Does sleep affect alcohol-related attention bias?

Abstract

Poor quality sleep can lead to executive function deficits, including problems with inhibitory control. Similarly, substance use is associated with decreased inhibitory control for substance-related stimuli. Therefore, this study investigated whether sleep quality is associated with attentional bias. Participants were 39 university students (18-28 years, 29 females). An eye tracking task was used to measure attentional bias for alcohol-related stimuli. Alcohol usage and sleep quality were measured using self-report questionnaires (AUDIT and PSQI respectively). An attentional bias related to alcohol usage was observed within the participants. However, there was no association observed with sleep quality. Therefore, we conclude that sleep quality may not influence attentional biases.

Keywords: Attentional bias, substance use, sleep quality, inhibitory control

Does sleep affect alcohol-related attention bias?

Attentional bias is the preferential processing of stimuli which has developed increased saliency e.g. alcohol-related stimuli for heavy alcohol drinkers (e.g. Field & Cox, 2008). Substance use is often associated with cue reactivity to substance-related stimuli, usually with signs of physiological arousal and subjective craving (Carter and Tiffany, 1999). These biases have been demonstrated to predict relapse in users abstaining and in substance-use treatment (e.g. Cox, et al., 2002). Attentional biases have also been demonstrated to be heavily involved in substance use maintenance i.e. increased attentional biases are thought to lead to further substance seeking behaviour (Field & Cox, 2008). Furthermore, attentional biases, once developed, have been observed to be stable (Wilcockson, Pothos, & Cox, 2019), difficult to inhibit (Wilcockson & Pothos, 2015) and context has also been found not to affect the expression of attentional biases (Wilcockson, Pothos, & Parrott, 2018). Thus potentially demonstrating the robust (i.e. stable, strong, and intransient) nature of attentional biases.

However, Christiansen, Schoenmakers, and Field (2015) have reported that attentional biases may be sensitive to environmental context and variables that influence the strength of subjective craving such as stress, acute alcohol effects, environment, and expectation of substance availability. Further, Field and Christiansen (2012) state that establishing the internal reliability of attentional bias tasks intending to measure substance-related attentional biases, such as the emotional-Stroop and the dot-probe is essential for the development of the area, because internal reliability has been argued to be low for these tasks (e.g. Ataya, et al., 2012). Field and Christiansen (2012) suggest that reliability of such tasks can be improved if stimulus selection is tailored specifically for each individual. This partly motivated the development of the Wilcockson & Pothos (2015) attentional bias task. This task would not suffer from such individual stimulus selection, as participants would only look at the pictures that they themselves cannot inhibit their gaze away from. The rest of the stimuli, the experimental stimuli that a participant may not have an attentional bias for (e.g. a heavy drinker who does not have an attentional bias for white wine picture stimuli because they only drink ale), would not affect the attentional bias results, as only the gaze away from the fixation region caused by specific distractor stimuli is being measured. The task therefore measures the inability to inhibit the orientation of attention towards user-specific alcohol-related stimuli. Previous demonstrations of the task have found that heavy drinkers have impaired inhibitory control for alcohol-related stimuli (see Wilcockson & Pothos, 2015; Qureshi, et al., 2019).

Because inhibitory control is impaired, these findings may suggest that executive function is impaired in heavy drinkers specifically for alcohol-related stimuli. Substance use may compromise the executive cognitive function in users, which then causes higher impulsivity and poorer inhibitory control (Klinger & Cox, 2004).

Previous literature has demonstrated that inhibitory control can be affected by sleep quality. Anderson and Platten (2011) found that sleep deprivation led to higher impulsivity and poor response inhibition towards negative emotional stimuli. Further, Hasler et al. (2015) discovered that young adolescents with recognised alcohol use disorders report more insomnia, hypersomnia, and a greater difference in weekday and weekend sleep duration and onset than youths who do not use or misuse alcohol. Note also that Christiansen, Schoenmakers, and Field (2015) suggest that attentional biases would be sensitive to variables such as stress, context, and environment. Therefore, it is plausible that sleep quality may also affect attentional biases. Overall it would seem that alcohol is associated with poorer sleep and inhibitory control. This relationship may lead to increased alcohol-related attentional biases, which in term would lead to further alcohol consumption. Therefore, understanding whether sleep is associated with alcohol-related attentional biases may have implications for both understanding attentional biases but may also inform treatment approaches.

In order to measure inhibitory control of attentional biases, Wilcockson and Pothos (2015) designed an eye-tracking task that uses a gaze contingency paradigm to measure participants' compulsion to attend to and process alcohol-related stimuli. This measures the inability to inhibit the orientation of attention towards an alcohol-related stimulus. Using this task, we can examine an intriguing hypothesis; namely, if poor sleep decreases executive function, would this decrease in executive function cause decreased inhibitory control for alcohol-related stimuli and even increase substance use? In the current study, we measure whether performance on the Wilcockson & Pothos (2015) inhibitory control for attentional biases task is affected by self-reported sleep quality. It is predicted that participants who report poorer sleep may have decreased executive function, which may mean decreased inhibitory control for alcohol-related stimuli, and subsequently, increased substance use.

Methods

Participants

Forty-five participants were recruited, however six participants were excluded due to technical issues, so the final sample was 39 participants (10 males; 29 females). Participants were aged 18 – 28 years (m = 20.56; SD = 2.11) from the undergraduate and postgraduate populations at Lancaster University. Participants received subject-pool credit in return for participation. There were no inclusion or exclusion criteria for participants in the study and all participants had normal/corrected vision. Ethical approval was granted by the Lancaster University Psychology Department Ethics Committee.

Materials

Eye Tracking Task

The eye tracking stimuli and procedure were taken from Wilcockson and Pothos (2015). Stimuli consisted of alcohol-related pictures and matched neutral-control pictures, consisting of office supplies. They were matched so that the shape, colour and size were similar. For example, a hand holding a pint of lager against a purple background was matched with a hand holding a light-coloured folder against a purple background. The alcohol-related stimuli included lagers and bitters, red and white wine, spirits such as gin, whisky and vodka, and alcopops, such as Smirnoff Ice. The neutral-control pictures included office materials such as folders, books, phones and staplers. The category of office-related images was included in order to have a category of neutral-control images that were semantically related to one another, like the alcohol images were (because semantic relatedness can increase the degree of cognitive bias, e.g., Warren, 1972). Further, we opted for neutral-control images rather than a control condition of more broadly similar stimuli (e.g. non-alcohol appetitive stimuli), so that participants would not be distracted by the control category stimuli in anyway (see Qureshi, et al., 2019). Each category contained 16 pictures which all measured 105 mm x 105 mm. Each stimulus could appear in one of ten locations and the stimuli were presented randomly. Matched pictures were always located in the same location but did not appear consecutively. The fixation target was the same size as the distractor stimuli and was visually salient, appearing as a bullseye target. This fixation target also appeared in one of the ten locations, but never in the same location as the previous distractor stimuli so that the participant had to look at a different area of the monitor on each trial. There were 120 trials in total. The eye-tracking task was carried out using an EyeLink Desktop 1000 eye-tracker (SR Research Ltd., Ontario, Canada). Participants sat 55cm away from the monitor which was set at 60Hz. Experimenter

Builder Software Version 1.4.128 B (SR Research Ltd., Ontario, Canada) was used to control the stimulus events during the eye-tracking task.

PSQI and AUDIT

Sleep quality was measured using the Pittsburgh Sleep Quality Index (PSQI: Buysse, et al., 1991). The PSQI is a series of 19 questions about sleep quality, sleep latency (i.e., how long it takes to fall asleep), sleep duration, habitual sleep efficiency (i.e., the percentage of time in bed that one is asleep), sleep disturbances, use of sleeping medication, and daytime dysfunction. Each item is weighted on a 0–3 interval scale. The total score is then calculated from the seven component scores, providing an overall score ranging from 0 to 21, where lower scores denote a healthier sleep quality.

Alcohol usage behaviours were recorded with the Alcohol Use Disorders Identification Test (AUDIT: Saunders, et al., 1993). The AUDIT consists of ten questions. Participants respond to how strongly a series of statements relate to them e.g. 'never' or 'daily'. Scores 0 – 7 are considered low risk of alcohol drinking behaviours, whilst scores over 8 are considered to be at an increased risk of hazardous drinking behaviours. Both questionnaires were administered using Qualtrics (Qualtrics, Provo, UT).

Procedure

Participants first completed the PSQI and the AUDIT. Participants were made aware that the study was related to drinking and sleeping patterns. The eye tracking task started with a nine-point calibration. Participants were then instructed to always look at the fixation target within the attentional bias task and ignore all other distractor images that appeared on screen. On each trial, the fixation target appeared on screen first. Once it had been attended to for a fixed interval of one second, the distractor stimulus appeared as well. There was only one distractor on each trial. If the participant directed their gaze towards the distractor, the stimuli disappeared instantly. Participants were required to fixate upon the fixation target for at least 10 milliseconds in order for distractor stimuli to reappear. The fixation target was displayed for five seconds, so the maximum duration the distractor stimulus could be displayed for was four seconds. The number of times a participant looked at the distractor stimuli in each stimulus category (alcohol-related and neutral-control) was recorded and then the break frequency variable was calculated by subtracting neutral-control scores from the alcohol-related scores. Thus, a higher break frequency score indicated a preference for the alcohol-related stimuli.

Results

The study aimed to determine whether quality of sleep had an effect on alcohol-related attentional bias and alcohol use in university students. First, we will demonstrate whether there was an alcohol-related attentional bias associated with alcohol usage within the sample. Then, we can explore whether alcohol usage or attentional bias are affected by sleep quality. Bayesian analyses (with default priors) are also reported so that any null results can be interpreted meaningfully (see Rouder, et al., 2012). By using p-values alone, a p-value>.05 could either mean that not enough data was collected or that there were indeed no differences between, e.g., two groups. As we are speculating regarding a difference between groups, e.g., sleep quality groups, for us to be able to interpret a null result between the two groups it is important to use Bayes factors. With Bayes results less than a third indicating a true null result and Bayes results more than 3 indicating strong evidence in favour of the alternative hypothesis.

A significant positive correlation was observed between the attentional bias score and the AUDIT score (r(37)= .398; p=.012; BF_{10} = 4.14: see Figure 1). This suggests that increased break frequency for alcohol-related stimuli was associated with increased AUDIT scores i.e. alcohol drinking behaviours. Further, by categorising participants using the AUDIT hazardous drinking score of +/-8, we are able to compare low hazardous drinking (N= 15) to high hazardous drinking (N= 24). It was observed that low hazardous drinking (M=-.03 ;SD=.08) significantly differed from high hazardous drinking (M=.03; SD=.08) in terms of attentional bias (t(37)=2.272; p=.029; BF_{10} = 2.25). These results indicate that participants scoring 8 or more on the AUDIT (indicative of hazardous drinking) made increased break frequency errors for alcohol-related stimuli. Therefore, confirming that an alcohol-related attentional bias was observed within the sample which was congruent with alcohol-related behaviours as indicated by the AUDIT. To explore task reliability, we conducted a split-half reliability test. Alternate trials were placed into one of two groups. This was performed for alcohol and control stimuli separately. A partial correlation was then performed to see if the two halves of the data correlated with each other, whilst taking into account the participant's AUDIT score. It was found that control stimuli (r(1086)=.758;p<.0005) and alcohol stimuli (r(1086)=.773: p<.0005) were responded to the same in each half of the experiment. This provides an indication that our AB measure of break frequency scores is reliable.

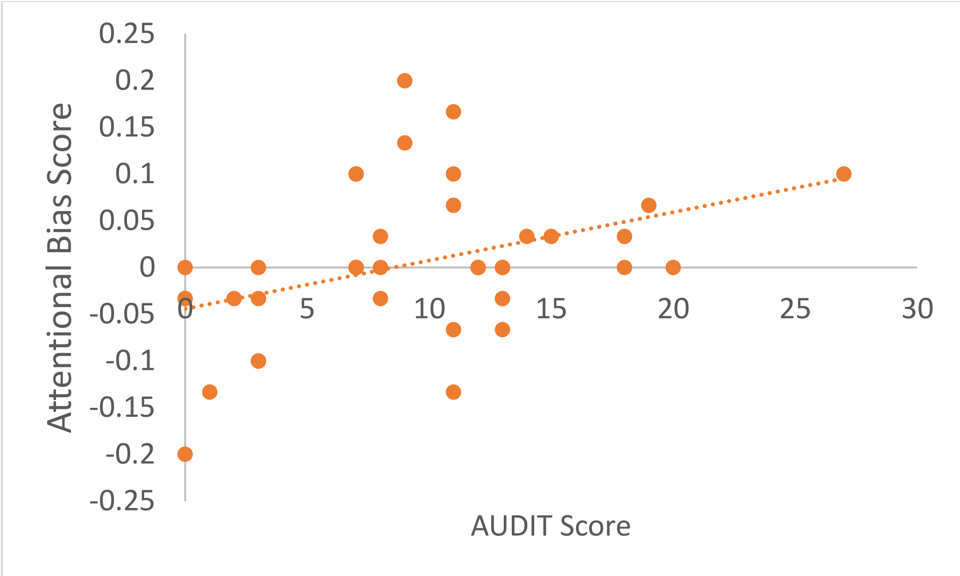

Figure 1. The association between alcohol usage behaviour (as measured with the AUDIT) and the attentional bias score.

Next, we considered whether sleeping behaviour was associated with either alcohol behaviour or attentional bias. It was found that neither alcohol behaviour (r(37)=-.08; p=.626; BF_{10}=.22) nor attentional bias (r(37) = -.12; p = .45; BF_{10} = .26) was associated with sleep. To explore sleep further, the PSQI data was used to categorise participants as either being a below or above average sleeper. This was performed by use of a mean split. Mean PSQI score was 6.44 (SD=3.70). Therefore, participants scoring less than 6.44 were considered less indicative of problematic sleeping ("good sleepers"; N= 24; range = 2 - 6), whilst participants scoring more than 6.44 were considered as being more at risk of problematic sleeping ("bad sleepers"; N= 15; range = 7 - 19). It was observed that the good sleepers (M=9.54; SD=6.12) did not differ from the bad sleepers (M=9.13; SD=6.62) for alcohol usage (t(37)=.196; p=.845; BF_{10} = .32), nor did the good sleepers (M=-.001; SD=.089) differ from the bad sleepers (M=.013; SD=.069) for attentional bias (t(37)=.547; p=.588; BF_{10} =.35). These results indicate that sleep does not affect alcohol usage or alcohol-related attentional biases.

Discussion

This study investigated whether sleep quality affects attentional biases. An attentional bias associated to alcohol usage was observed. However, sleep was not associated with either attentional bias nor alcohol usage. The results imply that attentional biases are phenomena which are not affected by sleep quality i.e. heavy drinkers will always demonstrate an attentional bias for alcohol-related stimuli regardless of whether they have good or bad quality sleep.

Whether attentional biases are stable or transient is an important distinction for the literature (see Christiansen, Schoenmakers, & Field, 2015). Because attentional biases can lead to substance seeking behaviour (see Field & Cox, 2008), it is important to understand factors which may influence them. This study has demonstrated that attentional bias is not associated with sleep quality, suggesting that the decrease in executive control which is associated with poor quality sleep does not affect attentional bias. If this study had found that sleep affected attentional bias, then this may have implied that by improving executive control then attentional bias may be impaired, potentially leading to decreased substance use. This may have had important implications for substance use treatment. Nevertheless, it appears that instead this study has further indicated that attentional biases are not transient, and once developed, are hard to control.

It is important to consider key methodological issues. One key issue is whether the eye tracking task measures inhibition or saliency. Because heavy drinkers only break the target threshold for alcohol and not neutral-control stimuli it would appear that this demonstrates that the inhibitory control deficits are specific for the alcohol-related stimuli. Therefore, it seems that heavy drinkers are specifically impaired in terms of alcohol-related inhibitory control, as measured in this task, rather than merely having poorer inhibitory control in general. Therefore, it appears that the stimulus saliency (i.e. whether a stimulus is salient for a participant) is causing the poorer inhibitory control. Another issue is that the study measured alcohol-related attentional bias and sleep in students, but it is important to state that this could be different from a non-student population. Previous research has shown that alcohol consumption in adults is strongly associated with disturbed sleep (Hasler et al., 2015). However, Van Reen et al. (2016), observed that alcohol use in university students is related to later sleep and rise times, but found no significant association between alcohol use and sleep quality. This distinction between the populations may suggest that the flexibility of university schedules allows students to catch up on sleep despite late nights spent drinking alcohol. However, note that the mean score of the PSQI in this study was 6, indicating that this student sample were reporting a high degree of poor sleep quality as the clinical cut off is typically 5. Therefore, future research could explore the association between sleep and attentional bias in non-student populations. Further, Christiansen, Schoenmakers, and Field (2015) have highlighted the importance of environmental and internal factors when measuring attentional biases. Therefore, because attentional biases may be transient and context dependent, further research is required to reliably state that sleep is not a further extraneous variable when measuring attentional biases.

In conclusion, sleep was not found to be associated with attentional bias. It would seem that once an attentional bias has been established, it has the capacity to influence our inhibitory control for substance-related stimuli irrespective of other factors (sleep quality) which may also affect executive function.

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