthy peers served as a control group (HC). Based on cognitive motivational models of addiction, we hypothesized that SD patients would be characterized by an AB for personally relevant substance stimuli. We expected this bias to appear at both relatively short (500 ms) and relatively long (1250 ms) presentation times. In addition, based on the findings that individuals with relatively weak EC abilities are at risk for developing substance misuse and dependency ([de Wit, 2009](#); [Verdejo-García and Pérez-García, 2007](#)), we hypothesized that the SD group would be characterized by a relatively weak EC, compared to the HC group. As a subsidiary issue, we expected that ABs would be decreased six months after entering treatment, along with substance use and problem severity. Since common therapies are aimed at increasing control over behavior (e.g., cognitive behavior therapy; see, e.g., [Beck, 2011](#)), and there are indications that prolonged abstinence is beneficial for cognitive functioning ([Fernandez-Serrano et al., 2011](#)), we further expected that EC would increase.

2. Method

2.1. Participants and recruitment

Participants were 78 alcohol- or drug-dependent young patients (12–25 years) and 64 young healthy controls. Youth between 12 and 25 years old who entered intake procedure at VNN Addiction Care, who were diagnosed with alcohol, cannabis, amphetamine, or GHB use disorder were eligible for this study. Patients were excluded if they were diagnosed with gambling disorder, or entered treatment for problematic gaming. HCs were matched at group level for age, gender, and educational level with the SD group.

SD patients were recruited at intake procedure of VNN Addiction Care, a large addiction care facility in the northern part of The Netherlands. The therapist leading the intake invited them to participate in a study about the development of substance use and abuse, which consisted of two sessions of 90 min each. Originally, the study also included a third assessment, which was dropped halfway through data collection, based on the large attrition between baseline and follow-up (FU). The participation of both SD and HC group throughout the study is demonstrated in [Fig. 1](#). The final baseline patient sample resulted in a total of 72 SD patients (48 male and 24 female; mean age = 19.7, SD = 2.8; see [Table 1](#) for group characteristics). Twenty SD patients (26.3%) reported that they had not used their primary substance over the previous month. SD patients mainly received assertive community treatment, or

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