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CONSCIOUS APPRAISAL AND THE MODIFICATION OF AUTOMATIC PROCESSES IN ANXIETY

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Abstract. Intrusive thoughts, flashbacks, panic attacks and sudden physiological arousal are each experienced as involuntary, are difficult to control, and lead to considerable distress. Such observations have led to the suggestion that anxiety disorders are associated with the operation of automatic information-processing biases. Clinical and experimental evidence for this proposal is reviewed and three different classes of routes to the development and modification of these automatic processes are described: an innate route, repetition/habituation, and conscious appraisal. The review focuses in particular on the third route, proposing that automatic processing biases can be altered by accessing and modifying conscious appraisals of internal and external events. Indirect evidence is provided by selective attention paradigms in anxiety, treatment studies and clinical observations, although further research will be necessary for a direct test of the pathway. The implications for the theory and practice of psychological therapy for anxiety disorders are described.

Keywords: Anxiety, attention, involuntary, unconscious, automatic, information-processing.

Introduction

During recent years, the question of the role of automatic information-processing biases in anxiety has proved to be an area of considerable theoretical interest (Beck & Clark, 1997; Power & Dalgleish, 1997; Mathews & Mackintosh, 1998; Mayer & Merckelbach, 1999; Mogg & Bradley, 1998; Robinson, 1998; Wegner & Smart, 1997; Wells & Matthews, 1994; Williams, Watts, MacLeod, & Mathews, 1997). This paper first considers the evidence for automatic biases in anxiety disorders and then focuses on identifying the routes to their development and modification.

Experimental psychologists view automatic processes as being capacity-free, often unconscious, and involuntary (Bargh, 1989), in contrast to controlled processes, which are capacity-dependent, conscious and voluntary. It has been proposed that the two kinds of processes should not be perceived as intrinsically separate but as functionally related (Neumann, 1984). Automaticity can be regarded as an emergent property depending on both the processing system and the situational context. Often a process can be unconscious, yet appears to depend upon intention on the part of the individual;

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we are not aware of the processes that underlie the production of words, although when we speak a sentence it appears, making perfect sense. These processes are described as *preconscious*. Psychologists are beginning to see automatic processes as the norm rather than the exception. After a review of PET scan studies of the acquisition of automatic cognitive skills, Raichle (1997) concludes that, "... much of our behaviour, although conscious in appearance, is governed by non-conscious processes which have obviously evolved to allow us to perform in a sophisticated and efficient manner."

As mentioned above, one of the defining properties of an automatic process is that it can be involuntary. This notion is important for the understanding of anxiety disorders. Intrusive thoughts, flashbacks, panic attacks and sudden physiological arousal are each experienced as involuntary, are difficult to control, and lead to considerable distress. As Beck and colleagues explain, "It would seem most parsimonious in theorising about threat responses to consider the primal response as a non-volitional behavioural pattern activated by the perception of threat. This pattern might or might not be consistent with the conscious motivation to reduce threat" (Beck, Emery, & Greenberg, 1985, p. 44). Recent cognitive accounts of anxiety disorders also appear to subscribe to a similar view: "As panic and avoidance become more chronic, the behaviours involved become habitual and awareness of the specific cognitive component diminishes although it can often be produced by further exposure" (Salkovskis, Clark, Hackmann, Wells, & Gelder, 1994, p. 561).

The evidence for automatic processing biases in anxiety has been reviewed elsewhere (Mathews & Mackintosh, 1998; Mogg & Bradley, 1998; Wells & Matthews, 1994; Williams et al., 1997). Using Bargh's (1989) tripartite structure, McNally (1995) carried out one of the most comprehensive reviews and concluded that anxiety disorders are associated with information-processing biases that can be involuntary and unconscious, but he found little evidence that the processing biases in anxiety are capacity-free. Among the range of automatic processes in anxiety, biases in selective attention are the most researched and will be described in some detail here.

Research into selective attention in anxiety began with the adoption and modification of a number of paradigms measuring attention in experimental cognitive psychology, in particular the Stroop task (Stroop, 1935) and the dot-probe paradigm. Several reviews of these paradigms have concluded that anxious individuals show a bias to attend to threatening stimuli (Mogg & Bradley, 1998; Dalgleish & Watts, 1990; Williams et al., 1997; Mathews, 1997). In the modified dot-probe task (MacLeod, Mathews, & Tata, 1986), individuals are presented with two stimuli on a computer screen, each in a different location. One of these stimuli is threatening (e.g., a threatening word or picture) whereas the other stimulus is neutral. After a short period of time the stimuli disappear and a dot appears in one of these two locations of the screen. The participants are instructed to press a button as soon as they see the dot. Although the participants are asked to read out only one word (or in later versions to ignore both stimuli), the anxious patients typically react faster to the dot that appears in the spatial location of a threat word, indicating a bias towards threat.

Selective attention paradigms are designed to minimize the effects of voluntary strategies of attention. First, the stimuli are usually presented for 500 milliseconds or less. Intervals of this length have been associated with automatic activation and reduced

effects of conscious attention (Posner & Snyder, 1975; Neely, 1977). Second, participants are explicitly asked to react as fast as possible to every dot that follows the stimuli, yet they demonstrate an attentional bias, indicating a lack of voluntary control over their attention. An alternative explanation is that the participants in these studies intermittently break with their instructions and engage in voluntary monitoring of threat (Wells & Matthews, 1994). Nevertheless, further evidence suggests that the attentional bias may be involuntary, in the sense that it occurs preconsciously, before voluntary processes can be exercised. Certain studies have presented stimuli very briefly, followed by a pattern mask, so that the stimuli cannot be consciously reported (for a review, see Williams et al., 1997, p. 112). For example, Mogg, Bradley and Williams (1995) found vigilance to threat in generalized anxiety disorder (GAD) patients using stimuli that were presented for only 14 milliseconds and then masked. Similarly, the same group of researchers have found trait anxiety in healthy controls to be associated with an attentional bias to masked threat words presented for 14 milliseconds (Mogg, Bradley, & Hallowell, 1994; Mogg, Kentish, & Bradley, 1993). One criticism of these studies is their failure adequately to adjust the presentation time for each individual to ensure that each participant was not aware of the stimuli (Wells & Matthews, 1994), but certain evidence suggests that the occurrence of voluntary strategies cannot be the only explanation. Where studies have excluded participants who showed indications of awareness, the effect of anxiety on attention to subliminal threat cues remains (Mogg et al., 1993; Mogg, Bradley, & Williams, 1995; Van den Hout, Tenney, Huygens, Merkelbach, & Kindt, 1995). Also, certain studies of anxiety patients have found greater attentional bias from subliminal stimuli compared to equivalent stimuli that were open to full awareness (Fox, 1996; MacLeod & Hagan, 1992; MacLeod & Rutherford, 1992). If the biases in attention were truly automatic, we might expect this result. The participants' attempts at voluntary control to try to prevent their biases in attention might be unable to work at very short presentation times. A recent study of a different paradigm, the startle response, supports this view. Presenting participants with a threatening word 60 milliseconds before presenting a loud noise increased the magnitude of their startle response to the noise, relative to presenting them with a non-threat word, and the effect showed a trend to be greater in high trait anxious individuals (Aitken, Siddle, & Lipp, 1999).

The above studies are among a range of evidence indicating automatic processing biases in anxiety. Other studies have found implicit memory biases in anxiety, although the evidence is mixed (for reviews, see McNally, 1995; Russo, Fox, & Bowles, 1999; Williams et al., 1997). Several authors have also described neuroanatomical evidence of a substrate for automatic processes in fear (Lang, Cuthbert, & Bradley, 1998; Mathews & Mackintosh, 1998; McNally, 1998; Windmann, 1998). The evidence suggests that there are two separate routes to the fear response in the brain: a slow, elaborate, conscious route through the cortex, and a fast, simple, non-conscious route through the sub-cortical areas of the brain that can operate independently (LeDoux, 1998). In agreement with other reviews, on the balance of evidence, it appears likely that biases in information-processing in anxiety disorders can occur without awareness, or despite conscious attempts to control the biases. Nevertheless, further research will be required to fully confirm these findings in response to earlier critiques (Wells & Mathews, 1994).

Three routes to the modification of automatic processes

The above evidence suggests that anxiety is associated with biases in automatic processing, yet it is clearly not the only concern with respect to treatment. We need to ask two further questions about these biases. How did the biases develop and how can they be modified? Both questions are related. If we can find out how automatic biases develop we may be able to reverse them.

It may be useful to propose three routes to change, which bear a close resemblance to the pathways proposed to be involved in the acquisition of phobias (Merckelbach, de Jong, Muris, & van den Hout, 1996; Rachman, 1991). First, the biases could have developed via a non-associative route, that is they may be innate, requiring only background stimuli to be triggered, but no associative learning. Second, they could have emerged as an earlier learned or innate process, which is then reinforced through repetition, and reduced by extinction over time. Such an account regards the individual as relatively passive, and it is comparable to the way behaviours are said to be learned during conditioning. Third, the automatic processes may develop through the acquisition of new information that changes higher order beliefs, or schema, which in turn modify lower order automatic processes. This account is consistent with the notion that conscious appraisal of the kind that occurs in cognitive therapy can be in itself responsible for changing automatic processes. Rather than viewing the development of automatic biases as a passive process, this account proposes that as individuals actively pursue new higher-order goals, their automatic biases change accordingly. Each of these pathways is shown in Figure 1 and will now be described in more detail.

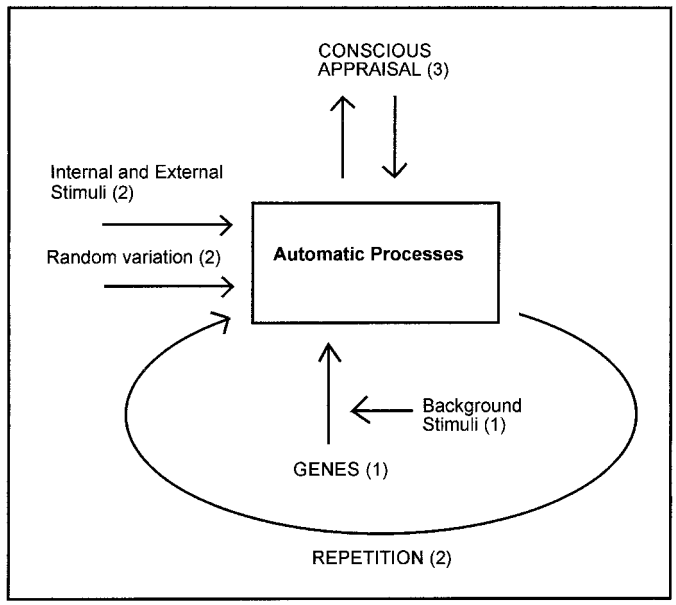

Figure 1. Three routes to the modification of automatic processes in anxiety. The components of each route, (1), (2) and (3) are labelled in parentheses

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The innate route

Many of the behaviours elicited by animals are instinctual rather than learned. Among these instincts are stereotyped responses to innate threat cues. For instance, infant rhesus monkeys bred in isolation exhibit fear to slides of adult monkey's facial threat displays (Hetherington & Parke, 1982) and day-old animals freeze in response to a visual cliff (Gibson & Walk, 1960). Menzies and Clarke (1995) have described evidence that many phobias, such as fear of heights and fear of water, emerge in humans at a young age, and without any prior experience of aversive consequences of the fear-provoking stimuli. Consequently, they suggest that these fear reactions could be innate. Similarly, Leventhal (1984) proposes a basic level of information-processing involving an innate set of programs that generate a specific set of emotional responses in response to external cues.

In itself, suggesting that a fear reaction can be innate, does not necessarily imply that the development of automatic processing biases in individuals with anxiety disorders result from innate *differences* between individuals, although it remains a strong possibility. For example, the time course of genetic expression could be responsible for experienced or observed changes in automatic processes in an individual over time. Finally, as Menzies and Clarke (1995) explain, the timing of certain background experiences may be responsible for triggering the expression of innate fear responses. For example, prior self-produced locomotion appears to be necessary for a child to show distress when placed on a visual cliff. Further research may be required to determine if this triggering process can be explained by other learning processes. For example, vicarious learning has been shown to partly account for the acquisition of certain early onset fears, such as snake phobia (Cook & Mineka, 1989). Also, Menzies and Clark (1995) acknowledge that further research is required to identify the role of cognitive processes in the acquisition of childhood fears (Davey, 1992). The evidence also suggests that learning can change psychological processes that are thought to be innate. Clarke and Jackson (1983) suggest that individual differences in fear can result from differences in the habituation of fear during exposure.

The repetition/habituation route

Several authors have suggested that cognitive processes in anxiety can become automatized by repetition, and that the most effective way to extinguish them is habituation through response prevention and prolonged exposure to the feared situation (Brewin, 1989; Foa & Kozak, 1986; Power & Dalgleish, 1997, 1999; Wegner & Smart, 1997). On the face of it, this explanation sounds highly plausible, but there are also problems with postulating this route. First, repetition may strengthen an automatic process, but repetition by itself will not be responsible for any changes in a process. Change must arise from another source. It is possible that changes could arise externally from new stimuli or internally from random neural noise. These new stimulus-response links would then be reinforced during repetition. A second problem for such an account is that while considerable evidence supports the notion that cognitive processes can operate without awareness, learning new cognitive processes may require conscious attention (Hoyer & Lincourt, 1998; Norman & Shallice, 1986). In particular, no studies of

exposure treatment for anxiety have ruled out the possibility that changes in conscious appraisal are mediating the changes in automatic processes and evidence suggests that manipulating patients' appraisals during exposure treatment can affect its efficacy (for a review, see Kazdin & Wilcoxon, 1976). One way to investigate the role of conscious appraisal in exposure would be to block it using a concurrent attention-demanding task. Evidence from cognitive psychology suggests that this manipulation may prevent changes in automatic processes. For example, Crabb and Dark (1999) found that lists of words must be encoded attentionally, as indicated by reading the words out loud, in order for them to affect performance in a later implicit memory test. Several studies have found that implicit learning is reduced by a concurrent attention-demanding task (Cohen, Ivry, & Keele, 1990; Frensch, Lin, & Buchner, 1998; Stadler, 1995), and it appears that attention is required to facilitate the organization of learning rather than simply to provide extra capacity.

Despite the above reservations, further results do not support the notion that blocking conscious attention completely obliterates learning and certain well-controlled studies have found that complex cognitive processes can be learned in the absence of intentional control or introspection about what has been learned (Frensch, 1998; Lewicki, Czyzewska, & Hoffman, 1987). One example is the "mere exposure effect" in which individuals can develop an emotional preference for stimuli that follow rules of a complex artificial grammar, despite being unaware of the rules of this grammar (Manza, Zizak, & Reber, 1998). One clinical study reduced anxiety by exposing subjects with briefly presented masked stimuli (Lee, Tyrer, & Horn, 1983), although this study has been criticized on methodological grounds (Mayer & Merckelbach, 1999). Further evidence could shed light on a possible role of non-conscious learning in modifying automatic processes in anxiety.

Conscious appraisal

The third route to the development of automatic processes in anxiety relies on neither instinct nor repetition. In this account, automatic biases develop when higher order beliefs or goals are modified through the acquisition of new information from the environment or from memory that occurs in consciousness. Information can be in the form of language and in the form of sensory information such as bodily changes, internal images and external perceptions of the environment. To explain this account, it is necessary to further explain the difference between the *operation* and the *modification* of an automatic process. Automatic processes can operate without awareness, or they may operate against the efforts of voluntary control. However, voluntary processes can be responsible for *changes* in automatic processes. Take an everyday example: once an individual has learned to drive a car, the complex routines they have learned are operated relatively effortlessly. We know this because they can drive at the same time as carrying out other complex tasks, and often people make "slips of action" (Reason, 1984) such as driving to places they had no intention of going. Nevertheless, the procedure of learning to drive usually takes days of concentration and controlled practice. Existing accounts of cognitive skill acquisition (Anderson, 1983; Norman & Shallice, 1986) fit this example.

A complex skill, such as chess-playing, which once required conscious access and integration of one's pre-existing procedures, memories and new facts from the environment, becomes proceduralized in experts (Anderson, 1983). In contrast to the novice chess-player, chess experts have a poor awareness of the reasons underlying their decisions, even though their performance is clearly superior. Recent evidence from several brain scanning studies has shown that the change from strategic to automatic processing with practice is accompanied by dramatic changes in the underlying brain circuitry involved in the task (see Raichle, 1997, for a review). In a typical experiment, participants were asked to generate a verb to match a series of nouns, for example, generating a word like "hit" in response to "hammer". During effortful learning, many areas of the cortex and sub-cortical regions of the brain are active. However, after a short practice, only isolated areas of the brain remain active while engaged in the task, which is experienced as effortless and automatic. Rather than simple repetition of low level processes of the brain being required to learn automatic processes, initial learning is accompanied by a widespread activity throughout the brain and the subjective experience of effortful learning. These findings concur with the suggestion presented earlier that conscious attention is often required for the organization of information during the learning of implicit rules and automatic skills.

In these models, a process can *operate* automatically but it is *modified* through higher order control. The same may be said of emotional processes. For example, Power and Dalgleish (1997) explain this particularly clearly:

> . . . emotions can be generated without this appraisal process occurring at the time of the event's occurrence. The appraisal only needs to have occurred at some time in the emotional history of the individual's experience of that event or, for a small circumscribed set of events, in the evolutionary history of the species. That is to say, the process of emotion generation can become automatised so that it appears as if a concurrent process of appraisal is occurring even though it is not and has in fact occurred at some time in the emotional past. (p. 179).

Lovibond (1993) makes a similar point:

> While both Pavlovian and operant *learning* in humans requires active attention and cognitive processing of the subject . . . performance based on Pavlovian conditioning is involuntary. That is, if prior learning has led us to believe that a significant event of some sort is about to occur, we display anticipatory responses appropriate to that event automatically. . . . The same effects as produced by conditioning may be demonstrated in the laboratory by verbal instruction. (p. 125).

This account suggests that automatic biases can develop through conscious attention. In doing so, it must explain why automatic biases in anxiety are nevertheless perceived as involuntary, are often intensely distressing and are actively suppressed. One solution is to accept that, although certain automatic reactions are consistent with the conscious beliefs currently entertained in certain contexts, in another context they may be perceived as distressing and in need of suppression. In this respect, anxious individuals appear to have beliefs that conflict with one another in certain situations. The writings of Beck (1976) suggest he may hold this view:

> People can have totally contradictory concepts or beliefs simultaneously. When the patient is removed from the phobic situation, he holds the concept that it is relatively harmless. He is also generally faintly aware of having the notion that it is dangerous. As he approaches the phobic situation, the idea of its dangerousness becomes progressively greater until it completely dominates the appraisal of the situation. His belief switches from the concept, "It is harmless" to the concept, "It is dangerous". (p. 163).

The account presented here is similar to the views of psychologists who propose the coexistence of several conflicting, relatively autonomous, higher order cognitive systems that often go by different names, such as goals (Pervin, 1989), working models (Bowlby, 1973), schemata (Beck, 1976; Horowitz, 1988), protospecialists (Minsky, 1987) and control systems (Powers, 1973). In the current account, these cognitive systems can operate outside awareness, but can be modified by reaching awareness. So in some cases, patients will not be able to report the beliefs that motivate their behaviour. Within cognitive psychology, a history of research indicates that cognitive processes can often be inconsistent with current conscious introspections of their causes (Kihlstrom, 1987; Nisbett & Wilson, 1977). This idea is also common in personality psychology. For instance, in their review of the goal theories of personality, Emmons, King and Sheldon (1993) state, "... goals are accessible to conscious awareness, although there is no requirement that the goal be represented in consciousness while the person is in active pursuit of it."

Ideally, changing automatic processes through conscious appraisal should be adaptive. Automatic processes are useful because individuals need to react quickly, especially

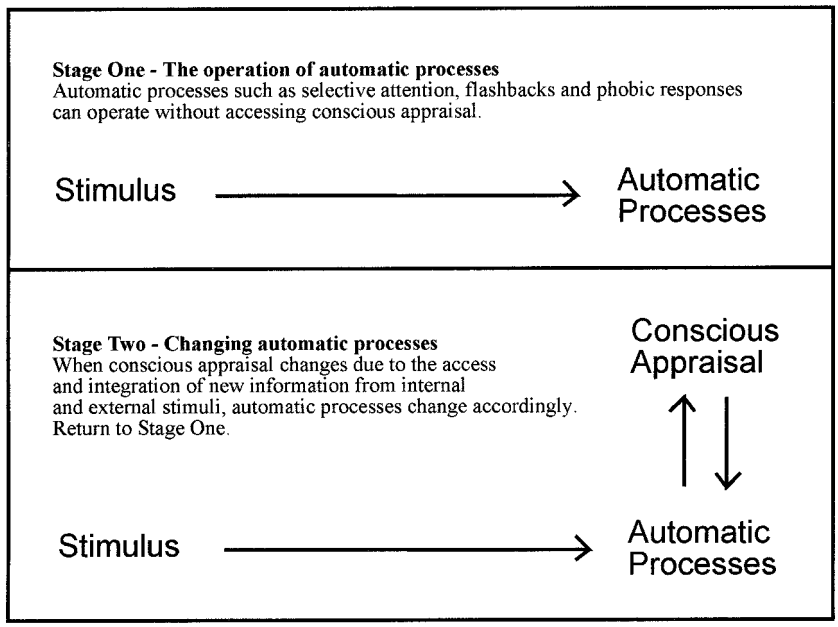

Figure 2. Illustration of how an automatic process can operate without awareness but may be modified through conscious appraisal

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where imminent danger is a possibility. But importantly, the nature of the danger and the sources of safety in our environment change over time. The system must weigh up new information and judge whether new evidence from current experience, from accessing past memories, or from observing or listening to others, requires a change in a previously adaptive automatic process. In a general sense, processes that have been learned operate more efficiently if they take up few resources, yet they need to be updated in the light of new information.

In summary, it is proposed that all individuals, including anxiety patients, have many beliefs and goals that are activated at different times, providing the potential for conflict. A significant method of modifying automatic biases is to modify the higher order beliefs that are associated with the automatic biases. Modifying beliefs and goals occurs through access to information, either from the external environment or from memory. This route is shown graphically in Figure 2. The remaining sections describe the evidence that is consistent with this view.

Evidence for the effects of conscious appraisal on the modification of automatic processes

1. Automatic information-processing biases associated with anxiety have a functional relationship with higher order belief systems

If high order beliefs are responsible for modifying automatic information-processing biases, we would expect the two to be consistent. As Mogg and Bradley (1998) describe:

> . . . enhanced subjective appraisal of threat would explain why anxiety-prone individuals exhibit a preattentive bias for objectively low threat stimuli. That is, anxiety-prone individuals assign a relatively higher threat value to "mild" stimuli which activates the goal engagement system, which in turn elicits automatic orienting responses. (p. 841)

The evidence suggests that both the content of appraisals and the stimuli that elicit automatic responses are specific to the concerns of the patient. A good example of this consistency lies in the biases associated with panic disorder and agoraphobia with panic attacks. Several paradigms have found an attentional bias towards physical threat stimuli in patients with panic disorder. They show greater interference from physical threat words on the Stroop test (Ehlers, Margraf, Davies, & Roth, 1988; McNally, Riemann, & Kim, 1990) and show implicit memory for physical threat stimuli (Amir, McNally, Riemann, & Clements, 1996). Similarly, convergent evidence indicates that these patients show stronger catastrophic beliefs about the physical consequences of bodily sensations than other anxiety patients (Chambless & Gracely, 1989; Clark et al., 1997; Harvey, Richards, Dziadosz, & Swindell, 1993; Reiss, Peterson, Gursky, & McNally, 1986; Taylor, Koch, & McNally, 1992).

Further evidence for a convergence of interpretative and automatic biases exists in two other anxiety disorders: social phobia and spider phobia, although the evidence is more complex. For instance, social phobics have been shown to interpret social situations in more negative ways than other anxiety patients (Amir, Foa, & Coles, 1999; Stopa & Clark, 2000). Consistent with this view, they show greater interference to social

threat words than physical threat words on the Stroop task (Hope, Rapee, Heimberg, & Dombeck, 1990; Mattia, Heimberg, & Hope, 1993). High socially anxious individuals and social phobics also appear to show improved detection of angry faces (Gilboa-Schechtman, Foa, & Amir, 1999) and negative social cues (Veljaca & Rapee, 1998). However, these studies have not ruled out the possibility that this superiority may be a function of the hypervigilance associated with general (trait) anxiety rather than being due to differences in social anxiety. Evidence suggests that trait anxiety is associated with improved detection of angry faces (Byrne & Eysenck, 1995) and attentional bias towards negative faces (Bradley, Mogg, Falla, & Hamilton, 1998; Mansell, Clark, Ehlers, & Chen, 1999). Moreover, the pattern of attentional bias in socially anxious individuals appears to change under the socially threatening conditions of having to perform a speech. Under this condition, Amir and colleagues (Amir, Riemann, Burns, Lorenz, & Mullen, 1996) found that the Stroop interference effect was suppressed and Mansell et al. (1999) found that high social anxiety was associated with an attentional bias *away* from emotional faces. The apparent discrepant findings may be resolved if one considers that the attentional biases associated with social anxiety are dynamic rather than static, and that they have a functional relationship with the higher order goals of socially anxious individuals. On arriving in a feared social situation, socially anxious individuals may be hypervigilant for signs of negative evaluation by others, but on detecting a possible social threat, their attention turns to the search for safety. Avoiding eye contact, along with the use of other safety behaviours, can lead to perceived safety by reducing one's perceived, and actual, attention from others (Clark & Wells, 1995).

The existence of a functional relationship between attentional biases and higher order beliefs is further supported by studies of spider phobics. Contrary to the view that spider phobia is a prepared, irrational fear that is unconscious and inaccessible to conscious introspection, when spider phobics are interviewed, they report a range of highly threatening and idiosyncratic beliefs about spiders and their reactions to them (Arntz, Lavy, van den Berg, & Van Rijsoort, 1993; Thorpe & Salkovskis, 1995). Consistent with the account, studies using the Stroop task indicate that spider phobics have an attentional bias for spider words (Watts, Trezise, & Sharrock, 1986; Lavy, van den Hout, & Arntz, 1993). However, Thorpe and Salkovskis (1998) found that when a real spider is used as a threat cue, attention is divided between the spider and the source of safety (the exit). Prioritizing attention to the source of safety may also explain why Mathews and Sebastian (1993) found a reduced Stroop interference for snake words, when a live spider was present in the room, compared to when it was absent. It may also account for the reduced processing of large, threatening spiders by spider phobics (Watts, Sharrock, & Trezise, 1986). As in social phobia, attention may be directed towards sources of safety when a severe threat is present.

Further research will be necessary to confirm that the attentional biases to the specific threats in these disorders do not generalize to all threat cues by including the appropriate control stimuli. For example, although social phobics' attentional bias appears to be specific to social rather than physical threat stimuli, the picture for panic disorder is less clear. One study has shown that the panic patients' attentional bias to threat is specific to physical rather than social stimuli (Hope et al., 1990), but another study has found that the bias generalizes to social threat words (Maidenberg, Chen, Craske,

Bohn, & Bystritsky, 1996). However, a clear disconfirmation of the view presented here would require the bias for social threat words to remain even when controlling for patients' reports of their fear of social situations. Further research could also ensure that the biases can be regarded as automatic by presenting stimuli outside awareness.

2. Anxiety patients report beliefs and goals that conflict with one another

A model that suggests that automatic biases are influenced by higher order beliefs must explain why automatic processes are often perceived as involuntary and are strongly resisted. Once we accept that patients are prone to make threatening interpretations of their feared situations, it becomes more apparent that when a patient comes for psychological treatment, they are articulating a conflict in their goals. For instance, panic disorder patients fear that an extreme physical catastrophe may occur, and make attempts to prevent it. Yet, these behaviours severely limit their mobility, which in turn compromises their functioning in home and work life. Similarly, social phobics often fear social rejection from others, making the avoidance of rejection a primary goal in their lives, yet their pursuit to this end is interfering with other life goals, such as succeeding at work and maintaining relationships. Social anxiety has been conceptualized as a significant doubt in one's ability to present a desired impression on others (Leary, 1983), a view that is supported by considerable evidence (Leary & Kowalski, 1995). This view also reflects the conflict of two high order cognitive processes: a goal to present a desired impression on others, and a belief about one's inadequacy at being able to succeed at this. Recent computerized methods have been developed to record anxiety patient's goals and their degree of conflict, which can be directly targeted during therapy (Michalak & Grawe, 1999; Lauterbach, 1990). Certain studies have shown that conflict between goals and beliefs are associated with increased anxiety and other negative moods (Emmons & King, 1998; Perring, Oatley, & Smith, 1998), although no studies appear to have compared degree of conflict between non-clinical and clinically anxious groups.

3. Assessing and modifying conscious appraisals during treatment can modify automatic processes

Cognitive therapy for anxiety disorders is aimed at identifying and modifying threatening interpretations of internal and external events (Beck et al., 1985). In itself, this is not evidence that the interventions modify automatic processes. Clinical and experimental evidence does, however, provide support for the view.

The experience of repetitive, threatening and involuntary images characterize a range of anxiety disorders including panic disorder (Ottaviani & Beck, 1987), agoraphobia (Wells & Papageorgiou, 1999), obsessive-compulsive disorder (De Silva, 1986), social phobia (Hackmann, Surawy, & Clark, 1998) and post-traumatic stress disorder (APA, 1994). Hackmann (1998) reviews several accounts of the way that images can be modified or eliminated during treatment. The author suggests that accessing and modifying the meaning of distressing images may be a powerful therapeutic intervention. For example, one patient who was obsessed with the fear of getting AIDS experienced a vivid, repetitive image of himself lying in bed in hospital. While recounting these

experiences in detail with the therapist, he was amazed to realize that the bed in this image was exactly the same as the bed in which he had been lying on an earlier stay in hospital for a broken arm. The implication was that what he was imagining was an image of the past rather than an accurate prediction of the future. Typically, further recovery is achieved when the meaning of the image is further transformed. For example, a patient with social phobia experienced a recurrent image of himself vomiting in social situations. The experience of the involuntary image was eliminated after a therapy session in which the patient ran the image past the point where it usually stopped, to realise that after this point people would help him clear up, were sympathetic, and encouraged him to stay (Hackmann, personal communication). The notion of modifying involuntary processes through accessing and changing meanings is not unique to cognitive therapy. In psychoanalysis the therapist attempts to access the patient's past memories in order to construct a narrative of the patient's experiences. Freud and Breuer (1995) described case studies in which hysterical symptoms, which are typically experienced as involuntary, could be eliminated through consciously accessing and constructing a narrative of early traumatic experiences that had previously been inaccessible to awareness.

The above clinical observations have some empirical support. Certain studies have found evidence for the effects of interventions involving conscious appraisal on automatic processes. Mattia et al. (1993) found that responders to cognitive behaviour therapy for social phobia showed a greater reduction in selective attention as measured by the Emotional Stroop task, relative to non-responders. More importantly, cognitive therapy for GAD has led to a reduction in selective attention to masked threat words, relative to controls (Mogg, Bradley, Millar, & White, 1995). These findings support the pathway presented here. Nevertheless, a more rigorous test could involve the comparison of cognitive therapy without exposure with exposure-only techniques. The model would predict that automatic processing biases would be modified at least as well by the cognitive intervention. In particular, reduction in threat-related beliefs would predict the reduction of the automatic processing biases that were functionally related to them, such as attentional bias to threat and safety. To be most resistant to alternative interpretations, the interventions should each be a one-session treatment under controlled conditions, and careful consideration placed to preventing cognitive manipulations in the exposure-only condition, and preventing exposure in the cognitive condition. This may be very difficult in practice. Small changes in conscious appraisal could facilitate exposure (e.g., the therapist may have to promise to stay nearby when a spider is in the room) and exposure could facilitate belief change (e.g., when the patient realises that the spider does not run up the arm when placed on the hand, this disconfirms a prior held belief). Nevertheless, preliminary evidence already indicates that cognitive interventions with no exposure can reduce the frequency of panic attacks in patients with panic disorder (Salkovskis, Clark, & Hackmann, 1991) and reduce the frequency of flashbacks and other involuntary, distressing symptoms of post-traumatic stress disorder (Ehlers & Clark, 2000).

4. Experimentally modifying an anxious individual's conscious appraisal of a situation modifies their biases in automatic processing

Certain evidence would provide the most rigorous test of the pathway being proposed here. The study would require the following: (a) an information-processing paradigm

that measures automatic processing biases; (b) an anxious group and a control group; (c) a neutral context versus a context that would influence higher order belief systems, but not directly target automatic processes. The model would predict that the anxious participants would show an automatic bias compared to the control group, but that this bias is only present in a context that activates or modifies their concerns.

There appear to be no studies that directly test this hypothesis. Nevertheless, many findings provide at least partial support. Several have demonstrated that cognitive manipulations aimed at increasing perceived control or reducing catastrophic misinterpretations can significantly reduce panic patients' incidence of panic attacks (see Clark, 1993, for a review). Clearly, a more direct test of the hypothesis would use a more robust index of automatic processing.

The change in skin conductance associated with threatening stimuli has been used as an index of fear. Early studies paired phylogenetic (e.g., snakes and spiders) and ontogenetic threat stimuli (e.g., guns and knives) with a shock that led to a conditioned electrodermal response. The former took longer to extinguish (Ohman, Fredrickson, Hugdahl, & Rimmo, 1976). Initially, the findings were taken as evidence that certain biologically prepared stimuli are resistant to extinction. Yet, further studies have shown that changing people's expectation of threat to specific stimuli through verbal information can modify the electrodermal skin response (see Davey, 1995, for a review). As an example, McNally (1981) first conditioned subjects to elicit an electrodermal response to one of two different phobic stimuli. He then informed them that the contingencies were reversed, which led to an immediate reversal of their electrodermal response to the other phobic stimulus. Research into the electrodermal response indicates that an unconscious process can be modified by changes in conscious appraisal.

Research into nocturnal panic is consistent with the view presented here. Presumably, if cognitive processes cause panic attacks during sleep, they are automatic in nature. Recent research has indicated that modifying conscious appraisal of bodily information triggers nocturnal panic attacks (Craske, 1999; Craske & Freed, 1995). Prior to sleep, the participants were fitted with instruments to measure their physiology and EEG activity, which bleeped during increased arousal. They were divided into two conditions: expected and unexpected. The patients in the expected condition were told to anticipate some bleeps during the night because they would indicate natural fluctuations in their body. Participants in the unexpected condition were told not to expect any bleeps because these would indicate extreme changes in their body that would be less likely. In fact, all participants would receive a set of bleeps at a point during their sleep known to be associated with panic attacks. As predicted by the cognitive model, patients in the unexpected condition experienced significantly more panic attacks triggered by the tones.

Perhaps the most convincing evidence that conscious, strategic processes can influence the operation of automatic processes comes from a detailed study of selective attention in which the conditions were cleverly manipulated (Fox, 1996). The author found that attentional bias to subliminal threat cues only occurred when masked trials appeared in the same focal area as a previous unmarked trial and the two trial types were randomly intermixed. Fox (1996) concluded that attentional bias on masked trials depended on prior awareness of threat-related material. In line with the account proposed here, the conscious expectation of immediate threat may have activated an automatic process to detect threat stimuli. Fox (1996), referring to Bargh (1989) notes that,

"... although attentional bias effects in anxiety may be automatic in the sense of outside awareness, they may also be conditional on the subject's intentional goals and general understanding of the task."

At this stage, the direct empirical evidence for the effects of conscious appraisal on automatic processes is by no means conclusive. Further studies could explore selective attention to briefly presented masked stimuli in different contexts chosen to activate different high order beliefs.

5. The onset of involuntary processes in post-traumatic stress disorder (PTSD) and other anxiety disorders can be triggered by changes in the appraisal of a traumatic event

Clinical evidence suggests that involuntary processes can be modified in one experience and do not require repeated exposure. This occurs in post-traumatic stress disorder (PTSD), where a single traumatic experience can precipitate the distressing symptoms of PTSD, including involuntary images (flashbacks), involuntary re-experiencing of the trauma and fear reactions such as exaggerated startle and hypervigilance.

One explanation for the onset of these symptoms could be the strong emotional arousal at the time of the trauma (Brewin, 1989). However, another significant characteristic of trauma is the *meaning* of the event. A view that conditioning occurs when an event has an important meaning would be consistent with contemporary conditioning accounts of anxiety (Davey, 1997; Mineka & Zinbarg, 1995). Davey (1997) reviews a range of evidence that casts doubt on the view that repetitive pairings of neutral stimuli and an aversive experience are necessary for conditioning. Conditioning occurs when the stimulus is seen to *predict* the aversive consequence. One trial is sufficient if the stimulus provides a significantly better predictor than other stimuli around at the time. Furthermore, conditioned responses can emerge a long time after the initial trauma. One such process is UCS re-evaluation. Davey (1997) reviews experimental studies demonstrating UCS re-evaluation through a range of methods such as the acquisition of verbal information, the interpretation of internal cues, and cognitive rehearsal. The meaning of a trauma can be reevaluated weeks or years after it happens, and this can precipitate PTSD. Davey, de Jong and Tallis (1993) cite, among others, the example of a male bank employee who was threatened with a gun during a bank robbery. He showed no signs of residual fear after this experience until he was interviewed by the police 10 days later. The police told him he was lucky to be alive because the robber had already killed several people. From this point on, the employee developed the debilitating involuntary symptoms of PTSD. The contemporary cognitive conditioning theory described by Davey (1997) provides a major contribution to our understanding of the aetiology of anxiety disorders. As yet, the approach has not been directly applied to the issue of changes in automatic processes, but further research could address the issue.

Implications

This review has described three possible routes to the development of automatic processes in anxiety. In this concluding section, the implications for addressing biological, behavioural and cognitive explanations of anxiety disorders will be described.

One continuing debate concerns the maintenance of panic disorder (e.g., Clark, 1997; Power & Dalgleish, 1999; Windmann, 1998). Several theorists have suggested that panic disorder is caused at least in part by an oversensitive automatic threat detection system, creating false alarms to innocuous cues (Barlow, 1988; Klein & Klein, 1989; Windmann, 1998). The model proposed here would agree in one sense in that these models provide an explanation for the *proximal* cause of a panic attack. Indeed, the automatic detection of threat may precede conscious verbal thoughts during the short period of a panic attack. The evolutionary function of a fear response is to act as fast as possible, not to wait for a conscious thought to form. Nevertheless, this explanation is compatible with a necessary *distal* explanation that implicates catastrophic misinterpretations of bodily sensations. This is the key explanation with regard to maintenance of the disorder, and therefore treatment. The account here would suggest that the subconscious threat detection system is formed from the associative connections that also play part of the higher order beliefs, which are reported as catastrophic interpretations, yet the conscious elements of this belief system may not be activated at this time. This may be similar to what D. M. Clark means when he says that ''catastrophic misinterpretations may be so fast and automatic that patients may not always be aware of them'' (Clark, 1988, p. 76). The cognitive model of panic disorder is necessary to explain the findings that panic patients consistently make catastrophic misinterpretations of their bodily sensations and that they are significantly less likely to panic when their tendency to make catastrophic misinterpretations is reduced by verbal information (Clark, 1993). The cognitive model also explains why the overactive alarm system specifically detects bodily threats in panic disorder, whereas the evidence presented earlier suggests that the brain appears to be primed to detect very different threat stimuli in other anxiety disorders such as spider phobia and social phobia; individuals with these disorders have different beliefs about what is immediately threatening.

The third route to the modification of automatic biases may also help close the distinction between cognitive and behavioural models of anxiety disorders. The operation of many processes is seen to be simple and reflexive, just like the behavioural model, but the mediation of change is seen to involve conscious appraisal. For instance, a claustrophobic patient may escape a stuffy lift as a reflexive response to the physical sensations triggered by breathlessness. She may not need to think or imagine that she is going to suffocate while in the lift to reflexively escape the lift. Nevertheless, the automatic reaction would be consistent with one of the patient's beliefs. Through the downward arrow technique of cognitive therapy it may be possible to access this belief, which is usually manifest as a prediction of a certain catastrophic consequence. Allowing patients to access their beliefs, test their predictions and change their interpretations can lead to recovery and a beneficial change in the automatic processes that characterize the disorder. Note that the verbalization of beliefs is neither necessary nor sufficient for a change in cognitive processes. In laboratory studies, animals learn to predict significant outcomes without using language. Similarly, the verbal expression of a new belief as a proposition does not necessarily imply that the cognitive systems maintaining a disorder have necessarily been modified (Teasdale, 1999). Nevertheless, in humans, language provides a extremely versatile tool for developing, communicating and testing predictions.

Throughout, it has been suggested that changing conscious interpretations can modify automatic processes in anxiety. This description conceals the complexities in information-processing involved in such a process. Although there is limited space to discuss these complexities here, certain theorists have described some candidate models. In particular, the Perceptual Control Theory of W. T. Powers (1973) and the Society of Mind suggested by Marvin Minsky (1987) provide such frameworks. Minsky states that to understand the mind we must break it down into "agents" that by themselves are not intelligent, but which through their inter-relationships lead to intelligent behaviour. The efficiency of such a system to become reorganized with new experience would dictate the limits of how much modification of automatic processes by higher order processes is possible over time. Already, many computer programs are constructed from hierarchies of "objects" that operate autonomously, yet change their operation when higher level objects are modified. It remains an open question as to how effectively we can apply such models to information-processing in anxiety disorders.

It remains to be seen whether the route has implications for other areas of psychopathology. Preliminary evidence suggests automatic biases may be related to several other emotions, including anger (Cohen, Eckhardt, & Schagat, 1998), depression (Bradley, Mogg, & Millar, 1996; Reynolds & Brewin, 1999; Watkins, Vache, Verney, & Mathews, 1996) and jealousy (Intili & Tarrier, 1998).

Above all, the strongest implication is for further research. The current review has provided a range of convergent, yet largely indirect evidence. Until we find more direct evidence for the effects of conscious appraisal on the automatic processing biases associated with anxiety, we will not know for sure whether the human brain is capable of this highly adaptive way of updating its outdated, reflexive responses to threat in the light of new or previously inaccessible information.

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