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Reward sensitivity, attentional bias, and executive control in early adolescent alcohol use

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HIGHLIGHTS

- Higher reward sensitivity was related to heavier adolescent alcohol use.
- Alcohol attentional bias was positively related to adolescent alcohol use.
- Executive control was negatively related to young adolescent alcohol use.
- Attentional bias predicted alcohol use only in weak executive control adolescents.

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ABSTRACT

This study examined whether attentional bias for alcohol stimuli was associated with alcohol use in young adolescents, and whether the frequently demonstrated relationship between reward sensitivity and adolescent alcohol use would be partly mediated by attentional bias for alcohol cues. In addition, this study investigated the potential moderating role of executive control (EC), and tested whether the relationship between alcohol-related attentional bias and alcohol use was especially present in young adolescents with weak EC. Participants were 86 adolescents (mean age = 14.86), who completed a Visual Probe Task (VPT) as an index of attentional bias, a flanker-task based Attention Network Task (ANT) as an index of EC, the sensitivity of punishment and sensitivity of reward questionnaire (SPSRQ) as an index of reward sensitivity, and an alcohol use questionnaire. High reward sensitivity, high alcohol-related attentional bias, and weak EC were all related to alcohol use. The relationship between reward sensitivity and alcohol use was not mediated by alcohol-related attentional bias. As hypothesized, attentional bias was only associated with alcohol use in participants with weak EC. Together, the present findings are consistent with the view that high reward sensitivity and low EC may be considered as risk factors for adolescent alcohol use. The independent contribution of reward sensitivity and attentional bias might suggest that adolescents who are highly reward sensitive and display an attentional bias for alcohol cues are at even higher risk for excessive alcohol use and developing alcohol abuse problems. Future research using a longitudinal approach would allow an examination of these risk factors on subsequent alcohol use. Treatment implications are discussed, including the importance of strengthening EC and reducing the rewarding value of alcohol use.

1. Introduction

There is considerable evidence supporting the view that alcohol-related stimuli capture the attention of people who use or abuse alcohol (see for review, Field & Cox, 2008). Using the Visual Probe Task (VPT), previous studies have demonstrated an alcohol-related attentional bias in heavy users of alcohol when picture pairs were presented for a longer period of time, such as 500–2000 ms (e.g., Field, Mogg, Zetteler, & Bradley, 2004; Miller & Fillmore, 2010; Townshend & Duka, 2001). In addition, recent studies have found that controlled executive processes (e.g., Executive Control, EC) moderate the relationship between automatic appetitive processes (e.g., attentional bias) and alcohol use. These findings suggest that relatively weak executive functioning increases the influence of appetitive processes on alcohol use, and that especially people with weak EC are at risk to develop excessive alcohol use (Farris, Ostafin, & Palfai, 2010; Friese, Bargas-Avila, Hofmann, & Wiers, 2010; Houben & Wiers, 2009; Peeters et al., 2012, 2013; Thush et al., 2008). However, not much is known about the role of attentional bias and the possible moderating influence of EC in (early) adolescent alcohol use.

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It has been hypothesized that an alcohol-related attentional bias develops by the process of classical conditioning. That is, by repeated experience of the rewarding effects of drug-taking, alcohol-related cues would become associated with these rewarding effects and would consequently acquire the ability to grab the user's attention (e.g., Franken, 2003; Robinson & Berridge, 1993, 2001). Following this perspective, adolescents with high reward sensitivity could be especially at risk for developing attentional bias for alcohol cues. Germane to this, it has been argued that people's responding to appetitive cues in the environment depends on their trait reward sensitivity (Gray, 1970, 1982). People high on reward sensitivity are sensitive to stimuli that signal unconditioned reward and the relief from punishment. In the development of early adolescent alcohol use this would imply that the initial responses to alcohol-related cues would vary as a function of adolescents' reward sensitivity, whereas the repeated experience of the effects of alcohol use would subsequently shape the development of alcohol-related attentional bias. In line with this view, previous research has found a consistent link between adolescent substance use and high reward sensitivity (Knyazev, 2004; Lopez-Vergara et al., 2012; O'Connor & Colder, 2005; Pardo, Aguilar, Molinuevo, & Torrubia, 2007; van Hemel-Ruiter, de Jong, Oldehinkel, & Ostafin, 2013). Moreover, reward sensitivity has been found to be a significant predictor of reactivity to alcohol cues (Glautier, Bankart, & Williams, 2000; Kambouropoulos & Staiger, 2001, 2004; Zisserson & Palfai, 2007). Of the few studies that have examined attentional bias for alcohol cues in adolescents, none have included measures of reward sensitivity. Thus it remains to be tested whether individuals with high reward sensitivity also show stronger alcohol attentional bias and whether the previous findings of a relationship between reward sensitivity and alcohol use might be (partly) mediated by attentional bias for alcohol cues. Therefore, the first aim of this study was to test further the interrelationships between reward sensitivity, attentional bias for alcohol cues, and early adolescent alcohol use.

The few studies that have examined attentional bias for alcohol cues in adolescent samples found evidence for an attentional bias in heavy drinking adolescents (16–18 years: Field, Christiansen, Cole, & Goudie, 2007), and high-risk adolescents (12–16 years: Pieters et al., 2011; 15–20 years: Zetteler, Stollery, Weinstein, & Lingford-Hughes, 2006), but not in an unselected group of adolescents (15–21 years: Willem, Vasey, Beckers, Claes, & Bijttebier, 2013). The results of the latter study showed a moderating role for self-reported attentional control in the relationship between attentional bias and alcohol use such that the relation between attentional bias and alcohol use was significant for participants with strong attentional control but not for those with weak attentional control. The direction of this finding was unexpected and is difficult to explain. Given the debate regarding whether self-report methods are adequate assessments of EC capacity (cf., Reinholdt-Dunne, Mogg, & Bradley, 2009; Wiers, Ames, Hofmann, Krank, & Stacy, 2010), the present study used a performance measure of EC to test further if EC moderates the relationship between attentional bias for alcohol cues and common adolescent alcohol use. Based on previous research investigating the moderating role of EC processes on automatic processes (Farris et al., 2010; Friese et al., 2010; Houben & Wiers, 2009; Peeters et al., 2012, 2013; Thush et al., 2008) we expected that especially adolescents with weak EC capacity would show a relationship between alcohol attentional bias and alcohol use. Thus the present study extends previous research in two important ways. First, this study examines the relationship between reward sensitivity and alcohol attentional bias and tests whether the previously reported relationship between reward sensitivity and adolescent alcohol use is mediated by attentional bias. Second, the study investigates the potential moderating role of EC on the relationship between alcohol-related attentional bias and alcohol use in (young) adolescents by using a performance measure instead of a self-report (subjective) index of EC.

In short the present study tested if i) reward sensitivity would be positively related to adolescent alcohol use, ii) this relationship would be mediated by attentional bias for alcohol pictures, and iii) EC moderates the relationship between attentional bias for alcohol pictures and alcohol use, such that the relation is demonstrated in individuals with weak (but not strong) EC.

2. Method

2.1. Participants and recruitment

Participants were recruited from two different Dutch secondary schools. A total of 88 adolescents in between 12 and 18 years of age agreed to participate and returned the signed informed consent forms. One participant was excluded because of more than 25% missing on the SPSRQ, and one because of more than 25% errors on the ANT. This resulted in a total of 86 participants (37 male and 49 female; mean age = 14.86, SD = 1.37). Descriptive statistics are presented in Table 1.

2.2. Assessments and outcome measures

2.2.1. Questionnaire measures

2.2.1.1. Self-reported alcohol use. Alcohol use was measured using a substance use questionnaire developed by TRAILS (Tracking Adolescents' Individual Lives Survey, see van Hemel-Ruiter et al., 2013). Alcohol use was calculated as an aggregate of the standardized scores of the eight quantity and frequency items (e.g., "At how many of the weekdays do you normally drink alcohol?"; Cronbach's alpha = 0.91). As the aggregate alcohol use variable demonstrated a non-normal distribution, a log10 transformation was conducted. The statistical significance of the results did not differ when the analyses were conducted with either the raw or the transformed variables. For ease of interpretation, we report the results based on the raw scores.

2.2.1.2. Reward sensitivity and punishment sensitivity. The Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ, Torrubia, Ávila, Moltó, & Caseras, 2001) is a self-report measure of reward sensitivity (RS; 24 items, e.g., "Do you often do things to get praised?") and punishment sensitivity (PS; 24 items, e.g., "Do you often refrain from doing something because you are afraid of it being illegal?"). Participants can respond to these questions with either yes or no. RS and PS are calculated by summing the 24 questions of which participant answered yes. The total score can thus range from 0 to 24, and a higher score reflects a higher reward sensitivity or punishment sensitivity. Cronbach's alpha for reward sensitivity = 0.77, for punishment sensitivity = 0.86.

2.2.2. Computerized measures

2.2.2.1. Attentional bias. Attentional bias was assessed with a VPT (MacLeod, Mathews, & Tata, 1986). In this task we used pictures of three different categories: alcohol, tobacco, and cannabis. For the purpose of the current study only the alcohol trials are relevant. Each category consisted of ten different picture pairs, which were composed of a substance-related picture and a neutral picture. The neutral pictures were matched on composition and brightness. Another eight pairs of neutral pictures were used as practice trials at the beginning of the

Table 1
Sample characteristics (N = 86).

Variable	Mean (SD) or percentage
Female gender	57%
Age	14.86 (1.37)
Servings of alcohol/week over previous month[a]	3.84 (5.20)
Lifetime Abstainer of alcohol	15.1%

[a] One serving of alcohol contains approximately 11 ml of pure alcohol.