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Relationship between Disgust and Memory Biases in Spider Fear

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Abstract

The literatures examining disgust's role in information processing biases and evidence for memory biases in anxiety disorders are both mixed, suggesting small or fragile effects. Thus, to maximize power and reliability, a mega-analytic approach was used to examine data across two studies to determine whether a memory bias for spider-relevant information exists under conditions when disgust is elevated and if the bias is specific to highly fearful individuals. Disgust was manipulated by having a large tarantula present or absent (at encoding and/or at recall) when individuals high (N=158) or low (N=108) in spider fear completed a free recall task. Results indicated that, as expected, the spider's presence was related to enhanced recall of spider information. However, this bias was driven by the presence of the spider during encoding only (as opposed to during recall), and high trait spider fear was not necessary for the memory bias to be expressed. Finally, there was a small effect for individual differences in trait and state disgust to predict spider recall, but this effect disappeared when anxiety was also included as a predictor, suggesting only a limited role for disgust in memory biases related to specific fears.

Keywords

explicit memory; disgust; fear; free recall; spider phobia

The current study integrates research on memory biases in anxiety disorders with the emerging field examining the role of disgust in information processing biases. A mega-analysis was conducted using data from two studies to examine the impact of disgust on explicit memory biases in spider fear. Disgust was manipulated by having a large tarantula present or absent when individuals high or low in spider fear completed a free recall task. The aims of the present investigation were to determine: 1) whether a memory bias for spider-relevant information exists under conditions of elevated disgust, 2) if the bias is specific to highly fearful individuals, and 3) to what extent individual differences in state and trait disgust sensitivity predict preferential recall of spider information.

Evaluating memory biases in fear and anxiety disorders has been a surprisingly difficult task. Although cognitive models of anxiety (e.g., Beck, Emery, with Greenberg, 1985) predict that fearful individuals will preferentially attend to, interpret, and remember threat-relevant information, empirical support for biases in recall and recognition have been inconsistent. This is especially true in spider phobia. While several studies have found that individuals with spider phobia show enhanced memory for spider-relevant information when compared to non-phobic individuals (e.g., Rusted & Dighton, 1991; Watts & Cole, 1992), other studies have shown that persons with spider phobia show poorer memory for spider-

relevant information (e.g., Watts & Dalgleish, 1991; Watts, Trezise, & Sharrock, 1986), or look comparable to non-phobic individuals (e.g., Thorpe & Salkovskis, 2000). These inconsistent memory findings have been puzzling, given that individuals with spider fear do more reliably show selective attention to spider information (e.g., Lavy, van den Hout, & Arntz, 1993; van den Hout, Tenney, Huygens, & de Jong, 1997) and interpret ambiguous information in a threatening way (e.g., de Jong & Muris, 2002).

A number of methodological and theoretical explanations have been offered to explain the inconsistent findings. While it is likely that no single factor can clarify the mixed findings, the current study focuses on the role of disgust as a potentially important feature in observing memory biases tied to spider fear. Additionally, to address some of the methodological limitations cited against previous work in this area, a variety of features thought to increase the likelihood of observing memory biases were incorporated in the study designs (see Coles & Heimberg, 2002). In particular, a free recall memory paradigm was selected that requires a deep level of semantic processing via elaboration of the stimuli (following Becker, Rinck, & Margraf, 1994 and Becker, Roth, Andrich, & Margraf, 1999). Further, memory for spider information was examined because there is considerable evidence that disgust is implicated in spider phobia and because spider fearful individuals are relatively homogenous in terms of the stimuli that elicit their fear. This homogeneity can enhance the sensitivity of the free recall task by increasing the likelihood that the presence of a spider will activate subjective feelings of fear and disgust for most participants.

Impact of Negative Affect on Memory Bias

The focus on priming disgust was selected given theoretical proposals that activating state negative affect, such as anxiety, may enhance the expression of memory biases for vulnerable individuals who are already high in trait fear (see MacLeod & Mathews, 1988; Mathews & MacLeod, 2002). Most relevant studies examining memory biases in spider fear have not measured disgust. However, it is likely that many of the provocations used to activate negative affect in these studies elicited disgust as well as anxiety, given that they involved interactions with spiders. There is now robust evidence that spiders elicit both anxiety and disgust reactions (see Woody & Teachman, 2000). Thus, by examining studies that have used spider provocations and then tested explicit memory, we can develop hypotheses about the likely impact of disgust on memory. Clearly, though, this involves making some inferences. Hence, one goal of the present study was to directly assess subjective feelings of disgust, and then evaluate how disgust specifically predicts spider word recall.

Not surprisingly, given the mixed findings for memory biases in general, studies that have evaluated the impact of a spider provocation on recall of spider information have also obtained inconsistent findings (and even mixed results within a given study; e.g., Watts & Coyle, 1992). For example, Watts and Dalgleish (1991, Study 1) did not find evidence that a spider provocation enhanced recall of spider information in a spider phobic versus non-phobic sample. In fact, they found reduced recall for spider relative to control words in the phobic group. However, the authors noted that the absence of a provocation effect may be explained in part by a low number of words recalled overall, thus reducing the ability to detect effects. In a follow-up study, Watts and Dalgleish (1991, Study 2) employed two spider provocation conditions, one that involved approaching a live spider prior to encoding and the other that involved approaching a dead spider. It was expected that the dead spider condition would elicit less state anxiety than the live condition. As before, the authors did not find enhanced memory for spider words when participants approached the live spider; however, even in the dead spider condition, individuals with spider phobia reported moderate state anxiety. Thus, one reason for the absence of a spider provocation effect on

recall may have been the lack of a condition that was really low in state anxiety or disgust. Hence, the present studies include a condition where the spider is not at all present to maximize the contrast between low versus high spider provocation conditions.

In contrast to Watts and Dalgleish, the first study used in this mega-analysis (Smith-Janik & Teachman, 2008) did find an effect of a spider provocation on explicit memory. Specifically, a free recall paradigm was employed to examine memory for spider words among individuals who were either high or low in spider fear. The spider provocation conditions in the study involved either having a large tarantula present during both encoding and recall, or not having the spider present at any point during the study. Results indicated enhanced memory for spider words among the high fear group who also had the spider present, relative to the other groups. Smith-Janik and Teachman also obtained measures of state and trait disgust in this study, but these indicators of disgust have not been previously analyzed. Of specific interest are whether disgust was elevated following the spider provocation and whether disgust was a unique predictor of spider recall.

Overall, results from prior studies investigating the role of spider provocations on memory are mixed, though we do see a number of methodological differences across the studies that may partly explain the incongruent results. Notwithstanding, previous support for the link between state anxiety and memory biases (e.g., Watts & Coyle, 1992), combined with the theoretical expectation for enhanced recall of phobic-relevant information under conditions of increased negative affect, leads us to expect that elevated disgust should predict preferential recall of spider information.

Role of Disgust in Specific Fears and Phobias

The argument for expecting disgust to play a role in information processing biases in spider fear follows from the considerable body of evidence suggesting that disgust is heightened in certain specific fears, especially blood-injection-injury (BII) and spider phobia. For instance, research shows that disgust sensitivity is elevated among persons with strong animal fears (e.g., Davey, Forster, & Mayhew, 1993; de Jong, Andrea, & Muris, 1997; Klieger & Siejak, 1997; Merckelbach, de Jong, Arntz, & Schouten, 1993). In addition, the links between disgust sensitivity and specific fears cannot be accounted for by their shared relationship with neuroticism (Mulken, de Jong, & Merckelbach, 1996) or trait anxiety (Matchett & Davey, 1991). Further, disgust related to spiders is reduced following successful treatment (de Jong et al., 1997). Thus, there are a number of reasons to expect that disgust is tied to phobic reactions.

At the same time, it is not clear *how* disgust is implicated in specific fears and phobias, which may complicate expectations for disgust's role in information processing biases. In particular, it is not known whether disgust plays a unique role in the etiology or maintenance of anxiety problems (see discussions in Olatunji & McKay, 2006, and Woody & Teachman, 2000), or whether disgust simply occurs as an epiphenomenon of the fear reaction (Thorpe & Salkovskis, 1998). While some researchers have suggested that disgust and fear likely amplify one another in a synergistic fashion (see Sawchuk, Meunier, Lohr, & Westendorf, 2002), the limited evidence to date has found clearer evidence for anxiety inductions elevating disgust reactions than for disgust inductions elevating anxiety (Davey, Bickerstaffe, & MacDonald, 2006; Marzillier & Davey, 2005). These complex findings raise questions about whether the relationship between fear and disgust is uni- or bi-directional, and in turn, whether disgust will play a role in information processing biases if it does not cause or confer vulnerability to anxiety.

Relationship between Disgust and Information Processing Biases

To date, little is known about the role of disgust and contamination concerns in cognitive processing (see Rachman, 2004). However, numerous researchers have suggested that sensitivity to disgust should be associated with unique information processing biases, especially if disgust sensitivity serves as a vulnerability factor for specific anxiety problems in the same way that anxiety sensitivity operates (see Olatunji & McKay, 2006). As noted above, evidence for disgust causing anxiety is lacking, but there is considerable evidence for distorted beliefs tied to contamination in non-fearful populations (Rozin & Fallon, 1987; Rozin & Nemeroff, 1990). Moreover, among spider- and BII-fearful populations, there is evidence for enhanced (explicit) appraisals tied to disgust and contamination following phobic-relevant provocations (Teachman & Saporito, in press). Finally, Sawchuk et al. (2002) highlight the likely adaptive nature of a link between disgust and information processing: "If the evolutionary significance of disgust involves protecting the organism from infection and contamination (Plutchik, 1990), then some degree of an attentional and/or memory bias would be expected for the detection and recollection of potential contaminants in the environment. Such a bias should be amplified in a phobic population if disgust serves a functional role in responding to certain classes of threatening stimuli." (p. 508).

Despite this theoretical expectation of disgust-relevant processing biases, the available evidence for preferential processing of disgust-relevant stimuli among fearful populations, or for disgust leading to preferential processing of phobic or disgust stimuli, has been somewhat mixed. In particular, when disgust has not been primed, there is little evidence for disgust-relevant processing biases among fearful samples. For example, Sawchuk et al. (2002) observed no differences in BII-fearful, spider-fearful, or non-fearful groups across two studies using signal detection to examine recognition memory for phobia-relevant and general disgust pictures. Similarly, using spider phobic and non-phobic groups, Olatunji (2006) did not find a significant change in the evaluation of the disgustingness of previously neutral pictures after their pairing with spiders (see also Olatunji, Lohr, Sawchuk, & Westendorf, 2005, Study 2, for related findings with BII-fearful participants). An interesting exception to these null findings is the more consistent results for a relationship between spider fear and expectancy biases favoring disgust-relevant consequences (e.g., de Jong & Peters, 2007; van Overveld, de Jong, & Peters, 2006). Together, these findings suggest that without priming disgust, information processing biases tied to disgust appear to be fairly circumscribed. Further, there is little evidence for disgust-relevant explicit memory biases.

In contrast, when disgust has been primed, results suggest that disgust likely plays a role in information processing biases, though again, results have been inconsistent. For instance, Davey, Bickerstaffe, and MacDonald (2006) found that a disgust mood induction (involving a vignette combined with disgust "music," such as burping and farting sounds) led to a negative interpretation bias on a homophone task among unselected participants. Similarly, Charash and McKay (2002) found that after undergraduate participants read a disgust story (about a cockroach crawling into one's mouth), a measure of disgust sensitivity was positively related to one's reaction time to disgust words on a Stroop test, as well as to the number of disgust words subsequently recalled after the Stroop test. Interestingly, in a subsequent study again using stories to prime various emotions and examining Stroop effects, Charash, McKay, and Dipaolo (2006) found no overall Stroop effect for disgust words, but did find that participants primed with a fear-relevant story showed more interference for disgust words. These findings, while not wholly consistent, suggest that disgust provocations can contribute to disgust-relevant biases in information processing even among unselected (presumably, mostly non-fearful) individuals.

Among fearful and phobic samples, findings also indicate a likely role for disgust, though again with some inconsistencies. For instance, Olatunji, Sawchuk, Lee, Lohr, and Tolin (2008) found only mixed evidence for a Stroop effect for spider-relevant words among a sample diagnosed with spider phobia. Specifically, more Stroop interference was evident for the spider phobic group following exposure to a dead spider, which likely elicited some disgust, and no evidence was found for an implicit memory bias on a white noise judgment task. Mixed results also emerged in a study with participants high in BII symptoms following a disgust mood induction that involved viewing video scenes of maggots and larvae (Sawchuk, Lohr, Lee, & Tolin, 1999). No group differences in Stroop interference effects were evident for medical or disgust words, but more of these words were completed during a subsequent word stem completion task by the BII-fearful (versus non-fearful) participants.

Overall, although findings have been inconsistent, these results suggest a relatively more promising role for disgust when the emotion has been activated. There are a number of challenges in applying these past findings to the current study question. One issue is that these prior studies have not used similar methods or samples as those used in the current study (i.e., a comparable free recall paradigm to assess explicit memory with a spider fearful sample). Also, there is considerable heterogeneity in results across information processing paradigms, in part because of differential sensitivity and reliability across tasks. More significantly, subjective reports of disgust were often not measured after the disgust primes to verify the expected affective impact of the manipulation (e.g., Charash & McKay, 2002; Charash et al., 2006). And, even when disgust was measured (e.g., Davey et al., 2006), analyses were not conducted to determine the specific relationship between feelings of disgust and the information processing bias measure. Evaluation of this relationship is important if we want to examine how disgust, as an affective response, predicts individual differences in biased processing. This will be a central question in the current research.

Overview

Evaluating the role of disgust in explicit memory in spider fear is challenging, given the mixed findings in the literature. Across three lines of research, theoretical expectations lead to the hypothesis that disgust will predict preferential memory for spider stimuli, but in each case the empirical data present some interpretive challenges. First, there is some evidence for enhanced recall of spider information when negative affect has been activated, but results are inconsistent and there is little data to speak specifically to the role of elevated disgust (as opposed to anxiety). Second, the evidence is fairly robust that disgust sensitivity is elevated in spider fear, but it is not clear whether disgust is only a consequence of fear, or also plays a causal or vulnerability-enhancing role. Third, the limited findings examining disgust in information processing tasks suggest that when disgust is activated, phobic-relevant biases are somewhat more likely to emerge, but again the results have not been consistent.

Given the mixed findings, it seems likely that if disgust plays a role in information processing biases, the effects are relatively small. This does not mean they are not meaningful, and as outlined above, there are many reasons to expect a relationship between disgust and information processing biases. The current study was thus designed to maximize power and use a memory paradigm with relatively established sensitivity. Rather than looking at single studies in isolation that are vulnerable to problems of small sample size, etc., a mega-analysis was conducted by combining the data from two studies. One study is a previously unpublished data set, and the other study includes data that has been partially reported previously (Smith-Janik & Teachman, 2008); however, the relevant disgust data have not been examined. Both studies used similar recruitment procedures for the high and low spider fear groups, a comparable spider manipulation (presence of a live spider), and the

same free recall task. The mostly parallel designs allowed the data to be readily combined. One notable difference involved the addition of extra conditions in the second study. Specifically, as noted earlier, the first study (Smith-Janik & Teachman, 2008) found that only participants who were both high in spider fear and had the spider present exhibited preferential recall of spider words. This study could not disentangle the stage in the memory process at which the spider's presence contributed to enhanced recall, because the spider was present during both the encoding and recall stages. As a result, the second study added high fear groups where the spider was only present at encoding or at recall.

By using the mega-analytic approach, this study had a large enough sample to evaluate: 1) whether a memory bias for spider-relevant information exists under conditions of elevated disgust, 2) if the bias is specific to highly fearful individuals, and 3) to what extent individual differences in disgust predict preferential recall of spider information. It was hypothesized that the spider provocation would elevate state disgust and that this elevation would be associated with a memory bias favoring recall of spider words (but not other word categories). Further, given the link between disgust and spider phobia, as well as the theoretical expectations for enhanced biases when trait and state fears interact (e.g., Mathews & MacLeod, 2002), it was expected that the memory bias would be strongest among highly spider fearful individuals. This study was designed to add to and help clarify the disgust and memory bias literatures in the following ways: 1) employing the use of a large sample, 2) directly measuring trait and state disgust, 3) assessing disgust at multiple time points, and 4) allowing for comparison of the impact of elevated disgust at encoding versus at recall. Finally, the large sample and multiple disgust indicators permitted the use of structural equation modeling (SEM) techniques to help reduce the impact of the unreliability of single measures, thus enhancing the likelihood of observing a significant relationship between disgust and spider recall should it exist.

Method

Participants

For Study 1, participants were 111 undergraduate students (74% female) enrolled in psychology courses. Mean age was 19 years ($SD = 1.08$), and 75% reported race and/or ethnicity as Caucasian, 5% African American, 3% Hispanic, 10% Asian, 5% biracial, and 1% as Bangladeshi. Study 2 participants were 189 undergraduate students (68% female) with a mean age of 19 years ($SD = 1.06$). Seventy-six percent reported race and/or ethnicity as Caucasian, 7% African American, 1% Hispanic, 10% Asian, 5% biracial, and 1% as Middle Eastern. For both studies, the sample was pre-selected based on responses to the "spider" distress item on the nine-item animal/insect fears subscale of the Fear Survey Schedule-III (FSS-III; Wolpe & Lang, 1964; the item "crawling insects" was replaced with "spiders"). Participants who rated their spider fear as a 1 ("not at all") or a 2 ("a little"; for the Low Fear group), or as a 5 ("very much"; for the High Fear group) were invited to participate (following recruitment procedures from Teachman, Gregg, & Woody, 2001). Study 1 employed a 2×2 design with spider fear (low versus high) and spider condition (no spider versus spider present at both encoding and recall) as the between-subject variables. This resulted in four groups: 53 Low Fear (28 No Spider, 25 Spider Both) and 51 High Fear (26 No Spider, 25 Spider Both). Study 2 replicated the basic design of Study 1, but also sought to disentangle the differential impact of having the spider present at encoding versus at recall for the High Fear Group. The focus was on the High Fear group given that these participants were expected to be most reactive to the presence of a spider. Study 2 used a spider fear (low versus high) by spider condition (no spider, spider present at both encoding and recall, spider present at encoding only, spider present at recall only) design where fear and condition were not fully crossed (i.e., the Low Fear group did not participate in the encoding only and recall only spider conditions). Study 2 included six groups: 64 Low Fear

(33 No Spider, 31 Spider Both) and 125 High Fear (30 No Spider, 31 Spider Both, 32 Spider Encoding, 32 Spider Recall).

Materials

Spider fear was measured using both the Spider Phobia Questionnaire (SPQ; Klorman, Weerts, Hastings, Melamed, & Lang, 1974) and the Fear of Spiders Questionnaire (FSQ; Szymanski & O'Donohue, 1995). The FSQ includes subscales to assess fear of harm and avoidance. Disgust sensitivity was assessed using the Disgust Scale (Haidt, McCauley, & Rozin, 1994), which provides a total score, as well as eight domain scores (including one specific to animals). In addition, to better characterize the general emotional health of the sample, participants completed the Anxiety Sensitivity Index (ASI; Reiss, Peterson, Gursky, & McNally, 1986) to assess concerns about the consequence of anxious symptoms, as well as the Beck Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996) to assess severity of depressive symptoms. Finally, the effect of spider condition on participants' state affect was also assessed. Subjective ratings of disgust and anxiety were obtained at three time points (at baseline, at encoding, and at recall) using a Subjective Units of Distress Scale (SUDS). The SUDS verbal analogue scale ranged from 0 (very low) to 100 (very high). Ratings at encoding and recall were obtained at the start of those phases of the study for all participants. In the spider present conditions, ratings were obtained immediately after the spider had been brought in to the room.

The explicit memory measure was the same across Study 1 and 2, and was a modified version of an incidental free recall task used by Becker and colleagues (Becker et al., 1994). During encoding, participants were presented with words from three categories of 10 stimulus words each: spider words (spider-relevant category); panic words (a threatening but spider-irrelevant category); and neutral, furniture words (a control category, where words were still semantically-related). See Smith-Janik and Teachman (2008) for the full word lists and details on word selection and matching. Each word was presented for 10 seconds and participants were instructed to imagine themselves in relation to the word in order to enhance elaboration of the stimulus (as done in the paradigm used by Becker et al., 1994, and Becker et al., 1999). To prevent rehearsal, a five-minute distracter stage (assembling a jigsaw puzzle without the spider present) followed encoding. Participants were then given five minutes to write down as many words as they could recall, including words for which they were uncertain.

Procedure¹

For both Study 1 and 2, participants were randomly assigned to the spider condition prior to participation, depending on their fear group. Participants were not informed that the study involved a memory test. For the spider present conditions, a large tarantula was placed in a clear plastic cage on the testing table approximately two feet to the right of the participant. Participants in the spider present conditions were informed that a harmless spider would be in the room with them in a cage at different times during the study. Participants were always informed when the spider would be brought into the room, and their consent was obtained. Questionnaires were presented in a random sequence to minimize order effects, and the questionnaires and memory task were counterbalanced.

¹Only those measures and procedures relevant to the current hypotheses and completed by both study samples are reported here. In particular, the Study 2 sample also repeated the recall stage of the memory test via email approximately two days following the original test to evaluate the effects of a delay on spider recall, but these data are not discussed here. Contact the first author for further details.

Results

Data Reduction

As described in Smith-Janik and Teachman (2008), for Study 1, prior to conducting the planned analyses, self-reported fear of spiders was examined to confirm group allocation. To simplify analyses, total SPQ and FSQ scores were transformed to z-scores and then combined to create a spider fear total score, given the high correlation between the two questionnaires, $r=.89$, $p<.001$. The distribution of participants' scores showed some between-group overlap. To ensure accurate group assignment, cut scores of $1.5 SD \pm$ the High and Low Fear group means were used. This cut score was chosen to eliminate group overlap, while excluding as few participants as possible. Using the cut scores, 4 Low Fear and 3 High Fear participants were excluded. The final sample for Study 1 included 104 participants; 53 Low Fear (28 No Spider, 25 Spider Both) and 51 High Fear (23 No Spider, 28 Spider Both). The same approach was used to reduce the data for Study 2. A cut score of $1.25 SD \pm$ the High and Low Fear group means was selected because this SD cut point removed the fewest number of participants while eliminating any overlap between groups. This cut 9 Low Fear and 18 High Fear participants, leaving a final sample of 162 participants; 55 Low Fear (27 No Spider, 28 Spider Both) and 107 High Fear (22 No Spider, 30 Spider Both, 29 Spider Encoding, 26 Spider Recall).

Descriptive Statistics

For comparative purposes, the demographic, symptom and baseline affect descriptive statistics are depicted in Table 1, separated by fear group and study. However, given the goal of maximizing power and reliability, the combined sample ($N=266$) was used for all analyses. To check for fear group differences in demographic, symptom and affect variables (at baseline), a series of independent samples t-tests were run comparing the High and Low Fear groups. As expected, there were no group differences in the age of the sample ($t_{(220)}=1.53$, $p>.10$, $d=.21$), or in SUDS ratings of baseline anxiety ($t_{(264)}=.78$, $p>.10$, $d=.10$) or disgust ($t_{(264)}=.24$, $p>.10$, $d=.03$). There was a nonsignificant trend for the High Fear group to endorse more depressive symptoms on the BDI ($t_{(259)}=1.71$, $p=.09$, $d=.21$) and to report significantly higher anxiety sensitivity (ASI: $t_{(259)}=3.69$, $p<.001$, $d=.46$). Further, as anticipated, the High Fear group scored higher than the Low Fear group on all measures of spider fear (FSQ total score: $t_{(259)}=24.07$, $p<.001$, $d=2.99$; FSQ fear of harm subscale: $t_{(259)}=19.92$, $p<.001$, $d=2.48$; SPQ: $t_{(259)}=27.13$, $p<.001$, $d=3.37$) and disgust (DS total score: $t_{(259)}=8.64$, $p<.001$, $d=1.07$; DS animal subscale: $t_{(259)}=8.10$, $p<.001$, $d=1.01$). Finally, typical of spider fearful samples, the High Fear group had a higher percentage of females (84%) than the Low Fear group (51%; $\chi^2=33.12$, $p<.001$). Note, a decision was made not to covary gender because of its close tie to fear group membership.

When checking for spider condition differences *within* each fear group, results were consistently non-significant as expected (all $p<.05$) across the demographic (age and sex), symptom (BDI, ASI, FSQ total and fear of harm subscale, DS total and animal subscale) and baseline affect (anxiety and disgust) variables. The only exceptions to this pattern were higher FSQ fear of harm scores in the Spider Both versus No Spider groups in the Low Fear sample ($F_{(1, 106)}=4.23$, $p=.04$, $\eta_p^2=.04$), and higher ASI scores in the Spider Encoding versus No Spider and Spider Both groups in the High Fear sample ($F_{(3, 149)}=4.84$, $p=.003$, $\eta_p^2=.09$). The overall pattern of equivalence across spider conditions suggests random assignment was effective.

Effect of the Spider Condition Manipulation on Disgust

It was expected that the spider condition manipulation would alter state disgust, such that disgust would be elevated whenever the spider was present. To examine this hypothesis, a

repeated measures analysis of variance (ANOVA) was conducted with two between subjects factors (fear group: High, Low; spider condition: No Spider, Spider Both, Spider Encoding, Spider Recall) and one within subjects factor (time of SUDS disgust rating: encoding, recall). Standardized residuals were used (after regressing the individual's baseline disgust) for the disgust ratings at encoding and at recall. This was done so that change in disgust in response to the spider condition manipulation could be examined independent of baseline disgust (see recommendations for examining change using residuals in Hummel-Rossi & Weinberg, 1975). As expected, there was a significant main effect of fear group (higher ratings from the High Fear group; $F_{(1, 256)}=47.26, p<.001, \eta_p^2=.16$) and spider condition (the No Spider group reported less disgust than the other three groups, who did not differ from one another; $F_{(3, 256)}=14.84, p<.001, \eta_p^2=.15$). There was also a significant fear group by spider condition interaction ($F_{(1, 256)}=35.15, p<.001, \eta_p^2=.12$), as well as a time of SUDS disgust rating by spider condition interaction ($F_{(3, 256)}=61.23, p<.001, \eta_p^2=.42$).

To unpack the interactions, spider condition differences in disgust ratings were compared using univariate ANOVAs with post hoc Scheffe tests for disgust at encoding and at recall separately for each fear group. Among the Low Fear group, there was no effect of spider condition at recall ($F_{(1, 104)}=.92, p>.10, \eta_p^2=.01$), but there was at encoding. Specifically, there were higher ratings by the Spider Both group compared to the No Spider group ($F_{(1, 105)}=4.99, p=.03, \eta_p^2=.05$). Among the High Fear group, there was a significant effect of condition at both encoding ($F_{(3, 153)}=15.18, p<.001, \eta_p^2=.23$) and at recall ($F_{(3, 153)}=23.22, p<.001, \eta_p^2=.31$). As expected, at encoding, the Spider Both and Spider Encoding groups had significantly higher disgust ratings than both the No Spider and Spider Recall groups (all $p<.01$, except the difference between Spider Encoding and Spider Recall was a trend at $p<.10$). The Spider Both and Spider Encoding groups did not differ from one another ($p>.10$), and the No Spider and Spider Recall groups did not differ from one another ($p>.10$). The analogous pattern was evident for the disgust ratings among the High Fear group at recall. The Spider Both and Spider Recall groups had significantly higher disgust ratings than both the No Spider and Spider Encoding groups (all $p<.001$). The Spider Both and Spider Recall groups did not differ from one another ($p>.10$), and the No Spider and Spider Encoding groups did not differ from one another ($p>.10$). Thus, as expected, having the spider present at any time point resulted in elevated disgust. Not surprisingly, these effects were stronger for the High Fear group, who were expected to be more reactive to the spider than the Low Fear group. See Figure 1.

Evidence of Memory Bias

Given that disgust was elevated by the spider condition manipulation, it was then possible to examine the association between disgust and memory bias by asking whether memory biases occurred as a function of the manipulation. It is important to note that while the above data show that the manipulation did alter state disgust as anticipated, the manipulation also altered state anxiety and likely primed the concept of spiders (see Smith-Janik & Teachman, 2008). These other factors may also have contributed to a memory bias. To examine recall of spider words (including words from the lists that were altered in some way; e.g., a singular noun recalled as plural), a repeated measures ANOVA was run with two between subjects factors (fear group and spider condition) and one within subjects factor (word type: spider, panic, neutral). Results indicated a significant main effect of word type (spider words recalled more than panic words, which were in turn recalled more than neutral words; $F_{(2, 255)}=107.80, p<.001, \eta_p^2=.46$). Further, the expected word type by spider condition interaction was also significant ($F_{(6, 512)}=2.33, p=.03, \eta_p^2=.03$). There were no other significant main effects or interactions (all $p>.10$). Of particular note and contrary to hypotheses, there were no significant main or interactive effects for fear group, suggesting

that spider recall was influenced by the presence of the spider but not strongly influenced by trait spider fear.

To understand the significant word type by spider condition interaction, follow-up univariate ANOVAs examining the effect of condition for each word type were then conducted. There was no significant effect of condition for the panic ($F_{(3, 258)}=.02, p>.10, \eta_p^2=.000$) or neutral words ($F_{(3, 258)}=.07, p>.10, \eta_p^2=.001$), but there was the expected significant effect for spider words ($F_{(3, 258)}=5.78, p=.001, \eta_p^2=.06$). Post hoc tests on the spider words indicated greater recall by the Spider Both group compared to the Spider Recall ($p=.01$) and No Spider ($p=.052$) groups, which did not differ from one another ($p>.10$). Spider Encoding did not differ from the Spider Both or No Spider groups (both $p>.10$), but was significantly higher than the Spider Recall group ($p=.04$). These results suggest that having the spider present during encoding (regardless of whether it is also present at recall) promotes higher spider word recall, while having the spider present only at recall does not enhance subsequent memory for spider words (See Figure 2). Strengthening this conclusion, a contrast comparing spider word recall for the groups that had the spider present at encoding (Low Fear/Spider Both, High Fear/Spider Both, High Fear/Spider Encoding) to those who did not (Low Fear/No Spider, High Fear/No Spider, High Fear/Spider Recall) was significant ($t_{(256)}=4.00, p>.001, d=.50$).

Taken together, these findings suggest an effect of the spider condition manipulation that is driven primarily by having the spider present during encoding, rather than by having high trait spider fear.

Does Disgust Predict Spider Recall?

The above analyses suggest that a manipulation associated with disgust has an influence on spider word recall but does not directly evaluate the link between disgust and memory. To address this question, we used structural equation models (SEM) to examine the link between recall of spider words and a latent factor reflecting state and trait disgust. This approach makes it possible to build a latent measure of disgust in order to model inter-individual differences while taking into account intra-individual variability and measurement error across indicators. This latter point is important because there is debate regarding whether low relations among affect measures reflect meaningful individual desynchrony or poor psychometric properties of measures (see Lang, 1985 and Zinbarg, 1998). All models were fit to the data using AMOS, and full information maximum likelihood methods were used so that incomplete data were treated as missing at random (Little & Rubin, 1987).

Model 1a (see Figure 3) was developed to parsimoniously test the hypothesis that disgust would predict number of spider words recalled. A “true score” latent factor of disgust was created to reflect the variance common to the different disgust indicators. The factor was comprised of the state disgust ratings at encoding and at recall (standardized residuals were used as described above), as well as the DS animal subscale. The subscale was selected, rather than the total score, to reflect a measure of trait disgust sensitivity more specific to spiders than the DS total provides. To examine the internal validity of the proposed factor, correlations among the indicators within the latent factor were evaluated to determine the empirical support for the selected combination of indicators. Significant correlations were observed among each of the three disgust indicators, so all were retained (r range: .22–.68; all $p<.001$).

Figure 3 depicts Model 1a (which includes the full sample) with standardized coefficients noted and significant coefficients labeled with an asterisk. As expected, each of the disgust indicators loaded significantly onto the latent factor. Further, there was a non-significant

trend for the latent Disgust factor to predict spider recall (coefficient = .13; $p = .06$), suggesting a small effect. Moreover, as noted in Table 2, Model 1a provides a good fit to the data based on assessment of absolute model fit, including the root-mean-square error of approximation index (RMSEA; less than .08 can be considered an acceptable fit as defined by Browne & Cudeck, 1993; lower numbers are better), the comparative fit index (CFI) and normed fit index (NFI). Both the CFI and NFI vary from 0–1, with values above .90 indicating an acceptable fit (Hu & Bentler, 1999; higher numbers are better).

Model 1a was then compared to a nested structural regression model (see McArdle & Hamagami, 1996) to examine change in fit to the model when the path from disgust to spider recall was set to zero (labeled Model 1b in Table 2). Comparing nested models allows alternative hypotheses to be evaluated systematically by testing the change in chi-square value, with higher values indicating worse fit (Joreskog & Sorbom, 1979). Consistent with the results for Model 1a, when setting the path to zero from the Disgust factor to spider recall in Model 1b, there was a trend ($p = .06$) toward a loss in fit, suggesting that allowing disgust to freely predict spider recall does add (at the level of a nonsignificant trend) to the model. Note, results for the baseline 1a model were quite similar when examined within the high fear sample alone ($N = 158$; referred to as Model 1c). Again, the overall fit was good, and there was a non-significant trend for the latent Disgust factor to predict spider recall (coefficient = .16; $p = .07$). Results were also fairly similar when the model was examined when only including those groups where the spider was present at some point (i.e., omitting the No Spider condition, leaving $N = 166$; referred to as Model 1d). In this case, the overall fit was again strong and the magnitude of the coefficient was comparable, but there was no longer a trend for the latent Disgust factor to predict spider recall (coefficient = .11; $p = .20$). Table 2 outlines the goodness of fit indices and the change in fit ($\Delta\chi^2$ on Δdf) for the various models.

Evaluating the predictive validity of disgust in its own right is of interest, but given the typically strong relationship between disgust and anxiety, we also examined whether disgust would be uniquely predictive of spider recall when taking into account the variance explained by anxiety. As depicted in Model 2, a latent anxiety factor was added to the baseline Model 1a. This factor was created to be analogous to the disgust latent factor. The anxiety factor included state anxiety ratings at encoding and at recall (standardized residuals), as well as the FSQ fear of harm subscale (selected because of the interest in measuring fear specifically, rather than avoidance or some of the other correlates of spider phobia captured in the total FSQ). As expected, correlations among the indicators on the Anxiety latent factor were all significant (r range: .42–.72; all $p < .001$), and loaded onto the latent Anxiety factor (see Figure 4). As noted in Table 2, Model 2 did not provide as good a fit to the data. Of particular interest, when both anxiety and disgust are included in the model (and allowed to correlate with one another), disgust was no longer predictive of spider recall (disgust coefficient = .03, $p > .10$). Further, while anxiety did show a small effect as a predictor of spider recall, it did not reach significance (anxiety coefficient = .13, $p > .10$; see Figure 4). Last, in a final exploratory model where the Anxiety and Disgust latent factors were *not* allowed to inter-correlate, the effect for anxiety as a predictor was a nonsignificant trend and disgust was not a significant predictor (anxiety coefficient = .13, $p = .054$; disgust coefficient = .05, $p > .10$).

Taken together, these SEM results suggest a small effect for disgust as predictive of spider recall on its own. However, the effects are not very robust and disgust was not a unique predictor when anxiety was entered into the model.

Discussion

A mega-analytic approach was used to examine data across two studies to determine 1) whether a memory bias for spider-relevant information exists under conditions when disgust is elevated, 2) if the bias is specific to highly fearful individuals, and 3) to what extent individual differences in disgust predict spider recall. As expected, having a large spider present during a free recall task elevated feelings of disgust, especially for those already high in spider fear. Further, the spider's presence was related to enhanced recall of spider information. However, this memory bias appeared to be driven by the presence of the spider during encoding only (as opposed to during recall), and there was not strong evidence that being high in trait spider fear was necessary for the memory bias to be expressed. Finally, SEM analyses suggested that while there was a small effect for individual differences in trait and state disgust to predict spider recall, this already small effect disappeared when anxiety was also included in the model. These results suggest a limited role for disgust in memory biases related to specific fears and phobias, and it is not clear that this role is unique from the one played by anxiety.

Given the mixed findings in both the memory bias in anxiety disorders literature, as well as the disgust in information processing biases literature, the current study was designed to maximize power and reliability by looking at results across studies, and obtaining multiple, direct measures of disgust at several time points. Taking these steps provided considerable opportunity to observe a significant relationship between disgust and spider recall should it exist. Yet, the conclusion from the current data must be that disgust has only a limited impact on memory for spider information.

Impact of the Spider Manipulation on Recall

When looking at the effect of the spider manipulation, it was clear that state disgust was elevated whenever the spider was in the room. Yet, the impact of the manipulation on spider recall was only evident when the spider was present during encoding. In fact, spider recall was lowest when the spider was only present during the recall phase (though this condition did not differ significantly from the No Spider condition). This may occur because the presence of the spider at recall alone divides attention between the spider and the recall task, hurting task performance. In this sense, when the spider is encountered for the first time at recall, it may serve as both a distractor and a recall cue. In contrast, having the spider present at both encoding and at recall enhanced memory for spider information, possibly because some habituation to the spider had occurred by the time the recall phase occurred². A related question concerns why having the spider present at encoding in particular might be critical for selective memory processes. One possibility, suggested by the affect-as-information hypothesis (Clore et al., 2001), is that negative affect will cue more item-specific processing at encoding, thus leading individuals to attend more closely to the specific stimuli, rather than encoding at a more global level (attending to the gist; see Storbeck & Clore, 2005). Further evaluation of item-specific versus global processing, as well as their interaction with negative affects like ratings of disgust at different processing time points, will be important to determine the reliability of the current findings.

It is somewhat difficult to compare the current results to prior studies because of differences in the spider manipulation conditions. For example, Watts and Coyle (1992) did find

²A challenge to this idea is the evidence that disgust ratings were not significantly lower at recall than at encoding for those groups that had the spider present at both time points (see Figure 1).

Notwithstanding, it is important to keep in mind that affect ratings were taken at the outset of each period, so the possibility of habituation over the course of the combined encoding and recall periods is still likely. Also, a secondary analysis did suggest that subjective anxiety was significantly lower at recall than at encoding for the Spider Both group ($t(108)=2.25, p=.03, d=.22$).

enhanced recall of spider words by individuals with (versus without) spider phobia when a live spider was present during encoding, which is mostly consistent with the current findings. However, there was not a condition where the spider was not present. In contrast, in their Study 1, Watts and Dalgleish (1991) had a live spider at both encoding and recall, encoding only, recall only, or at neither stage, but did not find an effect of the spider manipulation. While these results do contradict the current findings, it should be noted that the authors commented on the likely possibility of floor effects due to the low number of words recalled. In their Study 2, Watts and Dalgleish (1991) had participants approach either a live or dead spider and found no evidence for enhanced memory for spider words in the live spider condition. However, the manipulation occurred prior to encoding, so the primary threat was removed when encoding took place. Finally, none of these studies directly measured whether disgust was induced following the manipulations (though this seems very likely). Clearly, the effect of state affect on memory bias is somewhat fickle. Evidence supporting its impact seems strongest when negative affect is present during encoding (and not initially during recall), but more work is needed to determine the moderators of these slippery effects.

The finding that the effect of the spider manipulation on memory was driven primarily by having the spider present during encoding, rather than by having high trait spider fear, is notable given the ongoing questions about the role of memory biases in specific phobias (see review in Coles & Heimberg, 2002). In previous work (e.g., Smith-Janik & Teachman, 2008), we and others (e.g., MacLeod & Mathews, 1988; Mathews & MacLeod, 2002) have proposed that it is the interaction of state and trait fear that will lead to the clearest expression of information processing biases. Yet, the absence of a main or interactive effect for fear group in the present study makes it difficult to argue that trait fear played an important role in the biases observed. One possibility is that the spider was large enough and close enough to participants that it elevated substantial disgust and fear for all participants. These elevations in negative affect may have led to item-specific processing and enhanced recall (see above), even if participants did not have high trait fear. In this sense, the spider may have captivated attention (and processing resources) for the Low as well as High Fear groups. This leaves open the possibility that for milder negative affect provocations, vulnerability due to trait fear may play a more critical role. Future research that includes multiple state affect manipulations within the same study to elicit different levels of disgust intensity would enable a more direct evaluation of this issue. It is also important to note that the current sample was not diagnosed, so the fear group results may be attenuated given the subclinical nature of the sample. However, this seems unlikely to fully account for the findings given that the current study means on standard measures of spider phobia were comparable to those observed in diagnosed phobic samples.

It is also worth considering the potential contribution of cognitive avoidance by the high fear group to the current findings. There is some evidence that certain anxiety disordered populations may initially orient their attention very rapidly toward threat cues, but then avert their attention away from these cues because of their threatening nature (Foa & Kozak, 1986; see Pflugshaupt et al., 2005, for example in spider phobia). It is possible that this occurred in the present study, so that any initial effects of preferential processing of spider information by the high fear group would have been eliminated by the subsequent avoidance of the information, resulting in no group differences. Resolving this question is challenging because it likely requires testing memory for spider information after only brief exposure to the stimuli (i.e., testing memory early enough that avoidance at encoding would not yet have occurred; however, avoidance of stimuli rehearsal may still be an issue in this case).

Disgust as a Predictor of Spider Recall

The findings for disgust as a predictor of spider recall are consistent with the idea that disgust has only a small role in information processing biases. Even with a large sample size, use of SEM to create a more reliable disgust factor, and a good fitting model, the effect size was small and was only a nonsignificant trend. Also, this effect was substantially diminished when anxiety was added to the model as a predictor, suggesting that anxiety and disgust are not unique predictors of memory bias. It is worth noting that the measurements of anxiety and disgust shared considerable method variance in the current study (especially for the SUDS ratings). Further, fully distinguishing these emotional states in subjective reports has often been challenging (see Woody & Teachman, 2000), thus making the test with anxiety also included in the model a difficult one. Notwithstanding, even when disgust was the only affective predictor, the effect was small. This may help explain why previous findings on selective processing of information related to disgust have been so mixed. Large samples and sensitive tests are presumably needed to detect small effects, and these seem more pronounced when disgust has been activated. It may also be important to consider whether disgust might interact with other emotions (e.g., fear) or vulnerability factors (e.g., behavioral inhibition) to play a more significant role in information processing.

The finding that the effect of individual differences in disgust as a predictor of spider recall is small does not mean it is inconsequential. Psychology and medicine have a long history of small effect sizes having important consequences (e.g., the famous example of aspirin's effect on lowering risk for cardiovascular disease; Sanmuganathan, Ghahramani, Jackson, Wallis, & Ramsay, 2001). At the same time, we would not want to argue that the cost/benefit analysis of recalling more words tied to a phobia is comparable to protecting against heart failure! It remains to be seen to what extent the variance explained by disgust's role in information processing biases can be tied to the more established impact of processing difficulties on anxiety disorders. Demonstrating the link between disgust and information processing to concrete markers of pathology, such as treatment outcome and avoidance behavior, will be critical. This will help determine the clinical significance of disgust's role in information processing. For instance, we suspect that having very strong residual disgust in reaction to phobic stimuli, even following successful treatment, may leave a person more vulnerable to return of fear because of heightened avoidance motivation. Along these lines, manipulating the selective processing of disgust-relevant information and establishing whether it has a causal relationship with anxiety symptoms will be valuable.

The question of whether disgust is causally involved in anxiety problems is a challenging one to resolve. As noted earlier, while the evidence is fairly robust that disgust sensitivity is elevated in spider fear, it is not clear whether disgust is only a consequence of anxiety, or also plays a causal or vulnerability-enhancing role (see negative findings from Davey et al., 2006; Marzillier & Davey, 2005). If both disgust and information processing biases are consequences of fear and phobic reactions (or one is a consequence and the other a cause), rather than reflecting a shared vulnerability or playing a causal role, then it is less clear that they would be expected to be linked. After all, it is not unusual to see desynchrony (low relationships) among different components of the fear reaction (see Lang, 1985), and it is possible that disgust and information processing biases are two relatively independent components.

Limitations and Conclusion

The current results need to be interpreted in light of the study's limitations. In particular, the sample was not formally diagnosed, fear groups were not matched on gender, and the decision to have a fear group by spider manipulation design that was not fully crossed (i.e., Study 2 did not include Low Fear recall and encoding only groups) resulted in samples sizes

that were not equivalent across all cells. In addition, as noted, it is difficult to isolate the effects of disgust, given the frequently high correlation between disgust and anxiety ratings, and because phobic-relevant manipulations usually have multiple effects (e.g., presence of the spider elicits both anxiety and disgust, and primes the concept of spiders). In this sense, our test is not a 'pure' evaluation of the effects of disgust alone on information processing. Also, it should be noted that our conclusions are specific to explicit memory biases, leaving open the question of how disgust (either on its own or in interaction with other forms of emotion dysregulation) might influence implicit memory and other biases.

Despite these limitations, the use of a mega-analytic approach provides an unusual opportunity to obtain an estimate of the effects of a disgust induction on memory bias that is arguably more reliable than can be obtained from most single studies. Disgust appears to have a small impact on memory bias related to spider fear. Now the critical question is whether this small effect has large implications or can be ignored with a dismissive 'yuck'.

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Figure 1.
State disgust at encoding and recall by spider condition and fear group.

Figure 2.
Number of words recalled for each word category by spider condition and fear group.

Note. indicate error terms. * = $p < .05$, † = $p = .06$

Figure 3.

Disgust as a predictor of spider word recall: Structural equation model with standardized coefficients noted.

Note. indicate error terms. * = $p < .05$

Figure 4.

Disgust and anxiety as predictors of spider word recall: Structural equation model with standardized coefficients noted.

Table 1

Sample characteristics

Measure	Study 1 Low Fear		Study 1 High Fear		Study 2 Low Fear		Study 2 High Fear	
	M	SD	M	SD	M	SD	M	SD
Age	19.08	1.26	18.88	.91	18.86	1.07	18.70	.91
Fear of Spiders Questionnaire (FSQ)	24.74	7.79	75.35	21.33	23.80	6.54	77.10	22.02
FSQ-Fear of Harm subscale	13.49	4.10	37.59	12.62	13.32	3.85	39.04	12.76
Spider Phobia Questionnaire	3.38	2.23	16.33	4.31	3.92	2.39	16.51	4.61
Disgust Scale (DS)	15.22	5.14	19.04	4.22	16.18	4.65	21.27	3.83
DS-Animals subscale	3.28	1.48	4.64	1.16	3.04	9.76	4.04	15.40
Beck Depression Inventory	8.04	6.16	9.98	7.15	9.51	7.29	10.53	7.85
Anxiety Sensitivity Index	17.23	8.65	20.14	8.74	19.60	8.43	24.02	9.96
Baseline Anxiety (0–100 SUDS rating)	17.62	15.33	17.69	15.98	16.11	13.01	18.66	16.07
Baseline Disgust (0–100 SUDS rating)	1.04	3.03	1.00	4.24	.76	2.44	1.01	3.85

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Fit statistics for the baseline and competing models

Table 2

Goodness-of-fit indices							
	χ^2	df	$\Delta\chi^2/\Delta df$	p value	Δ NFI	CFI	RMSEA
Model 1a: Disgust predicting spider word recall	.55	2	---	---	.997	1.00	.000
Model 1b: Path from disgust factor to spider recall set to zero	4.21	3	3.66/1	$p=.06$	.978	.993	.039
Model 1c: Disgust predicting spider word recall – high fear sample only	.40	2	---	---	.995	1.00	.000
Model 1d: Disgust predicting spider word recall – spider present samples only	1.10	2	---	---	.989	1.00	.000
Model 2: Disgust and anxiety (correlated) predicting spider word recall	125.46	12	---	---	.822	.832	.189

Note: $\Delta\chi^2/\Delta df$ =change in chi-square and degrees of freedom relative to the baseline model; p value indicates whether the alternate model is significantly different from the baseline model based on $\Delta\chi^2$ tested on a χ^2 distribution with df equal to the Δdf between the models; NFI = Normed Fit Index; CFI = Comparative Fit Index; RMSEA = root-mean-square error of approximation.