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ROLE OF COGNITION IN STRESS-INDUCED AND FEAR CIRCUITRY DISORDERS

Jonathan D. Huppert, Ph.D.
Edna B. Foa, Ph.D.
Richard J. McNally, Ph.D.
Shawn P. Cahill, Ph.D.

AUTHOR: 1) Below are affiliations for each chapter author as they will appear in the contributor list in the front of the book. Please review these carefully and provide any missing information or updates. (This information will be moved to the front matter to create an alphabetical list of contributors at the next stage of production.)

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Jonathan D. Huppert, Ph.D.
[AFFILIATION]
[ADDRESS]

Edna B. Foa, Ph.D.
[AFFILIATION]
[ADDRESS]

Richard J. McNally, Ph.D.
[AFFILIATION]
[ADDRESS]

Shawn P. Cahill, Ph.D.
[AFFILIATION]
[ADDRESS]

In this chapter, we review research on the cognitive aspects of panic disorder, posttraumatic stress disorder (PTSD), social anxiety disorder (SocAD), and specific phobia. We refer readers to the comprehensive review by Harvey et al. (2004) for greater detail than we can present in this chapter. We concentrate here on studies concerning cognitive biases favoring the processing of threat-related information. For each disorder, we examine cross-sectional, longitudinal, treatment, and experimental studies to ascertain whether biases may play a causal role in the maintenance and etiology of these syndromes. We conclude by summarizing what is known about the role of cognition in anxiety and providing suggestions for further research.

Definitions, Experimental Paradigms, and Assumptions

DEFINITIONS

We define *cognitions* as information structures that result from perception, learning, memory, or reasoning and that include representations of stimuli, responses, and their meaning. Cognitions are distinct from physiological anxiety symptoms and are often assessed through self-report inventories or questionnaires. *Cognitive processes* are mechanisms underlying cognitions that are involved in the detection, encoding, storage, retrieval, and utilization of information such as attention, interpretation, and memory.

Cognitive research comprises two approaches (McNally 2001). One relies on interviews and questionnaires to ascertain the content of conscious cognitions, such as beliefs that certain bodily sensations signify catastrophic consequences. The other approach eschews self-report and relies on reaction time and other

methods from cognitive science to reveal underlying biased cognitive attentional, memory, and interpretive processes that relate to the signs and symptoms of anxiety disorders. Although often presented as such, these two approaches need not be contradictory and are likely complementary.

Cognitive processes range from *automatic,* which are used without effort or awareness, to *strategic,* which are used purposefully with awareness (Bargh 1989), and cognitions also may be in or out of awareness. Biases in cognitions and cognitive processes—as they relate to anxiety disorders—refer to differences between anxious and nonanxious individuals on measures of cognitions or cognitive processes in response to ambiguous, threat-relevant, or threat-neutral stimuli. The most common focus of investigations has been biases in attention allocation, memory, and interpretation.

EXPERIMENTAL PARADIGMS

The human information-processing system has limited capacity, and any bias for attending to threat-related information should result in heightened anxiety. To test whether individuals with anxiety disorders are, indeed, characterized by an attentional bias that favors threat, researchers have devised paradigms such as the emotional Stroop (see J.M.G. Williams et al. 1996 for a review) and the dot probe (MacLeod et al. 1986). The emotional Stroop requires subjects to name the colors of words that vary in disorder relevance (e.g., "suffocate" in panic disorder) as quickly and as accurately as possible while ignoring the meanings of the words. Delays in color naming occur when the meaning of the word captures the subject's attention despite the subject's attempt to focus on its color. Attentional bias toward threat is inferred from slower naming of the color for threat words than for nonthreat words. Many researchers believe that the task is not a pure measure of attentional bias and have increasingly relied on the dot probe paradigm.

In the dot probe, a central fixation cross is followed by two stimuli (either words or pictures) presented simultaneously (one threat and one nonthreat), and then a probe (e.g., an E or an F) replaces one of the two stimuli. The subject is asked to press a key describing the probe (E or F) as quickly as possible. Attentional bias toward threat is reflected in faster responding to a probe that replaces the threat stimulus than to a probe replacing the nonthreat stimulus. Attentional bias away from threat is inferred from faster responding to the probe that replaces the nonthreat stimulus.

If information about threat were more accessible from memory than nonthreatening information, then individuals exhibiting such a memory bias would be especially prone to experience heightened anxiety. Several memory paradigms have been used to examine memory biases in anxiety disorders. In explicit memory tasks, individuals are asked to remember word lists, and then the numbers of threat versus nonthreat words recalled are examined. In implicit memory tasks, individ-

uals are asked to engage in tasks related to words and then are asked to complete sentences or word fragments to determine whether prior exposure to threat words facilitates greater use of these words in comparison with control words (for more information on measures of memory, see Coles and Heimberg 2002; MacLeod and Mathews 2004). Memory bias for threat information is inferred from greater recall or use of threat-related words compared with control words.

In everyday life, people encounter many situations in which the implications and meanings behind what people say are ambiguous. Individuals engaging in conversations do not usually provide explicit constant approval and may even censor themselves if they think critically. Any bias for interpreting such ambiguous stimuli or situations (e.g., an ambiguous facial expression or comment during a conversation) in a threatening manner should heighten anxiety. Paradigms for assessing an interpretive bias for threat require subjects to interpret ambiguous scenarios or other stimuli. In self-report or other explicit measures, interpretation bias for threat is inferred from a more frequent resolution of ambiguous information corresponding with a threat/negative interpretation. In other methods that do not rely on explicit answers to determine interpretations, bias toward threat is inferred from shorter decision times for threat-related words in word associations, grammatical decisions, or other tasks.

ASSUMPTIONS

Most cognitive theories of anxiety disorders embody several guiding assumptions, including the following: 1) cognitions play a causal role in the etiology and/or maintenance of the anxiety disorders through cognitive biases for focusing on negative and/or ignoring positive information and through negative evaluations; 2) individuals differ in the degree to which they focus on negative or positive information; and 3) the tendency to focus on negative information increases vulnerability to anxiety, whereas the tendency to focus on positive information increases resiliency.

Cross-Sectional Studies

There have been many cross-sectional studies on cognitions (e.g., evaluations, thoughts, beliefs) or cognitive processes (e.g., attention, memory, interpretations). For comprehensive reviews of these studies in anxiety disorders, see Harvey et al. 2004 and M. Williams et al. 1997. Overall, these studies show that self-report measures tend to reveal content-specific negative evaluations among individuals with a given anxiety concern compared with nonanxious control groups and individuals with different anxiety concerns. Furthermore, several studies suggest that the greater the strength and frequency of the negative evaluations, the more severe

are the anxiety symptoms reported. Finally, experimental paradigms often reveal cognitive biases in anxious individuals (M. Williams et al. 1997). In the following sections we summarize the most robust findings for each specific anxiety disorder.

PANIC DISORDER

Individuals with panic disorder have catastrophic interpretations/evaluations of bodily sensations (see Casey et al. 2004 and Clark 1996 for reviews). Overall, these individuals also tend to have more negative thoughts than positive thoughts about agoraphobic situations (Schwartz and Michelson 1987) and hold strong beliefs about their inability to cope with panic (Telch et al. 1989). Specifically, individuals with panic disorder interpret changes in bodily sensations associated with a panic attack (e.g., increased heart rate, trembling, sweating) to mean that they are dying, going crazy, or losing control. Panic disorder patients also reveal a tendency to respond fearfully to anxiety-related sensations because of their supposed harmfulness; such anxiety sensitivity is discussed by Reiss and McNally 1985 and Reiss et al. 1986. Also, panic disorder patients are likely to overestimate the probability of having physical symptoms and exaggerate the cost of having them (McNally and Foa 1987; Uren et al. 2004).

In addition to findings of negative evaluations on self-report measures in individuals with panic disorder, data from interpretation-bias paradigms show that these individuals are more likely than nonanxious control subjects to resolve ambiguous stimuli related to physical sensations in a threat-congruent fashion (Harvey et al. 2004). Attentional bias studies have shown that individuals with panic disorder are hypervigilant to bodily sensations as well as to physical threat words (Harvey et al. 2004; M. Williams et al. 1997). Explicit memory biases for threat occur in these individuals, whereas less consistent findings emerge from tasks of implicit memory (MacLeod and Mathews 2004).

POSTTRAUMATIC STRESS DISORDER

Negative views about oneself (i.e., inability to cope, incompetence) and about others or about the world (as threatening/dangerous) are higher in individuals with PTSD compared with nonanxious control subjects (Ehlers et al. 2005; Foa et al. 1999; Nasby and Russell 1997). Furthermore, evidence is accumulating regarding the specificity of the cognitive predictors of PTSD compared with predictors of other anxiety disorders (Ehring et al. 2006). Experimental paradigms have shown that individuals with PTSD are faster to respond to threat meanings of ambiguous words (Amir et al. 2002) and to complete sentences with threat meanings (Kimble et al. 2002), reflecting a negative interpretation bias. Emotional Stroop studies suggest an attentional bias for trauma cues in PTSD patients (Foa et al. 1991; McNally 1998; McNally et al. 1990). One dot-probe study indicated an attentional

bias for threat (Bryant and Harvey 1997), whereas another did not (Elsesser et al. 2004). Data on explicit memory biases also indicate biased memory, whereas implicit memory paradigms have yielded conflicting findings for this disorder (McNally 1998).

SOCIAL ANXIETY DISORDER

Individuals with SocAD, especially those with the generalized subtype, exhibit negative self-evaluations and fear of negative evaluations by others (Glass et al. 1982; Stopa and Clark 1993; Sturmer et al. 2002). These negative evaluations are related to the "social self," or how one performs in interpersonal situations (e.g., "I will sound stupid when I meet someone new"; "I will freeze during my speech."). These individuals also overestimate the probability of negative social interactions and exaggerate the cost of such interactions (Foa et al. 1996). Some studies have suggested that individuals with SocAD also have biased beliefs about the interpretations of their symptoms by others, about how their performance is related to their character, and about the long-term consequences of negative performance (J.K. Wilson and Rapee 2005). Socially anxious individuals also exhibit negative interpretations of ambiguous social situations on self-report measures (Amir et al. 1998; Hirsch and Clark 2004).

Experimental procedures have also shown a lack of a positive interpretation bias in socially anxious individuals (Hirsch and Mathews 2000), and one study found both the presence of a negative bias and the lack of a positive bias (Huppert et al. 2007). Attentional biases for threat occur in the dot-probe and emotional Stroop tasks. There is also evidence of vigilance to threat faces over neutral faces (Mogg et al. 2004) and to threat words over neutral words (Heinrichs and Hofmann 2001). However, another study found more avoidance of faces than objects (Chen et al. 2002). Some theorists have suggested that the primary difficulty of individuals with SocAD is disengaging from threat stimuli, rather than a bias for attending to them (Amir et al. 2003). Studies of memory biases in social anxiety have yielded mixed results (Coles and Heimberg 2002).

SPECIFIC PHOBIA

Individuals with specific phobia overestimate the likelihood of danger posed by the feared stimulus. Studies support the notion that people with specific phobias have biased estimations of the likelihood of danger and the extent of injury or harm (Jones and Menzies 1995; Menzies and Clarke 1995). There are no data on interpretation bias in specific phobia. In a number of studies, these individuals have shown attentional bias toward threat in emotional Stroop (Watts et al. 1986) and visual search paradigms (Öhman et al. 2001). Furthermore, eye-tracking paradigms have suggested attention-to-threat stimuli (Pflugshaup et al. 2005). How-

ever, no attentional bias emerged from a study using threat words in the dot-probe paradigm (Wenzel and Holt 1999), perhaps because the words did not sufficiently activate the fears. Studies also suggest selective recall and other memory biases in specific phobias (Watts et al. 1986).

AUTHOR: Which Watts et al. 1986 references (a or b) are intended by the cites above? Also, sentence beginning "Furthermore": what *about* the stimuli is significant here? The sentence seems incomplete: "paradigms have suggested stimuli." Please review.

In summary, studies of individuals with anxiety disorders consistently reveal negative evaluations, as well as negative attentional and interpretation biases, that are specific to the concern of their disorder. The data on memory bias are less consistent. It is important to note that these findings may, or may not, mean that negative cognitive biases cause the disorders.

Longitudinal Studies

Longitudinal studies offer a stronger level of evidence regarding the causal role of a given cognitive factor in an anxiety disorder. If the negative cognitions precede the onset of the disorder, then the alternative explanation that the cognitions are part of the disorder itself can be eliminated. However, it remains possible that an underlying predisposition (genetic or otherwise) may cause the cognitions and the subsequent disorder, rather than the cognitions themselves causing the disorder. These considerations notwithstanding, longitudinal studies are quite informative. However, it is difficult and costly to collect longitudinal data, and only a few studies have been conducted on cognitions and anxiety. In fact, there are no longitudinal studies for any anxiety disorder other than PTSD, although some studies have examined the ability of specific evaluations of bodily sensations (i.e., anxiety sensitivity) to predict panic attacks. No published study yet has examined whether cognitive processes predict the onset of any anxiety disorder, but some studies are in progress (e.g., those by Mineka and Craske in the United States and by Margraf in Germany). Moreover, even in PTSD, researchers have been able to collect data only prior to the emergence of disorder, not prior to the exposure to trauma.

PANIC DISORDER

Self-reported negative evaluations of bodily sensations, as measured by elevated scores on the Anxiety Sensitivity Inventory, predict subsequent spontaneous panic

attacks (Reiss et al. 1986). Two of these studies examined panic attacks during basic training in a military setting (Schmidt et al. 1997, 1999), and two examined whether these negative evaluations predicted the onset of panic attacks in adolescents (Hayward et al. 2000; Weems et al. 2002). Even after controlling for a number of relevant variables (e.g., previous history of panic attacks, baseline anxiety levels), researchers found that elevated anxiety sensitivity increased vulnerability for having panic attacks, other anxiety symptoms, and/or general impairment. Other studies have shown that elevated anxiety sensitivity predicts the onset or maintenance of panic attacks over time (Ehlers 1995). Only one study to date has examined whether anxiety sensitivity predicts onset of anxiety disorders: Individuals with elevated anxiety sensitivity had a fivefold increased risk for developing an anxiety disorder 3 years later. This included an eightfold risk for panic disorder (Maller and Reiss 1992). In a recent replication and extension of this study, Schmidt et al. (2006) found that elevated Anxiety Sensitivity Inventory scores were related to a twofold increase in the incidence of anxiety disorders and a 2.5-fold increased risk for panic attacks at a 1- to 2-year follow-up. There was also an increased risk for panic disorder per se. Schmidt and Bates (2003) have suggested that anxiety sensitivity varies significantly within panic disorder patients and is therefore likely to affect how the disorder manifests (the types of symptoms, comorbidity, medication use) in addition to whether it occurs.

POSTTRAUMATIC STRESS DISORDER

Because the diagnostic criteria for PTSD require a traumatic event, as well as a set of symptoms related to that event, and because only some trauma survivors develop chronic PTSD, this disorder lends itself readily to examining longitudinal risk factors for the disorder. Specifically, studies have evaluated individuals shortly after a traumatic event to examine which individuals subsequently recover compared with which develop chronic PTSD. Findings of these studies suggest that negative views about the self and world (e.g., "I am incompetent"; "The world is dangerous"); negative interpretations of initial symptoms (e.g., "Experiencing intrusive thoughts means I am weak"); negative interpretations of others' responses (e.g., "They think I am weak for having nightmares"); and perceived permanent change all predict PTSD severity 6 months to 1 year after the trauma (r values range from 0.35 to 0.66). Organization of the memory and appraisals of the trauma memory also predicted PTSD severity 6 months after assessment, even when researchers controlled for initial symptom severity (Halligan et al. 2003). Another study found that perceived "nowness" of a memory (viewing a memory as a current occurrence instead of in the past), distress due to the memory, and lack of context of the memory were strong predictors of later PTSD severity. This occurred even after researchers controlled for initial symptom severity (Michael et al. 2005). Results of another longitudinal study have suggested that ex-consequentia

reasoning (e.g., "If I feel anxious, there must be danger") is related to later PTSD severity, although this relationship became nonsignificant after initial PTSD severity was controlled for (Engelhard et al. 2002). Some recent work has begun to examine cognitive processes as predictors. For example, Michael et al. (2005) found that primed word stems were related to symptom severity soon after the trauma and were predictive of subsequent symptom severity 3 and 6 months later. However, this association was no longer significant after controlling for initial PTSD symptoms, except for predicting later flashbacks.

In summary, anxiety sensitivity predicts later panic attacks in adults and adolescents. Accumulating data suggest a relationship between anxiety sensitivity and later development of psychopathology, although the relationship with panic disorder is less established. With PTSD, certain negative cognitive evaluations predict later severity of PTSD symptoms. However, the evaluations of many individuals who participated in these studies took place weeks and even months after the trauma had occurred, and it is possible that these negative cognitions developed as a result of factors that had occurred after the trauma and before the evaluation. Indeed, several cognitive predictors of chronic PTSD involve negative appraisals of PTSD symptoms, the reactions of others, and perceived change as a result of the trauma. Prospective studies of at-risk groups (e.g., soldiers in training) should determine whether cognitive abnormalities precede exposure to trauma and thus constitute causal risk factors for PTSD.

Treatment Studies

Many cognitive-behavioral therapies (CBTs) are designed to correct negatively distorted cognitions and cognitive biases. If the presence of negative cognitions and cognitive biases are, indeed, the mechanisms causing the disorder, then a change in cognitions and cognitive biases should mediate the reduction of symptoms after treatment. However, few data corroborate the idea that changes in cognitions/cognitive biases precede reduction in symptoms. This is partially due to the difficulty in establishing the temporal order of cognitive changes and symptom changes. Nonetheless, treatment studies across the anxiety disorders have indicated that cognitions and cognitive processes tend to change with successful treatment. Moreover, some studies have shown that 1) cognitions and cognitive processes after treatment are similar to those among individuals without anxiety disorders, 2) change in the processes is related to symptom change, and 3) change in cognitions predicts maintenance of gains. Significantly more data exist for evaluations on self-report measures of cognitions than on behavioral tasks of cognitive processes.

PANIC DISORDER

In one of the first studies on cognitions in panic, McNally and Foa (1987) found that panic disorder patients who were successfully treated with CBT did not differ from nonpatients in estimating probabilities and costs of interoceptive sensations, whereas untreated patients had higher estimated probabilities and costs than the other two groups. Interestingly, Stoler and McNally (1991) showed that treated panic disorder patients continued to report elevated estimations of threat in a sentence completion task. However, although these biased interpretations remained, the way of coping with panic-related thoughts had changed. Future studies should determine whether less-biased thoughts lead to less relapse or whether such biases decrease further over time. Such data may help account for the superior maintenance of symptom remission when CBT for panic is withdrawn compared with medications being withdrawn (Barlow et al. 2000). Not only do negative cognitions change with treatment but such changes also are related to symptom reduction. Specifically, change in anxiety sensitivity and in catastrophic interpretations of physical sensations has been related to change in many aspects of panic disorder (Clark et al. 1997; McNally and Lorenz 1987; Schmidt and Bates 2003; Westling and Öst 1995). Additionally, posttreatment cognitions have been predictive of maintenance of treatment gains (Clark et al. 1994, 1999; Otto and Reilly Harrington 1999; Schmidt and Bates 2003; Westling and Öst 1995). There are no data that we are aware of that report changes in attentional biases after therapy.

POSTTRAUMATIC STRESS DISORDER

Fewer studies have examined the relation between PTSD-related cognitions and treatment effects in patients with PTSD. Resick et al. (2002) reported that guilt-related cognitions, hindsight bias, wrongdoing, and lack of justification all changed significantly with CBT treatments. Foa and Rauch (2004) found that changes in beliefs about the self and the world were strongly related to changes in PTSD symptoms after prolonged exposure. Posttreatment cognitions were also correlated with symptom severity at 1-year follow-up (S. Rauch, personal communication, DATE). Ehlers et al. (2005), using CBT, reported that change in cognitions was related to change in symptom severity. Only one study involving the emotional Stroop examined changes in cognitive processes with treatment in PTSD before and after CBT (Divineni et al. 2004). In this study, no relationship between changes in attentional bias and changes in symptom severity occurred in a sample of motor vehicle accident victims who had received treatment for PTSD.

AUTHOR: Please provide date of personal communication cited above.

SOCIAL ANXIETY DISORDER

Most studies of SocAD have examined changes in self-report measures or self-statements as a result of treatment. Results indicate that overestimations of the probability and cost of mildly negative events are reduced pre- to posttreatment and that these changes are strongly correlated with changes in symptom severity (Foa et al. 1996; McManus et al. 2000; J.K. Wilson and Rapee 2005). Furthermore, J.K. Wilson and Rapee (2005) found that reductions in beliefs that negative social events reflect negative personal characteristics were positively related to maintenance of treatment gains at 3-month follow-up. Heimberg et al. (1990) found that positive cognitions increased and negative cognitions decreased after group CBT. Chambless et al. (1997) found that changes in cognition were strongly related to SocAD symptoms immediately after treatment but not at follow-up. Inconsistent with the Heimberg et al. (1990) findings, Bruch et al. (1991) did not find a large increase in positive thoughts at posttreatment, although such changes had occurred by follow-up. Heinrichs and Hofmann (2005) also found a relationship between increases in positive self-statements and decreases in negative self-statements and symptom reduction after treatment. In addition to the multiple studies demonstrating changes in negative thoughts, judgments, and evaluations after treatment, studies have also found changes in interpretation bias (Franklin et al. 2005) and attentional bias (Lundh and Ost 2001; Mattia et al. 1993) after treatment. For example, Mattia et al. (1993) found that Stroop interference for social threat words declined following either successful CBT or successful pharmacotherapy. Patients who failed to respond to either treatment continued to exhibit the attentional bias for threat cues.

SPECIFIC PHOBIA

Three studies have shown decreases in attentional bias after exposure treatment for specific phobias. All three studies involved the emotional Stroop and demonstrated reductions in response time to threat-related color naming after treatment, reflecting reduction in attentional bias (Lavy and van den Hout 1993; Lavy et al. 1993; Watts et al. 1986a).

In summary, it is well documented that negative cognitions related to specific disorders may be reduced with successful treatment and that this change is related to symptom change. Some studies have also shown that these changes are related

to maintenance of gains at follow-up. Fewer data exist on the changes in cognitive processing biases with treatment, although there is some evidence regarding changes in attentional bias in social anxiety disorder and specific phobia. More information is needed in this area. Overall, these data suggest that changes in cognitions/cognitive biases reduce symptoms, thereby implying that biases may at least be maintaining symptoms. However, the data do not speak directly to whether cognitions and biases cause the disorders in the first place.

Experimental Studies

The strongest evidence for a causal role of cognition/cognitive bias on anxiety comes from experimental manipulation of cognitions/biases, demonstrating that these manipulations influence symptom manifestation or severity.

PANIC DISORDER

Several studies have involved manipulations of cognitions related to panic and then tested whether the manipulations influence the occurrence of panic during a subsequent induction procedure. Other studies examined the relationship between perception of control over the environment and panic attacks during a CO_2 challenge. In a classic study (Sanderson et al. 1989), individuals diagnosed with panic disorder were told that when a light appeared, they could turn a dial to decrease the concentration of CO_2 that they had inhaled, although in reality the dial did not change the CO_2 concentration. In half the subjects, the light turned on during the trial, but for the other half, it never turned on. Significantly more patients reported panic attack and negative cognitions in the group that did not have the chance to use the dial. This experiment has been replicated a number of times with similar results, suggesting that thoughts or beliefs of control over anxiety symptoms are related to panic attacks.

SOCIAL ANXIETY DISORDER

Fewer studies have examined cognitive manipulations in SocAD to determine their effects on performance. However, a number of recent studies by Hirsch et al. (2003, 2005) have begun to examine the impact of manipulating negative imagery on social anxiety. They found that holding the image of another person displaying confidence decreased interpretation bias (Hirsch et al. 2005), whereas holding a negative self-image increased anxiety and negative observer ratings of performance (Hirsch et al. 2003).

SPECIFIC PHOBIA

Attempts to manipulate cognition in specific phobias and to determine what impact this manipulation has on severity of symptoms or fear have been reported. However, some researchers have attempted to manipulate one's sense of self-efficacy—that is, the expectations about one's abilities to successfully perform a specific task (Bandura 1977). In one series of studies, Bandura et al. (1982, experiments 2 and 3) used vicarious modeling (observing a study confederate interact with a spider) to manipulate levels of self-efficacy to different levels either across independent groups (experiment 2) or for different tasks within subjects (experiment 3) among highly avoidant patients with spider phobia. After self-efficacy was raised to the prespecified levels, subjects were tested for actual performance and accompanying distress and physiological arousal (experiment 3 only) on a carefully graded behavioral-avoidance task. Results indicated that behavioral performance corresponded with levels of induced self-efficacy and that higher levels of self-efficacy were associated with lower levels of self-reported distress and physiological reactivity.

TRAINING COGNITIVE BIASES

Some of the strongest evidence that cognitive biases may play a causal role in the manifestation of anxiety comes from experiments that manipulate cognitive biases and assess how the manipulations influence anxiety and emotional vulnerability (MacLeod et al. 2002; Mathews 2004; Mathews and MacLeod 2002; Yiend and Mackintosh 2004). Although these studies used nonclinical populations, the results are quite compelling.

MacLeod et al. (2002) have used a modified dot-probe paradigm to manipulate attentional bias. The probe predominantly replaced either a threat (to induce negative bias) or a nonthreat (to induce positive bias) word. The results of their studies showed that bias changed in the intended direction after training and that individuals who were trained to have a negative bias rated a separate stressor task as more anxiety-provoking than did individuals who were trained to have a positive bias.

In a second study, MacLeod et al. (2002) found a strong relationship between induced attentional bias and the level of anxiety during the stressor task. These results led to a series of additional studies in which individuals selected for high-trait anxiety were successfully trained over a number of sessions to have a positive bias. This change in bias has been associated with a change in trait anxiety. Similar results have emerged for individuals with high levels of social anxiety, with training leading to decreased levels of social anxiety when compared with a neutral training control condition (MacLeod et al. 2002). Some researchers have used attentional bias training with socially anxious patients, with initial reports of success (Amir et

al. 2004), although Harris and Menzies (1998) reported no change in symptoms in attentional training with individuals with specific phobias.

Similarly, exciting evidence has been found in a line of research manipulating interpretation biases (Grey and Mathews 2000; Mathews and Mackintosh 2000; E. Wilson et al. 2006; Yiend et al. 2005). This work has shown that individuals with moderate levels of anxiety can be trained to interpret ambiguous scenarios as either negative or positive through solicitation of "correct" answers to sentence completion tasks (or other similar methods) that guide the individual to either positive or negative resolutions. This line of work has shown that individuals trained to have negative interpretations tend to present with elevated levels of trait anxiety after training (Mathews and Mackintosh 2000); that a single-session training of the bias can last for 24 hours (Yiend et al. 2005); and that individuals with an induced negative bias rate video clips of anxiety-provoking scenarios as more distressing than those induced with a positive bias (E. Wilson et al. 2006; Yiend and Mackintosh 2004).

Conclusion

Hundreds of studies have examined the relationship of cognitions and cognitive biases to anxiety and to anxiety disorders. The majority of the studies suggest that cognitions and cognitive processes are biased in patients with anxiety disorders. With some exceptions, the general pattern emerging is that patients are biased toward negative or threat aspects of content-specific concerns in evaluations, interpretation, attention, and memory and that these biases tend to decrease with successful treatment. Longitudinal data are limited, although some large studies are in progress. Furthermore, recent studies have shown increased vulnerability to anxiety when these biases are induced.

Future research should examine the effects of directly reducing these negative biases among individuals with anxiety disorders or whether such training can prevent individuals from developing an anxiety disorder. Although research on the neurobiological correlates of these disorders has already begun, much more needs to be learned about the interplay of neuroendocrine response and cognition (Abelson et al. 2005; Gaab et al. 2005; van Honk et al. 2000), neuroimaging and cognition (Odile et al. 2005), neurophysiology and cognition (Pauli et al. 2005), and genetics and cognition (Schmidt et al. 2000). The question of whether cognitions and cognitive processes are *constitutive* (i.e., essential aspects of the disorder that are not etiological in nature) or *causal* (i.e., distinct processes that precede the disorder and inevitably lead to it) needs further examination. Regardless of their etiological role, cognitions and cognitive processes constitute a central aspect of stress and fear-related disorders.

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