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Less than meets the eye: Reappraising the clinical relevance of attentional bias in addiction

Paul Christiansen [a,b,*], Tim M. Schoenmakers [c,d], Matt Field [a,b]

[a] Department of Psychological Sciences, University of Liverpool, Liverpool, United Kingdom
[b] UK Centre for Tobacco and Alcohol Studies (UKCTAS), United Kingdom
[c] IVO Addiction Research Institute, Rotterdam, The Netherlands
[d] Erasmus Medical Center, Rotterdam, The Netherlands

HIGHLIGHTS

- Attentional bias is hypothesised to have clinical relevance in substance abusers.
- The association between attentional bias and relapse is inconsistent across studies.
- The effect of attentional bias modification on substance use is also inconsistent.
- Attentional bias is as a marker of the underlying motivational state.

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ABSTRACT

Recent years have seen an explosion of interest in attentional bias in addiction, particularly its clinical relevance. Specifically, numerous articles claimed to demonstrate either that (1) attentional bias measured in treatment settings could predict subsequent relapse to substance use, or (2) direct modification of attentional bias reduced substance use and improved treatment outcomes. In this paper, we critically evaluate empirical studies that investigated these issues. We show that the evidence regarding both of these claims is decidedly mixed, and that many of the studies that appear to yield positive findings have serious methodological and statistical limitations. We contend that the available literature suggests that attentional bias for drug cues fluctuates within individuals because it is an output of the underlying motivational state at that moment in time, but there is no convincing evidence that it exerts a causal influence on substance use. Future research should make use of experience sampling methodology to characterise the clinical significance of fluctuations in attentional bias over time.

1. Introduction

Motivationally-relevant cues attract and hold the attention: the hungry dieter will notice cakes in the canteen, the anxious person will detect threatening shapes in the shadows, and the depressed person will focus on the negative comments amongst the positive. Attentional bias (AB) towards substance-related cues is also seen in people who frequently use those substances, including individuals with substance use disorders (American Psychiatric Association, 2013). Literature documenting the presence of AB in substance users has been extensively reviewed elsewhere (Cox et al., 2006; Field & Cox, 2008; Wiers, Field, & Stacy, 2014) and this evidence is consistent with theoretical models which posit that AB plays a causal role in the onset, maintenance and recurrence (relapse) of substance use disorders after a period of abstinence (Cox et al., 2006; Franken, 2003; Field & Cox, 2008; Wiers et al., 2014).

Three recent narrative reviews (Cox, Fadardi, Intriligator, & Klinger, 2014; Field, Marhe, & Franken, 2014; Marhe, Luijten, & Franken, 2014) reviewed the clinical relevance of AB in substance use disorders and reached quite different conclusions despite considering many of the same studies. In the current review we offer a comprehensive, detailed, and critical review of studies that investigated two key issues: the predictive validity of AB as a predictor of relapse to substance use after treatment, and the efficacy of attentional bias modification (ABM) as an intervention to prevent relapse or reduce substance use among those with substance use disorders. In contrast to the other recent reviews, which aimed to provide a broad overview of the literature, our goal here is to critically dissect the methods used and results that were reported in previous studies. Our conclusions are considerably more pessimistic than those offered in other reviews, and by the

* Corresponding author at: Department of Psychological Sciences, University of Liverpool, Liverpool L69 7ZA, United Kingdom. Tel.: +44 151 794 6959.
E-mail address: prc@liv.ac.uk (P. Christiansen).

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authors of much of the original research. The important theoretical and clinical implications of our review will be highlighted throughout this paper.

2. Measurement issues and literature search strategy

Although a number of measures of AB for substance cues have been described, the addiction Stroop task and the visual probe task are the most frequently used and to our knowledge these are the only two measures that have been used to investigate the issues that are central to this review paper. Full descriptions of both measures and discussions of their strengths, weaknesses and underlying psychological processes can be found elsewhere (Field & Cox, 2008; Field, Munafò, & Franken, 2009). Importantly, both tasks rely on measurements of manual reaction time to make inferences about attentional deployment.

In the addiction Stroop task, participants are instructed to name the colour in which substance-related and matched neutral words are printed, whilst ignoring the content of those words. Slower colour-naming times for substance-related words are interpreted to indicate that those words captured the attention (Cox et al., 2006), but it should be noted that slower colour naming could also reflect a non-specific freezing response to stimuli that are perceived as threatening (Algom, Chajut, & Lev, 2004; Greenaway, Mogg, & Bradley, 2012), cognitive avoidance of stimuli that are perceived as threatening (De Ruiter & Brosschot, 1994), or individual differences in general inhibitory control ability (Crunelle, Veltman, Booij, van Emmerik–van Oortmerssen, & van den Brink, 2012).

In the visual probe task, a pair of words or images is presented side-by-side on a computer screen before being removed and replaced by a visual probe that appears on one side of the screen. Participants must respond to this probe as quickly as possible and AB is inferred if they are faster to respond to probes that replace substance-related words or images compared to probes that replace neutral images.

Both of these tasks are characterised by unacceptably low internal reliability, particularly the visual probe task for which internal reliability may be close to zero (Ataya et al., 2012). Although there is debate about the reliability of both measures—it is undoubtedly poor, but may not be bad as Ataya et al. have suggested based on a re-analysis of only their own data (see Field & Christiansen, 2012)—this issue is important for understanding the predictive validity of the tasks, and we return to it later in the paper.

This review is concerned with relapse, specifically the relationship between AB and relapse to substance use after a period of abstinence, and the effects of ABM on relapse in patients who are trying to abstain. Different researchers have used different definitions and indicators of relapse, and there is no universally accepted 'gold standard' measure. One could argue that it should be treated as a dichotomous variable (within a pre-defined follow-up period), but given that it is normal for patients to have multiple relapses before they eventually achieve abstinence, this measure may not adequately capture the nature of recovery from substance use disorders. Alternative measures, such as the duration of abstinence/latency to relapse have been reported in some studies and arguably this is more appropriate from both a clinical perspective (because it yields a more detailed description of progress) and a methodological one, because it has greater statistical power. Another important point is that some patients have a goal of reducing their substance use rather than abstaining altogether, in which case indices of the quantity or frequency of substance use may be more informative than crudely categorising participants as relapsed or abstinent.

In this review, we included peer-reviewed studies that have been published or accepted for publication in peer-reviewed journals. Studies were initially identified on the basis of review articles (Cox et al., 2006; Franken, 2003; Field & Cox, 2008; Wiers et al., 2014; Cox et al., 2014; Field et al., 2014; Marhe et al., 2014), and based on searches of Scopus and PubMed using the following search terms: 'Attentional bias OR Stroop' AND 'addiction OR alcohol OR tobacco OR nicotine OR smoking OR drug OR cannabis OR marijuana OR cocaine OR heroin OR opiates OR amphetamine'. These searches resulted in 1172 results. The titles and abstracts of these papers were inspected to identify any papers that investigated either (1) the relationship between AB and subsequent substance use or relapse, or (2) the effects of ABM. A total of 28 articles, describing 27 unique studies, were retained for detailed consideration: 16 papers (15 studies) for the first section (prediction of relapse, Table 1) and 12 papers (12 studies) for the second (ABM). We did not conduct a formal meta-analysis or report effect sizes because the variation in predictor and outcome measures used in different studies would have rendered statistical comparisons between studies meaningless. In any case, our primary aim was to critically discuss the methods used and interpretation of data obtained in previous studies, something that could not have been achieved with meta-analysis.

3. Predictive validity: does attentional bias predict relapse?

The first issue is whether AB can predict relapse to substance use in people who are currently attempting to maintain abstinence. If so, the implication would be that AB is a valid indicator of *presumably stable* individual differences in the psychological processes that underlie loss of control over substance use, as opposed to an unwelcome but ultimately irrelevant consequence of chronic substance use (Field & Cox, 2008; Franken, 2003; Wiers et al., 2014). This would also be consistent with claims that AB could causally influence substance consumption, although the only true test of AB's causal role can come from studies of ABM, which we discuss in the next section. If the predictive validity of AB measured in clinical settings could be established this would also have immediate clinical applications, because it could be used to assess a patient's prognosis and their need for more intensive relapse prevention interventions.

Several studies reported that performance on the addiction Stroop (measured in the clinic) predicted subsequent relapse in those attempting abstinence (Carpenter, Schreiber, Church, & McDowell, 2006; Cox, Hogan, Kristian, & Race, 2002; Janes et al., 2010; Marissen et al., 2006; Powell, Dawkins, West, & Pickering, 2010; Waters et al., 2003) and one additional study reported that performance on the alcohol Stroop predicted reduction in drinking among problem drinkers who did not have an abstinence goal (Cox, Pothos, & Hosier, 2007). However, three other studies used the Stroop and failed to find this relationship (Field, Mogg, Mann, Bennett, & Bradley, 2013; Kennedy, Gross, Ely, Drexler, & Kilts, 2014; Marhe, Luijten, Van De Wetering, Smits, & Franken, 2013), and three additional studies found a relationship between Stroop interference and treatment outcome, but in the opposite direction (i.e. larger attentional bias was associated with better treatment outcomes; Carpenter, Martinez, Vadhan, Barnes-Holmes, & Nunes, 2012; Mitchell et al., 2013; Spiegelhalder et al., 2011). Three of the aforementioned studies also included a visual probe task, and all found no significant relationship between this measure of attentional bias and subsequent relapse (Field et al., 2013; Spiegelhalder et al., 2011; Waters, Shiffman, Bradley, & Mogg, 2003). The latter refers to the same study as the earlier paper by Waters, Shiffman, Sayette, et al. (2003), but the Stroop and visual probe task data were reported in two different articles. Significantly, only one paper to date has reported an association between attentional bias measured by the visual probe task and relapse (Garland, Franken, & Howard, 2012).

A simple comparison of 'hits' and 'misses' suggests that the evidence is equivocal: Seven hits to six misses for the addiction Stroop, and one hit to three misses for the visual probe task. Most of these studies (including those that reported positive findings) were probably underpowered to detect any relationship between attentional bias and treatment outcome, and it is notable that underpowered studies can yield spurious positive as well as null findings (Button et al., 2013). More importantly, we contend that methodological weaknesses and inconsistencies mean that many of the apparently positive findings cannot be taken at face value.

For example, Carpenter et al. (2006) reported that Stroop interference for cocaine words predicted treatment outcome in cocaine-