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Automaticity in Anxiety Disorders and Major Depressive Disorder

Bethany A. Teachman[1], **Jutta Joormann**[2], **Shari Steinman**[1], and **Ian H. Gotlib**[3]
[1]University of Virginia
[2]University of Miami
[3]Stanford University

Abstract

In this paper we examine the nature of automatic cognitive processing in anxiety disorders and Major Depressive Disorder (MDD). Rather than viewing automaticity as a unitary construct, we follow a social cognition perspective (Bargh, 1994) that argues for four theoretically independent features of automaticity: unconscious (processing of emotional stimuli occurs outside awareness), efficient (processing emotional meaning uses minimal attentional resources), unintentional (no goal is needed to engage in processing emotional meaning), and uncontrollable (limited ability to avoid, alter or terminate processing emotional stimuli). Our review of the literature suggests that most anxiety disorders are characterized by uncontrollable, and likely also unconscious and unintentional, biased processing of threat-relevant information. In contrast, MDD is most clearly typified by uncontrollable, but not unconscious or unintentional, processing of negative information. For the anxiety disorders and for MDD, there is not sufficient evidence to draw firm conclusions about efficiency of processing, though early indications are that neither anxiety disorders nor MDD are characterized by this feature. Clinical and theoretical implications of these findings are discussed and directions for future research are offered. In particular, it is clear that paradigms that more directly delineate the different features of automaticity are required to gain a more comprehensive and systematic understanding of the importance of automatic processing in emotion dysregulation.

Keywords

automaticity; anxiety; depression; unconscious; efficient; unintentional; uncontrollable

Because of his book *Blink*, Malcolm Gladwell (2005) received remarkable fame for disseminating psychological findings on the power of split-second decisions. There is no doubt that processing information rapidly, or outside of conscious awareness or control, has adaptive value. When a car is hurtling towards you at full speed, contemplative reflection on the pros and cons of getting out of the way would only serve to – well, get in the way. Yet, it is equally clear that our ability to decide if a stimulus is positive or negative in less than the blink of an eye can also co-occur with intense emotion dysregulation. In this paper we

Correspondence concerning this paper should be addressed to Bethany Teachman at the Department of Psychology, University of Virginia, P.O. Box 400400, Charlottesville, VA 22904-4400. Phone: 434-924-0676, Fax: 434-982-4766, bteachman@virginia.edu..

examine the nature of automatic cognitive processing in anxiety disorders and Major Depressive Disorder (MDD) in an attempt to understand both how automaticity is related to these forms of psychopathology and how these processes are similar and different across anxiety disorders and MDD.

Rather than viewing automaticity as a single, unitary construct, we follow a social cognition perspective (Bargh, 1994) that argues for four different features of automaticity that can co-occur but are theoretically independent: automatic processing of information can be unconscious (the individual lacks awareness of the stimulus); efficient (processing the stimuli requires minimal attentional resources); unintentional (no goal is needed to engage in the process); and uncontrollable (the process is difficult to avoid, alter or stop). Thus, instead of being limited to general claims about the role of automatic versus strategic processing, we can evaluate the empirical evidence that supports the presence or absence of a given feature in anxiety disorders and MDD. We begin by outlining our rationale for the importance of research examining automaticity in advancing our understanding of emotion dysregulation, and then consider the challenge of defining automaticity. Within this framework, we review the empirical support (or lack thereof) for each of the four features of automaticity in anxiety disorders and MDD. Our focus is on the processing of emotionally-relevant information (e.g., pictures and words associated with sad and anxious moods) because of the theoretical importance of this type of information in contributing to the etiology and maintenance of anxiety disorders and MDD. Finally, we consider the clinical and theoretical implications of our findings and the specific directions that future research should take in order to move the field forward. Thus, our review has two inter-related goals: to examine the evidence for the different features of automaticity in anxiety disorders and MDD; and to evaluate the utility of the information-processing paradigms that are typically used in this field as measures of automatic cognitive processing.

Using this social cognition perspective allows us to integrate and advance findings from a number of past reviews that have highlighted different features of automaticity. This is the first review that examines a range of automaticity features across both the anxiety disorders and MDD to permit a more comprehensive and direct comparison. We believe that this review is timely because many recent studies have used paradigms that were not available 15 or more years ago, when the last major reviews in this area were written (e.g., Hartlage, Alloy, Vázquez, & Dykman, 1993; McNally, 1995). Finally, evaluating the empirical literature on automaticity is important not only to advance psychopathology theory, but also clinically. If we want to understand why a depressed person with a high-status job and loving family believes he is a worthless failure, why a person with social phobia sees only the one scowling face in a room full of smiles, why a person with panic disorder is convinced that the 200th panic attack is the one that will bring on a heart attack, we need to consider the role of automatic processing of emotional information in these disorders.

Focus on Automaticity in Anxiety Disorders and MDD

The choice to focus on automatic cognitive processing in anxiety disorders and MDD follows from the large theoretical and empirical literatures that have been established in these domains. Moreover, given the high comorbidity of anxiety disorders with MDD, understanding their unique and common components has been an ongoing challenge (see Barlow, Allen, & Choate, 2004). While considerable progress has been made in determining the shared and distinct symptoms of anxiety disorders and MDD (see Clark, Watson, & Mineka, 1994; Mineka, Watson, & Clark, 1998), questions remain concerning the overlap in their information-processing profiles.

The impetus for examining information processing in anxiety disorders and MDD comes from early cognitive models formulated by Beck and colleagues (Beck, 1967, 1976; Beck, Emery, & Greenberg, 1985) that suggest that dysregulation of emotion in these disorders is maintained by selective attention to, interpretation of, and memory for cues that are relevant to anxious or depressive schemas. These models focus on both the *content* of cognitive biases (themes of threat or danger for anxiety, and of loss or failure for MDD) and biased *processes* (in attention, interpretation, encoding, recall, etc.). We use the term bias to indicate preferential processing of material that has a disorder-relevant emotional valence or meaning -- not necessarily greater or lesser accuracy (akin to Mathews & MacLeod, 2005). Beck's models of anxiety and depressive disorders, as well as more recent cognitive models, posit that biases in the processing of information not only maintain disordered affect, but also play either a contributory or a causal role in the onset and maintenance of, and recovery from, emotional difficulties (e.g., Abramson, Alloy, & Metalsky, 1988; Beck & Clark, 1997; Clark, 1986; Power & Dalgleish, 1997; Salkovskis, 1989; Young, 1999).

The field has now reached an exciting juncture; it is clear that anxiety disorders and MDD are characterized by information-processing biases. Moreover, new studies are also demonstrating the causal relation between information-processing biases and mood (see Hakamata et al., 2010; Hertel & Mathews, 2011; MacLeod & Mathews, 2012). It is also clear, however, that processing biases are not identical across the disorders; discrepant results have been obtained for anxiety disorders versus MDD in terms of the sensitivity and specificity of biases, especially in attention and memory (see Mathews & MacLeod, 2005; Williams, Watts, MacLeod, & Mathews, 1997). Thus, from initial questions about the existence and importance of information-processing biases, the field has progressed to debates about the precise nature of the biases and the ways in which they are similar in content and form across anxiety and depressive disorders.

Automaticity in information-processing biases has been one of the primary candidates that has been proposed to explain the discrepant findings across different forms of emotion dysregulation. As we will discuss, although different features of automaticity have been emphasized either implicitly or explicitly in various theoretical accounts of information processing in emotion dysregulation, they have in common the idea that some aspect of non-strategic or non-controlled processing can help us understand how information-processing biases operate in, and/or distinguish between, anxiety disorders and MDD (see Beck & Clark, 1997; Dalgleish, 2004; Fox, 2004; Hartlage et al., 1993; Mathews & Mackintosh, 1998; Mathews & MacLeod, 2005; McNally, 1995; Mogg & Bradley, 2005; Öhman & Mineka, 2001; Teasdale & Barnard, 1993; Wells & Matthews, 1996; Williams et al., 1997; Yiend, 2010).

Defining Automaticity

In their comprehensive review of prominent theoretical perspectives on automaticity, Moors and De Houwer (2006) note the lack of consensus regarding the definition of this construct. Early ‘capacity’ models of automaticity emphasized processes that could operate without utilizing substantial attentional resources, thus producing minimal interference on other tasks (typically referred to as efficient, effortless, or capacity-free; e.g., Hasher & Zacks, 1979; Posner & Snyder, 1975; Shiffrin & Schneider, 1977). These models varied, however, with respect to the other features of automaticity that were deemed necessary or sufficient. Different terms have been used to describe automatic processing, including fast, unintentional (in terms of not being chosen or established by the person), or the related concept goal-independent (a process or act that does not require a goal for its occurrence). Automaticity has also been defined as obligatory or involuntary (difficult to avoid), happening outside conscious awareness, uncontrolled/uncontrollable (hard to suppress or alter once started), autonomous (both unintentional and uncontrollable), or purely stimulusdriven (bottom-up or data-driven processing) (see review in Moors & De Houwer, 2006). Further, these early models were premised on an all-or-none conceptualization of automaticity, such that different features of automaticity were expected to covary so that all features would be activated (or would be inactive) simultaneously.

This idea of a tightly linked latent automatic construct has been challenged by Bargh (1989, 1992, 1994), among others, who suggested that the features could in fact occur independently (i.e., a process could be unintentional, but not unconscious). Bargh postulated a set of optional but frequently present features that he termed “the four horsemen of automaticity:” efficient, unintentional, uncontrollable, and unconscious. In this sense, there are connections among the four features of automaticity, but they are not always tightly linked or activated in an all-or-none fashion (e.g., just as Miyake and others have suggested that while various components of executive functioning are typically correlated, they are also separable; e.g., Miyake et al., 2000).

While Bargh's feature list is not as inclusive as those proposed by other theorists (e.g., Moors & De Houwer, 2006), our decision to focus on the ‘four horsemen’ in the current review has a number of advantages. First, these four automatic processes can be separated fairly readily with minimal overlap. Second, as a result of this, it is feasible to think about how tasks might reflect variable combinations of the four features, so that it is more practical to examine the empirical support for biases in a given feature in psychopathology research. Third, these four features encompass those selected and discussed by previous theorists who have examined the nature of automaticity in anxiety disorders and MDD, allowing for direct comparison. Specifically, McNally (1995) outlined the evidence for automaticity in anxiety that reflected the features capacity-free, unconscious, and involuntary. Hartlage et al. (1993) focused on efficient or effortless processing in depression. Other theorists have emphasized the roles of unconscious and efficient processing, particularly as they apply to attention allocation in anxiety (e.g., Fox, Russo, Bowles, & Dutton, 2001; Mogg & Bradley, 2005; Williams et al., 1997). In each case, the features outlined in these accounts can be incorporated into Bargh's four-feature framework. Thus, the selection of the four-feature framework is based on empirical research and on a desire to maximize both parsimony and separability of the features (making hypotheses concerning the presence or absence of various features falsifiable). At the same time, it is important to note that we do not see the four features as the only meaningful or valid classification scheme for understanding automaticity.

In this paper we consider evidence for and against the automaticity features in anxiety disorders and MDD. We are guided in this analysis by a specific set of assumptions. First, we assume that automaticity is not a tightly linked latent, cohesive construct, but instead, involves a set of potentially independent features, many of which occur on a continuum. Second, unlike traditional views that assume that strategic, intentional processing is the dominant or default mode (see review in Moors & De Houwer, 2006), we are sympathetic to more recent views suggesting that automatic, unintentional processing of information is the default mode, with controlled, conscious processing occurring to help organize and regulate the abundance of complex non-conscious information and skills (see Bargh, 2005; Kelso, 1995; Wegner, 2002). Third, we decided to organize the review around the features of automaticity, rather than around a specific form of cognitive processing bias (e.g., selective attention, implicit memory, etc.), based on the assumption that, under certain conditions, a given feature of automaticity can affect multiple forms of cognition (e.g., one could make an interpretation, redirect attention, or retrieve information efficiently if processing the relevant stimuli required minimal resources).

Empirical Evidence for Automaticity in Anxiety Disorders and MDD

To evaluate evidence for the various features of automaticity in anxiety disorders and MDD, it is critical to determine what a given task or paradigm is actually measuring. This is no easy feat; as Rachman (1997, p. 17) noted, "the very interconnectedness of emotions and cognitions that is so fascinating, will be a great challenge to researchers. The selection and isolation of the variable of interest, in a manner that allows one to maintain constancy in the rest of the interconnecting web, is difficult and will require the introduction of new methods to replace our presently superficial ones." Although a number of intriguing paradigms have been developed over the past decade that can help address this challenge, both older and newer tasks still include a mix of automatic and strategic features, making their classification difficult. We assume that many features of automaticity are continuous rather than dichotomous (e.g., responding can be minimally, somewhat, or extremely efficient); consequently, when we suggest that a task reflects a given feature, this simplification has heuristic value. Nevertheless, even when a task does not perfectly reflect a given feature of automaticity, convergent results obtained across tasks and disorders can still help us understand more about that feature in anxiety disorders and MDD. We focus here on the paradigms that have been used most frequently to assess information-processing biases in anxiety and depressive disorders: those that emphasize the distinct processing of emotional information (e.g., preferential attention to the word "danger" or "death" for a person with panic disorder, or the word "worthless" for a person with MDD).

In the following sections, we review each of the four automaticity features separately (unconscious, efficient, unintentional, uncontrollable) and evaluate evidence for that feature first in anxiety disorders and then in MDD. For each feature, we highlight methodological issues that arise in defining the feature as it has been applied to psychopathology research, discuss related challenges in measuring the feature (e.g., how do we know that unconscious processing has occurred) and the consequent implications for which tasks were included or excluded in each review section, and then consider the results for empirical support across the included tasks. On a few occasions, a given task may provide evidence for more than one automaticity feature, so will be mentioned in multiple sections of the paper (e.g., the supraliminal Stroop task).

Methodology

To enable replication of our systematic review process and the conclusions drawn, we describe the rationale for each of the guidelines used to organize the review.

Inclusion/Exclusion Criteria Based on Sample Selection—In selecting studies for this review, we decided to focus on investigations that assess clinical, rather than analog, samples because it is not clear that persons with subclinical levels of depressive and anxious symptoms exhibit the same information-processing biases as do clinically disordered individuals (although see Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007). Thus, in the area of anxiety, we include studies with participants that cover panic disorder, agoraphobia, obsessive compulsive disorder (OCD), post-traumatic stress disorder (PTSD), social phobia, specific phobias, and generalized anxiety disorder (GAD); we omit studies with samples that only include high trait-anxious participants.[1] Similarly, in the area of depression, we focus on studies of participants with diagnosed

[1]We did not include studies of acute stress disorder in this review. Although there are promising examples of acute stress disorder research in the domains of directed forgetting and thought suppression (e.g., Moulds & Bryant, 2002), there is not an adequate body of research to review at this time. Specifically, only four articles related to acute stress disorder met our search criteria, and only one used a task that assessed a feature of automaticity other than uncontrollable processing. Further examination of automatic processing in acute stress disorder is thus an important avenue for future research.

MDD, but omit investigations with bipolar, remitted, dysthymic or dysphoric samples, or with samples in which depression is operationalized only by high scores on self-report measures of symptoms.

In addition, we restrict our focus to studies of adults, rather than of children or adolescents. Because there are far fewer studies upon which to draw in the child literature, and because methodologies are more diverse, conclusions at this stage would be tentative at best. For similar reasons, we also exclude samples that included exclusively older adults, given the paucity of studies and concerns about how developmental factors (e.g., age-related changes in executive functioning) would influence performance on the measures of cognitive processing. Finally, we exclude studies in which participants had a primary diagnosis other than an anxiety disorder or MDD, such as Parkinsons or dementia.

Search Guidelines—We carefully reviewed the published literature based on searches in PsycInfo targeting each of the relevant tasks (e.g., modified Stroop, visual search, etc.). To maximize coverage of the relevant studies, we used multiple search terms for tasks (e.g., visual probe, dot probe, etc.) to capture variable reporting methods, and more than one person conducted searches on each topic to allow cross-checking. The search terms were the keywords [disorder name] AND [task name]. In cases where there are multiple common names for a disorder (e.g., depression and major depressive disorder), we searched ([disorder name 1] OR [disorder name 2]) AND [task name]. In cases where there are descriptor adjectives used with a task (e.g., supraliminal or subliminal as descriptors for Stroop), we searched [disorder name] AND [task name] AND ([adjective descriptor 1] OR [adjective descriptor 2]). The disorder names used in the searches were: panic, agoraphobia, obsessive compulsive, post traumatic, social phobia OR social anxiety, phobia OR phobic, generalized anxiety, depression OR major depressive disorder. The task/paradigm names used in the searches were: Stroop AND (masked OR subliminal OR unconscious OR supraliminal OR unmasked), Stroop AND (modified OR emotional), visual probe, dot probe, visual search OR pop out, implicit association, association task, Affective Simon Task, Go/No-go, thought suppression, directed forgetting, Sternberg, ignore/suppress task, Think No Think, Posner, priming, dual task, dichotic listening, load, cognitive load, attentional blink, rapid serial visual presentation OR RSVP.

Readers may notice that a small number of task names that are sometimes associated with a given feature of automaticity are not included in this list of search terms (e.g., tachistocopic for unconscious processing). These exclusions reflect decisions that a given task did not adequately assess the relevant feature of automaticity based on our criteria. So that readers can have the opportunity to review our decision rules, for each automaticity feature we include a Methods section that outlines the inclusion and exclusion guidelines followed for the tasks reviewed in that section.

The initial literature searches provided reference information for 474 articles that were potentially appropriate based on the abstract. Each of these articles was then checked by at least two different reviewers to determine if the article included a diagnosed sample and an appropriate task that included emotion-relevant stimuli (e.g., depression-relevant versus neutral words). All other articles were excluded. To locate additional articles that might have been omitted by this search process, we then examined recent review articles that have considered subsets of the relevant studies (e.g., a review paper specific to implicit association measures in psychopathology; Roefs et al., 2011). Twenty-five articles were added based on these additional checks. This resulted in a final count of 183 study entries for the review (an article could provide more than one study entry; e.g., multi-experiment papers).

Tables 1-4 list the studies included in the review, with a separate table for each feature of automaticity. For space reasons, these tables are very brief, noting only the samples assessed in each study, task(s) used, and whether the study was classified as showing evidence for a given automaticity feature or not. Two raters reviewed the primary results for each study to determine whether each study provided evidence for a given feature of automaticity (coded as yes, no, or mixed). For the interested reader, however, more comprehensive tables are available in Excel spreadsheet format as an online supplement at [*insert url here*]. Note that some studies included diagnosed groups that were not the focus of this review (e.g., trichotillomania, somatoform disorder, mixed anxiety samples). Entries related to these groups are included in the online supplement, but not in Tables 1-4. These supplemental tables detail the samples (diagnoses, comorbidity with anxiety and depressive disorders, control group, size and gender distribution), the paradigm (including task details such as presence of stressor, format and content of stimuli, duration of stimuli presentation), and a description of the primary between- and within-group results. As is evident in Tables 1-4, within each feature of automaticity, studies are organized by disorder (anxiety disorders alphabetically, followed by MDD). Within each disorder, studies are organized by task (tasks listed alphabetically), and within each task, articles are organized alphabetically by first author. If the study included stimuli that were not directly disorder-specific (e.g., physical threat words for a social phobic sample), an asterisk follows yes, no, or mixed in the evidence column. The full list of references for the articles included in the automaticity Tables 1-4 can be found as an online supplement at [*insert url here*], labeled Appendix A.

Unconscious Processing

The terms unconscious and automatic have often been treated as overlapping (e.g., Kihlstrom, 1987), probably in part because consciousness has frequently been posited to be a prerequisite for strategic, controlled processing (see discussion in Moors & De Houwer, 2006). While we do not hold that unconsciousness is a necessary feature of automaticity, there is little doubt that it is a convincing marker of automatic processing. In his seminal writings on automaticity, Bargh (1994) noted three ways in which a person might lack awareness of a cognitive process (we are using the terms unconscious and unaware interchangeably for the purposes of this paper). The individual might be unaware of the stimulus itself, or of the way that a given stimulus is categorized or interpreted, or of how the stimulus is influencing subsequent responses, such as judgments or emotional reactions. In the current review, we focus primarily on the first instance – awareness of the stimulus – because the literature is most robust to address this aspect of consciousness in anxiety disorders and MDD.

Methods: Unconscious Processing—Lack of awareness of the stimulus despite activation of the meaning of the stimulus, termed subliminal semantic activation, is typically assumed when there is evidence for significant indirect effects of the stimulus (e.g., difference in reaction time when responding to a subsequent target) in the absence of direct effects[2] (e.g., inability to detect the stimulus; Holender, 1986). This effect is usually achieved by presenting a stimulus for a brief duration and then masking it so that it is no longer possible to process its meaning. The subliminal Stroop and dot-probe tasks, for example, effectively control the stimulus presentation to prevent awareness of words or pictures, so these tasks are reviewed here. Similar conditions exist in lexical decision tasks if a subliminal target or prime is presented, and in affective priming tasks that use subliminal emotional material as primes and ask participants to evaluate the valence of the probe. There are a small number of studies that have used alternate tasks to reduce awareness; namely,

[2]It is important to note, however, that evidence for the absence of direct effects is often not tested directly in psychopathology research, and effects can be difficult to replicate (see Draine & Greenwald, 1998).

investigating perceptual thresholds for tachistoscopically presented material, and dichotic listening tasks, in which individuals attend to one channel of information while hearing another channel that is not supposed to reach the threshold of awareness. However, the controls are often less stringent and more variable in these studies, leading to confusion about the actual level of stimuli impoverishment (such as evidence that information presented to the supposedly unattended channel has reached momentary awareness in dichotic listening tasks; e.g., Wenzel, 2006); therefore, these studies are not reviewed here.

Similarly, there are a number of tasks that likely demonstrate lack of awareness of biased *responding* to emotional stimuli, but both because this lack of awareness is rarely assessed and because there are opportunities for conscious processing in these paradigms, we will not review these tasks here. Examples include word-stem completion, white noise implicit memory task, homograph interpretation task, and implicit association tasks (e.g., Implicit Association Test). Finally, although compelling support for unconscious processing related to anxiety comes from the extensive work by Öhman and his colleagues assessing acquisition, maintenance and extinction of fear responding to phobic-relevant stimuli (e.g., Esteves, Parra, Dimberg, & Öhman, 1994; Öhman & Soares, 1993, 1998), these studies do not usually use diagnosed samples so are not reviewed here.

Results: Unconscious Processing In Anxiety Disorders—Table 1 presents studies evaluating unconscious processing in anxiety disorders. Investigators using a modified dot-probe task, in which stimuli are masked rather than presented for the typical 500 ms or longer, have sometimes found that anxious individuals attend selectively to emotional stimuli. In the dot-probe task, participants are asked to indicate the location of a dot that appears on a computer screen immediately after a pair of stimuli have been presented and removed, one of which is typically fear-relevant (i.e., two words are presented simultaneously, one neutral and one that reflects threat content). If responding is consistently faster on trials in which the dot appears in the same spatial location as the threat stimulus, then an attentional bias is inferred because the participant was presumably already attending to that location and focusing on the threat-relevant stimulus. This is thought to reflect unconscious processing because the masked stimuli were presented for a very brief duration.

Although few studies have been conducted to date using the dot-probe task with clinically anxious samples, early results are intriguing, but inconsistent. Mogg, Bradley, and Williams (1995) found that individuals with GAD showed a bias toward negative words relative to a control group when stimuli were presented for only 14 ms. In contrast, Mathews, Ridgeway, and Williamson (1996) did not find an effect in their GAD sample, and Elsesser, Heuschen, Pundt, and Sartory (2006) did not find an effect in a mixed specific phobia sample. This pattern of results suggests that findings are more robust when the sample is homogenous with respect to the specific anxiety disorder being examined. Notably, based on the results of their meta-analysis, which included both diagnosed and trait anxious samples, Bar-Haim et al. (2007) concluded that not only was there evidence for a dot-probe interference effect in anxious samples, but the effect size was almost twice as large for subliminal than for supraliminal versions of the task (importantly, the reverse order of effect sizes was found for the Stroop task, suggesting these two tasks do not capture identical processes).

The question of unconscious processing of threat stimuli in anxious samples has also been examined with the subliminal Stroop task, in which stimuli are masked so that participants are unaware of the content of the word or picture presented. The subliminal Stroop measures the latency to name an attribute of a word (or picture), such as ink color. Time to name the ink color is compared when the stimuli are emotion-relevant versus neutral or other control stimuli. The assumption is that the color of emotion words will be named more slowly because of interference caused by their semantic content (even though the meaning of the word is irrelevant to the task of naming its ink color).

The subliminal Stroop task has been used most frequently to assess the unconscious feature of automatic processing; interestingly, it has also produced equivocal results, with even meta-analyses reaching different conclusions about the robustness of subliminal effects (Bar-Haim et al., 2007; Phaf & Kan, 2007). A bias for preferential attention to either negative or fear-specific masked stimuli has been observed across a variety of anxiety disorders, including panic disorder with agoraphobia (e.g., Lundh, Wikström, Westerlund, & Öst, 1999), GAD (e.g., Bradley, Mogg, Millar, & White, 1995), PTSD (Harvey, Bryant, & Rapee, 1996), OCD (Kyrios & Iob, 1998), and specific phobias (e.g., van den Hout, Tenney, Huygens, & de Jong, 1997). At the same time, however, several studies have failed to find biases on the masked Stroop, even in disorders in which others have obtained positive results (see Table 1). Some of the null findings are likely due to methodological differences across studies, including approaches to masking, stimuli presentation durations, and small sample sizes (see also Williams, Mathews, & MacLeod, 1996, for a thorough discussion of the likely mechanisms underlying Stroop interference). Further, effects on the Stroop task are more consistent when a blocked design is used (i.e., when stimuli from a given category are grouped together; Bar-Haim et al.), and when naturalistic stimuli, such as facial expressions or pictures of animals (rather than words), are used (Bar-Haim et al.).

The subliminal lexical decision task has been used to examine latency to determine whether a string of letters is a real word when the target is either presented subliminally, or following a subliminally presented prime that varies in disorder relevance. Although Wikström, Lundh, Westerlund, and Högman (2004) found that snake phobic participants were faster than control participants to judge masked snake words, suggesting unconscious processing, other investigators have failed to find group differences in GAD (Bradley, Mogg, & Williams, 1995) or panic disorder (Schniering & Rapee, 1997) samples.

Importantly, in the 25 studies reviewed for this section, the extent and consistency of the evidence varied considerably across the anxiety disorders. For instance, support for unconscious processing was strongest in GAD (with approximately two-thirds of studies finding positive results), and effects were most likely to be obtained when the Stroop (versus dot-probe or lexical decision) task was used, and when GAD samples did not have a comorbid depressive disorder (see Table 1). Interestingly, interference effects were often evident for a range of negative words, rather than being anxiety-specific. In contrast, the review indicated moderate support for unconscious processing in panic disorder, PTSD, OCD and specific phobias, and no support in social phobia (only two studies with diagnosed social phobia samples were found, and both did not show the expected interference effects). Thus, the evidence on the whole suggests moderate support for unconscious processing in anxiety disorders, with about half the published studies finding the expected effect, but disorder-specific differences are important. Interestingly, prior reviewers have reached different conclusions about the extent of disorder-specific differences. For example, whereas Wenzel and Holt (1999) point to particularly mixed results in specific phobias, Bar-Haim et al. (2007) suggest the magnitude of effects is small to moderate and comparable across the various anxiety disorders. One major difference across the reviews is that Bar Haim et al. included undiagnosed samples in their review, which may contribute to the discrepant conclusions.

At this stage, converging evidence suggests that among many anxious populations, threat-relevant stimuli are likely processed before they reach conscious awareness (these effects are fairly robust for GAD, but are more modest in other disorders). Further, this assertion is limited to tasks that use data-limited approaches by making stimuli impoverished (typically through masking) so that awareness of the content of the stimuli is obscured. Clearly, more reliable and sensitive tasks are needed.

Results: Unconscious Processing in MDD—Almost all of the experimental tasks that have been used in research on anxiety disorders have also been used to assess biased processing in MDD; however, findings from the MDD literature paint a different picture. When investigators have attempted to find evidence of group differences in unconscious processing of emotional (primarily negative) material in MDD, the results have been mostly null (see Table 1). Most relevant studies in MDD have used either the modified Stroop task or an attentional allocation paradigm, like the dot-probe task. Strikingly, no investigation using these experimental tasks has found a bias in clinically depressed participants when the stimuli have been masked. In one of the first studies in this area, Mogg, Bradley, Williams, and Mathews (1993) used a modified Stroop task and presented anxiety-related (e.g., cancer, collapse), depression-related (e.g., failure, misery), positive, and neutral words, either subliminally (followed by a mask) or supraliminally. Whereas participants who were diagnosed with GAD exhibited slower color naming of all negative words at both subliminal and supraliminal exposure durations, diagnosed depressed participants did not differ from control participants in the subliminal condition (see also Lim & Kim, 2005). Importantly, using a Stroop task, Bradley, Mogg, Millar et al. (1995) found that only patients diagnosed with GAD who were *not* comorbid with a depressive disorder exhibited biased processing for negative words. GAD patients who were also diagnosed with a depressive disorder did not differ from the control participants, leading Bradley et al. to urge researchers to consider more carefully the role of concurrent depression in unconscious processing of threat-related information in anxiety disorders (though see Bar-Haim et al., 2007, who did not find differences in their meta-analysis between studies that included or excluded participants with comorbid depressive disorders).

Several investigators have used the dot-probe task with briefly presented and masked emotional words to investigate processing biases in MDD. Here, too, the results have not suggested strong evidence for unconscious processing. Mathews et al. (1996) found evidence for biased processing in depressed patients only when the stimuli were presented for relatively long exposure durations (permitting awareness of the stimuli). We should point out, however, that Mathews et al. did not use depression-relevant stimuli, but instead used anxiety-relevant words. Mogg, Bradley, and Willaims (1995) also found biased processing in the subliminal condition of a dot-probe task for participants diagnosed with an anxiety disorder, but no bias for their diagnosed depressed sample. Mogg et al. used depression-relevant and anxiety-relevant words, but did not find an effect of word category on the performance in the MDD group. One important difference between the studies reviewed here and those reviewed in the anxiety disorders section is that whereas studies of anxiety have used both words and pictures, all of the subliminal Stroop and dot-probe studies in MDD have used only words as stimuli. Thus, whether biases are observed could depend on the salience of the stimuli and on the degree to which the presented stimuli are important to the participants' concerns. While pictures of spiders are likely highly relevant to all spider phobic participants, words such as "misery" and "death" are clearly negative, but may vary in how relevant they are to a given depressed person. No studies so far have systematically compared word and picture stimuli within the same design. In addition, no published dot-probe studies have examined biased processing of subliminally presented pictures or emotional faces in depressive disorders, so it remains to be seen if these stimuli would yield different results.

Null results were also obtained in studies using affective priming designs, in which investigators examine whether the subliminal presentation of valenced primes, usually words or pictures, affects the subsequent processing of a valenced probe. Affective priming refers to a faster response time when probe and prime share the same valence than when the prime is neutral. Participants diagnosed with MDD do not show an affective priming effect (Dannlowski, Kersting, Donges et al., 2006; Dannlowski et al., 2007). The only exceptions to this clear pattern of null findings come from studies using implicit memory tasks that examine priming effects that do not rely on intentional retrieval instructions. Bradley, Mogg, and Millar (1996) used subliminal priming (with neutral or depression-relevant words as primes and targets) followed by a lexical decision task, and found that, compared to nondepressed individuals, diagnosed depressed participants showed greater subliminal priming for depression-relevant than neutral words (see also Bradley, Mogg, & Williams, 1995). Bradley and his colleagues were careful to ensure that the priming effects were conceptual rather than perceptual (i.e., priming effects due to the meaning of the stimuli versus their physical appearance). Thus, it is possible that unconscious processing can be found in MDD when the conceptual memory system is engaged. However, evidence for unconscious processing is not robust in tasks that examine the immediate response to subliminal material or selective attention for such material. Thus, once depression-relevant information has been activated in memory, it may remain accessible for longer periods of time and bias subsequent processing in depressed individuals. Future investigations should examine this proposition more systematically.

In sum, with remarkably few exceptions, our review of the literature on unconscious processing of emotional information in MDD suggests that depressed individuals are not characterized by unconscious biases in their processing of emotional information, relative to nondepressed groups.

Efficient Processing

Moors and De Houwer (2006) note that efficient processing often leads to the subjective experience that processing is effortless (see also Bargh, 1989); thus, it is not surprising that the terms efficient, effortless, and capacity-free have often been used interchangeably to refer to this feature of automaticity. Demonstrating efficient processing has proven to be challenging, in part because many researchers believe this feature lies on a continuum (e.g., Hasher & Zacks, 1979; Logan, 1985). Thus, while it is plausible to think of a threshold that defines a process as occurring above or below conscious awareness (though see Phaf & Kan, 2007), it is harder to choose a logical point to define efficiency. As a result of the complexities in evaluating efficient processing, researchers have operationalized the construct in different ways, leading to disagreement about what tasks reflect efficient processing.

Methods: Efficient Processing—Bargh (1994) uses a seemingly simple definition of efficiency; he describes this feature as the "extent to which the perceptual or judgment process demands attentional resources" (p. 24), a definition that has been used by many other automaticity researchers (see Moors & De Houwer, 2006)[3]. McNally (1995) suggests that for efficiency to be demonstrated (he uses the term capacity-free), "processing of threat

[3]While we concur with Bargh's definition, we think that his approach to operationalizing this feature may be problematic. Specifically, Bargh suggests that efficiency is demonstrated when interference effects (e.g., slowing on an alternate, unrelated task) occur despite conscious attention being directed elsewhere. Thus, Bargh argues that a task such as the modified Stroop, in which the meaning of a stimulus interferes with naming the ink color of that stimulus, is a prototypical example of efficient processing. A limitation of this view is that it assumes that because it was not task-relevant to direct attention toward emotional information, then directing attention to the emotional information consumed few or no processing resources. However, interference effects imply that processing the emotional meaning did consume resources in that it was more difficult to meet the explicit task demands (i.e., naming ink color). In addition, participants may still direct their attention to emotional information (despite it being task-irrelevant). Moreover, emphasizing the direction of attention, rather than the amount of processing resources used, may lead to confusion because it is possible for attention to be directed toward emotional information but use minimal attentional resources, suggesting that the process is still relatively efficient.

cues should not disrupt other concurrent tasks" (p. 748). McNally argues that tasks like the Stroop and dual-task paradigms demonstrate that processing the emotional meaning of stimuli interferes with other task demands, and thereby highlights that the processing is *not* efficient. We agree that dual-task paradigms (in which participants perform the primary task while simultaneously completing a second task that is believed to require attentional resources) are an effective way to operationalize efficiency, and we focus on these studies in this review. Nevertheless, we are reluctant to rely on the broader category of reaction-time tasks that assess interference effects based on a task-irrelevant feature (e.g., the Stroop and dot-probe tasks) as indicators of efficiency, so (unlike McNally, 1995) do not include these tasks in this section. One concern is that in the absence of interference effects, it is impossible in these tasks to know if emotional information was processed in the first place. That is, without an interference effect, it is possible that activation of emotional information occurred efficiently, but it is also possible that it did not occur at all, so one cannot assume that the information had no impact on subsequent processing.

The dichotic listening task, although often conceptualized as a dual-task paradigm, is also not a strong test of efficient processing. This is because the task is generally set up such that participants are not actually encouraged to conduct simultaneous tasks (they are only asked to listen to one channel), and it is typically the case that threat information is presented to the unattended channel. If this threat information has no impact on the processing of material in the attended channel, it is difficult to know whether the null result occurred due to efficient processing of the threat information or due to lack of activation of this information because it was truly unattended. (Note that this is the same problem with interpreting results on other interference tasks, such as the Stroop task, as evidence for efficient processing – the tasks can reflect inefficiency more effectively than they can efficiency.) Thus, dichotic listening tasks are only reviewed here in the studies where the task is completed at the same time as an independent secondary task, making it a more reliable dual-task paradigm.

Another approach to assess efficiency more directly (besides dual-task paradigms) is to evaluate whether the processing of emotional information is made more difficult when different levels of distracting information are presented. If varying levels of distraction do not differentially impair performance, then the inference is that processing emotional information requires minimal resources because increasing load does not affect completion of the primary task. Certain forms of visual search tasks offer this opportunity. There are a number of variants in this class of tasks (we discuss an alternate form in the section on uncontrollable processing), but the specific case in which participants are instructed to detect an emotion-relevant stimulus among a set of neutral distracters can demonstrate efficient processing if increasing the number of distracters does not influence the time it takes participants to detect the emotional target.

Some other tasks, such as the attentional blink task (often referred to as a Rapid Serial Visual Presentation paradigm; RSVP) in which participants are asked to identify two sequentially presented targets that appear very rapidly, can potentially provide a useful measure of efficient processing. Specifically, the efficiency of correctly naming the second target varies by the time interval between presentation of the two targets because if the timing is very close then it becomes more difficult to identify the second target. Typically, the emotion-relevant stimulus is presented as the second target (e.g., Trippe, Hewig, Heydel, Hecht, & Miltner, 2007); however, presenting it as the first target and manipulating the time lag may better capture (in)efficient processing because one could then determine whether the resources to process the emotional first target interfered with naming the subsequent neutral second target as a function of how much intervening processing time was allowed (see Yiend, 2010).

Thus, this review of efficiency is limited to studies that use dual-task paradigms or a paradigm in which load or time lag is manipulated (e.g., varying the number of distracters). Few studies with diagnosed samples meet these rigorous requirements, so this is a critical area for future research.

Results: Efficient Processing In Anxiety Disorders—For a list of studies evaluating efficient processing in anxiety disorders, see Table 2. Although there has been little work with the variable-distracter variant of visual search tasks with diagnosed samples, a study by Eastwood et al. (2005) provides an intriguing example of the complexity of findings with respect to efficient processing in anxiety disorders. These authors examined speed of detecting happy or sad schematic faces among sets of neutral schematic face distracters and varied the number of distracters in the arrays. Using diagnosed, treatment-seeking samples with social phobia, panic disorder, or OCD, as well as a non-clinical control group, Eastwood et al. found that persons with social phobia and participants with panic disorder had shallower slopes for detecting the sad versus happy faces than did participants in the other two groups. This finding indicates that changes in distracter set size had a smaller impact for the negative (compared to positive) stimuli for these participants, suggesting a relative bias to detect negative stimuli more efficiently. Importantly, the slope was not flat, suggesting that distracter set size did have an effect (i.e., there was some loss of efficiency), just less of an impact for the negative than for the positive faces. This negative versus positive face bias was not evident either in the control group or in the OCD group; whether this reflects a true difference across anxiety disorders or a methodological issue particular to this study (e.g., the OCD sample contained only 16 people and stimuli were not OCD-specific) is unclear. Nevertheless, this appears to be a promising approach for investigating efficiency because of the opportunity to manipulate distracter set size.

Unfortunately, few studies conducted with diagnosed samples have used paradigms that have a second task that requires attentional resources. Nonetheless, there are some interesting dual-task studies that highlight the seeming inefficiency of processing emotional information in anxiety disorders. Beck, Stanley, Averill, Baldwin, and Deagle (1992) had participants read aloud one word from a pair of presented words that varied in their threat content, while simultaneously detecting a small probe. They found that panic disordered patients were slower to detect the probe during presentation of panic-relevant and positive stimuli, suggesting that processing the emotional information (irrespective of valence) reduced the efficiency with which participants completed the secondary task. They modeled their paradigm on an earlier study by MacLeod, Mathews, and Tata (1986), who also found that GAD patients were slower to detect probes when threat items were presented in the word pair.

Finally, the RSVP paradigm has yet to be used frequently with diagnosed samples, and there is little evidence for efficient processing with this task (e.g., Olatunji, Ciesielski, & Zald, 2011, found reduced target detection accuracy for erotic material among a sample with OCD at long, but not short, stimulus durations, suggesting processing of disorder-relevant material was not efficient).

At this stage, it is clear that more research is needed that systematically introduces a secondary task, thus manipulating attentional resource demands, in order to assess efficiency in anxiety disorders (we found only a handful of articles addressing this feature in anxiety disorders, and no disorder showed strong evidence of efficiency). Thus, while the results of studies to date suggest that processing is not efficient in anxiety disorders, this conclusion must remain tentative.

Results: Efficient Processing In MDD—Similar to our discussion of the anxiety disorders literature, evaluating efficiency of processing in MDD is difficult because few studies have provided reason to believe that emotional information was activated and also incorporated a secondary task that required attentional resources. For a description of studies evaluating efficient processing in MDD, see Table 2. In one of the few actual dual-task investigations of dichotic listening in diagnosed MDD participants, McCabe and Gotlib (1993) combined the dichotic listening task with a secondary task in which participants' response times to a light probe were assessed while they were engaged in the dichotic listening task. Clinically depressed participants took longer to respond to the light probe when negative words, compared to positive or neutral words, were presented on the unattended channel, suggesting inefficiency in the processing of negative material.

Similar to the Eastwood et al. (2005) study discussed previously, Suslow et al. (2004) manipulated set size in a visual search task. Contrary to Eastwood et al.'s findings, however, Suslow et al. did not find display size to differentially affect processing of positive or negative material in control participants, compared to MDD participants. These findings suggest that processing of mood-congruent information is efficient for both groups. In sum, findings so far are mixed, but most importantly, there is a paucity of studies from which to draw conclusions about the efficiency of emotional processing in MDD.

Unintentional Processing

Bargh (1994) posited that intention reflects "whether one is in control over the instigation or 'start up' of processes" (p. 16), and contended that activation of valence evaluation regularly occurs without intention, with significant consequences for all manner of social phenomenon, including stereotype activation and trait inferences. In more recent writings in the area of social cognition, Gawronski and Bodenhausen (2007) reinforced this definition and conclusion, noting that evaluative associations and resulting emotional reactions can occur regardless of the (lack of a) goal to evaluate the object. They draw on findings from cognitive neuroscience that suggest that affective responses, indexed by activation in the amygdala, can occur without intent to evaluate (e.g., Cunningham, Raye, & Johnson, 2004). It is important to note that labeling a process as unintentional is not equivalent to stating that it is counter to, or against, one's conscious intentions; rather, it simply means that intention is not required.

Relatively little has been written about the role of unintentional processing in anxiety disorders and MDD, perhaps not surprising given Shiffrin and Schneider's (1977) view that this feature is an optional, but not requisite characteristic of automaticity. For instance, Hartlage et al. (1993) focused on effortful processing in depressive disorders, but paid less attention to the unique role of goal-dependent processing. In his important review of automaticity in anxiety disorders, McNally (1995) emphasized the criterion 'involuntary,' which in some respects blends the features unintentional and uncontrollable. The emphasis in McNally's paper, however, seemed to be on the control component.

Methods: Unintentional Processing—Tasks that assess interference effects, such as the Stroop task, have often been used in cognitive and social psychology to investigate unintentional processing (see Moors & De Houwer, 2006; Posner & Snyder, 1975). While this relatively simple method of evaluating intention (assessing biases that are due to goal-irrelevant features of the task) is frequently followed, Moors and De Houwer (2006) note the limitations of using this yardstick. In particular, giving task instructions that are irrelevant to the processing of emotional information (e.g., naming ink color, identifying the location of a dot probe) does not preclude the individual from simultaneously having a goal of evaluating valence or emotional information. Further, if one accepts that goals can be activated unconsciously (and there is considerable evidence for this idea; see reviews in Bargh, 2005, and Moskowitz, Li, & Kirk, 2004), then it becomes even more complicated to determine whether processing is truly unintentional. To date, paradigms used in psychopathology research do not directly assess whether participants had a conscious or unconscious goal of processing emotional information. This is a critical area for future research. In the meantime, however, to have some confidence that a task actually demonstrates unintentional processing, we focus on paradigms in which it is plausible that participants did not have a goal to engage in the act of processing emotional information, yet this processing clearly occurred. While some studies that show interference effects fit these criteria more effectively than do others, because goal activation has so rarely been assessed, each paradigm requires that we make some assumptions if we are to infer that unintentional processing occurred.

The supraliminal Stroop task provides some useful evidence to assess unintentional processing so we review this task here. This task is similar to the subliminal Stroop task except that stimuli are presented for a longer duration and are not masked, permitting conscious processing of items. One reason why it is plausible that participants do not have a goal to process the meaning of words is that the color naming task occurs simultaneously with the presentation of the word (activating its meaning), so participants may be aware that processing the meaning is distracting them from the assigned task of color naming. Moreover, instructions for the task frequently tell participants explicitly that they should ignore the meaning of the word and just try to state the color (e.g., Teachman, Smith-Janik, & Saporito, 2007). Thus, while we still have to accept that participants follow this instruction, it is plausible with this task that there is no goal to engage in processing the emotional meaning of the stimuli. Notably, we exclude functional magnetic resonance imaging (fMRI) studies in which the Stroop task was completed while the participant was in the scanner, because the task is usually administered in an atypical format in these studies (e.g., stimuli are presented for very long durations).

We decided to also review evidence from supraliminal dot-probe tasks here, although we feel this task provides more ambiguous evidence for unintentional processing than does the supraliminal Stroop task. On the dot-probe task, two stimuli (typically, one neutral and one threat-relevant) are presented simultaneously and participants are simply asked to identify the location in which a dot probe appears following the stimuli presentation (or to identify some feature of the probe, such as whether a presented arrow is pointing up or down). Thus, participants are not instructed to attend to the meaning of the stimuli, and these previously presented stimuli are irrelevant to the goal of finding the probe. It seems reasonable, then, to infer that participants would not have a goal of focusing on the emotional stimuli because they are supposed to be irrelevant to identifying the probe. However, given that the emotional stimuli are presented separately from the material that requires a response (i.e., the probes), it is possible that participants intentionally want to process the stimuli and view this as a goal separate from reacting to the probe. We also include evidence from a related paradigm, a modified Posner task, that tries to distinguish among attentional processes, such as difficulty disengaging from, versus enhanced orienting toward, threat stimuli by presenting a single stimulus followed by a probe on either the same or the opposite side as the stimulus.

The subliminal variants of the Stroop and dot-probe tasks provide an interesting case where the lack of awareness of the emotion-relevant stimuli means it is unlikely that participants will have a conscious goal to process stimuli of which they are unaware, thereby making these tasks reasonable candidates for assessing unintentional processing. Determining goal activation with these paradigms, however, is particularly difficult. So, while we will not reiterate the findings for the subliminal Stroop and dot-probe tasks here in the interest of space (see section on unconscious processing), we believe that these tasks also provide some evidence, albeit imperfect, that speaks to unintentional processing.

We do not include tasks, such as lexical decision, visual search, and many priming tasks, in which participants need to identify the meaning of stimuli to perform the goal-relevant feature of the task (e.g., deciding if a stimulus is a word or fits a particular category), because we do not think it plausible that participants do not have a goal of processing the meaning of the emotional stimuli. Notably, while priming studies are generally limited in their ability to assess unintentional processing, an exception to this is the negative priming task in which participants are asked to ignore the prime. In this task, participants are explicitly instructed to respond to a target word (e.g., the red word) and to ignore a distracter word (e.g., the blue word) that is presented simultaneously and in close proximity to the target word. Participants are instructed to evaluate whether the target word is positive or negative. On the next trial, a target word is presented that is either related or unrelated to the previously ignored word. The latency to evaluate the valence of a target word when a negative distracter on trial A is followed by a negative target on trial B comprises the critical condition. This latency is compared to a control condition in which the previously presented distracter from trial A is unrelated to the target on trial B. The comparison assesses the strength of inhibition of the previously presented, task-irrelevant distracter. Thus, we also review negative priming studies here.

In summary, although we have noted variability in the likely effectiveness of these tasks to capture unintentional processing, there are a number of tasks in which it is plausible that participants did not have a goal to engage in the act of processing emotional information, yet this processing apparently occurred. Thus, in this section we evaluate whether there is convergent evidence of unintentional processing across the following paradigms: supraliminal and subliminal Stroop and dot probe tasks, the modified Posner and negative priming tasks.

Results: Unintentional Processing In Anxiety Disorders—For a summary of studies evaluating unintentional processing in anxiety disorders, see Table 3. The majority of relevant evidence comes from supraliminal Stroop studies; in fact, there are dozens of relevant investigations. While there are certainly many null findings, the overall body of evidence points to supraliminal Stroop effects, with multiple positive findings for each of the anxiety disorders. Nevertheless, it is important to note that consistency of the evidence was variable across disorders in our review. Effects were robust for both GAD and PTSD (with the majority of published studies showed significant interference effects), and also reasonably consistent for social phobia. There was more moderate evidence of interference effects in panic disorder and specific phobias, with approximately half the studies showing significant effects. In contrast, the evidence was weak in OCD, with fewer than one-quarter of studies showing the expected effects. It is not immediately obvious why effects differ so much for OCD, though it does seem clear that interference effects on the Stroop task are enhanced when investigators use personally relevant, negative stimuli (see Williams et al., 1996; Yiend, 2010), which may be more challenging to do for OCD samples given the considerable heterogeneity of the symptom presentations in this disorder.

On the dot-probe task, an attention bias to threat-relevant information is inferred from relatively faster responses on trials in which the dot appeared in the same spatial location as the threat (versus neutral) cue. Evidence for enhanced identification of the dot following threat-relevant cues has been observed in each of the anxiety disorders (see Table 3). Further, in the related modified Posner task, Amir, Elias, Klumpp, and Przeworski (2003) found that individuals with social phobia were slower than were control participants at diverting their attention from social threat cues. Again, however, results for the dot-probe and Posner tasks vary across disorders. The findings mostly paralleled the pattern observed with the supraliminal Stroop task, though there are fewer tests with the dot probe task with diagnosed samples, and there were generally more mixed findings. Once more, results were strongest for GAD, and findings in studies of social phobia and panic disorder were also mostly in the expected direction. However, the small number of studies (usually only 1-3 per disorder) for OCD, PTSD, and specific phobias did not indicate a reliable pattern of effects. There were also only three negative priming studies identified, and the results of these studies were not consistent.

Small sample sizes may explain the results for at least some null findings. Also, Mogg and Bradley (2006) propose that results may be more robust in specific phobias when stimuli are presented for shorter (200 ms) rather than for extended durations (500 ms or longer), suggesting an initial orienting effect. In contrast, dot-probe effects are found fairly consistently in GAD at a longer duration (500 ms), perhaps indicating less rapidly engaged avoidance tendencies in GAD (see Mogg & Bradley). Notably, some investigators have reported a bias *away* from threat-relevant information on this task (e.g., Chen, Ehlers, Clark, & Mansell, 2002), suggesting possible avoidance of threat stimuli (and counter to the expectation of unintentional orienting toward threat stimuli).

Taken together, the supraliminal and subliminal Stroop, the dot-probe, and the negative priming tasks provide some evidence that processing emotional information occurs unintentionally across a range of anxiety disorders, though results vary by disorder. The combined evidence across tasks indicates strong support for unintentional processing in GAD and PTSD (over three quarters of studies showed expected effects), considerable evidence in social phobia (approximately two thirds of studies showed expected effects), more moderate support in panic disorder (around half of studies), and only minimal support in specific phobia and OCD (approximately one quarter to one third of studies). Overall, Bar-Haim et al. (2007) reported a combined effect size on the Stroop and dot-probe tasks of d=.32 for the subliminal versions and d=.48 for the supraliminal versions, suggesting small to moderate effect sizes. Thus, while it is important to keep in mind that it is sometimes ambiguous in these paradigms whether participants adopted a goal of processing the emotional information, the findings are congruent with the idea of unintentional processing in most of the anxiety disorders.

Results: Unintentional Processing In MDD—In contrast to the anxiety disorders literature, which provides many examples of interference effects on the supraliminal Stroop and dot-probe tasks (as well as some failures to replicate), the findings in the depression literature are considerably less robust (See Table 3). Gotlib and Cane (1987) were the first to demonstrate a Stroop effect in clinically depressed participants. Using an exposure duration of 1500 ms, they tested participants before and after treatment, and found that the MDD patients showed increased interference in response to negative words only pre-treatment. In contrast, Mogg et al. (1993) compared participants with GAD and participants diagnosed with depressive disorders, and did not find increased interference for the depressed participants (see also Constant et al., 2006; Dozois & Dobson, 2001; Fritzsche et al., 2010). Similarly, Bradley, Mogg, Millar et al. (1995) also found that MDD was not associated with increased Stroop interference; furthermore, as noted earlier, the interference effect was not present in GAD patients who were comorbid with depressive disorders. Sigmon and colleagues (Sigmon et al., 2007) found increased interference in their depressed sample, but it was not specific to negative words. Findings from other studies of increased interference for negative words in MDD must be considered preliminary given small sample sizes (e.g., Dai & Feng, 2011; Dudley, O'Brien, Barnett, McGuckin, & Britton, 2002). Overall, these findings suggest that Stroop interference from negative words, even if the words are presented at longer presentation times, does not reliably characterize MDD.

The primary exceptions to this pattern are studies that have investigated Stroop interference for self-descriptive words, often combined with a priming procedure. Segal and Vella (1990), for example, demonstrated that depressed patients showed increased Stroop interference in response to positive (e.g., trustworthy, sincere) and negative (e.g., selfish, quarrelsome) self-descriptive words when the Stroop task was preceded by the presentation of a self-descriptive prime (in which participants rated self-descriptive adjectives). Similarly, Segal, Gemar, Truchon, Guirguis, and Horowitz (1995) reported the strongest interference effects in a condition in which depressed patients had to respond to negative self-descriptive words on a Stroop task that followed the presentation of negative sentences (e.g., hard to trust others; see also Nunn, Matthews, & Trower, 1997). Segal et al. (1995) concluded that interference effects in MDD are observed only if the stimuli are clearly self-relevant and if the Stroop task is combined with a priming procedure prior to performing the task.

In sum, these studies provide inconsistent evidence for unintentional processing of emotional material in MDD. There are many null results. However, if priming is used and the emotional material is characterized by high personal salience and stimuli are presented for relatively long periods of time (e.g., a full second or more), the emotional content of the presented stimuli seems to interfere with performance on the concurrent task. It is challenging to interpret these findings in terms of unintentional processing. Specifically, we must question whether participants had no conscious or unconscious goal to process the material if it is necessary for emotional material to be presented for prolonged durations, if it needs to be highly relevant to the person, if it follows an emotional prime, or if it interferes only if participants are given explicit instructions to elaborate on it (see Watkins, Vache, Verney, & Mathews, 1996). The activation of unconscious goals to engage in the processing of the material, or even conscious, intentional elaboration of the material, seems likely under these circumstances. Therefore, while some Stroop studies report evidence for interference effects in MDD, these studies do not provide convincing evidence that the processing of the emotional material was indeed unintentional.

As we discussed previously, dot-probe studies do not provide as strong a test of unintentional processing because participants are not usually given an instruction to ignore the emotional faces or words that are presented before the dot probe. Still, one could argue that participants might recognize that the best strategy to respond to the probe is to ignore the previously presented emotional material and to stay focused on the center of the screen. Results from the dot-probe task in MDD are as inconsistent as the Stroop findings. Early studies using the dot-probe task found no indication of a depression-associated bias when presenting the stimuli supraliminally for 500 ms (MacLeod et al., 1986; Mathews et al., 1996). As Bradley, Mogg, and Lee (1997) pointed out, however, investigators have found attentional biases in MDD using tasks with relatively long stimuli exposure durations of one second or more. In addition, it is noteworthy that most studies have used verbal stimuli (i.e., valenced words) to assess biases in depressed participants.

In one of the first studies to use the dot-probe task with emotional faces in a sample with MDD, Mogg, Millar, and Bradley (2000) did not find evidence for an attentional bias to sad faces at a one-second exposure duration (though 13 of the 15 depressed participants in this study had a comorbid diagnosis of GAD, making it impossible to determine whether the absence of an attentional bias was due to MDD or to co-occurring GAD). In contrast, in two studies, Gotlib, Kasch, et al., (2004) and Gotlib, Krasnoperaova, Yue, and Joormann (2004) found that clinically depressed participants (with no comorbid anxiety disorder) oriented towards sad faces that were presented for one second; GAD and social phobia control participants did not exhibit this bias. Moreover, the attentional bias in the depressed participants in these studies was specific to sad faces; it was not obtained in response to the presentation of angry or happy faces. These findings were replicated in new samples of depressed participants who exhibited attentional biases towards sad faces that were presented for one second (Fritzsche et al., 2010; Joormann & Gotlib, 2007; see also Donaldson, Lam, & Mathews, 2007). Using a Posner task, Leyman, De Raedt, Schacht, and Koster (2007) reported attention to angry faces in MDD using a 1000 ms presentation time. Similarly, Ellenbogen and Schwartzman (2009) reported that depressed participants in a modified Posner task had difficulties disengaging from negative pictures. In sum, although the dot-probe task has limitations for assessing unintentional processing, it is noteworthy that depressed participants are again only distracted by emotional material if it is presented for a long duration. Thus, as with the Stroop results, it is not clear that the conditions under which dot-probe effects appear are consistent with evidence for unintentional processing (i.e., that participants had no goal to process this material).

Contrasting results have been found, however, using a negative priming task. Goeleven, De Raedt, Baert, and Koster (2006) and Joormann and Gotlib (2010) found that MDD participants showed interference effects when making valence judgments if they had been primed with a negative irrelevant picture (see also Dai, Feng, & Koster, 2011; Yao et al., 2010). Other studies, however, did not find a difference between MDD and control participants in negative priming for negative material (Leung, Lee, Wong et al., 2009; Leung, Lee, Yip, Li, & Wong, 2009). Some of these findings, however, should be considered preliminary given the small sample sizes (e.g., Leung, Lee, Wong et al., 2009). Thus, although replications are needed, negative priming designs warrant attention in future studies of unintentionality in MDD. In addition, as we described earlier, explicitly instructing participants to ignore a prime does not ensure that they have no conscious or unconscious goal of processing the stimulus, especially if it is highly salient and is presented for a long time.

Our conclusion that MDD is not strongly or uniquely characterized by unintentional processing of the emotional meaning of stimuli may seem surprising. In summarizing these findings, it is important to keep in mind that there are considerable data indicating that unintentional processing of the negative valence of stimuli characterizes healthy participants and individuals with psychological disorders alike. Bargh (1994) summarizes the literature on the automatic affective evaluation effect and concludes that an initial evaluation of all stimuli as good or bad is part of information processing in general. In a recent review, Ferguson and Zayas (2009) pointed out that humans continuously evaluate stimuli in an automatic fashion. These evaluations take place even when individuals have no intention to evaluate them. Indeed, the fact that the unintentional affective evaluation of negative stimuli is so ubiquitous could explain, in part, why depressed and nondepressed people do not differ on tasks assessing intentionality. That is, because both depressed and nondepressed individuals might show the same pattern of unintentional evaluation, no group differences would emerge on the tasks. Indeed, both depressed and nondepressed people have been found to be biased to process emotional over neutral material (see Koster, Verschuere, Burssens, Custers, & Crombez, 2007).

If this is the case, though, why does our review of unintentional processing suggest that people with anxiety disorders differ from their non-anxious counterparts? It may be that the stimuli used in studies on anxiety disorders vary considerably in their threat value for anxious and non-anxious participants. Thus, stimuli like trauma cues and spiders might be very emotionally relevant for anxious individuals, but not for non-anxious people. In contrast, the reason that fewer differences between depressed and nondepressed individuals have been found may be because material that is evaluated negatively by depressed participants is also evaluated negatively by nondepressed participants. While these explanations are speculative, they are nevertheless consistent with the finding that depression-associated differences are obtained in unintentional processing if the stimuli are particularly self-relevant or are processed self-referentially.

In sum, although it would be too strong a conclusion to state that there is no evidence for unintentional processing of emotional information in MDD, it is certainly the case that the data for this component of automaticity are less compelling at this stage than they are for anxiety disorders. We speculate that this might be due to the ubiquitous nature of unintentional processing of negative material, such that both depressed and nondepressed participants unintentionally evaluate emotional material as good or bad. Further, the finding that differences between depressed and nondepressed individuals in interference effects are obtained most frequently when stimuli are presented for an extended period of time and are personally relevant, or when the initial encounter with the stimulus calls for greater elaboration, raises questions about whether these effects can correctly be labeled unintentional.

Uncontrollable Processing

Like intentionality, controllability also reflects a goal-related process. But whereas intentionality focuses on the goal to engage in processing the emotional meaning of a stimulus, controllability reflects the goal to avoid, alter, or stop this processing. It has long been recognized in the field of anxiety disorders that fear processing is difficult to control. McNally (1995) noted that “it is the inability of the patient to terminate fear-generating processing once it starts that is the hallmark of pathological anxiety” (p. 752). Similarly, Wells and Matthews (1994) suggested that “insensitivity to voluntary control” is one of the two key criteria for automaticity (“independence from attentional resources” is the other criterion). Moreover, Öhman and Mineka (2001) proposed that an evolved fear module exists that is “relatively impenetrable to cognitive control.” Other theorists have gone a step further, positing that uncontrollability may play a causal role in the development of anxiety disorders. In particular, Mathews and MacLeod (2005) suggested that “emotional disorders are likely to arise when strength of emotional activation exceeds the capacity for attentional control over mental contents” (p. 177).

Methods: Uncontrollable Processing—Establishing evidence for uncontrollable processing falls prey to the same problem that we identified regarding the measurement of unintentional processing; specifically, goals related to processing emotional information are not typically measured in psychopathology research. Thus, while interference effects are often used as evidence for uncontrolled processing – because the individual continued to process the emotional meaning of the stimulus even though it was not relevant to (and interfered with) the task demands – we do not know whether the individual could have, or tried to, avoid or override the process. This is especially problematic in light of the fact that controlled, self-regulatory processing can occur unconsciously. As a result, like the compromise we adopted for evaluating unintentional processing in the previous section, we rely on paradigms where it seems reasonable to infer participants’ goal state. Specifically, to infer uncontrollability, it must be reasonable to assume participants have a goal to counteract the activation of emotional information, either by avoiding, altering, or terminating this activation. Thus, akin to evaluating unintentionality, some paradigms that reflect interference effects meet this standard more effectively than do others.

For instance, the supraliminal Stroop task (discussed in the unintentionality section) likely provides evidence of uncontrollable processing of emotional information given that participants are often given a direct instruction to ignore the meaning of stimuli. Similarly, the negative priming design is a good candidate because, although participants are explicitly instructed to ignore an emotionally-relevant second stimulus in this task, it still influences task performance. The supraliminal dot-probe task does not as plausibly activate a goal of ignoring the meaning of the pictures or words presented prior to the probe; thus, it provides some evidence for uncontrollable processing, but it is less compelling. In fact, in some versions of the dot-probe task, participants are instructed to engage with this material (e.g., Asmundson & Stein, 1994, had participants read one of the presented words aloud), making an avoidance goal improbable. Thus, the supraliminal dot-probe task is not reviewed here.

The difficulty in determining participants' goal activation limits our ability to draw strong conclusions from any one task assessing uncontrollable processing. This is especially challenging with the subliminal variants of the Stroop and dot–probe tasks because there is no way to know whether participants have an unconscious goal to stop or avoid processing the impoverished stimuli. In these cases, participants are less likely to be aware of the influence of the subliminal stimuli (compared to the supraliminal stimuli), so may be less apt to spontaneously try to alter their processing. This limitation makes it difficult to determine whether or not processing can be controlled when there is a goal to counteract the process (i.e., if processing is uncontrollable). That said, processing of emotion-relevant stimuli on these tasks may still be uncontrolled in that the stimuli have effects even when there is no goal to alter or avoid the process. Given these constraints, and because our primary interest is in whether a process is controllable when an individual has a goal to counteract it, we consider the subliminal tasks to provide less impressive evidence regarding uncontrollable processing, and do not review them here.

Many priming paradigms (e.g., affective and semantic priming, and some forms of the lexical decision task) have this same limitation because it is not clear whether participants have a goal to counteract activation of the prime, given that the prime occurs in advance of the target presentation. Participants may not recognize that the prime is relevant to their reactions to the target stimuli so may not try to counteract the primes' effects (meaning the task may show uncontrolled processing, but it is hard to infer whether it was uncontrollable without evidence of a goal to alter processing of the prime).

We can feel most confident that uncontrollability has been demonstrated with tasks in which participants are given (or would likely assume) a goal to stop or avoid processing emotion-relevant information, and we see evidence that they have failed at this goal. As with the supraliminal Stroop and negative priming tasks, this goal seems plausible with implicit association tasks. There are a variety of implicit association approaches that share the assumption that reaction time (e.g., to classify stimuli) can reflect strength of association between concepts in memory. For instance, in the Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998), participants are asked to classify stimuli into superordinate categories while the categories are paired in a way that either matches hypothesized automatic associations between those categories or that contradicts those associations. Slower classification on the trials in one set of category pairings than in the other (e.g., when the category 'snakes' is paired with the category 'good,' versus when it is paired with the category 'bad') is interpreted as evidence that the categories are not readily associated. By changing the category labels and associated stimuli, this paradigm can be adapted to reflect a range of psychopathology-relevant associations (see De Houwer, 2002; Teachman & Woody, 2004; Roefs et al., 2011). Typically, the task is thought to reflect an automatic evaluation of some kind of target category (e.g., that the self is anxious versus calm, that spiders are dangerous versus safe), although the exact meaning of these automatic associations continues to be debated (e.g., Rothermund & Wentura, 2004).

We view implicit association measures as indicative of uncontrollable processing because participants are encouraged to categorize the stimuli without regard to the category paired with the one determining that trial's categorization (e.g., a picture of a python should be

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placed into the snake category just as quickly when the snake category is paired with the category good as when it is paired with the category bad). Yet, interference effects on this task (e.g., slower reaction times to classify stimuli when the superordinate target categories are paired with descriptor categories that are not readily associated with the targets) indicate an inability to stop processing the emotional associations that the category pairs represent. In addition, there is some evidence indicating that even when given an instruction to show a particular pattern on the task, it can be difficult to produce that effect (see Greenwald et al., 1998), though there are cases where instructions can influence performance (e.g., Fiedler & Blümke, 2005).

Visual search tasks also demonstrate an interesting example of uncontrollable processing. As we noted earlier in the section on efficiency, there are a number of variants in this class of tasks, but all have in common the idea that speed of detecting a target cue embedded in a matrix of other cues will vary as a function of whether the target is threat-relevant and whether the target is presented among a set of other cues that are threat-relevant. It is those cases in which the distracter items are threat-relevant that we see some evidence of uncontrollable processing (note, however, that it was the targets that were threat-relevant in the case of visual search tasks that help assess efficiency). When distracters are threat-relevant, it is likely clear to participants that they should stop processing the distracter stimuli once they have rejected them as not being the target; thus, it seems plausible that they would have a goal of counteracting the activation of the distracter stimuli.

Finally, we consider evidence from thought suppression and directed forgetting paradigms (and related tasks, such as Think-No-Think, and the modified Sternberg task), that reflect a different approach to evaluating uncontrollability. Unlike the previously discussed studies that examine interference effects, the explicit goal of thought suppression tasks is to override the intrusive presence of an unwanted thought. Typically, in thought suppression studies participants are asked to not think about a given thought or image (after having previously focused on that stimulus), and investigators examine the duration and/or frequency with which that unwanted thought is reported to have come to mind. A general finding from studies with non-clinical samples is that thoughts are more likely to recur when participants previously tried to suppress, versus simply monitor, them (see Wegner, 1994; Wenzlaff & Wegner, 2000). This suggests that uncontrollability is a common phenomenon; people find it difficult to purposefully alter their thoughts or stop thinking about a topic. In this section, we consider whether this difficulty is more pronounced in clinically anxious samples.

The directed forgetting paradigm is also relevant for evaluating uncontrolled processing because it includes explicit instructions to participants to not keep a given stimulus active in memory. There are two versions of this paradigm: the list version and the item version. In the list version of the task, participants practice learning a word list and are then instructed mid-way through to forget that list and focus instead on learning a new word list. They are later surprised with an incidental recall task that tests their memory for both word lists to determine whether the ‘directed forgetting’ instructions influenced recall. The general finding of this research is that individuals recall fewer items from the to-be-forgotten list than from the second list (see Golding, 2005). Poorer recall of the to-be-forgotten items following the list method is thought to reflect inhibited retrieval for these items (e.g., Bjork, 1989). An alternate version of the task, the item version, instructs participants to forget or remember individual items, rather than a full list. In this case, poorer recall of to-be-forgotten items is thought to reflect an encoding deficit for these items (see MacLeod, 1999). We expect that both versions of the task assess uncontrollable processing, but uncontrollability at the encoding stage may be more relevant for the item method, whereas uncontrollability at the retrieval stage may be more relevant for the list method. Here we examine whether clinical samples differ in their tendency to recall formerly to-be-forgotten, threat-relevant items.

In the Think-No-Think task, which is similar to directed forgetting tasks, participants first learn to associate neutral cue words with emotional target words. In the next phase of the experiment, participants try to suppress these learned associations (i.e., they are asked to not think about the associated target word when they see the cue word). This task provides an interesting measure of uncontrollability: not only are participants instructed to not think about the associated emotional word, but they are also given an opportunity to practice suppressing the word and are provided with feedback if they are unsuccessful. Finally, after completing this training phase, participants' recall of all words is tested.

Last, in the modified Sternberg task (also termed the Ignore/Suppress Task), participants are asked to learn two lists of words and are then instructed to forget one of them. To test the impact of the forgetting instructions, participants are then presented with a probe word and are asked to determine its source: the to-be-remembered list, the to-be-forgotten list, or a completely new word. Decision errors and latencies are assessed. This task assesses whether people are able to control the processing of emotional material by assessing how much the to-be-forgotten material interferes with the task of deciding whether the probe is a word that was supposed to have been maintained or forgotten.

Taken together, even using relatively conservative guidelines for task inclusion, there are a number of tasks that can be examined to infer uncontrollable processing: implicit association measures, visual search tasks (when threat-relevant stimuli are distracters), thought suppression and directed forgetting paradigms, as well as related tasks like Think-No-Think and modified Sternberg (all reviewed below), and the supraliminal Stroop and negative priming tasks (reviewed earlier).

Results: Uncontrollable Processing In Anxiety Disorders—For a list of studies evaluating uncontrollable processing in anxiety disorders, see Table 4. To date, the majority of studies of anxiety disorders that have used implicit association tasks, such as the IAT, Go/No-go Association Task (GNAT; Nosek & Banaji, 2001) and Extrinsic Affective Simon Task (EAST; De Houwer, 2003), have been conducted with undiagnosed anxious samples. Studies with diagnosed samples, however, are accumulating. For instance, Teachman and Woody (2003) found greater implicit spider fear associations in diagnosed phobic participants than in non-phobic controls, and Teachman et al. (2007) found more implicit panic associations in participants diagnosed with panic disorder. In addition, recent evidence from Glashouwer and de Jong (2010) points to the specificity of IAT effects and their sensitivity to symptom severity. Based on data from a large, multi-center study in the Netherlands, they found that individuals with anxiety disorders (GAD, panic disorder, social phobia and agoraphobia) had elevated self-anxious associations on an IAT, whereas individuals with MDD had elevated self-depression associations. Persons with comorbid depressive and anxiety disorders were elevated on both IAT tasks, and remitted individuals scored between the anxious/depressed diagnosed sample and the control group. (This study is listed in the MDD section of Table 4 because it uses a mixed anxiety disorders sample.) Together, these results suggest a pattern of more psychopathology-relevant implicit associations among anxious individuals, though to date not all of the anxiety disorders have been examined.

Similarly, the visual search task has only been applied with a subset of the anxiety disorders, but results have suggested a mostly consistent pattern among those disorders that have been investigated. For instance, Rinck and Becker (2005) reported that women with social phobia were slower to detect a target word embedded in a matrix of social anxiety-relevant words than within a matrix of alternate distracter words (see also Baños, Quero, & Botella, 2008). Further, Miltner, Krieschel, Hecht, Trippe, and Weiss (2004) established that persons with spider phobia were slower to detect a neutral (mushroom) picture amidst a matrix of spider pictures, relative to other matrices. Overall, these results are consistent with the findings from the supraliminal Stroop and implicit association paradigms – although more data are needed to determine whether this effect holds across the full range of anxiety disorders, even when it seems likely that anxious participants would have a goal of counteracting the activation of emotional information, interference effects suggest they were unable to control this process.

The results of studies using thought suppression and directed forgetting tasks are less consistent. In their meta-analysis of thought suppression studies, Abramowitz, Tolin, and Street (2001) did not find larger effects among participants with anxiety diagnoses than among nonclinical samples. It is important to note, however, that only four studies in their meta-analysis had used diagnosed anxiety disordered samples. The results of some more recent studies suggest that clinical samples do indeed have particular difficulty suppressing unwanted thoughts (e.g., in social phobia: Kingsep & Page, 2010; in agoraphobia: Fehm & Margraf, 2002; in OCD: Najmi, Riemann, & Wegner, 2009; in GAD: Becker, Rinck, Roth, & Margraf, 1998), though a recent meta-analysis again found minimal differences when comparing a range of psychopathology and healthy control samples (Magee, Harden, & Teachman, under review).

Few investigators have used the directed-forgetting paradigm to study anxiety disorders, and results vary by disorder. There is little evidence that PTSD samples differ in their tendency to recall formerly to-be-forgotten, threat-relevant items. For instance, no group differences were obtained in samples with PTSD relative to a no-trauma group (Zoellner, Sacks, & Foa, 2003), or to both a non-PTSD, trauma-exposed group and a no-trauma control group (McNally, Metzger, Lasko, Clancy, & Pitman, 1998). It is possible that dissociation tendencies that are particular to trauma reactions have a unique influence on directed forgetting because of related impairment in source memory (see Zoellner et al., 2003). In contrast, three studies have found that samples with OCD demonstrate a deficit in inhibiting retrieval of negative stimuli (e.g., Bohne, Keuthen, Tuschen-Caffier, & Wilhelm, 2005). Thus, as was the case with the thought suppression studies, given the paucity of investigations with diagnosed anxious samples and the inconsistent results, it is too early to draw firm conclusions about this paradigm across the anxiety disorders.

In summarizing the research on uncontrollability in anxiety pathology, it is important to separate the evidence derived from tasks that yield traditional interference effects (e.g., Stroop, negative priming, visual search and implicit association tasks) from the evidence drawn from thought suppression and directed forgetting studies. The latter category focuses on terminating the conscious processing of a previously focused upon stimulus; this evidence is not yet sufficiently compelling to support the position that the process is markedly different in clinical than in healthy samples (see Mathews & MacLeod, 2005). We consider this to be a rather different phenomenon, however, than the one assessed in the larger body of literature examining interference effects. These paradigms evaluate (indirectly) whether anxious individuals are unable to avoid or alter processing of an emotional stimulus or association, despite it being plausible that they had a goal to do so. In these studies, there was no initial, intentional focusing on the material as is the case in thought suppression and directed forgetting studies, and there may or may not have been explicit instructions to counteract processing the material (e.g., instructions to ignore the meaning of the word and focus only on the ink color are only sometimes used in Stroop tasks, whereas participants are routinely instructed to suppress in thought suppression studies).

Overall, we feel there is sufficient support for the hypothesis that uncontrollability is a common feature of automaticity in anxiety disorders. At this stage, this claim must be specific to uncontrollable processing of emotional information that was not previously held intentionally in working memory (demonstrated on the supraliminal Stroop, negative priming, visual search and implicit association tasks). Here, the convergent evidence is strongest in GAD and PTSD, followed by considerable evidence in social and specific phobias, moderate support in panic disorder, but almost no support in OCD. In contrast, results from the thought suppression and directed forgetting studies, in which participants receive explicit instructions to counteract processing material they have previously studied, suggest control difficulties most strongly in OCD (with a small number of positive results in agoraphobia, GAD, social and specific phobias, and no support in panic disorder or PTSD). Determining more explicitly what types of information are difficult to control across the anxiety disorders may help to explain the discrepant results for OCD samples across tasks (e.g., predominantly null findings on Stroop tasks, but relatively consistent, positive findings on thought suppression and directed forgetting tasks). While it seems likely that the tasks reviewed in this section capture distinct aspects of uncontrollability, it is noteworthy that all of the anxiety disorders show evidence of uncontrollable processing on at least some tasks.

Results: Uncontrollable Processing In MDD—As is the case in anxiety disorders, there is little doubt that uncontrollability is also an important feature of MDD. Indeed, cognitive theories of depressive disorders posit that difficulties in controlling negative thoughts, particularly in the form of rumination, play an important role in the onset, maintenance, and recurrence of depressive episodes. Rumination, which has been conceptualized as a trait-like response style that perpetuates depressive symptoms (Nolen-Hoeksema, 1991; Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008) and heightens vulnerability to future depressive episodes (Nolen-Hoeksema, Morrow, & Fredrickson, 1993), consists of persistent thoughts that enter consciousness and are difficult to control (Nolen-Hoeksema, 1987). Theorists have proposed that difficulties inhibiting the ongoing processing of negative material might underlie individual differences in rumination (Linville, 1996; Joormann, 2005, 2010). Similarly, Hertel (1997, 2004) has pointed out that depressive disorders are characterized by "habits of thoughts" and by difficulties in overriding these habits, manifested as deficits in cognitive control. For a summary of studies evaluating uncontrollable processing in MDD, see Table 4.

Given that uncontrollability plays such a central role in theoretical models of MDD, what is the empirical evidence for this construct? Evidence comes from the previously mentioned negative priming design, in which a number of studies suggest difficulties with inhibition for depressed participants (see Table 3), which we believe indicates uncontrollable processing.

We described implicit association paradigms in some detail with respect to anxiety disorders; not only has there been far less work with these tasks in the MDD field, but the findings are less consistent. Glashouwer and de Jong (2010) found differences between depressed and nondepressed participants in automatic self-depression associations (see also Risch et al., 2010). In contrast, De Raedt, Schacht, Franck, and De Houwer (2006) administered the IAT and the EAST to investigate implicit self-esteem in MDD and found no differences between diagnosed depressed and nondepressed participants (see also Franck, De Raedt, & De Houwer, 2008; Franck, De Raedt, Dereu, & van den Abbeele, 2007). Given the inconsistent findings and paucity of studies, it is difficult to make a clear statement about whether implicit association paradigms provide evidence for uncontrollability in MDD.

Notably, this pattern is similar to that obtained with MDD participants using visual search tasks. In contrast to the anxiety disorders literature, visual search tasks have been used infrequently in depression research, and the results have not suggested consistent distraction effects. The face-in-the-crowd task is probably the most frequently used visual search task in the MDD literature; overall, it appears that depressed participants are not distracted by negative facial expressions (Karparova, Kersting, & Suslow, 2005; Suslow et al., 2004), though Rinck and Becker (2005) did find that depressed participants were more easily distracted by negative words.

Only one study has examined intentional forgetting in participants diagnosed with MDD. Power, Dalgleish, Claudio, Tata, and Kentish (2000) used a directed forgetting task in which, halfway through the learning phase, depressed and nondepressed participants were instructed to forget the words they had learned so far. Power et al. (2000) used general positive and negative adjectives that permitted them to obtain self-descriptiveness ratings (e.g., ugly, smart). When participants were tested on their final recall for words from both halves of the list, only the depressed participants showed better memory for the to-be-forgotten negative (versus positive) words. Interestingly, however, Power et al. found this effect in only one of their three studies, the one in which participants made self-referent judgments about the words during the encoding phase.

Only two studies have used the Think-No-Think (TNT) design with MDD samples. The first study (Joormann, Hertel, Brozovich, & Gotlib, 2005) yielded surprising findings: MDD participants exhibited reduced memory for to-be-suppressed negative words on the final memory test, suggesting that they can successfully forget negative words, but only if given the opportunity to practice suppression. In the second study, Joormann, Hertel, LeMoult, and Gotlib (2009) investigated the role of specific strategies to increase intentional forgetting of negative material in the TNT task. These authors found that forgetting occurred only when depressed participants adopted a specific strategy, namely replacing the negative words they were supposed to forget with other negative words. These findings suggest that uncontrollability is a feature of MDD, but that it can be overcome with the use of specific control strategies.

Using a related task, the modified Sternberg (Ignore/Suppress) task, Joormann and Gotlib (2008) found that MDD participants showed longer decision latencies than did never-disordered control participants when a negative word was presented that came from the to-be-forgotten list. Further, the ability to remove irrelevant negative material from working memory was negatively correlated with rumination in the depressed group. These findings have now been replicated using different variants of the Sternberg task (Joormann & Gotlib, 2010; Joormann, Nee, Berman, Jonides, & Gotlib, 2010). In all of these studies, depressed participants had difficulties ignoring negative material that they had been instructed to forget, and the extent of this difficulty was correlated with a higher tendency to ruminate. This task is particularly promising because participants are first instructed to learn all words and are subsequently instructed to stop the processing of a subset of the words, a procedure that matches the criteria for uncontrollable processing more closely than do some of the tasks described earlier.

Although there are still too few studies conducted using these more recent, stronger tasks to allow firm conclusions, results across paradigms provide convergent evidence that MDD is associated with uncontrollable processing of negative material. Specifically, on tasks that require participants to learn the material and hold it in working memory (such as the TNT task or the Sternberg task), depressed participants show clear difficulties removing negative material from working memory (see related work by Joormann et al., 2010).

Thus, it seems that depressed participants can ignore negative material in the immediate environment when they are not given specific instructions to process or elaborate on it. Once negative material has entered working memory, however, depressed participants cannot remove it easily. These findings suggest an interesting pattern for MDD, compared to anxiety disorders. While there was little evidence that depressed individuals focus on negative material if they do not intend to process it, the findings summarized in this section suggest that depressed people have trouble terminating the processing of negative material upon which they have previously focused.

Implications of Automatic Processing for Anxiety Disorders and MDD

Clinical Implications

Elucidating the role of automaticity in anxiety disorders and MDD is not simply a theoretical exercise; a growing body of research suggests that there are substantial clinical implications of automatic processing in these disorders.

Anxiety Disorders—Although the field needs more prospective longitudinal investigations to determine whether automatic responding is a vulnerability factor for pathological anxiety, there are a number of suggestive findings. For instance, See, MacLeod and Bridle (2009) administered a modified dot-probe program designed to train attention toward non-threatening cues to Singaporean high-school students who were about to emigrate to Australia. See et al. found that students who underwent the positive training reported less state and trait anxiety following the move, suggesting that attenuating unintentional processing of threat can reduce vulnerability to a stressor. There are also many illustrations of relations between uncontrollable responding and state distress and avoidance. For example, using implicit association measures like the IAT and GNAT, specific implicit fear associations have been found to be related to degree of avoidance (e.g., spider fear associations predict avoidance and distress when participants are asked to approach a live spider in a cage; Teachman, 2007; Teachman & Woody, 2003), above and beyond standard self-report fear measures.

Further, measures of automatic processes, especially uncontrollable processes, also change over the course of successful treatment, including performance on the Stroop task (van den Hout et al. 1997), dot-probe task (Pishyar, Harris, & Menzies, 2008), visual search task (with threat cues as distracters; Baños et al., 2008), and IAT (Teachman & Woody, 2003). There is also evidence that automatic responding is related to treatment response. For instance, following treatment for social phobia, both Lundh and Öst (2001) and Mattia, Heimberg, and Hope (1993) found that Stroop effects were preferentially reduced for treatment responders. Further, Mogg, Bradley, Millar, and White (1995) found that Stroop effects predicted not only treatment response, but also maintenance of treatment gains; specifically, Stroop bias was reduced following treatment for GAD, and this change was related to diminished anxious thoughts both post-treatment and 20 months after initial testing. Also, using a repeated measures design in which implicit panic associations were assessed every three weeks over the course of 12-week cognitive behavior therapy for panic disorder, Teachman, Marker, and Smith-Janik (2008) found that the trajectory of change on the IAT predicted subsequent change in panic symptoms. Taken together, these studies highlight the likely importance of automatic processing (especially of uncontrollable processing) in predicting onset, maintenance, and reduction of anxiety problems.

Moreover, findings from recent cognitive bias modification studies, in which paradigms such as the dot-probe task are modified to directly alter control processes (e.g., training individuals to direct attention toward non-threat cues), are especially notable because they indicate that “automatic” does not mean “deterministic.” Clearly, it is possible to change automatic processes (see Mansell, 2000). For instance, results from two trials with diagnosed samples with social phobia indicate that attentional training using the dot-probe task achieves reductions in symptoms of social anxiety similar to those achieved by standard cognitive behavior therapy (Amir et al., 2009; Schmidt, Richey, Buckner, & Timpano, 2009). In fact, Schmidt et al. found that fully 72% of participants who received positive attentional training no longer met diagnostic criteria for social phobia following the intervention, and gains were maintained at a four-month follow-up assessment. Further, an analogous attentional training program for persons diagnosed with GAD led to reduced anxiety symptoms on both self-report and interviewer measures (Amir, Beard, Burns, & Bomyea, 2009). These findings point to the likely causal role of changing unintentional and uncontrollable processing to diminish anxiety pathology.

What do these findings mean for a therapist sitting with an anxious client? How can we incorporate the research suggesting that most of the anxiety disorders are characterized by uncontrollable, and likely unconscious and unintentional, processing of emotional information to improve treatment outcomes? Results of cognitive bias modification studies, in which control processes are trained, suggest that we can fundamentally change reactions to fear-evoking stimuli and, in turn, reduce symptoms. As these training paradigms become more widely available, it is not hard to imagine that clients might be assigned to complete the cognitive bias modification in the privacy of their own home or at their local library, either in advance of, or in tandem with, a brief, therapist-assisted exposure or cognitive therapy. Just as clinicians purchase copyrighted measures or books for their clients, perhaps buying cognitive bias modification programs will become standard. Moreover, becoming aware of automatic responses to emotional information is also likely to help clients understand their own reactions better, which can ultimately help them gain control of their behavior. Rather than punishing oneself for unintentionally attending to signs of blushing while giving a speech or associating speeches with negative evaluation, the client can use attentional or implicit association training techniques to set a new goal of finding all the smiling faces in the crowd. At this stage, it is too soon to know exactly how therapy can be improved by understanding and altering automatic processes, but the ubiquity of the processes means that there are numerous opportunities for intervention.

MDD—Results of longitudinal studies suggest that automatic biases can predict subsequent changes in depressive symptoms. Compton, Heller, Banich, Palmieri, and Miller (2000), for example, demonstrated that a reduced ability to disengage attention from negative material, indicating uncontrollable processing, was associated with increased reactivity to a distressing film clip (see also Ellenbogen, Schwartzman, Stewart, & Walker, 2002). Further, Ellenbogen, Schwartzman, Stewart, and Walker (2006) demonstrated that the ability to disengage from supraliminally presented dysphoric pictures was associated with changes in negative mood ratings in response to a subsequent stress task. Similarly, Johnson (2009a) reported that participants who switched their attention more quickly from neutral to emotional material were more frustrated by a stressful task. Johnson (2009b) also found that participants who were better able to focus on happy and avoid angry faces in a dot-probe task were less frustrated and worked harder in a stressful anagram task. These findings fit well with results of studies demonstrating that individual differences in controlling responding to negative material are associated with the use of both adaptive emotion regulation strategies, such as reappraisal, and maladaptive emotion regulation strategies, such as rumination (Joormann, 2005; Joormann & Gotlib, 2010). Finally, Brewin, Reynolds, and Tata (1999) showed that the amount of intrusive memories participants reported in an interview predicted less complete recovery from MDD six months later. These studies provide the first evidence that uncontrollable processing of negative material may be related to the onset and maintenance of depressive episodes. No investigations, however, have been reported examining the role of automaticity in predicting treatment response or relapse following treatment.

At this point, fewer studies using cognitive bias modification have been conducted in MDD than in the anxiety disorders (see Hallion & Ruscio, 2011). We suspect that training that focuses on the uncontrollable, prolonged processing of self-relevant or highly activated material in MDD will be most effective. Indeed, preliminary findings in support of this postulation come from two training studies using a dot-probe task with prolonged exposure durations (Wells & Beevers, 2010) and a Posner task with 1000 ms exposure durations (Baert, De Raedt, Schacht, & Koster, 2010). In both studies, attention training of either four sessions (Wells & Beevers, 2010) or 10 sessions (Baert et al., 2010) led to significant improvement in depression symptoms that were maintained at follow-up. In another study, Joormann et al. (2005) provided depressed participants with multiple opportunities to forget negative material that they had previously learned to associate with a neutral cue word. These investigators demonstrated that depressed participants' forgetting of the negative material could be improved with training (see also Joormann et al., 2009). In addition, Siegle, Thompson, Carter, Steinhauer, and Thase (2007) presented preliminary data demonstrating that a brief intervention aimed at increasing cognitive control in severely depressed outpatients led to significant decreases in both depressive symptoms and rumination. In this training, patients learn to attend selectively to certain sounds while ignoring irrelevant sounds (Siegle, Ghinassi, & Thase, 2007). Finally, investigators have used repetitive transcranial magnetic stimuli (rTMS) to alter neural activity in a region of the brain that has frequently been associated with cognitive control, the dorsolateral prefrontal cortex (DLPFC; e.g., Vanderhasselt, De Raedt, Leyman, & Baeken, 2009). These studies indicate that the development of training and treatment procedures that increase cognitive control in depressed participants is highly promising and support the proposition that uncontrollability in the processing of emotional material is a key feature in this disorder.

Theoretical Implications

In this review, we have built on a theoretical framework outlined by Bargh and other researchers in the area of social cognition to integrate evidence from a variety of different paradigms used with anxious and depressed samples. At the same time, we have been heavily influenced by the many prominent information-processing models of anxiety disorders and MDD that have spurred the wealth of recent research that made it possible for us to write this review at this time (see Bar-Haim et al., 2007; Beck & Clark, 1997; Dalgleish, 2004; Fox, 2004; Hartlage et al., 1993; Mathews & MacLeod, 2005; McNally, 1995; Mogg & Bradley, 2005; Öhman & Mineka, 2001; Teasdale & Barnard, 1993; Wells & Matthews, 1996; Williams et al., 1997, among others). While a full discussion of these models would constitute an article (or a book!) in its own right, a brief comment about how our conceptualization of the automaticity features fits with this earlier work highlights how the growing interest in testing information-processing biases have both reinforced and challenged some prior contentions about automaticity in emotion dysregulation.

Anxiety Disorders Theory—One of the most influential writings on automaticity in the anxiety disorders literature is McNally's (1995) review of automaticity features, which followed a three-feature model of automatic processing (capacity-free, unconscious, and involuntary). At the time, McNally concluded that when researchers cite evidence for automatic biases in anxiety, the findings most consistently demonstrated involuntary processing, rather than capacity-free or unconscious. Since McNally's review, the introduction of tighter controls for evaluating subliminal processing and a broader range of paradigms evaluating unconscious processing now allow us to be more confident that this feature is a characteristic of anxiety problems. It remains true, however, that findings are more mixed than would be expected on key paradigms (such as the subliminal Stroop task), and that there is considerable variability across disorders (e.g., reasonably clear evidence in GAD, but not in social phobia). Moreover, the evidence for unconscious processing is mostly limited to tasks that use impoverished stimuli, so we still know little about other aspects of unconscious processing, such as whether anxious patients are aware of their biased responding. Further, we agree in large part with McNally that processing emotional information does not seem to be efficient in anxiety disorders. However, we use different criteria for evaluating efficiency, believing that dual-task paradigms that directly manipulate attentional capacity provide the most compelling evidence (McNally included tasks showing interference effects more broadly). Finally, we think that McNally's assertion that anxious processing is involuntary is correct, but would refine this position, noting that support is stronger for the formulation that processing is uncontrollable than it is for the assertion that it is unintentional.

Other researchers have focused on either specific features of automaticity (e.g., unconscious: Fox et al., 2001; Mayer & Merckelbach, 1999) or specific disorders (e.g., phobias involving stimuli that are fear relevant from an evolutionary perspective: Öhman & Mineka, 2001; PTSD: Dalgleish, 2004; GAD: Mogg & Bradley, 2005). Our conclusions are generally not discrepant with these models, but we propose that automatic processing of threat information, particularly uncontrollable processing, may be one of the shared characteristics of anxiety problems (like avoidance motivation).

Notwithstanding, we found considerable variability in the extent and nature of the support for the various features of automatic processing in the anxiety disorders. Interestingly, Bar-Haim et al. (2007) reviewed evidence for attentional biases and concluded that effect sizes are comparable across the anxiety disorders. Several factors might contribute to these discrepant conclusions: Bar-Haim et al. reviewed a narrower set of tasks than we did (the Stroop, dot-probe, and modified Posner tasks only), but in a broader population (they included trait anxious and undiagnosed samples). Moreover, they characterized the literature based on average effect sizes, whereas we described the literature based on the proportion of studies that found the expected effect (e.g., interference effects for threat material). It is difficult to know which of these (or other) factors explain the different conclusions reached in the reviews, but it is clear that the number of available studies varies greatly across disorders; thus, conclusions about disorder-related differences are necessarily still tentative. Importantly, our reviews concur with respect to the basic conclusion that automatic processing is reliably associated with anxiety disorders.

The formulation that biased information processing contributes to the development and maintenance of emotional disorders follows from the initial cognitive models of Beck and colleagues (Beck, 1967, 1976; Beck et al., 1985). In early writings, Beck pointed to the role of “automatic thoughts.” These were intrusive thoughts in verbal or visual form whose content involved danger or harm for anxiety disorders (Beck et al., 1985), and negative views of the self, the world, and the future for depressive disorders (Beck, 1976). While the use of the term automatic provides an accessible and intuitively appealing term for clients, it has also created some confusion about what thought processes should be classified as automatic. So-called automatic thoughts have often been measured by self-report questionnaires (e.g., Automatic Thoughts Questionnaire; Hollon & Kendall, 1980), which permit slow, reflective responding and strategic endorsement (or rejection) of items. Thus, while we support the contention that automatic thinking is likely critical to anxiety, it is not clear that Beck-ian ‘automatic thoughts’ demonstrate this in a compelling way.

In more recent writings, Beck and Clark (1997) proposed a schema-based information-processing model in which some features of automatic processing are expected to always be active (e.g., uncontrollable), while other features fade over time and the role for strategic processing increases. This model has a number of appealing features, particularly because it integrates many components of anxious cognitive processing into a single model. At the same time, however, it is challenging to assess the temporal sequence outlined in the model. Thus, akin to Beck's earlier writings that took some time to validate empirically, the more recent model also presents a test for researchers.

MDD Theory—At first glance, our conclusions about automaticity in MDD might seem surprising in light of previous work. Whereas Beck's model clearly posits that automatic thoughts and the automatic activation of schema-congruent processing are central features of MDD, the current evidence suggests that automaticity does not play a central role in this disorder outside the context of uncontrollable processing. Other reviews, however, have noted the same discrepancy between earlier theoretical predictions for the role of automatic processing in MDD and the results of empirical studies. Williams et al. (1997), for example, proposed that MDD is not characterized by biases in tasks that focus on early automatic aspects of processing, but instead, by increased elaboration of negative material, leading to biases in explicit memory tasks. The conclusions we draw from our review are mostly consistent with this proposition, but Williams et al. tend to treat “automatic processes” as a single broad category. A strength of this review is that we do not contrast automatic with non-automatic processes, but instead, differentiate various features of automaticity.

One of the few publications in which automaticity was operationalized in a more detailed manner is the review paper by Hartlage et al. (1993). These investigators stated that automatic processing: 1) does not require attention or conscious awareness; 2) does not interfere with other processes or stress the capacity limitations of the system; and 3) occurs without intention or control. Although these three characteristics of automaticity overlap to a large degree with our four features, these authors did not use these criteria to differentiate constructs in the empirical literature. Hartlage et al. summarized the findings of their review as indicating that there is evidence that MDD interferes considerably with effortful processing, but only minimally with automatic processes. While we agree with Hartlage et al.'s analyses that not all features of automaticity play a role in MDD, we extend their analyses by pointing out that some features of automaticity might indeed be important in this disorder.

Our conclusion that it is primarily the prolonged processing of self-relevant and highly activated emotional material and the uncontrollability of this processing that is important for understanding MDD is consistent with a number of recent theoretical formulations. For example, Hertel (2004) identified deficits in cognitive control as a critical feature of MDD, and other authors have proposed that MDD is associated with difficulties in inhibiting irrelevant negative material (e.g., Joormann, 2005, 2010; Linville, 1996).

Anxiety Disorders Versus MDD—As we noted at the outset of the paper, making sense of the cognitive profiles of anxiety disorders and MDD is a considerable challenge given their shared symptom profile and high rates of comorbidity on the one hand, but seemingly different processing biases on the other (e.g., differential robustness of attentional versus memory biases across the disorders). In their seminal work, *Cognitive psychology and emotional disorders*, Williams et al. (1997) suggested that whereas anxiety disorders are characterized by biased processing of threatening information that occurs mainly at the priming stage, affecting passive, automatic aspects of encoding, MDD is characterized by biased elaborative processing. They focused predominantly on the automaticity feature “unconscious,” and for this feature, our conclusions are consistent with those offered by Williams et al., given that we also find more evidence for unconscious biases in anxiety disorders than in MDD.

In later writings, Mathews and MacLeod (2005) suggested that both anxiety disorders and MDD can involve difficulties exerting control over emotional processing, although they focused mainly on control of conscious thoughts or images, such as occurs in thought suppression studies. Thus, we mostly agree with Mathews and MacLeod`s conclusions about uncontrollable and unconscious processes, but we review a wider range of automaticity features and paradigms.

At the most basic level, our review provides the first evaluation in more than a decade to examine the evidence as a function of a range of automaticity features, rather than focusing only on one feature. We believe that this is the first review to systematically contrast findings in anxiety disorders and MDD across the range of features. One advantage of this approach is it allows us to consider prior theoretical models that have tried to understand the relation between anxiety disorders and MDD in a new light. For instance, Mogg and Bradley's (1998, 2005) cognitive motivational analysis suggests that persons with anxiety disorders and MDD have a more sensitive valence evaluation system, such that relatively mild disorder-relevant stimuli are treated as though the stimuli were of high intensity (for high-intensity stimuli, even the general population will show vigilance toward threat material; Koster, Crombez, Verschuere, & De Houwer, 2006; Yiend, 2010). Activation of this valence evaluation system then triggers a goal engagement system to orient resources to the stimuli. The model suggests that the reason attentional biases are rarely observed in MDD without the opportunity for substantial processing time is because MDD is characterized by low motivation and disengagement from goals, so selective orienting to depression-relevant material does not immediately occur. Anxiety disorders, on the other hand, are associated with a vigilant pattern characterized by high motivation to catch potential threats quickly; thus, early processing biases are evident in most anxiety disorders.

This model maps well onto findings from the current review. When motivation is low, as in MDD, attentional redirection will be more effortful so may only occur when attentional demands of the stimuli are high (i.e., when stimuli are presented for a long time or are very personally salient), thus we would expect to see little evidence of unconscious or unintentional processing in MDD, and the processing is likely to be costly (i.e., not efficient). In contrast, when motivation to detect threat is high, as it is in anxiety disorders, attentional redirection will be relatively facilitated so that it occurs even when stimuli are presented very rapidly or impoverished, or when there is no goal to process the stimuli. Hence, we would expect to see evidence for both unconscious and unintentional processing in anxiety. For both anxiety disorders and MDD, once the goal engagement system has been triggered, it will be difficult to alter or stop processing the stimuli, leading to the findings of uncontrollable processing. Thus, while further research is needed to empirically validate some components of the model (and see recent, related alternative models; Bar-Haim et al., 2007), overall, the model accounts for observed differences and similarities in features of automaticity between anxiety disorders and MDD.

Conclusions and Call for Future Research

At the outset of this paper, we argued that it was time to re-evaluate the role of automaticity in MDD and anxiety disorders because a large number of studies with novel paradigms had been conducted that were not available at the time of the last major reviews. The results of these studies have led us to reach different conclusions about the nature of automatic features in emotion dysregulation. By drawing from a social cognition perspective that considers four primary features of automaticity as potentially independent, we can characterize the similarities and differences in automaticity across anxiety disorders and MDD with greater precision. Thus, prior global evaluations of automaticity as a unitary construct that typified anxiety disorders, but not MDD, now appear overly simplistic. Instead, we find that whereas anxiety disorders involve uncontrollable, and likely also unconscious and unintentional processing of threat-relevant material, MDD only clearly involves uncontrollable processing.

Despite the wealth of new research that led to this (re)conceptualization of automaticity in MDD and anxiety disorders, in this review we have also highlighted numerous areas that require further research so that more definitive claims can be made. Thus, we consider the current paper a strong, but interim, report. In this context, we conclude with a call for future research so that we can move closer to understanding how the seemingly simple process of preferentially noticing the word ‘sad’ or a picture of a snake can have such significant consequences for the millions of people who struggle with anxiety disorders and MDD. Below, we outline five specific directions for future research that we think are important for moving the field forward.

1. There is a pressing need for new paradigms that can permit a stronger and more explicit operationalization and differentiation of key features of automaticity. This includes utilizing paradigms that assess goals to evaluate unintentional and uncontrollable processing, using tasks that do not rely on impoverished stimuli alone to examine unconscious processing, and implementing more dual-task paradigms to investigate efficiency.

Further, it is critical that we develop paradigms that can better disentangle the time course of a given process to determine whether there are difficulties with initial orientation versus with disengagement from emotional stimuli. Fox (2004) has proposed that whereas disengagement difficulties are common across anxiety problems, engagement effects are more pronounced in some anxiety disorders (e.g., specific phobias and perhaps social phobia) than in others (e.g., GAD). We suspect that whereas selective engagement with threat material is particularly related to unintentional processing of threat information, problems with disengagement are more likely related to uncontrollable and inefficient processing because of the capacity used for prolonged processing of threat material. Evaluating the time course of automatic processes will also help address questions about when to expect attentional vigilance versus avoidance (see Mogg & Bradley, 1998, 2004; Williams et al., 1997), the role of attentional control in inhibiting goal-irrelevant processing (Eysenck, Derakshan, Santos, & Calvo, 2007), and the primacy of affective versus cognitive responses (see Hirsch, Clark, & Mathews, 2006), all critical questions for determining the clinical import of automatic processing.

A number of paradigms that are either relatively novel (e.g., the Approach-Avoidance Task; Rinck & Becker, 2007; the parafoveal visual attention task: Calvo, Castillo, & Fuentes, 2006) or that reflect updated designs of older paradigms (e.g., tracking eye gaze; Garner, Mogg, & Bradley, 2006; Rinck & Becker, 2006; using eye gaze by a facial stimulus to direct attention; Fox, Mathews, Calder, & Yiend, 2007) may help address some of these open questions. For example, using updated eye-tracking methodologies, researchers have found that both dysphoric (Sears, Thomas, LeHuquet, & Johnson, 2010) and depressed (Kellough, Beevers, Ellis, & Wells, 2008) individuals spend less time than do control participants attending to positive pictures and have greater difficulty disengaging from negative pictures. Morevoer, Gerdes, Alpers, and Pauli (2008) found that patients with spider phobia fixated on spider distracter items for a longer duration than did control participants, but did not show enhanced attentional capture by these items. Further, gaze-contingent masking is now possible so that one can mask a stimulus once a saccade toward it has begun, but before overt attention to the item has occurred (e.g., Calvo & Eysenck, 2008), thereby providing considerably greater precision for determining the time course and overtness of attentional processing.

Adding conditions to existing paradigms and altering the scoring methods can also help to increase their explanatory power. For example, modifying double-cuing paradigms, such as the dot probe, to include a block in which detection of probes is also assessed when two neutral stimuli are presented (and then compared to the neutral-threat condition) could allow stronger differentiation between attentional engagement and disengagement processes (see further detail in Yiend, 2010). These and related paradigms may also be improved with revised scoring approaches that better account for possible group differences in variability and general response latency (e.g., see revised scoring methods for the IAT: Greenwald, Nosek, & Banaji, 2003: and for dot probe tasks: Mogg, Holmes, Garner, & Bradley, 2008).

2. An important direction for future research is to clarify the impact of trait versus state mood effects, and their interaction, on automatic processing (see MacLeod & Mathews, 1988; Mathews & MacLeod, 2002; Mogg & Bradley, 1998). The effect of increasing state anxiety or introducing a depressive mood induction has not resulted in consistent effects, with some studies finding that adding state effects enhances bias (e.g., Chen, Lewin, & Craske, 1996), others finding that these effects can reduce bias (e.g., Mathews & Sebastian, 1993), and even some suggestion that effects of a stressor may vary for MDD and anxiety disorders as a function of the timing of the stimuli presentation (e.g., subliminally versus supraliminally presented cues; Ellenbogen & Schwartzman, 2009). The idea that biases may be mood-state dependent (Persons & Miranda, 1992) has intuitive appeal, but it is not clear when and how state affect will influence automaticity, or how these effects are likely to differ across processes (e.g., attention versus memory), automaticity features (e.g., uncontrollability versus unconscious), or disorders.

3. Similar unresolved questions concern how automatic processing biases differ in samples that have pure depression- or anxiety-relevant pathology versus those that are comorbid (either for anxiety disorders and MDD, or with other disorders). Given the high rates of comorbidity of depressive and anxiety disorders (see Barlow et al., 2004), this is an important issue. Unfortunately, comorbidity is often not assessed, or individuals with and without comorbid emotional disorders are grouped together. Yet, on the occasions that investigators have compared individuals with pure versus comorbid conditions, results sometimes suggest that comorbidity does affect the expression of biases. For instance, Bradley et al. (1995) found subliminal Stroop effects for negative words only in patients with GAD, not in patients with GAD and comorbid depression (though see Bar-Haim et al., 2007). We suspect that comorbidity may result in discrepant outcomes for tasks that measure a feature of automaticity that differs across depression and anxiety (e.g., unconscious) relative to tasks that capture a common automatic feature (e.g., uncontrollable), but this is an open empirical question.

4. Another important avenue for further research concerns the generalizability of findings across various subgroups and populations. For example, little is known about how factors such as age, education, race, and ethnicity influence the presence and expression of cognitive biases. Work with anxious children suggests that developmental factors are important determinants of both whether a bias will be observed (e.g., Kindt, Bierman, & Brosschot, 1997) and the specificity of the biases (e.g., general versus specific threat; Muris & Merckelbach, 2001). Similarly, we do not know at what stage of psychopathology these biases emerge. In this review we have focused on studies using diagnosed samples, but it is not clear how analog samples, or individuals who are trait anxious or dysphoric, differ from clinical populations on these biases (though see Bar-Haim et al., 2007, regarding findings for trait anxiety). Although the model of automaticity followed for this paper assumes that many of the features of automaticity occur along a continuum (Bargh, 1994), it is also possible that they become functionally related to psychopathology only when they reach a certain threshold. Consistent with this formulation, some researchers have suggested that

results are more reliable in clinical than in subclinical samples (e.g., on the dot-probe task; Schmukle, 2005).

5. To date, progress on research examining automaticity in psychopathology has been more rapid for theoretical than for clinical advances. Questions about the necessary and sufficient mechanisms of change for the different automatic features will be critical in determining the ultimate clinical import of automatic processing. Moreover, research is needed that: a) evaluates the malleability of automatic processes in experimental paradigms (e.g., Clerkin & Teachman, 2010; Teachman, Woody, & Magee, 2006); b) prospectively investigates automatic processes as predictors of symptom change (e.g., Haeffel et al., 2007) and relapse; and c) examines change in automatic processes as mediators of treatment response. In addition, we expect that considerable gains can be made by borrowing from the developments in social cognition and cognitive science research. For instance, Gawronski and Bodenhausen (2007) have proposed an intriguing model to explain when manipulations are likely to shift explicit versus implicit measures, which may also inform therapeutic interventions.

6. We limited this review to studies that used cognitive experimental paradigms and applied them to emotional disorders. One important method that opens up exciting new possibilities for future research on automaticity is brain imaging and other neuroscience approaches. As more relevant research is conducted, adding results from brain imaging studies to the literature covered in this review could refine some conclusions. For example, Sheline et al. (2001) found activation of the amygdala to subliminally presented negative faces in depressed participants, suggesting that there may be unconscious processing in this disorder that was not obvious from our review of the cognitive studies. Moreover, Pessoa, McKenna, Gutierrez, and Ungerleider (2002) found that even differential amygdala activation to emotional (relative to neutral) faces in unselected samples required the availability of attentional resources, which the authors suggest challenges traditional notions about exactly what is automatic in processing emotion-relevant material. In fact, in more recent work, Pessoa and Adolphs (2010) suggest, “the cortex has a more important role in emotion processing than is traditionally assumed” (p. 773). Further, studies that incorporate psychophysiological indicators into the assessment of cognitive processing biases may help elucidate the mechanisms that guide the automatic processing effects. For instance, in a study measuring ERP, van Peer, Spinhoven, and Roelofs (2010) found that administration of cortisol to persons with social phobia altered processing of social threat information during an emotional Stroop task (decreasing P2 amplitudes for masked angry faces). Integrating neural and behavioral levels of analysis is essential to gaining a better understanding of the development and maintenance of automatic biases (e.g., see intriguing neural-network modeling of the dot-probe effects in anxiety using connectionist simulations; Frewen, Dozois, Joanisse, & Neufeld, 2008).

7. Finally, it is critical to acknowledge that our review cannot fully address the possibility that a file-drawer problem inflates the present results. While we have been diligent about systematically detailing those published studies that found null results, we do not account for the (likely) many unpublished studies. Notably, in their meta-analysis of the dot probe and emotional Stroop tasks in anxious samples (so, covering some of the tasks and samples we review here), Bar-Haim et al. (2007) argued that their finding of attention biases across anxious samples “cannot be reduced to insignificance in the next 11,339 studies, even if those studies yielded only null results. This number is 20 times as large as Rosenthal's (1991) fail-safe number, $5k + 10 = 570$ (k = number of studies included), such that the file-drawer problem is not of concern here” (p. 15). While we see this large fail-safe number as helpful to addressing the file-drawer concern for the present review, the lack of direct

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correspondence between the tasks and samples reviewed in the two papers means that this continues to be an important issue that should be addressed in future research.

It is clear that we still have much to learn about the nature of automaticity in anxiety disorders and MDD. At the same time, great progress has been made during the 15 years since the last prominent reviews. Most substantially, the field now recognizes that simple, global distinctions between automatic and strategic processing do not reveal the richness and complexity of cognitive processing in emotion dysregulation. We find the evidence compelling that aspects of automaticity are central to both anxiety disorders and MDD, yet the disorders differ on a number of features. In the future, we need work that explores the clinical implications of these findings to determine how automaticity, especially uncontrollable processing, can help explain why anxiety disorders and MDD develop and how these disorders are maintained despite the intense pain caused by the selective processing of negative information. With these insights, we can move closer to changing these maladaptive ways of processing the onslaught of information – both positive and negative – that bombards us each day.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Highlights

- Evaluates features of automatic processing in anxiety disorders and depression
- Anxiety disorders involve uncontrollable, unconscious, and unintentional processing
- Depression involves uncontrollable, but not unconscious or unintentional processing
- Neither anxiety disorders nor depression characterized by efficient processing

Table 1

Evidence for unconscious processing of emotion-relevant information.

Study	Diagnosis	Task	Evidence for unconscious processing?
Agoraphobia			
No studies (to our knowledge).			
Generalized Anxiety Disorder			
Bradley, Mogg, & Williams, 1995	DEP	LDT (following Sub-Priming)	Yes
	GAD		No
Mathews, Ridgeway, & Williamson, 1996	GAD	Sub-DPT	No*
	PD		Yes
	DEP		No*
Mogg, Bradley, & Williams, 1995	GAD	Sub-DPT	Yes
	DEP		No
Bradley, Mogg, Millar, & White, 1995	GAD	Sub-Stroop	Yes
	GAD with DEP		No
Mogg, Bradley, Millar, & White, 1995	GAD	Sub-Stroop	Yes
Mogg, Bradley, Williams, & Mathews, 1993	GAD	Sub-Stroop	Yes
	DEP		No
Obsessive Compulsive Disorder			
Kyrios & Iob, 1998	OCD	Sub-Stroop	No
Unoki, Kasuga, Matsushima, & Ohta, 1999	OCD	Sub-Stroop	Yes
Panic Disorder			
Schniering & Rapee, 1997	PD & PDA	LDT (following Sub-Priming)	No
Kampman, Keijsers, Verbraak, Naring, & Hoogduin, 2002: Exp 1	PD	Sub-Stroop	No
Kampman, Keijsers, Verbraak, Naring, & Hoogduin, 2002: Exp 2	PD	Sub-Stroop	No
Lim & Kim, 2005	DEP	Sub-Stroop	No
	PD		Yes
Lundh, Wikström, Westerlund, & Öst, 1999	PDA	Sub-Stroop	Yes
Quero, Baños, & Botella, 2001	PDA	Sub-Stroop	No
see also (above):			
Mathews, Ridgeway, & Williamson, 1996			
Post-traumatic Stress Disorder			
Devineni, Blanchard, Hickling, & Buckley, 2004	PTSD	Sub-Stroop	No
Harvey, Bryant, & Rapee, 1996	PTSD (with past car accident)	Sub-Stroop	Yes

Study	Diagnosis	Task	Evidence for unconscious processing?
McNally, Amir, & Lipke, 1996	PTSD	Sub-Stroop	Mixed
Paunovic, Lundh, & Öst, 2002	PTSD	Sub-Stroop	No
Social Phobia			
Mogg, Philippot, & Bradley, 2004	SP	Sub-Stroop	No
van Peer, Spinhoven, & Roelofs, 2010	SP	Sub-Stroop	No
Specific Phobia			
Wikström, Lundh, Westerlund, & Högman, 2004	Ph (snake)	LDT (following Sub- and Supra-Stroops)	Yes
Elsesser, Heuschen, Pundt, & Sartory, 2006	Ph (mixed)	Sub-DPT	No
Thorpe & Salkovskis, 1997	Ph (spider)	Sub-Stroop	No
	Ph (mixed--not spider)		No *
van den Hout, Tenney, Huygens, & de Jong, 1997	Ph (spider)	Sub-Stroop	Yes
Wikström, Lundh, Westerlund, & Högman, 2004	Ph (snake)	Sub-Stroop	No
MDD			
Dannlowski et al., 2007	DEP	Sub-APT	No
Dannlowski, Kersting, Donges, et al., 2006	DEP	Sub-APT	No
Dannlowski, Kersting, Lalee-Mentzel, et al., 2006	DEP	Sub-APT	Yes
	DEP (with comorbid anxiety)		Yes
Bradley, Mogg, & Millar, 1996: Expt 2	DEP	LDT (following Sub-Priming)	Yes
Constant, et al., 2006	DEP	Sub-Stroop	No
see also (above):			
Bradley, Mogg, & Williams, 1995			
Mathews, Ridgeway, & Williamson, 1996			
Mogg, Bradley, & Williams, 1995			
Bradley, Mogg, Millar, & White, 1995; Mogg, Bradley, Williams, & Mathews, 1993			
Lim & Kim, 2005			

Note. DEP = Depression/Major Depressive Disorder; GAD = Generalized Anxiety Disorder; OCD = Obsessive Compulsive Disorder; PD = Panic Disorder; PDA = Panic Disorder with Agoraphobia; Ph (XX) = Specific Phobia (XX = feared stimuli); PTSD = Post-traumatic Stress Disorder; SP = Social Phobia; LDT = Lexical Decision Task; Sub-APT = Subliminal Affective Priming Task; Sub-DPT = Subliminal Dot-Probe Task; Sub-Priming = Subliminal Priming; Sub-Stroop = Subliminal Stroop Task; Supra-Stroop = Supraliminal Stroop Task

* stimuli were not specific to row's disorder.

Table 2

Evidence for efficient processing of emotion-relevant information.

Study	Diagnosis	Task	Evidence for efficient processing?
Agoraphobia			
No studies (to our knowledge).			
Generalized Anxiety Disorder			
Mathews & MacLeod, 1986	GAD	DT (DL + RTT)	No
Obsessive Compulsive Disorder			
Olatunji, Ciesielski, & Zald, 2011	OCD	RSVP	No
Eastwood et al., 2005	SP	VST	Yes
	PD		Yes *
	OCD		No *
Panic Disorder			
Beck, Stanley, Averill, Baldwin, & Deagle, 1992	PD	DT (Read words with a RTT)	No
Wenzel, 2006	PD	DT	No
	SP	(DL with a RTT)	No
see also (above):			
Eastwood et al., 2005			
Post-traumatic Stress Disorder			
No studies (to our knowledge).			
Social Phobia			
see (above):			
Eastwood et al., 2005			
Wenzel, 2006			
Specific Phobia			
No studies (to our knowledge).			
MDD			
McCabe & Gotlib, 1993	DEP	DT (DL +RTT)	No
Suslow et al., 2004	DEP	VST	No
	DEP (with anxiety)		No

Note. DEP = Depression/Major Depressive Disorder; GAD = Generalized Anxiety Disorder; OCD = Obsessive Compulsive Disorder; PD = Panic Disorder; SP = Social Phobia; DL = Dichotic Listening; DT = Dual Task; RTT = Reaction Time Task; RSVP = Rapid Serial Visual Presentation Task; VST = Visual Search Task

* stimuli were not specific to row's disorder.

Table 3

Evidence for unintentional processing of emotion-relevant information.

Study	Diagnosis	Task	Evidence for unintentional processing?
Agoraphobia			
No studies (to our knowledge).			
Generalized Anxiety Disorder			
Bradley, Mogg, White, Groom, & de Bono, 1999	GAD	Supra-DPT	Yes
Gotlib, Krasnoperova, Yue, & Joormann, 2004	DEP	Supra-DPT	Yes
	GAD		No*
MacLeod, Mathews, & Tata, 1986	GAD	Supra-DPT	Yes*
	DEP		No*
Mathews, Ridgeway, & Williamson, 1996	GAD	Supra-DPT	Yes*
	PD		Yes
	DEP		Yes*
Mogg, Bradley, & Williams, 1995	GAD	Supra-DPT	Yes
	DEP		Yes
Mogg, Mathews, & Eysenck, 1992	GAD	Supra-DPT	Yes
Mogg, Millar, & Bradley, 2000	GAD	Supra-DPT	No
	Depressed (DEP and DYS)		No
Becker, Rinck, Margraf, & Roth, 2001	GAD	Supra-Stroop	Yes
	SP		Yes
Bradley, Mogg, Millar, & White, 1995	GAD	Supra-Stroop	Yes
	GAD + DEP		No
Martin, Williams, & Clark, 1991: Expt 2	GAD	Supra-Stroop	Yes
Martin, Williams, & Clark, 1991: Expt 4	GAD	Supra-Stroop	Yes
Mathews, Mogg, Kentish, & Eysenck, 1995	GAD	Supra-Stroop	Yes
Mogg, Bradley, Millar, & White, 1995	GAD	Supra-Stroop	Yes
Mogg, Bradley, Williams, & Mathews, 1993	GAD	Supra-Stroop	Yes
	DEP		No
see also 3 Sub-Stroop entries in unconscious table.			
see also 2 Sub-DPT entries in unconscious table.			
Obsessive Compulsive Disorder			
Amir, Cobb, & Morrison, 2008	OCD	NPT	Yes
McNally, Wilhelm, Buhlmann, & Shin, 2001	OCD	NPT	No
Harkness, Harris, Jones, & Vaccaro, 2009	OCD (checkers)	Supra-DPT	No
Foa, Ilai, McCarthy, Shoyer, & Murdock, 1993	OCD (washers)	Supra-Stroop	Yes
	OCD (nonwashers)	(with priming)	Yes

Study	**Diagnosis**	**Task**	**Evidence for unintentional processing?**
Kampman, Keijsers, Verbraak, Naring, & Hoogduin, 2002: Expt 2	OCD	Supra-Stroop	No
	PD		No
Kyrios & Iob, 1998	OCD	Supra-Stroop	No
Lavy, van Oppen, & van den Hout, 1994	OC (washers)	Supra-Stroop	Yes
	OC (checkers)		Yes
McNally et al., 1994	OCD	Supra-Stroop	No*
	PD		Yes
McNally, Riemann, Louro, Lukach, & Kim, 1992	PD	Supra-Stroop	No
	OCD		No*
McNeil, Tucker, Miranda, Lewin, & Nordgren, 1999	PTSD	Supra-Stroop	Yes*
	OCD		No*
	DEP		No
Moritz et al., 2008	OCD	Supra-Stroop	No
Moritz et al., 2004	OCD (checkers)	Supra-Stroop	No
Unoki, Kasuga, Matsushima, & Ohta, 1999	OCD	Supra-Stroop	No
see also 2 Sub-Stroop entries in unconscious table.			
Panic Disorder			
Horenstein & Segui, 1997: Expt 1	PD	Supra-DPT	Yes
	SP		No
Horenstein & Segui, 1997: Expt 2	PD	Supra-DPT (with 3 words)	Mixed
Kroeze & van den Hout, 2000	PD	Supra-DPT	Yes
Livermore, Sharpe, & McKenzie, 2007	COPD with PD or PA	Supra-DPT	No
De Cort, Hermans, Spruyt, Griez, & Schruers, 2008	PD	Supra-Stroop	No
Hope, Rapee, Heimberg, & Dombeck, 1990	SP	Supra-Stroop	Yes
	PD		Yes
Kampman, Keijsers, Verbraak, Naring & Hoogduin, 2002 : Expt 1	PD	Supra-Stroop	No
Lim & Kim, 2005	PD	Supra-Stroop	No
	DEP		Yes
Maidenberg, Chen, Craske, Bohn, & Bystritsky, 1996	PD	Supra-Stroop	Yes
	SP		Yes
McNally, Riemann, & Kim, 1990	PD and PDA	Supra-Stroop	Yes
Quero, Baños, & Botella, 2001	PDA	Supra-Stroop	No
Teachman, Smith-Janik, & Saporito, 2007	PD	Supra-Stroop	Yes
van Niekerk, Möller, & Nortje, 1999	PD	Supra-Stroop	No
	SP		
see also (above):			
Mathews, Ridgeway, & Williamson, 1996			
Kampman, Keijsers, Verbraak, Naring, & Hoogduin, 2002 : Expt 2			

Study	Diagnosis	Task	Evidence for unintentional processing?
McNally et al., 1994			
McNally, Riemann, Louro, Lukach, & Kim, 1992			
see also 5 Sub-Stroop entries in unconscious table.			
see also 1 Sub-DPT entry in unconscious table.			
Post-traumatic Stress Disorder			
Elsesser, Sartory, & Tackenberg, 2004	PTSD	Supra-DPT	No
Bryant & Harvey, 1995	PTSD	Supra-Stroop	Yes
	Ph (driving)		No*
Constans, McCloskey, Vasterling, Brailey, & Mathews, 2004	PTSD	Supra-Stroop	Mixed
Harvey, Bryant, & Rapee, 1996	PTSD (with past car accident)	Supra-Stroop	Yes
Litz et al., 1996	PTSD	Supra-Stroop	Yes
McNally, Amir, & Lipke, 1996	PTSD	Supra-Stroop	Yes
McNally, Kaspi, Riemann, & Zeitlin, 1990	PTSD	Supra-Stroop	Yes
Paunovic, Lundh, & Öst, 2002	PTSD	Supra-Stroop	Yes
Thrasher, Dalgleish, & Yule, 1994	PTSD	Supra-Stroop	Mixed
see also (above):			
McNeil, Tucker, Miranda, Lewin, & Nordgren, 1999			
see also 4 Sub-Stroop entries in unconscious table.			
Social Phobia			
Amir, Elias, Klumpp, & Przeworski, 2003	SP	PP	Yes
Asmundson & Stein, 1994	SP	Supra-DPT	Yes
Chen, Ehlers, Clark, & Mansell, 2002	SP	Supra-DPT	No
Gotlib, Kasch et al., 2004	DEP	Supra-DPT	Yes
	SP		No
Mogg, Philippot, & Bradley, 2004	SP	Supra-DPT	Yes
Mueller et al., 2009	SP	Supra-DPT	No
Musa, Lépine, Clark, Mansell, & Ehlers, 2003	SP	Supra-DPT	Yes
	Depressed SP (DEP and DYS)		No
Pishyar, Harris, & Menzies, 2008	SP	Supra-DPT	Yes
Sposari & Rapee, 2007: Expt 1	SP	Supra-DPT (anticipating a speech)	Yes
Sposari & Rapee, 2007: Expt 2	SP	Supra-DPT (anticipating a speech)	Yes
Stevens, Rist, & Gerlach, 2009	SP	Supra-DPT	Yes
Amir et al., 1996	SP	Supra-Stroop	Mixed
Andersson, Westöö, Johansson, & Carlbring, 2006	SP	Supra-Stroop	Mixed
Gerlach, Schiller, Wild, & Rist, 2006	SP	Supra-Stroop	Mixed

Study	Diagnosis	Task	Evidence for unintentional processing?
Gotlib, Kasch et al., 2004	DEP	Supra-Stroop	No
	SP		No
Holle, Neely, & Heimberg, 1997	SP	Supra-Stroop	Mixed
Kolassa & Miltner, 2006	SP	Supra-Stroop	No
	Ph (spider)		No*
McNeil et al., 1995	SP (generalized)	Supra-Stroop	Yes
	SP (generalized with avoidant personality)		Yes
	SP (speech)		Yes
Spector, Pecknold, & Libman, 2003	SP	Supra-Stroop	Yes
van Peer, Spinhoven, & Roelofs, 2010	SP	Supra-Stroop	No
see also (above):			
Becker, Rinck, Margraf, & Roth, 2001			
Horenstein & Segui, 1997: Expt 1			
Hope, Rapee, Heimberg, & Dombeck, 1990			
Maidenberg, Chen, Craske, Bohn, & Bystritsky, 1996			
van Niekerk, Möller, & Nortje, 1999			
see also 2 Sub-Stroop entries in unconscious table.			
Specific Phobia			
Kindt & Brosschot, 1998a	Ph (spider)	NPT	No
Elsesser, Heuschen, Pundt, & Sartory, 2006	Ph (mixed)	Supra-DPT	No
Wenzel & Holt, 1999	Ph (spider)	Supra-DPT	No
	Ph (blood/injury)		
Elsesser, Heuschen, Pundt, & Sartory, 2006	Ph (mixed)	Supra-Stroop	Yes
Kindt & Brosschot, 1998b: Expt 1	Ph (spider)	Supra-Stroop	No
Kindt & Brosschot, 1998b: Expt 2	Ph (spider)	Supra-Stroop (anticipating spider exposure)	Yes
Kolassa, Musial, Kolassa, & Miltner, 2006	Ph (spider)	Supra-Stroop	No
	SP		No*
Kolassa, Musial, Mohr, Trippe, & Miltner, 2005	Ph (spider)	Supra-Stroop	No
	SP		No*
Thorpe & Salkovskis, 1997	Ph (spider)	Supra-Stroop	Yes
	Ph (mixed--not spider)		No*
van den Hout, Tenney, Huygens, & de Jong, 1997	Ph (spider)	Supra-Stroop	Yes
Wikström, Lundh, Westerlund, & Högman, 2004	Ph (snake)	Supra-Stroop	Mixed
see also (above):			
Bryant & Harvey, 1995			
see also 3 Sub-Stroop entries in unconscious table.			
see also 1 Sub-DPT entry in unconscious table.			

Study	Diagnosis	Task	Evidence for unintentional processing?
MDD			
Ellenbogen & Schwartzmann, 2009	Depressed (DEP, bipolar-1, DYS)	MSCT	Yes
Dai, Feng, & Koster, 2011	DEP	NPT	Yes
Goeleven, De Raedt, Baert, & Koster, 2006	DEP	NPT	Yes
Joormann & Gotlib, 2010	DEP	NPT	Yes
Leung et al., 2009	DEP	NPT	No
Leung, Lee, Yip, Li, & Wong, 2009	DEP	NPT	No
Yao et al., 2010	DEP	NPT	Mixed
Leyman, De Raedt, Schacht, & Koster, 2007	DEP	PP	Yes
Donaldson, Lam & Mathews, 2007	DEP	Supra-DPT	Mixed
Fritzsche et al., 2010	DEP	Supra-DPT	Yes
Joormann & Gotlib, 2007	DEP	Supra-DPT	Yes
Constant et al., 2006	DEP	Supra-Stroop	No
Dai & Feng, 2011	DEP	Supra-Stroop	Yes
Dozois & Dobson, 2001	DEP (with comorbid anxiety)	Supra-Stroop	No
	DEP		No
Dudley, O'Brien, Barnett, McGuckin, & Britton, 2002	DEP	Supra-Stroop	Yes
Fritzsche et al., 2010	DEP	Supra-Stroop	No
Gotlib & Cane, 1987	DEP (DEP and DYS)	Supra-Stroop (priming in middle of task)	Yes
Kerr, Scott, & Philllips, 2005	DEP	Supra-Stroop	No
McNeely, Lau, Christensen, & Alain, 2008	DEP (DEP and DEP (remitted))	Supra-Stroop	No
Nunn, Mathews, & Trower, 1997	Depressed (DEP or DYS or adjustment disorder w/ depressed mood)	Supra-Stroop	Mixed
Segal, Gemar, Truchon, Guirguis, & Horowitz, 1995	DEP	Supra-Stroop	Yes
Segal & Vella, 1990	DEP	Supra-Stroop (with priming)	Mixed
Sigmon et al., 2007	DEP	Supra-Stroop	Yes
see also (above):			
Gotlib, Krasnoperova, Yue, & Joormann, 2004			
MacLeod, Mathews, & Tata, 1986			
Mathews, Ridgeway, & Williamson, 1996			
Mogg, Millar, & Bradley, 2000			
Mogg, Bradley, & Williams, 1995			
Bradley, Mogg, Millar, & White, 1995			
Mogg, Bradley, Williams, & Mathews, 1993			
McNeil, Tucker, Miranda, Lewin, & Nordgren, 1999			
Lim & Kim, 2005			
Gotlib, Kasch et al., 2004			

Study	Diagnosis	Task	Evidence for unintentional processing?
Musa, Lépine, Clark, Mansell, & Ehlers, 2003			
Gotlib, Kasch, Traill, Joormann, Arnow, & Johnson, 2004			
see also 4 Sub-Stroop entries in unconscious table.			
see also 2 Sub-DPT entries in unconscious table.			

Note. DEP = Depression/Major Depressive Disorder; DYS = Dysthymia; GAD = Generalized Anxiety Disorder; OCD = Obsessive Compulsive Disorder; PA = Panic attacks (but not PD); PD = Panic Disorder; PDA = Panic Disorder with Agoraphobia; Ph (XX) = Specific Phobia (XX = feared stimuli); PTSD = Post-traumatic Stress Disorder; SP = Social Phobia; MSCT = Modified Spatial Cueing Task; NPT = Negative Priming Task; PP = Posner Paradigm (Exogenous Cueing Task); Supra-DPT = Supraliminal Dot-Probe Task; Supra-Stroop = Supraliminal Stroop Task

*stimuli were not specific to row's disorder.

Table 4

Evidence for uncontrollable processing of emotion-relevant information.

Study	Diagnosis	Task	Evidence for uncontrollable processing?
Agoraphobia			
Fehm, 2003	SP	TSP	Yes
	A		Yes
Fehm & Margraf, 2002	SP	TSP	Yes
	A		Yes
Generalized Anxiety Disorder			
Reinecke, Becker, Hoyer, & Rinck, 2010	GAD	IAT (single-target)	Yes
Becker, Rinck, Roth, & Margraf, 1998	GAD	TSP	Yes
	SP		No
Mathews, Mogg, Kentish, & Eysenck, 1995	GAD	VST	No
Rinck, Becker, Kellermann, & Roth, 2003: Expt 1	GAD	VST	Yes
	SP		No
Rinck, Becker, Kellermann, & Roth, 2003: Expt 2	GAD	VST	Yes
see also 7 Supra-Stroop entries in unintentional table.			
Obsessive Compulsive Disorder			
Bohne, Keuthen, Tuschen-Caffier, & Wilhelm, 2005	OCD	DFT	Yes
Tolin, Hamlin, & Foa, 2002	OCD	DFT	Mixed
	SP		No*
Wilhelm, McNally, Baer, & Florin, 1996	OCD	DFT	Yes
Janeck & Calamari, 1999	OCD	TSP	Yes
Najmi, Riemann, & Wegner, 2009	OCD	TSP	Yes
Purdon, Rowa, & Antony, 2005	OCD	TSP	No
see also 10 Supra-Stroop entries in unintentional table.			
see also 2 NPT entries in unintentional table.			
Panic Disorder			
McNally, Otto, Yap, Pollack, & Hornig, 1999	PD	DFT	No
Teachman, Smith-Janik, & Saporito 2007	PD	IAT	Mixed
see also 13 Supra-Stroop entries in unintentional table.			
Post-traumatic Stress Disorder			
McNally, Metzger, Lasko, Clancy, & Pitman, 1998	PTSD	DFT	Mixed
Zoellner, Sacks, & Foa, 2003	PTSD	DFT	No
Beck, Gudmundsdottir, Palyo, Miller, & Grant, 2006	PTSD	TSP	No
see also 8 Supra-Stroop entries in unintentional table.			

Study	Diagnosis	Task	Evidence for uncontrollable processing?
Social Phobia			
Gamer, Schmukle, Luka-Krausgrill, & Egloff, 2008	SP	IAT	Yes
Kingsep & Page, 2010	SP	TSP	No
Baños, Quero, & Botella, 2008	SP	VST	Yes
Gilboa-Schechtman, Foa, & Amir, 1999	SP	VST	Yes
Rinck & Becker, 2005	SP	VST	Yes
	DEP		Yes
see also (above):			
Fehm, 2003			
Fehm & Margraf, 2002			
Becker, Rinck, Roth, & Margraf, 1998			
Rinck, Becker, Kellermann, & Roth, 2003: Expt 1			
see also 13 Supra-Stroop entries in unintentional table.			
Specific Phobia			
Huijding & de Jong, 2007	Ph (spider)	IAT	Yes
Teachman & Woody, 2003	Ph (spider)	IAT	Yes
Muris, Merckelbach, Horselenberg, Sijsenaar, & Leeuw, 1997	Ph (spider)	TSP	Yes
Zeitlin, Netten, & Hodder, 1995	Ph (spider)	TSP	Yes
Buodo, Sarlo, & Munafò, 2010	Ph (blood)	VST	No
Miltner, Krieschel, Hecht, Trippe, & Weiss, 2004: Expt 1	Ph (spider)	VST	Yes
Miltner, Krieschel, Hecht, Trippe, & Weiss, 2004: Expt 2	Ph (spider)	VST	Yes
see also 9 Supra-Stroop entries in unintentional table.			
see also 1 NPT entry in unintentional table.			
MDD			
Power, Dalgleish, Claudio, Tata, & Kentish, 2000: Expt 3	DEP	DFT	Yes
De Raedt, Schacht, Franck, & De Houwer, 2006: Expt 3	DEP	EAST	No
De Raedt, Schacht, Franck, & De Houwer, 2006: Expt 1	DEP	IAT	No
Franck, De Raedt, Dereu, & Van den Abbeele, 2007	DEP	IAT	Mixed
Franck, De Raedt, & De Houwer, 2008	DEP	IAT	No
Glashouwer & De Jong, 2010	DEP (current and Remitted)	IAT	Yes
Price, Nock, Charney, & Mathew, 2009	DEP	IAT	No
Risch et al., 2010	DEP (first-onset)	IAT	Yes
	DEP (recurrent)		Yes
Joormann & Gotlib, 2008	DEP	ST	Yes
Joormann, Nee, Berman, Jonides, & Gotlib, 2010	DEP	ST	Yes
Joormann, Hertel, Brozovich, & Gotlib, 2005	DEP	TNT	No
Joormann, Hertel, LeMoult, & Gotlib, 2009	DEP	TNT	Mixed
Karparova, Kersting, & Suslow, 2005	DEP	VST	No

Study	Diagnosis	Task	Evidence for uncontrollable processing?
see also (above):			
Rinck & Becker, 2005			
see also 17 Supra-Stroop entries in unintentional table.			
see also 6 NPT entries in unintentional table.			

Note. A = Agoraphobia; DEP = Depression/Major Depressive Disorder; GAD = Generalized Anxiety Disorder; OCD = Obsessive Compulsive Disorder; PD = Panic Disorder; Ph (XX) = Specific Phobia (XX = feared stimuli); PTSD = Post-traumatic Stress Disorder; SP = Social Phobia; DFT = Directed Forgetting Task; EAST = Extrinsic Affective Simon Task; IAT = Implicit Association Test; ST = Sternberg Task (Ignore/Suppress Task); TNT = Think-No-Think Task; TSP = Thought Suppression Paradigm; VST = Visual Search Task

* stimuli were not specific to row's disorder.