ARTICLE

Can't take my eyes off of you

Matt Field, winner of the Society's Spearman Medal, on attentional bias in addiction and anxiety disorders

When we experience emotional or motivational states, we find that environmental stimuli that relate to these states are able to grab our attention. Among individuals with emotional or motivational disorders, such as anxiety disorders and addiction, this 'attentional bias' seems to be a permanent feature. But does attentional bias just represent an output of the underlying state, or could it also bring about changes in states or even longer-term changes in 'traits'? The latter possibility has been the driving force behind recent research suggesting that attentional bias modification could have a role to play as a treatment for psychopathologies such as anxiety disorders and addiction.

questions

Could attentional bias contribute to some of the symptoms of psychological disorders?

Can we reduce our hunger just by looking away from food?

resources

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Imagine that you had a busy day at work so you missed lunch. On your walk home, crazy with hunger, you notice a billboard advertising some tasty food. Wouldn't the advert capture your attention more than it usually does? Or consider this scenario: I recently went to watch *Paranormal Activity* at the cinema, and when I got home that night every shadow in my house seemed to grab my attention until I figured out that they were just harmless shadows.

Such examples, supported by laboratory work, illustrate that as our 'wants' or 'fears' fluctuate, our selective attention becomes influenced by things that relate to these wants or fears. In this article, I will demonstrate how attentional biases are a robust characteristic of psychological disorders such as addiction and phobias, which are disorders of motivation and emotion, respectively. The interesting theoretical question is whether attentional bias is just another 'output' of the underlying emotional or motivational state, or whether it might actually contribute to experienced states and motivated behaviour itself. Finally, I will discuss recent research into developing new types of treatment for addictions and anxiety disorders that train people to overcome their attentional bias.

People with specific phobias (e.g. for spiders or snakes) have an attentional bias for pictures and words related to their fear

How do we measure attentional bias in the laboratory?

A variety of methods can be used to assess biases in selective attention, although here I will focus on the two most commonly used methods. The modified Stroop task is the classic example of an interference-based paradigm. In the task, participants are presented with words displayed in different colours and their task is to rapidly identify the colour of the word, while ignoring its semantic content. By introducing different types of words (e.g. those related to spiders versus those related to vegetables), we can compare participants' colour-naming speed for the different types of words. If participants are slower to colour-name, say, the spider-related words compared to the vegetable-related words, we would conclude that the spider-related words had interfered with colour-naming performance. This is usually attributed to the meaning of the words somehow 'grabbing the attention' and reducing the pool of cognitive resources needed for successful colour-naming.

An alternative task is the visual probe task, which is the classic example of a facilitation-based paradigm. In the task, a pair of pictures or words (e.g. a photograph of a woman smoking a cigarette, and a photograph of a woman

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applying lipstick) are simultaneously presented side-by-side on a computer screen for a relatively brief period, anything between about 10 milliseconds and 10 seconds (in different studies). After the pictures disappear, a small probe stimulus (e.g. an arrow pointing up or down) appears on either the left or right hand side of the screen such that it replaces one or other of the pictures. Participants are instructed to respond to the visual probe as quickly as possible. Over a series of trials, we can compare participants' reaction times when probes replace our picture category of interest (e.g. smoking-related pictures), and when probes replace our control category of pictures. If participants are faster to respond to probes that replace smoking-related pictures compared to probes that do not replace those pictures, then we infer that participants were directing their gaze to the smoking-related pictures just before the probe appeared in their place (so, attentional bias for smoking pictures), and this facilitated their reaction time. A real advantage of this task is that it can be combined with eye movement monitoring, such that we can constantly track where participants are looking while pictures are presented, which gives us a direct and unambiguous measure of biases in selective attention.

Addiction and anxiety disorders

Research conducted over the past 30 years or so has demonstrated that patients with anxiety disorders have an attentional bias for threat-related stimuli. For example, patients with social phobia have an attentional bias for threatening facial expressions; patients with specific phobia (e.g. for spiders or snakes) have an attentional bias for pictures and words related to their fear; and patients with generalised anxiety disorder have an attentional bias for general threat-related information (see Bar-Haim et al., 2007).

Substance abuse and dependence are also associated with attentional bias for substance-related cues. This has been demonstrated in heroin users, cocaine users, cannabis users, alcoholics and tobacco smokers (see Field & Cox, 2008). Unlike with attentional bias for threat-related stimuli, it seems unlikely that drug-related cues would have any inherent motivational properties in people who have not used drugs, so attentional biases are likely to be learned. Therefore, most theoretical models suggest that attentional biases develop through a classical conditioning process, in that the rewarding effects of drugs of abuse become associated with environmental cues that are present at the time of drug self-administration. Through this conditioning process, drugs acquire conditioned incentive-motivational properties, which causes them to grab the attention (e.g. Robinson & Berridge, 1993). The role of conditioning is supported by laboratory conditioning studies which demonstrate that arbitrary cues that are paired with drug administration or drug availability are able to grab the attention after relatively few pairings (e.g. Field & Duka, 2002).

Studies that used the modified Stroop task suggest that both anxiety disorders and substance-related problems are characterised by an identical pattern of attentional bias; that is, people with these disorders are slow to name the colour in which disorder-related stimuli are printed. However, studies that used experimental tasks that are able to discriminate between rapid orienting of attention, problems disengaging attention, and overt attentional avoidance (see Cisler & Koster, 2010), suggest a slightly more complicated picture. That is, there appears to be a qualitative difference between the types of attentional bias that are seen in anxiety disorders and substance-related problems. Anxiety disorders are characterised by rapid orienting of attention towards threat (when threat stimuli are presented very briefly), followed by problems disengaging attention from threat. When threatening stimuli are presented for fairly long periods of time (usually over one second), overt avoidance of the stimuli is often seen (Cisler & Koster, 2010). This is thought to reflect a hypersensitive system for detecting threat, which leads to rapid detection of threatening stimuli followed by problems disengaging attention from them. The subsequent diversion of attention away from threat is perhaps motivated by desire to reduce the anxiety caused by focusing attention on the stimulus (Cisler & Koster, 2010).

However, individuals with substance-related disorders seem to show a different pattern of attentional bias. To date, no published studies have used adequate methodologies to convincingly demonstrate rapid orienting of attention toward drug-related stimuli. Instead, substance abusers seem to show a bias in the maintenance or disengagement of attention, in that drug-related cues are able to 'hold', but perhaps not rapidly 'grab', their attention (see Field & Cox, 2008). At least, this seems to be the case in substance users who are not receiving treatment at the time when attentional bias is assessed. Alcohol-dependent individuals who are receiving (or who have recently received) treatment seem to show attentional avoidance of alcohol-related pictures (e.g. Townshend & Duka, 2007), which may be preceded by rapid orienting of attention toward those cues (see Noel et al., 2006, Stormark et al., 1997). Therefore, attentional bias in treatment-seeking alcoholics may be more akin to that seen in those with anxiety disorders, which might reflect the fact that alcohol-related cues are perceived as aversive or even threatening in those who have recently been detoxified from alcohol.

How does this apparent dissociation between the types of attentional bias seen in anxiety versus substance-related disorders sit with the observation that both disorders are characterised by Stroop-interference produced by disorder-related words? Any emotionally valenced stimulus could lead to colour-naming interference, regardless of whether its valence is positive or negative (e.g. Powell et al., 2002). Therefore, demonstrations of Stroop interference in any specific disorder are useful but they don't tell us if this

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interference arises because those cues are perceived as appetitive or aversive, or are positively or negatively valenced. In many disorders (such as the anxiety disorders) we can cautiously conclude that Stroop interference occurs because threat-related cues are appraised negatively. However, in substance-related disorders, drug-related cues might be perceived as either appetitive or aversive in different populations (e.g. those with alcohol dependence, versus tobacco smokers), or at different stages of the disorder (e.g. heavy 'social' drinking versus inpatient alcoholics). Indeed, drug-related cues might be simultaneously appraised as both appetitive and aversive in the same individuals. If we only use the Stroop task, we might conclude that substance-related disorders are characterised by 'attentional bias' in general. But if we use more sophisticated methods, a more complicated picture emerges.

Emotional and motivational states

Emotional and motivational disorders such as those described above are associated with attentional bias for disorder-related stimuli. But what of emotional and motivational 'states'? It stands to reason that an individual with generalised anxiety disorder would, on average, experience a higher level of anxiety than an individual without the disorder. Likewise, someone dependent on heroin would experience heroin cravings from time to time, but someone who had never used the drug would not. So a reasonable question to ask is: to what extent are attentional biases stable within individuals, or do they tend to covary with the strength of experienced emotional and motivational states?

Theoretical work from Lang and colleagues (1998) suggested that subjective states represent the most salient feature of emotion, but that all emotions (whether appetitive or aversive) have correlates in other response domains, including physiology, behaviour, and cognition. Indeed, Lang et al. (1998) specifically noted that strongly valenced positive and negative stimuli elicit increased physiological arousal, and such stimuli also influence attentional processes: highly arousing stimuli are more likely to be preferentially attended to than stimuli that provoke low feelings of arousal. Given this, one would predict that intense emotional states would be associated with increased attentional processing of environmental stimuli that are relevant to that emotional state.

With regard to subjective anxiety, there is good evidence to suggest a robust correlation between the current strength of self-reported state anxiety and the magnitude of attentional bias at that point in time (Bar-Haim et al., 2007). More compelling evidence for this association comes from studies in which anxiety was experimentally manipulated, for example by briefly exposing people to a stressful situation. Such studies demonstrate that attentional biases are increased in magnitude after a stressor compared to after a control manipulation (e.g. Edwards et al., 2006). Importantly, these effects are seen in both individuals with anxiety disorders, and in 'normal' controls (in whom state anxiety tends to fluctuate naturally, and can be experimentally manipulated with the use of laboratory stressors). Similarly, there is an association between appetitive motivational states, and

Subjective craving is experimentally increased after an experimental manipulation – such as administering a low dose of alcohol to social drinkers

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attentional bias for motivationally relevant cues. For example, self-reported hunger levels are associated with the magnitude of attentional bias for food-related cues (e.g. Nijs et al., 2010). In substance-related problems, attentional bias and craving strength are positively correlated, although a recent meta-analysis revealed that the association is fairly weak, with only 4 per cent of shared variance between the two (Field, Munafò et al., 2009). However, when attention was directly measured by monitoring eye movements or event-related potentials (rather than being indirectly inferred from reaction time tasks), the amount of shared variance increased to 13 per cent. Of course, this is still a long way off 100 per cent shared variance, but in the meta-analysis my co-authors and I discussed several methodological issues that may account for the generally low correlation.

With regard to experimental manipulation of craving states, I have conducted several studies in which craving strength was experimentally manipulated, for example by requiring smokers to abstain for several hours, by administering a low dose of alcohol to social drinkers, or by exposing social drinkers to the threat of public speaking. Again, the general pattern of results is that when subjective craving is experimentally increased after an experimental manipulation, attentional bias tends to increase alongside it, which again suggests some degree of coherence between the motivational state and attentional bias (reviewed in Field & Cox, 2008).

What does attention actually do?

Attentional bias for emotionally or motivationally relevant cues is clearly a feature of fairly stable emotional and motivational disorders, and it is associated with temporary fluctuations in emotional and motivational states. But could attentional bias actually play a causal role in the generation, escalation or maintenance of states, and even disorders? For example, with regard to addiction, one influential model argues that attentional bias simply represents an output of the underlying neurobiological adaptations that drive drug-seeking behaviour (Robinson & Berridge, 1993). On the other hand, an extension of this model (Franken, 2003) suggests that attentional bias might actually cause increased craving and drug-seeking behaviour, perhaps because if individuals find themselves repeatedly distracted by drug-related cues in their environment, they may ruminate on the anticipated positive consequences of drug use, and this unwanted distraction may reduce the ability to engage coping responses in order to resist the temptation to use drugs. Similarly, attentional bias might simply be an 'output' of underlying anxiety, or it may play a causal role by generating emotional states or increasing their intensity, and thereby be an important factor in the development and maintenance of emotional disorders (see MacLeod et al., 2002).

One way to test the potential causal role of attentional bias is to experimentally manipulate it before examining the effects of this on self-reported states or on motivated behaviour. This has been attempted in a number of recent studies, originally by MacLeod and colleagues (2002). They used a modified version of the visual probe task in which the location of visual probes was manipulated such that for one group of participants ('attend threat' group) probes replaced threat-related words on the majority of trials, but for another group ('avoid threat' group), probes replaced the threat-related words on a minority of trials. The aim was that, over repeated trials, the 'attend threat' group should direct their attention towards threat-related cues, whereas the 'avoid threat' group should direct their attention away from threat-related cues. This was indeed the case, although groups did not differ in self-reported state anxiety immediately after the manipulation. However, the important finding was that the 'attend threat' group showed a larger increase in state anxiety after they had completed a stressful task, compared to the 'avoid threat' group. The take-home conclusion from this study was that attentional bias for threat might not influence subjective anxiety *per se*, but it appears to increase vulnerability to stressors, such that when attentional bias is elevated, the subjective response to a stressor is elevated.

> "attentional bias may have a causal effect on craving strength"

This paradigm was adapted to probe the causal role of attentional bias in substance-related disorders. An initial study found that a group of heavy social drinkers in whom attentional bias for alcohol-cues had been experimentally increased reported higher levels of alcohol craving, and consumed more beer, than a group in whom attentional bias had been reduced (Field & Eastwood, 2005). However, subsequent studies have either failed to fully replicate these effects in heavy drinkers (Field et al., 2007; Schoenmakers et al., 2007) or failed to generalise the results to other populations such as tobacco smokers (Attwood et al., 2008; Field, Duka et al., 2009). The overall conclusion is that attentional bias may have a causal effect on craving strength, although this effect is weak and seemingly moderated by variables such as gender and participant awareness of the relationship between picture location and probe location during the attentional bias manipulation phase. To date, effects on substance-seeking or actual consumption in the laboratory have not been consistently found.

It has been suggested that, while these brief experimental studies are useful, they do not really get at the issue of the causal role of attentional bias in disorders such as anxiety and addiction. This is because they tend to focus on non-dependent substance users, or people who have higher than average anxiety levels but who do not have an anxiety disorder. Furthermore, they only focus on short-term changes in emotional or motivational states, or fairly artificial models of motivated behaviour in the laboratory. So some recent studies have looked at the effects of longer-term interventions that attempt to manipulate attentional bias over repeated sessions, usually spread over several weeks. In the anxiety literature, initial results are promising: attentional bias reduction can bring about long-lasting reductions in self-reported symptoms of social anxiety disorder (e.g. Schmidt et al., 2009), and it can lead to long-lasting reductions in anxiety levels among students who enrol at university in a foreign country, which is a stressful time (See et al., 2009). In the addictions, two recent studies examined the utility of attentional bias reduction as an adjunct treatment for heavy drinking, and both found some evidence for beneficial effects, including a reduction in the amount of alcohol consumed (Fadardi & Cox, 2009), or an increase in the amount of time that patients remained abstinent before relapsing to drinking (Schoenmakers et al., 2010). However, future studies with larger sample sizes and appropriate control conditions are required before this can be truly embraced as an intervention to reduce alcohol problems and, perhaps, other addictions too.

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