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Attentional Bias Differences between Fear and Disgust: Implications for the Role of Disgust in Disgust-Related Anxiety Disorders

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Abstract

Research demonstrates a relation between disgust and anxiety-related pathology; however, research has yet to reveal mechanisms by which disgust may contribute to anxiety. The current experiment examined attentional bias characteristics as one route by which disgust influences anxiety. Eighty undergraduate participants completed a rapid serial visual presentation attention task using fear, disgust, or neutral target stimuli. Task-relevance of the target's presentation was also manipulated. Results revealed that task-relevant disgust targets impaired attention among all participants, but task-irrelevant disgust targets impaired attention only in high disgust prone individuals. Difficulty in disengagement characterized both disgust and fear attentional biases, but the difficulty in disengagement was greater for disgust compared to fear attentional biases. High disgust prone individuals displayed exaggerated difficulty in disengaging attention from disgust targets compared to low disgust prone individuals. The results suggest that disgust attentional biases differ from fear attentional biases. The characteristics of disgust attentional biases are discussed as possible mechanisms by which disgust functions in certain anxiety disorders.

Keywords

disgust; fear; attentional bias; anxiety

Attentional biases refer to differential attention towards one stimulus class (e.g., fear) compared to another (e.g., neutral). Research demonstrates attentional biases towards threatening stimuli in anxious populations (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007). This research program on attentional factors has begun to inform the conceptualization of anxiety disorders (e.g., Beck & Clark, 1997; Mogg & Bradley, 1998).

Provided the importance of attentional biases in anxiety, it is surprising that research has scarcely investigated attentional biases towards disgust-related stimuli. Disgust is defined as a revulsion response towards potential contamination (Olatunji & Sawchuk, 2005; Rozin & Fallon, 1987). Research consistently reveals a relation between disgust and anxiety disorders such as spider phobia, blood-injection-injury phobia, and contamination fear-related obsessive-compulsive disorder (OCD; Olatunji & Sawchuk, 2005; Woody & Teachman, 2000). However, research has only begun to elucidate the processes by which disgust influences anxiety (Davey,

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Bickerstaffe, & MacDonald, 2006). Attentional biases towards disgust stimuli may be one possible process by which disgust influences certain types of anxious concerns.

One route by which the role of attentional biases in disgust and anxiety can be clarified is by elucidating the sub-processes that comprise attentional biases. Research reveals that attentional biases towards fear-related stimuli in anxiety is comprised of facilitated attention towards threat (i.e., quicker attentional engagement towards threat), difficulty in disengagement from threat (i.e., attentional dwelling on threat stimuli), and that attentional biases occur at both automatic and strategic stages of processing (Cisler, Bacon, & Williams, *in press*). Elucidation of the sub-processes comprising attentional biases have led to the formulation of temporal models of attentional biases towards fear stimuli (e.g., Cisler et al., *in press*; Koster, Crombez, Vershuere, Van Damme, & Wiersema, 2006).

Little research has investigated the characteristics of attentional biases towards disgust-related stimuli (Charash & Mckay, 2002; Sawchuk, Lohr, Lee, & Tolin, 1999; Thorpe & Salkovskis, 1998). It seems important to clarify the sub-processes that comprise attentional biases towards disgust stimuli in order to help clarify the manner by which disgust may play a role in particular anxiety disorders. For example, attentional biases towards fear-relevant stimuli have been observed at the automatic level of processing (Mogg, Bradley, Williams, & Mathews, 1993). These findings suggest that processing that is uncontrolled, unintentional, goal independent, or non-conscious (see Moors & DeHouwer, 2006 for a review of automaticity) may underlie these attentional biases and their influence on anxiety. Automatic processing has not been investigated in disgust, so it cannot be determined whether an influence of disgust on anxiety disorders similarly occurs via automatic processing.

A useful task to investigate the characteristics of attentional biases towards threat is the rapid serial visual presentation paradigm (RSVP). In this task, stimuli (e.g., words) are displayed rapidly one at a time such that each stimulus replaces the previous stimulus. A ‘target’ stimulus is typically displayed in a different color from the other stimuli and participants are asked to report this stimulus. Participants are additionally asked to detect the presence of a ‘probe’ stimulus that occurs after the target. The temporal distance between the target and probe is manipulated (e.g., the probe can occur 120 ms, 240 ms, or 360 ms after the target). The procedure assesses the ability to detect the probe as a function of the temporal distance from the target, providing a useful means to investigate the temporal characteristics of attentional biases. Research reveals that with neutral stimuli, identification of the target impairs detection of the probe for up to 500 ms (Raymond et al., 1992). Research demonstrates that emotional stimuli modulate the degree to which the target impairs probe detection (Anderson, 2005; Cisler et al., 2007; Fox, Russo, & Georgiou, 2005; Most, Chun, Widder, & Zald, 2005). Recent researchers have also manipulated task instruction in the RSVP in order to manipulate automatic versus strategic levels of emotional processing (Cisler et al., 2007). Thus, the RSVP is sensitive to emotional modulations and seems an appropriate tool to investigate the temporal characteristics of attentional biases towards disgust.

The current study was designed to address three research questions. First, we examine the temporal pattern of attentional biases for disgust stimuli. We examine automatic processing through manipulating the task-relevance of the emotional stimuli, thus allowing us to test whether attentional biases towards disgust reflect unintentional processing. Second, we examine whether the pattern of attentional biases produced by disgust stimuli differ from those produced by fear stimuli. Third, we examine whether individual differences in disgust proneness moderate the disgust attentional bias characteristics.

Method

Participants

Ninety-nine undergraduate participants (66 females) at a public university completed the experiment. Mean age of the participants was 19.92 (*SD* = 3.74). 80% of participants were Caucasian, 8.1% African-American, 5.1% Asian, 4% Hispanic, 2% identified themselves as 'other.'

Attentional task

Each trial of the RSVP consisted of 3 types of stimuli: 1 target, several distracters, and 1 probe. The probe and distracters were displayed in blue, the target was displayed in yellow (distinguishing it from the other stimuli), and the background was black. Each trial consisted of between 17–21 words, which varied randomly throughout the experiment, and each word was displayed for 120 ms. The target was presented at either serial position 7, 8, or 9, and the probe could appear in either of the four serial positions directly following the target. The probe could appear 120 ms (probe position 1), 240 ms (probe position 2), 360 (probe position 3), or 480 ms (probe position 4) after the target. Neutral distracter words filled in the remaining serial positions of the trial.

Target stimuli were manipulated as a within-subject variable and consisted of either fear (e.g., murder; 5 total fear words), disgust (e.g., feces; 5 total disgust words), or neutral (e.g., film; 5 total neutral words) words chosen from Charash and McKay (2002) who found that these words resulted in fearful ratings of the fear words, disgust ratings of disgust words, and attentional biases towards both word types. These authors also matched the words in frequency of use. Distracter words (e.g., journal) were always neutral in valence and chosen from the RSVP employed by Cisler et al. (2007). The probe appeared 4 times in each of the 4 serial positions. Consistent with previous versions of the RSVP (Arend & Botella, 2002; Cisler et al., 2007; Raymond et al., 1992), the probe stimulus (i.e., the word 'coat') was held constant across trials.

We additionally manipulated the instructions of the task as a within-subject variable. In the 'task-irrelevant' condition, participants were not directed to report the target. Thus, the target was not relevant to the primary task of detecting the probe. The purpose of the task-irrelevant condition was to assess whether task-irrelevant disgust and fear stimuli affect attention unintentionally, which is one feature of automaticity (Moors & DeHouwer, 2006). In the 'task-relevant' condition, participants were asked to report the target as well as detect the presence of the probe. This allowed for an assessment of the influence of disgust and fear words on attention during strategic, intentional processing.

In each condition, there were 16 trials using a disgust target, 16 using a fear target, and 32 (two sets of 16 trials) using a neutral target. There were twice as many neutral trials compared to disgust or fear trials in order to prevent more total trials being negative compared to neutral and participants developing a response bias and learning to orient to the target. To account for a false positive response bias (i.e., reporting the presence of the probe when the probe is not detected), we included an equal number of trials in which the probe did not appear. There were 64 trials in which the probe appeared, 64 trials in which the probe did not appear, and 128 total trials in each condition.

The task-relevant condition was identical to the task-irrelevant condition, except for the instructions: participants were told nothing about the target in the task-irrelevant condition, but asked to report the target in the task-relevant condition. There were 256 total trials in the experiment.

These manipulations result in the following repeated measures experimental design: 2 (task-relevant vs task-irrelevant RSVP condition) × 3 (target word: fear vs. disgust vs. neutral) × 4 (probe position: 1–4). The manipulation of target type relates to the investigation of whether disgust exhibits differential attention compared to neutral and fear stimuli. The manipulation of probe position relates to the investigation of the temporal characteristics of attentional biases towards disgust. The manipulation of instruction relates to the hypothesis of whether disgust and fear differ in attention as a function of stage of processing (i.e., automatic versus strategic).

We operationalize the sub-processes of attentional biases in the RSVP as follows. Poorer probe detection accuracy following an emotional target compared to a neutral target in the 'task-irrelevant' condition reflects automatic processing, such that the targets were task-irrelevant, suggesting that any effect the targets have on attention were due to unintentional (i.e., automatic) processing. Strategic attentional biases are defined as poorer probe detection accuracy following an emotional target compared to a neutral target in the 'task-relevant' condition, such that participants intentionally allocated attention to the targets, suggesting strategic processing. Difficulty in disengagement is reflected in decreased probe detection accuracy following emotional targets compared to neutral targets, such that lowered ability to detect probes suggests that attention was difficult to remove from the emotional targets.

Intentional Attention Check

In order to assure that participants were not intentionally attending to targets in the RSVP task-irrelevant condition, we included an explicit memory test following the task-irrelevant and task-relevant conditions. The explicit memory test consisted of asking participants to list on the computer as many of the target words as they could remember. Participants who were able to recall more than 1 word from any of the word categories following the task-irrelevant condition were removed from analyses (detailed in results section).

Disgust Propensity Measure

All participants completed the Disgust Scale (Haidt, McCauley, & Rozin, 1994), which is a 32-item scale measuring an individual's propensity to respond with disgust across different domains of disgust elicitors (e.g., body products). Internal consistency in the current study was .87.

Procedure

All aspects of the experiment were administered via MediaLab software on PC based computers. Participants first completed the Disgust Scale. Next, participants completed the task-irrelevant condition of the RSVP. After each trial, the computer prompted participants to indicate whether they had seen the word 'coat.' Three practice trials were allowed to familiarize with the task. The first explicit memory test followed the task-irrelevant condition, in which participants typed into the computer all of the target words they could recall. The next part of the experiment consisted of the RSVP task-relevant condition. After each trial of this condition, participants were asked to report what the yellow word in the trial was, they were then asked to indicate whether they had seen the word 'coat.' The second explicit memory test then followed, which was identical to the first explicit memory test. The order of the task-relevance manipulation was not counterbalanced and all participants first received the task-irrelevant condition followed by the task-relevant condition. This was done because if participants underwent the task-relevant condition first, they would be primed to attend to the targets in the task-irrelevant condition, which would likely confound the purpose of the task-irrelevant condition. The final part of the experiment asked the participants to rate the disgustingness and fearfulness of each of the three target words used in the experiment on a 5 pt Likert scale (e.g., ranging from 1 = 'not at all disgusting' to 5 = 'very disgusting').

Results

Manipulation Checks

Fear and disgust ratings—Fear ratings of fear words were significantly greater than fear ratings of both disgusting ($t = 8.05$, $p < .001$) and neutral words ($t = 12.60$, $p < .001$). Disgust words were rated more disgusting than both fearful ($t = 11.69$, $p < .001$) and neutral words ($t = 16.63$, $p < .001$). These data suggest that the target words adequately elicited the desired type of emotion.

Intentional attention check—We excluded 19 participants who were able to recall more than 1 target from each target word type in the task-irrelevant condition (e.g., participants who recalled more than 1 fear target, participants who recalled more than 1 disgust target, etc.). The excluded participants did not differ from included participants in sex, age, race, or in disgust proneness. This resulted in a final sample of 80 participants. Mean target recall in the task-irrelevant condition after participant exclusion was .65 ($SD = .73$). The low level of targets recalled in this condition makes it very likely that participants were not intentionally attending to the target stimuli. Target recall in the task-relevant condition ($M = 6.39$, $SD = 2.17$) was significantly greater than recall in the task-irrelevant condition ($t = 23.67$, $p < .001$), indicating that participants were indeed intentionally attending to targets in the task-relevant condition.

Primary Analyses

Probe detection accuracy as a function of target type and RSVP condition—We excluded the second set of neutral trials in order to balance the cell sizes for neutral compared to disgust and fear trials (e.g., there may be greater error variability among disgust and fear trials as a result of having less trials). A 2 (RSVP condition) × 2 (neutral target trial set: first neutral set vs. second neutral set) × 4 (probe position) ANOVA revealed no effect or interactions with neutral target trial set, validating our exclusion of these trials. Additionally, we repeated the primary analyses using the second set of neutral trials and the results were essentially the same as those reported below.

Probe detection accuracy was subjected to a 2 (RSVP condition) × 3 (target type) × 4 (probe position) ANOVA. To conserve space, only theoretically relevant results are reported. Results revealed a significant three-way interaction between probe position, RSVP condition, and target type, $F(6, 474) = 3.11$, $p = .005$, $\eta_p^2 = .04$. This interaction remained significant when recall for disgust, fear, and neutral words from the task-irrelevant condition were entered as covariates, indicating that individual differences in recall did not confound the results for attention.

Consistent with our research questions, we explored the three-way interaction by analyzing probe detection accuracy separately in each RSVP condition. Except where noted, we only report significant effects when controlling for multiple comparisons using Benjamini and Hochberg's (1995) procedure.

Task-irrelevant condition—A 3 (target type) × 4 (probe position) ANOVA revealed a probe position by target type interaction, $F(6, 474) = 4.52$, $p < .001$, $\eta_p^2 = .05$ (see Figure 1). We further explored this interaction by testing each of the negative emotion target types separately against neutral targets. A 2 (neutral target versus disgust target) × 4 (probe position) ANOVA revealed no main effects or interactions. A 2 (neutral target versus fear target) × 4 (probe position) ANOVA revealed a significant probe position by target type interaction, $F(3, 237) = 8.18$, $p < .001$, $\eta_p^2 = .09$. Follow up analyses revealed significantly decreased probe detection following fear compared to neutral targets at probe position 1 ($t = 4.36$, $p < .001$, $\eta_p^2 = .19$). We then tested probe detection accuracy following disgust targets against fear

targets. A 2 (fear targets versus disgust targets) × 4 (probe position) ANOVA revealed a significant target type by probe position interaction, $F(3, 237) = 4.04$, $p = .008$, $\eta_p^2 = .05$. Follow up analyses revealed a trend for poorer detection following fear targets compared to disgust targets at probe position 1 ($t = 2.19$, $p = .03$, $\eta_p^2 = .06$), but a trend for greater probe detection following fear targets compared to disgust targets at probe position 2 ($t = 2.42$ $p = .02$, $\eta_p^2 = .07$). The major results from the task-irrelevant condition are that fear stimuli affect attention unintentionally, whereas disgust stimuli do not.

Task-relevant Condition—Only trials in which the target was correctly identified were included in analyses. A 3 (target type) × 4 (probe position) ANOVA revealed a probe position by target type interaction, $F(6, 474) = 4.98$ $p < .001$, $\eta_p^2 = .06$ (see Figure 2). We further explored this interaction by testing each of the negative valence targets separately against neutral targets. A 2 (neutral target versus disgust target) × 4 (probe position) ANOVA revealed a significant probe position by target type interaction, $F(3, 237) = 6.16$ $p < .001$, $\eta_p^2 = .07$. Follow up analyses revealed poorer probe detection following disgust compared to neutral words at probe positions 3 ($t = 2.63$ $p = .01$, $\eta_p^2 = .08$), and 4 ($t = 5.40$ $p < .001$, $\eta_p^2 = .27$). A 2 (neutral target versus fear target) × 4 (probe position) ANOVA also revealed a target type by probe position interaction, $F(3, 237) = 6.18$ $p < .001$, $\eta_p^2 = .07$. Follow up analyses revealed poorer probe detection following fear compared to neutral targets at probe positions 1 ($t = 4.02$ $p < .001$, $\eta_p^2 = .17$), 3 ($t = 3.57$ $p = .001$, $\eta_p^2 = .14$), and 4 ($t = 2.69$ $p = .009$, $\eta_p^2 = .08$). We then tested fear and disgust targets against each other. A 2 (fear target versus disgust target) × 4 (probe position) ANOVA revealed a target type by probe position interaction, $F(3, 237) = 3.15$ $p = .03$, $\eta_p^2 = .04$. Follow up analyses revealed poorer detection following disgust targets compared to fear targets only at probe position 4 ($t = 3.01$ $p = .004$, $\eta_p^2 = .10$). This latter finding suggests an exaggerated difficulty disengaging attention from disgust compared to fear stimuli.

Effects of disgust propensity on attentional biases—We tested whether individual differences in disgust propensity moderated the current results by creating high and low disgust groups based on their scores on the Disgust Scale. The high group (n = 17; 16 females; Disgust Scale $M = 25.94$, $SD = 2.84$) was created by selecting participants who scored at least 1 *SD* above the sample mean; the low group (n = 14; 7 females; Disgust Scale $M = 9.5$, $SD = 2.57$) was created by selecting participants who scored at least 1 *SD* below the sample mean. The high disgust group's mean score was above a previously reported mean score of a clinical contamination fear sample ($M = 22.12$, $SD = 4.86$; Woody & Tolin, 2002). As such, creating this high disgust group allows us to test the attentional characteristics of a sample 'at risk' for clinically relevant anxiety disorders.

A 2 (high versus low disgust) × 2 (RSVP condition) × 3 (target type) × 4 (probe position) mixed ANOVA revealed only one significant effect involving group; a disgust group × probe position × target type interaction; $F(6, 174) = 2.26$, $p = .04$, observed power = .78, $\eta_p^2 = .07$). In the task-irrelevant condition, the high disgust group displayed a marginal trend for greater attenuation of probe detection at probe position 2 following disgust words relative to neutral words ($t = 2.7$, $p = .02$, $\eta_p^2 = .31$), whereas the low disgust group did not. There were no between group differences in attention towards disgust relative to fear targets, or towards fear relative to neutral targets.

In the task-relevant condition, the high disgust group displayed a marginal trend for greater attenuation of probe detection following disgust words relative to neutral words at probe position 3 ($t = 2.32$, $p = .03$, $\eta_p^2 = .25$) and significant attenuation at probe position 4 ($t = 3.05$, $p = .008$, $\eta_p^2 = .37$). The low disgust group only showed disgust attentional biases relative to neutral stimuli at probe position 1 ($t = 3.02$, $p = .01$, $\eta_p^2 = .41$). There were no between group

differences in attention towards disgust relative to fear targets, or towards fear relative to neutral targets.

Discussion

The results revealed no evidence of attentional biases towards task-irrelevant disgust stimuli among the sample as a whole or among low disgust individuals, but high disgust prone individuals did display attentional biases towards task-irrelevant disgust stimuli. Mackintosh and Mathews (1998) argue that mild threat-related distracter stimuli capture attention only among individuals who are highly anxious. The current results suggest a similar process for disgust stimuli, such that task-irrelevant disgust stimuli only affect attention among individuals who are easily disgusted. The influence of task-irrelevant disgust stimuli on attention occurred 240 ms after the disgust stimuli onset (i.e., probe position 2), compared to 120 ms (i.e., probe position 1) for fear stimuli. This difference between fear and disgust in attentional characteristics towards task-irrelevant stimuli suggests that although both fear and disgust attentional biases reflect automatic processing, they display distinct temporal characteristics. Moreover, automatic attention towards fear was present in the entire sample, but automatic attention towards disgust was present only in the high disgust prone individuals. Thus, the mechanism responsible for the distinct automatic attention towards disgust seems related to the mechanism underlying disgust proneness.

The results also reveal distinct disgust attentional bias characteristics compared to fear attentional biases in the task-relevant condition (i.e., during strategic processing). Whereas the impaired detection following fear and disgust words both lasted at least 480 ms (i.e., probe position 4), disgust targets produced greater impairment compared to fear targets at probe position 4. These data suggest that disgust may be characterized by an exaggerated difficulty in disengaging attention compared to fear-related attentional biases. The impaired attention following disgust targets at probe positions 3 and 4 appeared to be specific to the high disgust prone individuals, which again suggests that the mechanism responsible for the exaggerated difficulty in disengaging attention from disgust stimuli is related to the mechanism underlying disgust proneness.

The current results reveal distinct temporal characteristics of attentional biases towards disgust that may shed light on the role by which disgust influences anxiety. That high disgust prone individuals exhibit automatic attention towards disgust suggests that task-irrelevant disgust cues may capture a high disgust prone individual's attention and disrupt ongoing purposeful behavior. Moreover, the exaggerated difficulty disengaging attention from disgust cues may result in an excessive and impairing disruption of ongoing purposeful behavior. Fear-related attentional biases also occur automatically and exhibit delayed disengagement, but the disgust-related attentional bias appears to be characterized by exaggerated difficulty in disengagement compared to fear attentional biases. Thus, the role that disgust plays in certain anxiety concerns may be an exaggerated difficulty in disengaging attention from disorder-relevant stimuli when those stimuli are related to disgust (e.g., as with disorder-relevant stimuli in contamination fears). This exaggerated difficulty in disengagement may function in the maintenance of disgust-related anxiety disorders by keeping the individual in contact with disorder-relevant stimuli and necessitating exaggerated coping responses to escape the stimuli. For example, relatively innocuous disgust cues (e.g., a mildly dirty kitchen) may capture the attention of a disgust prone individual. Difficulty removing attention from the disgust cues may lead the individual to excessively clean the kitchen until cues of disgust no longer capture attention, thus reinforcing the excessive cleaning. This pattern of coping behavior resembles OCD phenomenology and suggests that attention could be a route by which disgust contributes to the development or maintenance of contamination fear-related OCD.

The current study is limited to lexical representation of fear and disgust stimuli. More ecologically valid pictures may yield different results regarding the temporal characteristics of attention towards disgust. We also did not measure arousal ratings for the targets, which could affect attention (Anderson, 2005). We manipulated task-relevance in order to manipulate automaticity. More strict manipulations of automaticity (e.g., backwards masking) may reveal different results. Features of attention towards disgust that were unique to high disgust prone individuals were based on a small subsample of our total sample, even though the effect sizes were large. Finally, the current results reveal impaired attention following both fear and disgust stimuli in the attend condition, but previous research with the RSVP has revealed impaired attention for fear stimuli followed by later heightened attention (Cisler et al., 2007). These inconsistencies necessitate replicating the current results using other attentional bias tasks.

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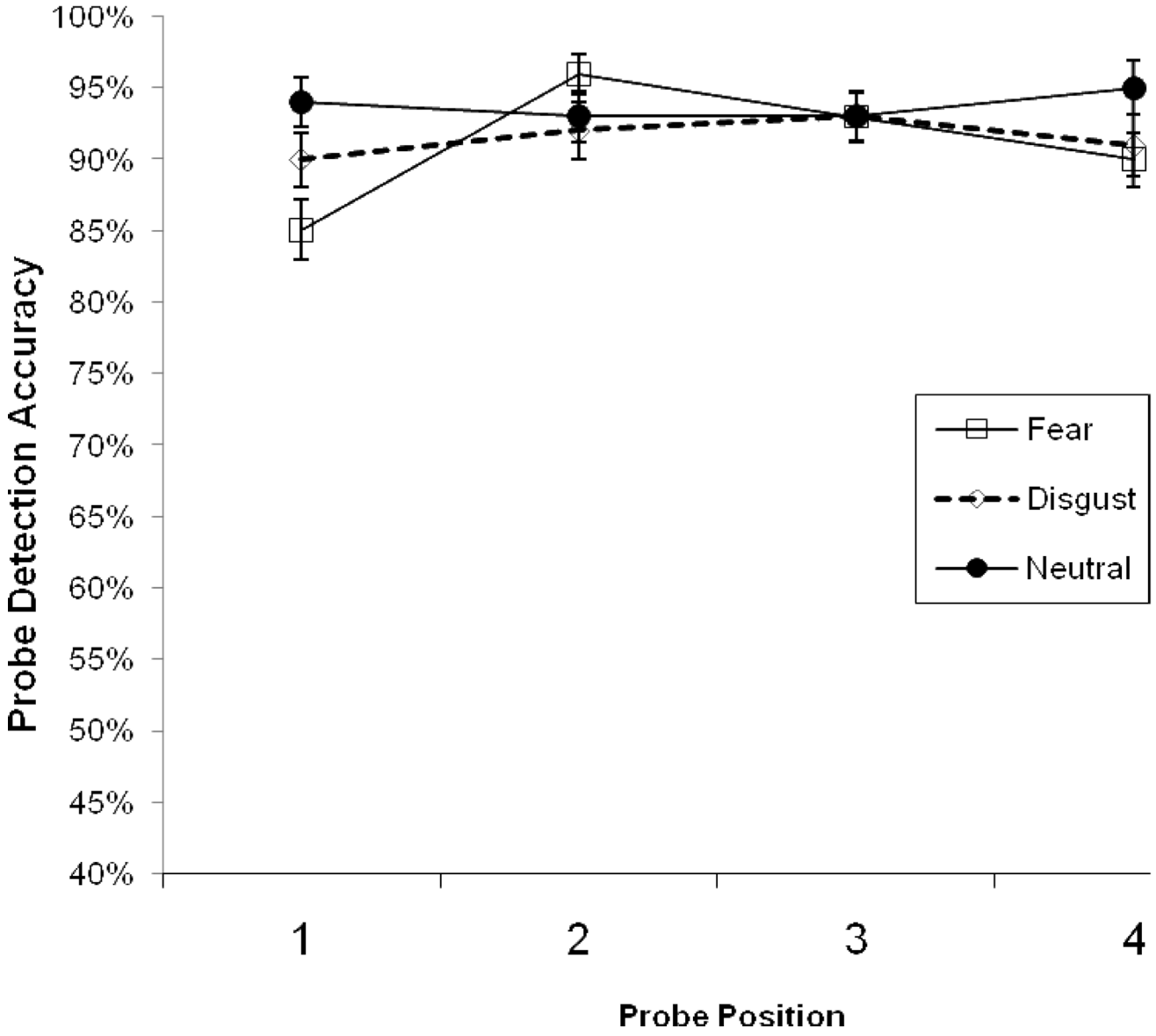

Figure 1.
Probe detection as a function of target type in the task-irrelevant condition for all participants included into analyses. Probe position 1 indicates that the probe appeared 120 ms after the target, probe position 2 indicates that the probe appeared 240 ms after the target, etc.

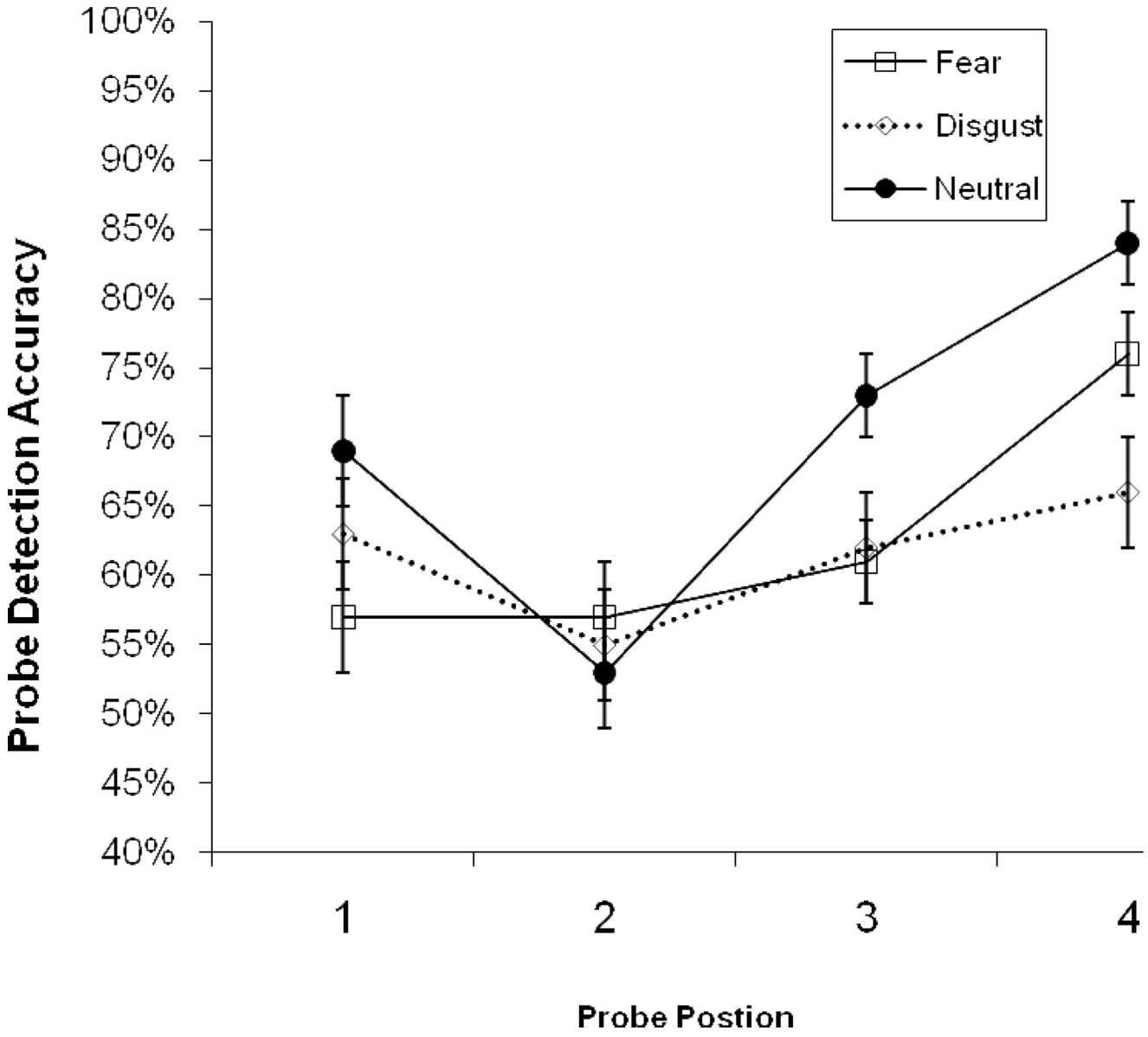

Figure 2.
Probe detection as a function of target type in the task-relevant condition for all participants included into analyses. Probe position 1 indicates that the probe appeared 120 ms after the target, probe position 2 indicates that the probe appeared 240 ms after the target, etc.