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The Effect of Self-Control on Attentional Bias for Alcohol Cues in Male Heavy Drinkers[1]

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Attentional bias for alcohol cues increases craving and subsequent alcohol consumption. Override processes can be used to disengage attention from alcohol cues. This requires self-control and implies that depletion of self-control would impair the ability to disengage attention from alcohol cues. This study examined the effect of self-control on attentional bias among male heavy drinkers. To manipulate self-control resources, an expression control task was used. Attentional bias was measured with a visual probe task. The Obsessive Compulsive Drinking Scale (OCDS; Anton, Moak, & Latham, 1996) assessed the urge to drink and persistent thoughts about alcohol. The results suggest that participants who scored relatively high on the OCDS showed more attentional bias after controlled emotional expression, compared to free emotional expression.

High levels of alcohol consumption are related to a number of social, psychological, and health problems, such as drunk driving, impaired memory, cirrhosis of the liver, and impaired brain functioning (Anderson, Cremona, Paton, Turner, & Wallace, 1993; Brokate et al., 2003; Leifman, 2000). In general, the risk of conceiving one of these illnesses or problems increases with higher levels of alcohol consumption. In Europe, more than 58 million adults (15%) can be classified as heavy drinkers, and 20 million of them are alcohol dependent. This represents 6% of the European population (Anderson & Baumberg, 2006).

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Because of the adverse consequences of excessive alcohol use and the large number of heavy drinkers, it is important to understand the mechanisms that explain drinking behavior. Several studies have shown that alcohol use and dependence are characterized by an attentional bias for alcohol cues (for an overview, see Field & Cox, 2008; Townshend & Duka, 2001). Individuals with an attentional bias for alcohol cues selectively attend to alcohol-related stimuli, at the expense of other stimuli (Field, Mogg, Zetteler, & Bradley, 2004).

Attentional bias for alcohol cues can be explained by Robinson and Berridge's (1993) incentive-sensitization theory, which states that with repeated heavy alcohol use, the dopaminergic response increases every time an individual consumes alcohol. As a consequence, alcohol is perceived as increasingly rewarding and more attractive, and the craving for alcohol rises. Through a conditioning process, alcohol cues become associated with the effects of alcohol and receive the same appetitive characteristics as alcohol. As a result, alcohol cues become increasingly attractive and the focus of attention. At this point, attentional bias has been created.

Not only does an attentional bias reflect levels of heavy drinking, it also has downstream implications for the escalation of alcohol intake. Several studies have shown a relationship between attentional bias for alcohol cues and craving. For example, Field and Eastwood (2005) found that heavy drinkers who were trained to direct their attention toward alcohol cues showed higher levels of craving and consumed more alcohol, compared to heavy drinkers who were trained to direct their attention away from alcohol cues, hence suggesting that attentional bias can elicit craving. Other studies have suggested that the relationship between attentional bias and craving is reciprocal, implying that craving increases the attractiveness of alcohol cues, and alcohol cues increase craving. This process will presumably lead to alcohol consumption (Field & Cox, 2008; Franken, 2003).

Although an attentional bias for alcohol cues is assumed to be related to craving and alcohol consumption, Schoenmakers, Wiers, and Field (2008) suggested that people can use override processes to inhibit automatic responses to alcohol cues. The relationship between attentional bias and craving would then depend on the extent to which people inhibit their automatic responses to alcohol cues.

Empirical support for this notion came from Stormark, Field, Hugdahl, and Horowitz (1997), who tested abstinent alcoholics and social drinkers with an attentional cuing task. In this computer task, two rectangles were presented simultaneously on the screen; one on the left and one on the right side. Sometimes one of the rectangles contained an alcohol-related word, and other times it contained a neutral word. Presentation of the words was followed by an asterisk, to which participants had to react as quickly as possible. Stormark et al. presented the words for 100 ms and 500 ms. They found that abstinent alcoholics were slower to respond when the asterisk emerged on the location of the empty rectangle, instead of the location of the alcohol word. Yet, this was only found in the 100-ms trials. When the alcohol words were presented for 500 ms, abstinent alcoholics were quicker to respond when the asterisk emerged on the location of the empty rectangle than when it emerged on the location of the alcohol word. These findings indicate that, given ample time, abstinent alcoholics consciously disengage attention away from alcohol cues, presumably in order to prevent an urge to drink and, therefore, maintain abstinence (also see Townshend & Duka, 2007). These findings suggest that the maintenance of attention (i.e., measured with cue-exposure times of 500 ms and longer) can be influenced by motivation and cognitive processes, even if one's initial reaction is an automatic attraction to alcohol-related stimuli (LaBerge, 1995).

To disengage attention from alcohol cues, some form of self-control is needed. Self-control strength is required any time an individual inhibits an urge, emotion, or thought to reach a goal (Baumeister, Bratslavsky, Muraven, & Tice, 1998; Baumeister & Heatherton, 1996; Vohs & Baumeister, 2004; Vohs & Heatherton, 2000). There is some indirect evidence for the relationship between self-control and attentional bias. Field, Christiansen, Cole, and Goudie (2007) offered participants a choice between a small, immediate reward and a larger reward that could be obtained after a delay. Choosing the small, immediate reward is an indicator of low self-control, since it is a sign that the individual is unable to delay gratification (Mischel & Ebbesen, 1970). Participants who chose the small, immediate reward showed more attentional bias for alcohol-related words on an alcohol Stroop task than did participants who chose the larger, later reward.

Field and Cox (2008) suggested that drinkers low in self-control might be more susceptible than others to the attention-grabbing properties of alcohol cues because they lack the ability to override the allure of the alcohol cues (cf. Stormark et al., 1997). However, it could also be possible that an attentional bias causes a temporary decrease in self-control via its effects on increasing cravings. In sum, self-control seems to be related to attentional bias, but the causal relationship is unclear. The goal of the present study is to study empirically the effect of self-control strength on attentional bias.

The present study examined the effect of self-control on attentional bias by manipulating self-control strength in an experimental design. Momentary self-control ability differs according to the number of self-control demands a person has experienced in a previous time frame. The strength model of self-control says that the ability to engage in controlled, deliberate, or overriding processes depends on the availability of self-control resources. These resources are conceptualized to be both finite and global, the implications of which are that when people engage in self-control across a variety of spheres, some of the supply of self-control resources is used. Because of a lessened supply of self-control resources, the individual is subsequently less able to engage in good self-control. Empirical tests of the model pair one self-control task with a subsequent self-control task, and compare performance on the second self-control task to the performance of a group that did not engage in self-control initially (e.g., Baumeister et al., 1998; Vohs, Baumeister, & Ciarocco, 2005). Recent summaries of the self-control strength model have reported that over 80 published studies have found evidence for this hangover effect (see Baumeister, Vohs, & Tice, 2007).

The present study investigated the effect of self-control exertion on attentional bias for alcohol cues. This effect was tested among a sample of heavy-drinking college students to find a first indication of the existence of the effect. Stormark et al. (1997) found a disengagement effect in abstinent alcoholics. As heavy-drinking college students are not comparable to alcoholics, the Obsessive Compulsive Drinking Scale (OCDS; Anton, Moak, & Latham, 1996) was used to detect a group of heavy drinkers with the highest urge to drink, and recurrent and persistent thoughts about alcohol. This group can be regarded as more "severe" drinkers, who may be more prone to the effects of self-control depletion than "normal" heavy drinkers. Therefore, we propose the following:

> *Hypothesis 1*. Heavy drinkers who score high on the OCDS will show more attentional bias for alcohol cues in the maintenance of attention when they are depleted than when they are not depleted.
>
> *Hypothesis 2*. Weakened self-control strength will lead to more attentional bias for heavy drinkers who score high on the OCDS than for heavy drinkers who score low on the OCDS.

We used an expression-regulation paradigm, which is known to require self-control, and thereby depletes self-control resources (Vohs & Heatherton, 2000).

Method

Participants

Study participants were 44 male university students, who received either course credit or €8 (approx. $10 US) in exchange for their participation. Only heavy drinkers were selected, as defined by the following criteria: consumption of 20 alcoholic beverages (Dutch standard drinking units of 10 g of alcohol) or more per week, consumption of 6 alcoholic beverages or more during one occasion at least once per week (Van Dijck & Knibbe, 2005), or both. One participant did not meet these criteria and, therefore, was excluded. Data from 1 participant were lost as a result of technical problems.

The mean age of the remaining 42 participants was 21.7 years ($SD = 2.0$). Participants' average self-reported alcohol use was 37.7 alcoholic beverages per week ($SD = 24.4$), and their average self-reported alcohol consumption in the last week was 28.7 beverages ($SD = 14.5$). On a range from 0 to 56, participants scored an average of 10.75 on the OCDS ($SD = 4.50$; range = 4–19).[3]

Materials

Attentional bias. We used a visual probe task to assess attentional bias. In this task, the same pictures were used as in previous studies (Field & Eastwood, 2005; Field et al., 2004; Schoenmakers et al., 2008). We used 14 pairs of alcohol and neutral pictures. The alcohol pictures consisted of alcoholic beverages or people drinking alcohol. The neutral pictures were matched on composition and brightness. Another 7 pairs of neutral pictures were used as practice trials at the beginning of the task (Schoenmakers et al., 2008). All pictures were 108 mm high and 135 mm wide. The pictures were presented on a 17-in. (431.8 mm) monitor, which was attached to a standard keyboard. The monitor resolution was set at 800×600 pixels.

Each trial started with a fixation cross presented for 500 ms in the middle of the screen on which participants were focusing their attention. Next, the cross disappeared and two pictures (one alcohol-related and one neutral) were presented, each to one side of the screen. The distance between the inner edges of each pair of pictures was 60 mm. The pictures were displayed for 2,000 ms. At exposure lengths of 2,000 ms, it is possible to make attention shifts between cues, which means that these durations can be used to detect biases in the maintenance of attention (Field & Cox, 2008). Immediately after the picture pair disappeared, a small arrow pointing up or down was presented at the location of either one of the pictures, and the participants had to respond to this arrow as quickly as possible by pressing the similar arrow on the keyboard. The next trial started 500 ms after each response.

The visual probe task started with 12 practice trials, followed by 3 buffer trials in which the practice pictures were presented once more. Next, 56

[3]The experiment was approved by the Ethical Committee of the Faculty of Social Sciences, Radboud University, Nijmegen, The Netherlands.

critical trials were presented, with every picture shown both on the left side of the screen and on the right side of the screen, and an equal number of arrows replacing alcohol pictures (which we label *congruent trials*) and arrows replacing neutral pictures (which we label *incongruent trials*). Response time and accuracy were recorded.

Obsessive Compulsive Drinking Scale (OCDS, Anton et al., 1996). The OCDS measures the drive to consume alcohol, recurrent and persistent thoughts about alcohol, and the struggle to control these drives and thoughts (Schippers et al., 1997). We used the Dutch translation of the OCDS (Schippers et al., 1997).

Sample items include "How much of your time when you're not drinking is occupied by ideas, thoughts, impulses, or images related to drinking?"; "How much do these drinking-related ideas, thoughts, impulses, or images related to drinking interfere with your social or work functioning?"; "Is there anything you don't or can't do because of them?"; and "How much of an effort do you make to resist consumption of alcoholic beverages?"

The items were rated on a 5-point Likert-type scale ranging from 0 to 4. The questions were aimed at the prior 7 days. The scale consists of 14 items and can be divided into an obsessive subscale and compulsive subscale, which, when added, create a total score ($\alpha = .67$).

Temptation and Restraint Inventory (TRI; Collins & Lapp, 1992). We used the TRI as a validation measure of the OCDS (Anton et al., 1996). The TRI is a 15-item scale that measures drinking restraint. The TRI has two subscales: cognitive and emotional preoccupation (CEP), and cognitive and behavioral control (CBC).

The CEP (9 items) measures difficulty controlling drinking, negative affective reasons for drinking, and thoughts about drinking. Previous studies (e.g., Rosenberg & Mazzola, 2007) have shown a correlation of .72 ($p < .01$) between the CEP subscale and the OCDS. In the present study, we found a correlation of .66 ($p < .01$). Cronbach's alpha of the CEP was .72.

The CBC (6 items) measures thoughts about limiting drinking and attempts to cut down on drinking. A sample item is "Is it hard to distract yourself from thinking about drinking?" Items in this study were rated on a 5-point scale (cf. Ricciardelli, Williams & Finemore, 2001), with higher scores indicating higher levels of drinking restraint. Previous studies (e.g., Rosenberg & Mazzola, 2007) have shown a correlation of .24 (*ns*) between the CBC subscale and the OCDS. In the present study, this correlation was .22 (*ns*). Cronbach's alpha of the CBC was .67.

Rosenberg and Mazzola's (2007) study additionally showed that the OCDS (Anton et al., 1996) and the CEP subscale were both significantly correlated with visual analogue scales measuring need, urge, craving, and compulsions for an alcoholic beverage (all ps $< .001$). These findings point toward a conceptual overlap between the CEP subscale and the OCDS, which suggests that the CEP subscale could be used as a validation measure of the OCDS.

Alcohol use. Self-reported alcohol use was assessed with the Quantity Frequency Variability scale (QFV; Dotinga, Van Den Eijnden, Bosveld, & Garretsen, 2005) and Weekly Recall (Lemmens, Knibbe, & Tan, 1988). The QFV consists of five questions and measures the number of alcoholic beverages participants usually drink in a week. A sample question is "How many glasses do you drink on average on a weekend day?" The Weekly Recall asks participants to report the number of glasses they consumed for every day of the previous week.

Procedure

Participants were tested in a laboratory between 12 p.m. and 7 p.m. They were asked to limit their drinking the night before the experiment. Upon their arrival at the laboratory, participants' breath alcohol level was checked with the breathalyzer SD-400. Only participants with a breath alcohol level of 0 could proceed with the experiment. The participants gave their informed consent. New appointments were made with participants who had a level above 0.

Next, half of the participants were randomly assigned to an expression control task in order to deplete their self-control strength, whereas the other half engaged in a similar task that did not require expression control and, therefore, was not expected to affect self-control strength. All participants were seated at a desk with a computer and were asked to watch a 4-min video segment of a Dutch stand-up comedian. Half of the participants received instructions to keep a neutral (i.e., expressionless) facial expression and not to feel any emotions internally. The other half of the sample received instructions to respond naturally and normally to the video. Participants were videotaped while watching the video, with a video camera in plain view. The video recording allows us to check whether participants followed instructions (cf. Schmeichel, Vohs, & Baumeister, 2003).

After the participants watched the video, they completed a visual analogue scale (VAS) as a manipulation check. This item asks how difficult it was to follow the instructions received prior to the video. To ensure that the effect of the manipulation task was not a result of mood, the participants completed three VAS mood scales. Participants answered the questions "How happy are you feeling right now?"; "How sad are you feeling right now?"; and "How down are you feeling right now?" on a 140-mm scale.

Subsequently, the participants completed the visual probe task as described in the Materials section. Next, the participants completed the Quantity Frequency Variability (QFV) and Weekly Recall to measure alcohol consumption and the OCDS (Anton et al., 1996) and the TRI (Collins & Lapp, 1992). Finally, the participants were thanked and paid.

Results

Manipulation Checks

As a check of the manipulation, the participants completed a VAS, with endpoints of *not at all* and *very much* to report how difficult it was to follow the instructions for the video-watching task. On a scale of 140 mm, participants in the expression control condition reported having significantly more difficulty following the instructions than did participants in the no-expression control condition ($M = 83.62$, $SD = 42.40$ vs. $M = 10.86$, $SD = 14.78$), $t(40) = 7.43$, $p < .001$. This suggests that participants in the expression control condition had to apply more self-control to follow the instructions than did participants in the no-expression control condition.

To check whether participants followed the instructions, a rater who was blind to conditions and hypotheses coded the participants' facial expressiveness. Scores were given on a 5-point scale ranging from 1 (*not expressive at all*) to 5 (*very expressive*). Participants in the expression control condition had a mean score of 2.67 ($SD = 0.91$), while participants in the no-expression control condition had a mean score of 3.57 ($SD = 0.98$). The difference between these two conditions was significant, $t(40) = -3.10$, $p < .01$, which indicates that participants in the expression control condition showed less facial expressiveness and, therefore, were complying with the instructions (Vohs & Heatherton, 2000).

We conducted *t* tests on the VAS mood scales, which revealed no significant differences between the expression control condition and the no-expression control condition on the items *happy* (expression control, $M = 92.86$, $SD = 21.04$; no-expression control, $M = 93.33$, $SD = 19.19$), *sad* (expression control, $M = 19.05$, $SD = 20.52$; no-expression control, $M = 15.76$, $SD = 17.98$), and *down* (expression control, $M = 16.19$, $SD = 18.14$; no-expression control, $M = 15.71$, $SD = 24.68$). Expression control is known to be an effortful control task that yields no reliable mood effects (Gross, 1998). In line with past research, engaging in expression control depletes self-control resources, but does not dampen mood (Vohs & Heatherton, 2000). Moreover, this (null) finding indicates that the possible effect of the expression control task was not mediated by mood.

Attentional Bias

Response latencies were removed if they were less than 200 ms or more than 2,000 ms. Because of participants' error responses, 2.3% of the data were removed. Attentional bias scores were calculated by subtracting the response time on congruent trials from the response time on incongruent trials. A positive score, therefore, was indicative of attentional bias. Interpretively, faster mean individual reaction times on congruent trials (when the probe replaces the alcohol picture) than on incongruent trials (when the probe replaces the neutral picture) indicate attentional bias.

We performed a one-sample *t* test to test whether there was an attentional bias at 2,000 ms in the total sample. No such effect was found ($M = 6.29$, $SD = 42.77$), $t(41) = 0.95$, $p = .35$.

Based on a median split, we divided the sample into a group scoring high and a group scoring low on the OCDS (Anton et al., 1996). Since the range of scores on the OCDS was quite restricted, we used the TRI (Collins & Lapp, 1992)—a questionnaire that is related to the OCDS—to test whether the high and the low OCDS groups showed substantial differences in preoccupation with alcohol. The high OCDS group scored significantly higher on the CEP subscale than did the low OCDS group (high OCDS group, $M = 1.90$, $SD = 0.52$; low OCDS group, $M = 1.58$, $SD = 0.33$), $t(29.57) = -2.30$, $p = .029$. This finding suggests that the differences in preoccupation with alcohol between the two OCDS groups are meaningful. No differences were found on the CBC subscale, which indicates that the high and low OCDS groups showed no differences in attempts to control alcohol intake. No attentional biases were found for the high or low OCDS groups in both conditions: high OCDS/expression control, $M = 17.80$, $SD = 35.50$, $t(9) = 1.59$, $p = .147$; high OCDS/no-expression control, $M = -7.11$, $SD = 20.36$, $t(8) = -1.05$, $p = .325$; low OCDS/expression control, $M = -5.96$, $SD = 34.32$, $t(10) = -0.58$, $p = .578$; low OCDS/no-expression control, $M = 17.96$, $SD = 62.04$, $t(11) = 1.00$, $p = .338$.

To test whether heavy drinkers who scored high on the OCDS were more prone to the effects of self-control depletion than were heavy drinkers who scored low on the OCDS, we performed multiple regression analyses to check for interaction effects between the OCDS and condition (expression control vs. no-expression control) with attentional bias as dependent variable. The results of the regression analyses reveal a significant interaction effect between condition and the OCDS, with attentional bias as dependent variable ($\beta = .45$, $SE = 40.32$, $p = .038$).[4] The results of the regression analysis

[4]Self-reported alcohol use (as measured with the QFV) was higher in the no-emotion suppression condition than in the emotion suppression condition ($M = 45.05$ units, $SD = 28.28$ vs. $M = 30.26$ units, $SD = 17.51$), $t(40) = -2.04$, $p = .048$. When we controlled for QFV scores in the regression analyses, we found similar results.

Table 1

Multiple Regression Analysis Testing the Effect of Depletion Condition on Attentional Bias Moderated by OCDS Score

	B	*SE*	β
Step 1			
Condition	1.56	13.52	0.02
OCDS score	–8.45	20.72	–0.07
Step 2			
Condition	1.68	12.94	0.02
OCDS score	–47.78	26.98	–0.37
Condition × OCDS	85.47	39.77	0.45*

Note. Step 1: $R^2 = .01$; Step 2: $\Delta R^2 = .11$.
*$p < .05$.

with attentional bias as dependent variable are shown in Table 1. Figure 1 depicts the interaction effect between depletion condition and OCDS score on attentional bias, based on a median split of the OCDS. As shown, participants scoring high on the OCDS seemed to have more attentional bias when they were in the expression control condition, than when they were in the no-expression control condition.

The differences in attentional bias between the expression control condition and the no-expression control condition for participants scoring high or low on the OCDS were tested with an independent-sample t test. We found a statistical trend between the expression control condition and the no-expression control condition for participants scoring high on the OCDS (expression control, $M = 17.80$, $SD = 35.50$; no-expression control, $M = -7.11$, $SD = 20.36$), $t(14.59) = 1.90$, $p = .078$. No differences were found between the conditions for participants scoring low on the OCDS (expression control, $M = -5.96$, $SD = 34.32$; no-expression control, $M = 17.96$, $SD = 62.04$), $t(21) = -1.13$, $p = .272$. This indicates that expression control tends to have an effect on attentional bias for participants scoring high on the OCDS, but not for participants scoring low on the OCDS.[5]

Similar regression analyses were performed to check for interaction effects between the CEP subscale and condition (expression control vs.

[5]We should note that the variance in the low OCDS/no-expression control group was higher than the variance in the other groups, which could explain the nonsignificant effect in this group.

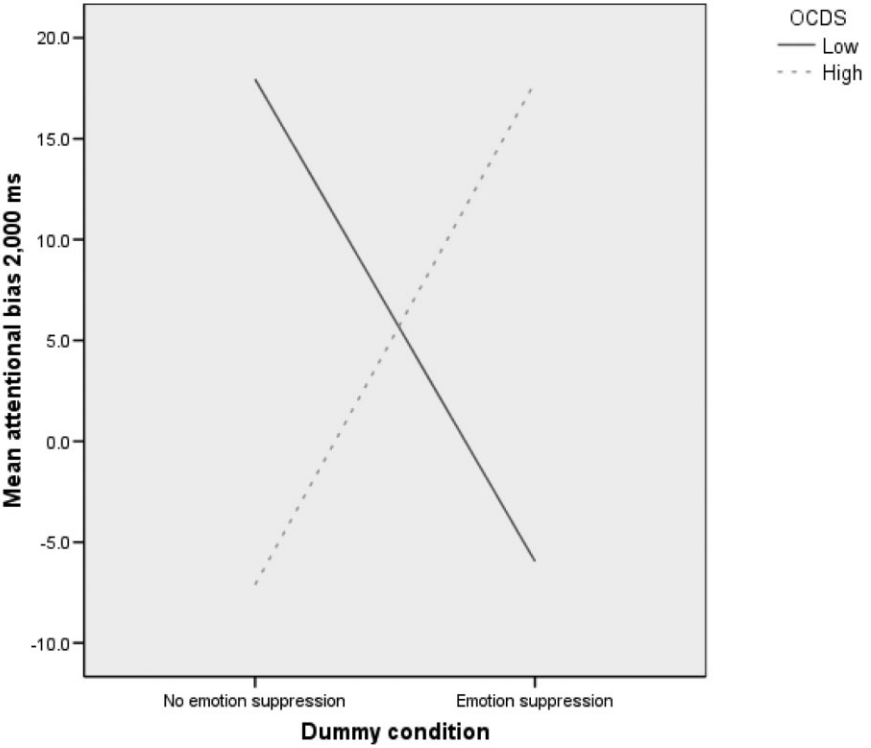

Figure 1. Interaction effect between Obsessive Compulsive Drinking Scale (OCDS) scores and condition (expression control vs. no-expression control). Values are mean attentional bias scores at 2,000 ms. Higher scores indicate more attentional bias.

no-expression control) with attentional bias as a dependent variable. This effect showed a statistical trend ($\beta = 0.43$, $SE = 30.10$, $p = .071$), and indicated a similar pattern of results as found with the OCDS, suggesting a crossover effect between cognitive preoccupation for alcohol and depletion condition (participants scoring high on the CEP scale: expression control, $M = 18.29$, $SD = 35.92$; no-expression control, $M = -1.22$, $SD = 29.38$; participants scoring low on the CEP scale: expression control, $M = -1.27$, $SD = 37.17$; no-expression control, $M = 13.54$, $SD = 60.95$).

Discussion

In the present study, we tried to find a first indication of an effect of self-control depletion on attentional bias for alcohol cues. The results show that a prior act of expression control, which weakened self-control strength, tended to predict alcohol-related attentional bias at 2,000 ms in heavy drinkers who scored high on the OCDS. More specifically, heavy drinkers scoring high on the OCDS whose self-control was depleted tended to show higher levels of attentional bias, compared to heavy drinkers scoring high on the OCDS whose self-control was not depleted. For heavy drinkers scoring low on the OCDS, no significant effect of depletion was found.

The depletion task tended to affect only the performance of the high OCDS group on the visual probe task. Previous studies have shown that self-control depletion only affects performance on subsequent tasks that require self-control (e.g., Muraven & Slessareva, 2003). This suggests that participants scoring high on the OCDS need more self-control for the visual probe task than do participants scoring low on the OCDS. Since the OCDS assesses recurrent and persistent thoughts about alcohol and the drive to drink, it is plausible that participants with higher scores on this scale have to exert more effort than do other heavy drinkers to disengage their attention from the alcohol cues.

Because the effect of depletion in heavy drinkers scoring high on the OCDS only reached the significance of a statistical trend, it should be interpreted with caution. Moreover, scores on the OCDS were rather low in the present sample ($M = 10.75$ on a scale ranging from 0 to 56, $SD = 4.50$; range = 4–19). Because of this restricted range and low average, the two groups that were created by conducting a median split may not show substantial differences on obsessive and compulsive thoughts about alcohol. However, the OCDS is usually administered in clinical populations of alcoholics to assess the cognitive aspect of alcohol craving, an important clinical feature of alcohol dependence (American Psychiatric Association, 1994).

Although heavy drinkers in a nonclinical sample are likely to report lower levels of obsessive and compulsive thoughts about alcohol, we expected that participants showing relatively “high” scores on the OCDS (despite the fact that these mean scores were, in fact, rather low) would have an increased preoccupation with alcohol and would, therefore, be more susceptible to the effects of self-control depletion on attentional bias for alcohol. This is supported by the scores on the TRI (Collins & Lapp, 1992), which indicated that the high OCDS group showed more preoccupation with alcohol (CEP), as compared to the low OCDS group. Previous studies have indicated that this CEP subscale significantly predicted increases in drinking-related problems (Collins, 1993).

The restricted range of scores in our study might indicate a floor effect. Nevertheless, we still found a statistical trend in this “high” OCDS group. We expect that the effect of self-control on attentional bias might reach significant levels in a more “severe” group.

Possibly, the effect of self-control depletion on attentional bias might be stronger in a sample of abstinent alcoholics, as shown in the study by Stormark et al. (1997). Abstinent alcoholics are, under nondepleted conditions, likely to be motivated to distract their attention from the alcohol cues, more so than heavy drinkers who score high on the OCDS. It has been stated that the maintenance of attention is influenced by motivation and cognitive processes, whereas initial orienting is likely to be an automatic response (LaBerge, 1995). Motivation would then appear to be an important concept in understanding the relationship between self-control and attentional bias. When abstinent alcoholics' self-control strength is depleted, they may become unable to distract their attention from alcohol cues, despite otherwise being motivated to do so. Future studies are needed to test this effect of self-control depletion on attentional bias in abstinent alcoholics.

Previous studies have shown that attentional bias can increase craving and alcohol consumption (Field, Duka et al., 2007; Field & Eastwood, 2005), giving attentional bias a central role in explaining drinking behavior. Our indication that a lack of self-control could heighten attentional bias in certain heavy drinkers suggests that these drinkers will focus more on alcohol cues when their self-control is depleted than when their self-control is intact. Lacking the self-control strength to distract their attention from the alcohol cues, cravings for alcohol and subsequent alcohol consumption could increase. Given that self-control strength is used every time people inhibit their impulses or urges (Baumeister et al., 1998), self-control can be depleted rather easily. Moreover, fighting the temptation to drink alcohol also depletes self-control strength (Muraven, Collins, Shiffman, & Paty, 2005; Muraven & Shmueli, 2006). Abstinent alcoholics repeatedly cope with alcohol-related thoughts, impulses, or images, which has an impact on their daily functioning (Kavanagh, Andrade, & May, 2005). Paradoxically, attempts not to drink may contribute to the consumption of alcohol via taxing self-control strength. In sum, the present study offers insight into the conditions under which attempts not to drink are likely to fail.

This study has some limitations that should be mentioned. Although the results of the present study suggest that self-control is related to attentional bias in more "severe" drinkers, recall that we included only male participants. Previous studies have suggested that there are no sex differences in attentional bias (Field & Eastwood, 2005). According to Campbell (2006), sex differences in self-control seem to be absent, weak, or generally inconsistent. Nonetheless, possible sex differences in the relationship between self-control and attentional bias should be examined in future research.

Moreover, we included only university students in our study. Self-control is an important component of executive functioning (Miyake et al., 2000). It has been found that higher educated individuals perform better on measures of executive functioning than do lower educated individuals (Bull & Scerif, 2001). Therefore, lower educated individuals might have lower levels of self-control than higher educated individuals. As a consequence, self-control depletion might have a stronger effect on lower educated subjects than on university students. Thus, future research should include high- and low-educated subjects to examine the relationship between self-control and attentional bias.

Another limitation of our study is that we included only exposure lengths of 2,000 ms. Previous studies have shown that exposure lengths of 200 ms or less are too short to make shifts in attention between cues (Field & Cox, 2008). These exposure lengths measure initial orienting. This is an automatic process that cannot be controlled. As a consequence, self-control depletion would have had no effect at these short exposure lengths. However, including a short exposure length could have tested this assumption and the hypothesis that our findings at 2,000 ms are a result of a conscious, disengagement process.

To summarize, the present study gives a first indication that attentional bias in the maintenance of attention can be influenced by self-control. This work should be an initiation for future studies to explore further that attentional processes under the influence of motivation and self-control can underlie problematic drinking behavior.

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