CHAPTER 27

# *Relevance of Research on Experimental Psychopathology to Substance Misuse*

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**Abstract:** In the domain of the emotional disorders, many research efforts have focused on the role of implicit cognition. Findings from these studies have provided important clues with respect to the role of implicit cognitions in the persistence of psychopathological complaints as well as to the returns of complaints after treatment. In this chapter, we take the findings of this line of research as the starting point and explore how it relates to theories in the areas of addiction. We mainly focus on attentional processes in an attempt to provide some clues in answering the main question of this chapter, which is: Do implicit drug-related cognitions have causal effects on craving and substance misuse?

## INTRODUCTION

An important impetus behind the increasing research in studies in the areas of cognition in psychopathology has been the rise of cognitive models implying that emotional disorders critically depend on the existence of maladaptive cognitive structures in memory (e.g., Beck et al., 1985). These so-called schemata are assumed to automatically influence all stages of individuals' information processing. Since relevant cognitions may not be accessible through introspection, empirical research testing the validity of these types of models predominantly relied on indirect performance-based measures of cognitive processes that are assumed to be functionally related to the underlying maladaptive schemata (Mathews & MacLeod, 1985).

One of the most studied phenomena in this respect is the involuntary tendency of anxiety patients to prioritize the processing of information that is relevant to their current concerns (often referred to as "attentional bias"). Recent models of addictive behaviors imply similar processes to be involved in substance use and misuse (Franken, 2003). In the last decade a rapidly growing number of studies appeared in the area of substance use and misuse focusing on "attentional" bias for drug-relevant stimuli (see also Bruce & Jones, Chapter 10; Field et al., Chapter 11). The basic assumption of the information processing models of psychopathology and addiction is

the idea that prioritizing threatening (in anxiety) or appetitive (e.g., in substance misuse) information contributes to the intensity of the problems. That is, these types of processing biases are not simply a symptom of addictive/emotional disorders, but are assumed to play a vital role in their causation and maintenance (Williams et al., 1997). More specifically, in emotional disorders it is assumed that there is a reciprocal relationship between emotional distress (e.g., fear) and a failure to inhibit the allocation of attentional resources toward threatening information (MacLeod et al., 2002; Mathews & MacLeod, 1994). Similarly, in addiction, current approaches assume that there is a reciprocal relationship between craving and "attentional bias" (Franken, 2003). In line with this view, it has even been argued that the development of an attentional bias for drug stimuli may be the core process underlying compulsive drug use and craving (Lubman et al., 2000).

A first prerequisite of these information processing models is that patients suffering from particular disorders are characterized by a disorder-specific bias in attention allocation. Following this, most initial research efforts have focused on demonstrating an attentional bias for concern-relevant stimuli (e.g., spiders for individuals with spider phobia; high caloric food in disinhibited dieters). A subsequent series of quasi-experimental studies focused on delineating the factors that are vital to reliably elicit (or inflate) processing biases. By directly or indirectly manipulating the motivational state in unselected, analogue, and clinical samples, it was tested whether indeed activating (or removing) particular current concerns or motivational states elicited (or reduced) functionally related processing biases. A related series of studies tested the influence of context cues and/or environmental settings on the strength of attentional biases.

Only a very few recent studies have begun to test the most critical assumption, namely that processing bias has a causal influence on the generation of complaints. In these studies, it has been investigated whether inducing a bias results in more distress in a subsequent stressful task. Relatedly, some recent studies took the opposite perspective and explored whether techniques to experimentally reduce the attentional bias in anxiety patients is also effective in reducing patients' complaints. In the remainder of this chapter, we discuss the results, promises, and potential implications of these various types of studies for the understanding and treatment of addictive behaviors.

## IS SELECTIVE PROCESSING BIAS A GENERAL CHARACTERISTIC?

One of the most popular paradigms to investigate selective processing priority is the so-called modified Stroop test. In the computerized version, participants are shown a series of words or pictures on the screen that are presented in various colors. It is their task to name the color of the words (or the color of the pictures, or the color of the background on which the pictures are presented) as quickly as possible. The contents of some of the words (or pictures) that are presented relate to the relevant clinical disorder (e.g., "beer" in the context of alcohol abuse). In the original color Stroop there is a dimensional overlap between the task-irrelevant feature (the meaning of the word, e.g., green) and the required response (naming the color of the ink in which the word is printed) (MacLeod, 1991). The so-called modified Stroop, however, is structurally different from the original color Stroop in that there is no such overlap between the task-irrelevant (distracting) meaning of the word (e.g., beer) and the name of the color. Hence, what is usually called the emotional or modified Stroop test is in fact no Stroop test at all (cf. De Houwer, 2003). Following this, it seems more appropriate to refer to this task as the color-naming interference task. Although the precise source of heightened color-naming interference has not yet been identified

(Williams et al., 1996), it is a clear indicator of a cognitive-processing bias.

### *Color-Naming Interference Task (Formerly Known as Modified Stroop)*

Clinical groups generally display heightened color-naming interference on trials displaying words related to their disorder. Accordingly, interference has been found for general threat words in generalized anxiety disorder (GAD; Mogg et al, 1995), spider-related words in spider phobia (Lavy et al., 1993), and food-related words in obesitas (Braet & Crombez, 2003). Similar results have been reported for pictorial stimuli in the context of spider phobia (Kindt & Brosschot, 1998) and bulimia nervosa (Stormark & Torkildsen, 2004). Taken together, the available evidence in the context of anxiety and eating disorders is in accordance with the idea that selective allocation of attentional resources is not restricted to threatening information but may be evident as well for attractive reward-related stimuli.

Adding to the idea that selective processing biases may also be a characteristic of approach-related motivational states, similar selective patterns of interference have been reported for alcohol-related words in alcoholics (Johnsen et al., 1994; Stormark et al., 1997), heroin cues in heroin-dependent inpatients (Franken, Kroon, Wiers et al., 2000), smoke cues in smokers (Waters & Feyerabend, 2000), and gambling-related words in pathological poker machine players (McCusker & Gettings, 1997). All in all, it seems that selective processing biases are the result of preoccupations with motivational salient stimuli, which are difficult to ignore when confronted with.

### *Dot-Probe Task*

Another paradigm that is often used to study attention allocation is the dot-probe paradigm. In the typical paradigm, participants are presented with pairs of words or pictures one of which is replaced by a dot. It is the participant's task to indicate as fast as possible the location of this dot. In some of the pairs one picture (or word) is related to the clinical concerns (e.g., glass of beer), and one is the neutral contrast (e.g., tool). The dot-probe paradigm capitalizes on the idea that when participants' attention is grabbed by the disorder-related stimulus, they are relatively fast on trials when the dot appears in the spatial vicinity of the disorder-related cue, and/or relatively slow when it appears in the spatial location of the control stimulus.

Similar to the results with color-naming interference tasks, results with the dot-probe test revealed heightened vigilance for general threat words in GAD (Mogg et al., 1995), and for food words in individuals scoring high on the Eating Disorder Inventory (EDI; Placanica et al., 2002). Similar results have been reported for visual stimuli. For example, social phobic individuals were found to display enhanced vigilance for angry faces relative to happy and neutral faces (Mogg, Philippot, et al., 2004) and women with bulimia nervosa for pictures of food items (see Dobson & Dozois, 2004).

In line with the idea that heightened vigilance for threatening information is related to an avoidance-related motivational state, a bias toward threatening information is typically only found for short (i.e., 500 ms) presentation times of the task-irrelevant pairs of stimuli, whereas the differential vigilance for angry faces in social phobics is absent when using longer presentation times (i.e., 1250 ms; Mogg, Philippot, et al., 2004). Accordingly, significant avoidance for injury scenes was found at longer exposure duration (i.e., 1500 ms) in participants with high levels of blood-injection-injury-fears, whereas a strong vigilance for these scenes was evident during the shorter (500 ms) presentations (Mogg, Bradley, et al., 2004). Similar results have been found using eye movement measurements during a

visual search task (i.e., participants were instructed to detect a spider as fast as possible in complex naturalistic slides). Relative to controls, spider-phobic individuals not only detected spiders faster and fixated closer to spiders during initial search, they also fixated further away from spiders following the detection of the spider (Pflugshaupt et al., 2005).

Unfortunately, within the existing literature there are thus far no studies in the context of eating disorders that used longer stimulus presentation times. So it remains to be seen whether the initial vigilance also shifts to avoidance in individuals suffering from eating disorders. An alternative and plausible hypothesis would be that the initial vigilance for "attractive" food stimuli would be sustained as would be predicted when selective attention for food stimuli is functionally related to an approach-related motivational state. Interestingly, this type of study has recently been done in the context of addictive behavior. Sustaining the idea that prioritizing drug-related information is indeed related to an approach-related motivational set, habitual smokers were found to display a maintenance of attention on smoking-related visual scenes when a longer (i.e., 2 s) stimulus duration was used (Mogg et al., 2003). A study measuring eye movements and gaze fixation during a similar dot probe test with a long stimulus presentation time (2 s), further confirmed the idea that addicted individuals are characterized by a biased maintenance of attention on smoking-related cues. Interestingly, this pattern was especially pronounced in participants who were experimentally deprived from nicotine (Field et al., 2004b), suggesting that nicotine deprivation promotes sustained attentional allocation to nicotine cues.

The majority of studies in the area of addiction, however, exclusively relied on the typical short (500 ms) stimulus presentation times, allowing only testing on the presence of initial vigilance. In general, these studies showed that substance misusers are characterized by heightened vigilance for drug-related stimuli. Accordingly, using a pictorial dot-probe test, Ehrman et al. (2002) revealed an attentional bias for smoke cues in heavy smokers, but not in individuals who never started smoking. Similarly, opiate-dependent individuals displayed a selective processing priority toward pictures of drug paraphernalia (Lubman et al., 2000), whereas heavy social drinkers were found to display vigilance for visually presented alcohol cues (Townshend & Duka, 2001). Corresponding to the alleged reciprocal relationship between initial vigilance and craving, correlations were found between individual's level of "craving" and differential attentional deployment in habitual smokers (Mogg et al., 2003), cocaine users (Franken, Kroon, & Hendriks, 2000), and recreational cannabis users (Field et al., 2004a). Because the level of craving (or the level of bias) in these studies was not experimentally manipulated, however, it remains to be seen whether these correlations have a causal (reciprocal) basis.

Findings with the Stroop and dot-probe tasks converge in several ways. Both tasks have identified specific biases in clinical groups but less consistent biases in nonclinical people. In addition, both tasks can be modeled in terms of processing along task-relevant and task-irrelevant pathways, with the effects arising because participants allocate attention to task-irrelevant pathways that convey threat or reward (Williams et al., 1996). Furthermore, both tasks are considered to tap relatively automatic processes that are difficult to control.

### *Spatial-Cueing Task*

A third type of tasks that has been used to study attentional bias in anxiety, are spatial-cueing tasks (e.g., Derryberry & Reed, 1994, 2002). Most important, these tasks can differentiate between tendencies to shift attention

toward particular stimuli versus difficulties in shifting away from these stimuli. This distinction is important as both forms of bias may have different implications for subsequent processes. Individuals who shift attention toward negative information may notice multiple threats but still process them rather superficially, resulting in only minor emotional distress. In contrast, those who have difficulty shifting away from threat may tend to lock onto the negative stimulus to process it deeply, resulting in stronger emotional responding (Derryberry & Reed, 1994). In a similar vein, both forms of attentional bias may differentially contribute to the generation of craving and substance misuse in addiction.

In the spatial-cueing tasks, participants are engaged in a motivated computer game in which they can gain or lose points depending on their speed in detecting simple circular targets. Before each target appears, a peripheral cue is presented that automatically orients attention to the positive location (where points can be gained if the response is fast enough) or the negative location (where points can be lost if the response is too slow). In half of the trials the target appears in the uncued location (invalid cue). Relatively fast responses on trials with a valid cue on the negative location are indicative of an attentional bias toward threat. Relatively slow responses on trials with an invalid cue on the negative location are indicative of a difficulty to disengage from threatening stimuli.

In keeping with the results from the other tasks, anxious participants showed a bias favoring threatening locations where points could be lost (Derryberry & Reed, 1994). Importantly, this bias only appeared when a cue on the negative location was followed by a target in the other (i.e., uncued) location. This finding questions the traditional view of the processes underlying the attentional bias phenomenon. That is, rather than facilitating attentional shifts toward threatening stimuli, it appears that anxiety delays the disengagement of attention from threat. Such a view is compatible with both the Stroop and dot-probe results. Difficulty in shifting away from threatening information would slow down color-naming when the anxious individual has difficulty shifting from the irrelevant threatening meaning to the relevant color information. In line with the idea that interference effects in the dot-probe task are also due to delays in disengaging from threatening information, the bias in favoring threatening locations mostly arise from slow reactions to neutral locations rather than from fast responses to threat locations (Brosschot et al., 1999; Koster et al., 2004).

In the original setup, the cues did not predict the target's location and participants should not have been intentionally motivated to attend them. To test whether attentional biases also arise in situations that promote a more intentional use of attention deployment, the task has been adapted in a way that the peripheral cues actually predicted the target's location during the majority of trials. In such a modified task, anxious individuals still displayed a similar attentional bias, also when using relatively long time intervals between cue and target (500 ms), suggesting that apart from automatic processes also more voluntary attentional processes are involved in anxiety (Derryberry & Reed, 2002).

The authors are not aware of studies using this paradigm in addiction research. This paradigm, however, seems even more promising than the often-used color-interference or dot-probe tasks in disentangling the underlying mechanisms of compulsive drug use and craving. It allows differentiating between the tendency to shift attention toward attractive stimuli and individuals' difficulty to shift away from attractive reward-related information (i.e., the positive location). In addition, it can be modified in a way to evaluate the relative importance of automatic and more voluntary attentional processes in the area of addiction.

## INFLUENCE OF EXPERIMENTALLY MANIPULATED CONTEXT AND/OR MOTIVATIONAL STATE

### *Deprivation*

A series of studies employed quasi-experimental methods to directly or indirectly influence participants' motivational state in an attempt to investigate whether this would result in parallel changes in individuals' patterns of selective information processing. In what can be considered as a first rigorous exploration of this issue, Lavy and Van den Hout (1993) asked half of their participants to refrain from food for 24 hours before performing a color-naming interference task. As predicted, fasting resulted in a more positive evaluation of food stimuli, an increased urge to obtain food, and in a heightened color naming interference for appetitive (food) cues.

A subsequent study using the dot-probe task, further confirmed these basic findings, and showed that heightened visual attention toward food words was mainly found in participants in the fasting condition (Mogg, et al., 1998). Furthermore, the strength of the bias was significantly correlated with hunger ratings and the estimated amount of food that could be eaten. This supports the hypothesis that such bias for appetitive cues is fueled by an approach-related motivational state. Together, it appears that "hunger" (and presumably also other drives and states) result in a difficulty to inhibit the allocation of resources to appetitive cues. This seemingly highly adaptive mechanism may become dysfunctional in restrained eaters who strongly try to regulate their food intake resulting in disinhibited eating patterns. The dysfunctional triggering of the vigilance for food cues may be further strengthened by the enhanced reward value of food after repeated periods of prolonged deprivation (cf. Brown et al., 1998).

A recent pictorial dot-probe study showed that fasting may not only induce a bias toward food in normal controls but may also change the focus of the habitually enhanced vigilance in analogue groups scoring high on the Eating Disorder Inventory (EDI; Placanica et al., 2002). More specifically, fasting resulted in an attentional shift from "healthy" low-caloric food items toward "unhealthy" high-caloric foods. This pattern of results may provide a clue for the apparent preference for high-caloric food in bulimia nervosa.

Together, these findings not only show that influencing motivational state results in predictable changes in attentional deployment, but also underline the importance of taking the motivational state during measurement procedures into consideration. Clearly, this type of process may also be involved in the context of addictions (see, e.g., Field et al., Chapter 11, for a discussion of the effects of nicotine deprivation on attentional bias).

### *Pre-Loads*

Using a different approach to manipulate individuals' motivational state, Overduin and colleagues (Overduin et al., 1995) provided half of the participants with an "appetizer" (a bit of pudding) just before a color-interference task. As an index of individuals' motivational set they measured the amount of ice cream participants ate during a subsequent "taste test" that was carried out immediately following the interference task. Interestingly, compared to the "nonappetizer" control group, participants in the "appetizer" condition showed heightened color-naming interference during food-word trials. Although the appetite manipulation was not generally related to the amount of ice cream participants consumed, the level of color-naming interference did strongly correlate with participants' actual amount of ice cream intake. Hence, in support of the vigilance-approach

hypothesis for appetitive cues, the processing priority of food words was not only inflated in the appetite condition but was also found to have predictive validity for subsequent food intake.

Using a similar strategy in the context of alcohol use, a group of social drinkers were sip-primed with alcohol immediately before starting a color-naming interference test including words referring to positive (reward/approach-related) alcohol outcomes and negative alcohol outcomes (Jones & Schulze, 2000). Similar to the results of Overduin et al. (1995), typically the alcohol-primed social drinkers displayed selective color-naming interference for positive alcohol words. Subsequent research presented a group of heavy and a group of light social drinkers with a "taste test" of either an alcoholic or a soft drink immediately prior to a color-naming interference test (Cox et al., 2003). In line with the pattern of previous findings, only heavy drinkers in the alcohol pre-load condition displayed relatively heightened color-naming interference for alcohol words compared to soft drink words. All in all, it appears that pre-loads of wanted/attractive consumables (e.g., food, drinks) can modify individuals' attention allocation. The crucial question that remains to be answered is whether this processing bias is causally related to craving, which in turn may support or disinhibit individuals' subsequent intake behaviors.

### *Treatment*

Another way to test the influence of motivational saliency on attentional bias is to reduce its saliency via therapeutic interventions. The influence of treatment on attentional bias in addiction is still a largely unexplored area. Meanwhile, studies in the area of anxiety disorders and bulimia nervosa showed that when the motivational saliency of initially threatening (or attractive) stimuli is removed after successful treatment, individuals' attentional bias is likewise removed (e.g., Lavy, Van den Hout & Arntz, 1993; Dobson & Dozois, 2004). It should be noted, however, that none of the apparently successful treatment studies included a no-treatment control group to test for mere test/retest effects. Meanwhile, the only study that did include such a no-treatment control group revealed that the reduction of color-naming interference for spider words in spider-phobic individuals was similar in the treatment and no-treatment control group (Thorpe & Salkovskis, 1997). Future studies including no-treatment control groups are necessary to more rigorously test whether reduction in attentional bias following treatment is indeed due to a reduction of the emotional saliency of disorder-relevant stimuli. In addition, it would be important for future studies to include follow-up assessments. From both a theoretical and a practical standpoint, it would be important to see whether a residual bias is predictive of the return of complaints (cf. de Jong et al., 1995). Unfortunately, thus far none of the studies on attentional bias tested the predictive power of residual attentional bias for relapse.

### *Context Cues*

To test the influence of context cues on individuals' attentional bias, a series of studies experimentally manipulated the context cues during the measurement procedure. For example, Braet and Crombez (2003) presented obese and normal-weight control children with two different color-interference tests. One test used the traditional random version in which food words and control words are presented intermixed, whereas the other test used the so-called blocked format in which various categories of words are

presented in separate blocks of trials. Although the mixed-presentation format is generally considered as the most stringent test of automatic attention allocation (e.g., less influence of post-attentional rumination; cf. Lavy & Van den Hout, 1993), the blocked version may be a better experimental analogue of the natural environment of obese children (or alcohol misusers, etc.). That is, in the natural environment of these children there is an abundance of food (and alcohol, etc.) cues. Thus, by mimicking the naturally abundant presence of food cues, the blocked format may be a more ecologically valid approach to detect the pathological attentional processes that are involved in these types of problematic behaviors.

As predicted, obese children showed stronger color-naming interference for food words than normal control children. Interestingly, this apparent hypersensitivity for food cues was considerably stronger in the blocked than in the mixed format. These findings are in line with the idea that the omni-presence of concern-related (e.g., food) cues may have a cumulative effect that hinders strategic attentional control. Eventually, the abundant presence of concern-related cues may lead to a breakdown when an individual is no longer able to expend sufficient extra effort to override the tendency for motivational salient stimuli to capture the individual's attention (cf. Mathews & MacLeod, 1994). Following this, in their natural environment, obese children may find themselves progressively unable to disengage their attention from food-related cues. In its turn, this may induce or enhance their craving for the forbidden food, with overeating as the eventual consequence. In line with this, a considerable correlation was found in the obese group between the level of color-naming interference and children being overweight. These findings are thought provoking and clearly point to the importance of studying the causal relationship between (attenuated) "attentional control" and craving in the area of addiction.

Following a different strategy to create a more valid experimental analogue of the seducing natural environment of substance misusers, Cox and his colleagues exposed half of their participants to a color-naming interference task in a setting containing alcohol-related visual cues (i.e., participants were surrounded by alcohol posters). Keeping in line with the idea that the presence of motivation-relevant cues may elicit a tendency to allocate attention toward motivationally salient stimuli, heavy social drinkers only showed interference effects for alcohol-words in the alcohol poster condition but not in the control condition (Cox et al., 1999). It would be interesting to see how this type of manipulation affects alcohol-dependent individuals and how these enhancing effects may be influenced by successful interventions. To the extent that apparently successfully treated alcoholics are not able to divert their attention away from alcohol cues under potentiated conditions (e.g., blocked format, tested in negative mood state, or in a drinking-relevant environmental context), these individuals could be at risk for relapse.

## ATTENTIONAL BIAS: CAUSAL AGENT OR EPIPHENOMENON?

As reviewed in the previous sections, there is evidence that anxiety and eating-disorder patients, as well as substance misusers, are characterized by selective processing biases, whereas these biases seem to be attenuated or even eliminated following treatment. Although this pattern of findings is consistent with (i.e., does not refute) the idea that attentional bias plays a critical role in the maintenance of psychopathological complaints, it is also consistent with the interpretation that attentional bias is a mere symptom of pathological anxiety (or addiction).

Following the motivational-cognitive model of emotional disorders, one of the most important questions regarding attentional bias is whether the bias precedes, and whether it contributes to, the development of complaints. In spite of its vital importance, only a small body of work has been undertaken to determine whether attentional bias has any influence on emotional dysfunction. In a first correlational approach, color-naming interference was assessed for supra- and subliminally presented general threat words in a group of women awaiting colposcopy ($N = 31$). A subgroup of these women ($n = 15$) later received a diagnosis of cervical pathology. It was found that the single best predictor of the seriousness of the elicited emotional distress in this subgroup was the level of color-naming interference on subliminal trials (MacLeod & Hagan, 1992). In other words, it appears that the subliminal interference effect represents an emotional vulnerability factor that is predictive of the level of experienced distress when faced with important stressors. Obviously, the women in this study experienced current situational stress of being in anticipation of a potentially threatening diagnosis during the assessment. To see whether the experience of current stress during assessment (which is likely to modulate attentional bias) is a necessary prerequisite for a predictive relationship to occur, a subsequent study was carried out in women who were not currently exposed to environmental stress. Yet, again, it was found that (subliminal) color-naming interference was the single best predictor of vulnerability to life stress (Van den Hout et al., 1995).

Using a conceptually similar approach, a group of nonanxious undergraduates ($N = 87$) with naturalistic variations in color-naming interference effects for panic-related threat stimuli were exposed to a biological-challenge task (brief inhalations of 20 percent carbon dioxide enriched air; Nay, et al., 2004). Consistent with the idea that threat-biased attentional processing has a causal influence and reflects a premorbid anxiety vulnerability factor, color-naming interference effects for both subliminally and supraliminally presented panic words predicted emotional responding above and beyond self-reported anxiety sensitivity (ASI). It would be interesting to see whether an inflated premorbid attentional bias for reward rather than threat-related stimuli would set people at risk for substance misuse (cf. Franken, 2003).

Although thought provoking and clinically important, causality can still not be inferred from these prognostic studies. Yet, these findings did instigate several researchers to perform the next step to critically test whether processing bias is causally related to anxiety symptoms. Accordingly, MacLeod et al. (2002) experimentally induced an attentional bias using a modified dot-probe task and tested the impact of this manipulation on subsequent emotional vulnerability. They tested students with average anxiety levels. During a large number of training trials (576), half of the participants consistently moved toward negative stimuli (experimental condition: attentional bias induction) and half of the participants consistently moved away from the negative stimuli (control condition) in the modified dot-probe task. This manipulation successfully induced an attentional bias: In the experimental condition, participants were faster on (new) negative words than on (new) neutral words on test trials, and in the control condition the opposite was found. It is important to note that the training had no effect on mood during the training itself. After a stress task, however, the experimental group reported higher levels of distress than the control group (and again in a replication study in the same article). These results clearly support the idea that attentional bias can causally mediate emotional vulnerability, lending substance to the previously speculative suggestions concerning the proposed causal role of attentional bias (see also Mathews &

MacLeod, 2002, for additional evidence). Thus far, no attempts have been reported to induce a bias for appetitive stimuli to test the causal relationship between heightened (and/or prolonged) vigilance for substance cues and craving or misuse.

## CHANGING DYSFUNCTIONAL ATTENTIONAL BIAS

The finding that a bias induction in nonanxious individuals can lower the threshold for evoking negative emotional reactions also points to an exciting therapeutic application. It suggests that a similar modified cognitive-experimental dot-probe task may also be used to reduce an already existent bias in anxiety patients, thereby reducing these patients' anxiety complaints. Indeed, research in a nonreferred sample of chronic worriers (40 percent met *DSM-IV* criteria for generalized anxiety disorder [GAD]), lent support to the idea that attentional retraining (AR) might be useful as a therapeutic tool (Vasey et al., 2002). At 5-day intervals, participants were exposed to five sessions of 30 minutes of AR using a modified dot-probe task. In the treatment condition, each session consisted of 216 trials in which probes followed neutral words on 204 trials. The placebo condition was identical to AR with the exception that probes followed neutral words on 50 percent of the trials and threat words on the remainder. The placebo condition did not affect individuals' bias for threat or their scores on the anxiety pathology questionnaires. Meanwhile, the treatment condition not only resulted in an attenuated threat bias, it also led to a considerable reduction of individuals' symptom scores. Adding to its clinical significance, these treatment effects compared favorably with the average effect for cognitive behavioral therapy for GAD in past-published studies.

In a similar vein, treatment-seeking socially phobic individuals ($N = 18$) completed eight sessions of either an attention training using a modified version of the dot-probe detection paradigm or a placebo condition (Amir, et al., 2004). During the training sessions participants were presented with 160 trials depicting rejecting (disgusting) and neutral faces. In the experimental condition, the dot appeared in 80 percent of the trials on the location of the neutral face, whereas in the placebo condition it appeared in 50 percent of the trials on that location. The modification training was not only effective in changing biased attention in socially anxious individuals but also substantially reduced symptoms of social anxiety as assessed by an independent rater as well as by standardized self-report measures. This change was clinically significant and of similar size as reported for traditional CBT [**Au: Please define CBT**] interventions (see also Dandeneau & Baldwin, in press). Importantly, AR has promise as a new treatment tool in the context of complaints in which attentional bias is assumed to play a vital role (e.g., Wiers et al., 2004). Currently, we are eagerly waiting for the first AR studies to emerge in the context of addictive behaviors.

## SUMMARY AND CONCLUSION

Several studies are presented that are relevant to the challenging hypothesis that processing biases for drug stimuli form the psychological nucleus of addiction (e.g., Lubman et al., 2000). Although several interesting studies appeared in the last years, most studies are still quasi-experimental. To test the viability of the current hypothesis, future research should focus on experimental designs in which processing biases are manipulated. The research area of addiction could profit from recent developments in anxiety research, in which experimental paradigms are developed to test the causal contribution of processing bias in the development and maintenance of complaints.

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