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## EFFECTS OF ANXIETY ON ATTENTIONAL ALLOCATION AND TASK PERFORMANCE: AN INFORMATION PROCESSING ANALYSIS\*

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**Summary**—An information processing signal detection methodology was employed to examine attentional allocation and its correlates in both normal comparison (NC) and generalized anxiety disorder (GAD) participants. In particular, the impact of neutral distractor and negative feedback cues on performance of an attention vigilance task was investigated. Individuals with GAD ( $N = 15$ ) evidenced impaired performance on an attention vigilance task relative to NC participants ( $N = 15$ ) when neutral distractor cues were presented. Contrary to prediction, no group differences in performance were detected under conditions in which participants were presented negative feedback cues they were told were relevant to their performance. Instead, GAD participants exhibited improvement during the experimental task such that their performance was equivalent to NC participants. Across trials, the clinically anxious group endorsed significantly higher levels of worry and negative affectivity; however, they failed to respond with concomitant physical arousal (e.g. increased muscle tension). These data are discussed within the context of Eysenck and Calvo's (1992, *Cognition and Emotion*, 6, 409–434) processing efficiency theory. Additionally, the results of this investigation provide support for Barlow's (1988, *Anxiety and its disorders: The nature and treatment of anxiety and panic*) conceptualization of anxiety as requiring the interaction of cognitive schema and physiological arousal. © 1997 Elsevier Science Ltd

**Keywords:** generalized anxiety disorder, worry, signal detection, information processing, attention vigilance

### INTRODUCTION

As part of research attempts to explore the relationship between cognition and emotion, investigators have developed information processing paradigms to examine the cognitive processes associated with emotional disorders, including generalized anxiety disorder (GAD). The cardinal diagnostic feature of GAD as defined by the DSM-IV is excessive worry (American Psychiatric Association, 1994). One hypothesized purpose of the phenomenon of worry is to help maintain hypervigilance to personally relevant threat-related cues (Mathews, 1990). In fact, a number of different information processing methodologies (Stroop, dot probe detection) have noted an encoding selectivity bias of GAD participants wherein they shift attentional resources to threat-related stimuli, resulting in increased detection of such cues (Williams, Watts, MacLeod & Mathews, 1988). These studies have shown that anxious individuals evidence reliable and differential allocation of attentional resources to threat in comparison to non-anxious comparison participants. It is important to note that this cognitive bias is detected only when there is a competition for attentional resources, such as when neutral and threatening stimuli are present concurrently (Eysenck, MacLeod & Mathews, 1987; Mathews & MacLeod, 1987).

Unfortunately, the noted attentional allocation to threat typical of individuals with GAD may translate into interference in performance of tasks at hand. For example, worry has been found to interfere with neutral, monotonous tasks (Borkovec, Robinson, Pruzinsky & DePree,

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1983), as well as tasks placing a demand on cognitive processing resources, such as a decision-making categorization task (Metzger, Miller, Cohen, Sofka & Borkovec, 1990). Thus, some researchers have theorized that the focus of attention on worry may disrupt concentration directed at concomitant environmental tasks (Borkovec, Shadick & Hopkins, 1991).

Along with behavioral disruption, recent empirical data indicate that worriers respond physiologically to anxiety-provoking situations in a unique manner. Research has found a surprising lack of autonomic reactivity in self-labeled worriers and persons with GAD under conditions of experimentally induced worry or stress (Borkovec *et al.*, 1983; Karteroliotis & Gill, 1987). Muscle tension is the only physiological measure that has manifested significant increases in response to stress or psychological challenge for GAD and high trait anxious participants relative to non-anxious controls (Fridlund, Hatfield, Cottam & Fowler, 1986; Hoehn-Saric, McLeod & Zimmerli, 1989). Despite the lack of peripheral physiological reactivity in self-labeled worriers and individuals with GAD, these participants report considerable subjective distress in reaction to experimental manipulations of psychological stress (Borkovec & Hu, 1990; Hoehn-Saric & Masek, 1981).

The model of anxious apprehension outlined by Barlow (1988) is relevant to an understanding of the reactions of individuals with GAD to threat-related stimuli. According to this model, certain cues or situations will elicit a negative affective state in clinically anxious individuals that is associated with perceptions of being unable to predict, control, or obtain desired results in the future. This preparatory response set results in an attentional shift from an external to an internal self-evaluative focus on physiological or other aspects of responding. Further increases in arousal result in attentional narrowing and hypervigilance for cues that are specific to any perceived sources of threat present in the situation. As a consequence, negative affect will increase such that performance may be disrupted and future avoidance of similar situations may occur.

Accordingly, the purpose of this investigation was to examine the differential allocation of attentional resources and its correlates (physiological and affective responses) in an anxiety disorder sample (GAD) and a non-anxious comparison group. The impact of neutral distractor and negative feedback cues on performance of an attention vigilance task was investigated. This paradigm was designed to be functionally related to the task at hand; participants were told that the visual negative feedback cues presented on the screen represented their performance on a task described as a valid measure of intelligence.

Based upon Barlow's (1988) model of anxious apprehension, it was hypothesized that as participants with GAD became increasingly anxious as a result of the accruing negative feedback (particularly in light of the perceived salience of the task), attentional narrowing to the feedback would occur and ultimately cause significant decrements in their task performance (i.e., responding to the neutral trigram task) as well as increments in negative affect and muscle tension in comparison to the normal comparison group. Likewise, GAD participants were expected to exhibit increased reaction times to the trigram task in the presence of the neutral distractor cues given that they tend to be somewhat more generally distractible than non-anxious participants (Eysenck, 1991).

## METHOD

### *Participants*

*Normal comparison (NC) participants.* Fifteen NC participants were recruited through newspaper advertisements and were matched to a GAD *S* on the basis of age and gender. Normal controls were excluded if they received a diagnosis of a past or current mental disorder based on administration of the Anxiety Disorders Interview Schedule for DSM-IV: Lifetime Version (ADIS-IV-L; Di Nardo, Brown & Barlow, 1994). In addition, NC participants had to score below a clinical level on the Penn State Worry Questionnaire (PSWQ < 46; Meyer, Miller, Metzger & Borkovec, 1990).

*GAD participants.* The clinical sample of 15 participants was acquired from the pool of anxiety disorder patients presenting to the Center for assessment. Clinical participants were only included if they scored in the clinical range of the PSWQ (> 57; Brown, Antony & Barlow,

1992), and if the consensus of two independent ADIS-IV-L interviewers was a principal DSM-IV diagnosis of GAD.

### *Reaction time task*

During both the baseline (BSL) and experimental (EXP) trials, trigrams were presented continuously at the geometric center of both the left and right halves of the computer screen at a rate of 1 per sec; trigrams changed simultaneously on both sides (600 trigrams per side per trial). In total, 1160 consonant-consonant-consonant (CCC) trigrams (e.g., 'RTK', 'PDT') and 40 consonant-vowel-consonant (CVC) trigrams (e.g., 'QAT', 'OCK') were presented. When a CVC trigram was presented, it was always paired with a CCC trigram. Order of presentation of CVC trigrams on the left and right halves of the computer screen was randomly determined. Vowel placement within the three positions of the trigram was counterbalanced during each trial.

Participants were instructed to push a button on the computer keyboard following a CVC presentation. If the *S* did so within 3 sec, a 'hit' was recorded whereas failure to respond resulted in the recording of a 'miss'. Pressing a response button in the absence of a CVC trigram resulted in the recording of a 'false alarm'.

Participants were told that a row of four Xs ('XXXX') would be presented at times in the center of the computer screen either above or below the trigram task. Participants were informed that this prompt was used in other research projects, but had no meaning for the task they were assigned. A total of 40 such distractor cues ('XXXX') were presented during the baseline trial; half were paired with a CVC presentation. The purpose of these distractors was to evaluate the possibility that anxious participants evidence increased general distractibility, regardless of the valence of the distractor.

All programming involved in the reaction time task was done in QuickBASIC (Version 4.5). The computer recorded all CVC trigram presentations and all button presses. An auxiliary timing subroutine, accurate to within 8 msec, was incorporated into the program to increase the precision of reaction time data (Graves & Bradley, 1987).

### *Experimental manipulations*

Following a baseline trial session, the salience of the subsequent experimental trial was manipulated using an instructional set informing participants that good performance on the task is reflective of verbal intelligence. Additionally, participants were informed that they would be given instantaneous feedback regarding their performance during the experimental task; the word 'MISS' would appear above the trigram presentations in the center of the computer screen when they failed to detect a CVC presentation. Participants were also informed that they would be given feedback on their performance and how it compared to others their age at the end of the experimental trial. Finally, participants were told that individuals with average verbal intelligence miss no more than 15 CVC trigrams during such a trial.

The primary purpose of the negative feedback cues was to evaluate the effects of negative feedback on task performance. In fact, all 'MISS' cues were bogus. Participants were presented a total of 20 'MISS' feedback cues to allow for accumulating levels of anxiety as the session progressed. Participants were again informed that the neutral distractor cues ('XXXX') would be presented below the trigram task during the second trial (20 were presented), although they had no relevance to the task they were about to complete. Thus, a total of 40 distractors (neutral and negative) were presented during the experimental trial; half of each type were paired with a CVC presentation. The two types of distractor cues were never presented simultaneously. All distractor cues were present on the screen for a total of 2 sec. When they accompanied a CVC trigram, they were presented 1 sec before and for the 1 sec during the CVC trigram presentation.

### *Measures*

*Pre-stimulus measures.* Prior to both trials, participants were asked to estimate their ability to perform well on the task (0 = not at all able to perform; 80 = able to perform extremely well). In order to assess motivation, participants rated how important it was for them to do well on the trigram task (0 = not at all important; 80 = extremely important).

*Physiological measures.* Heart rate and frontalis electromyographic (EMG) activity were recorded continuously via a Vitalog HMS-5000 ambulatory monitor.

*Reaction time task measures.* During the baseline trial, reaction times to CVC trigram presentations with and without neutral distractor cues were recorded. Measures from the experimental trial included reaction times to CVC trigram presentations in the presence of a 'MISS' feedback cue, in the presence of a neutral distractor cue, and in the absence of both types of distractor cues. During both trials, the number of hits, misses, and false alarms were recorded. This allowed *S* sensitivity ( $d'$ ) estimates to be calculated (Macmillan & Creelman, 1991). Increased *S* sensitivity ( $d'$ ) values reflect the participants' ability to detect vowels with relatively few false alarms.

*Post-stimulus measures.* Measures of self-rated worry (percentage of time worried during the trial), state negative affectivity (Positive and Negative Affect Scale—PANAS; Watson, Clark & Tellegen, 1988), and state anxiety (State-Trait Anxiety Inventory—STAI; Spielberger, Gorsuch & Lushene, 1970) were administered following each trial.

### *Design*

This investigation employed a 2 (Group: GAD, NC)  $\times$  [2 (Trial: BSL, EXP)  $\times$  3 (Distractor Type: CVC trigram presented without a distractor cue, CVC trigram paired with a distractor in the top portion of the computer screen, CVC trigram paired with a distractor in the bottom half of the screen)] design, with Group as the between-*S* factor, and Trial and Distractor Type as the within-*S* factors. The second level of the Distractor Type factor (i.e., the distractor cue presented in the top half of the screen) changed across trials. During the baseline trial, a neutral distractor ('XXXX') was presented both in the top and the bottom portions of the screen. In the experimental trial, the neutral distractor presented in the bottom portion of the screen remained unchanged ('XXXX') whereas the distractor presented in the top half of the screen was a negative feedback cue ('MISS').

### *Procedure*

After physiological sensors were attached and the task was described, participants were asked to complete the pre-stimulus measures. Next, a 3-min training trial was conducted to ensure that participants understood the instructions for the task. Following this training, the 10-min baseline trial was conducted. Afterwards, participants completed the state versions of the STAI and PANAS. Participants were then given a description of the experimental trial and completed the pre-stimulus measures. A training demonstration of the experimental trial was then conducted by the experimenter while the *S* observed; the computer was programmed to respond with valid performance feedback during this demonstration. The purpose of this training trial was to enhance the credibility of the subsequent bogus feedback during the experimental condition and to acclimate the *S* to the placement of both distractor types. Immediately following this training trial, the 10-min experimental trial was conducted. Following completion of the trial, participants completed the post-stimulus measures and were then fully debriefed.

## RESULTS

The age of participants ranged from 18 to 65 y ( $M = 36.13$ ;  $SD = 12.88$ ) and 80% of the sample was female. A one-way analysis of variance (ANOVA) revealed no significant group differences in education ( $M = 14.80$  y;  $SD = 2.55$ ). A  $\chi^2$  analysis failed to indicate any significant differences in marital status; 47% of the entire sample were married, 47% were single, and 6% were widowed/divorced.

### *Pre-stimulus measures*

The pre-stimulus questionnaire was analyzed with a 2 (Group: GAD, NC)  $\times$  2 (Trial: BSL, EXP) ANOVA. Results revealed a significant main effect of Group in estimates of how well participants expected themselves to do on the task,  $F(1, 28) = 6.21$ ,  $P < 0.05$ , with NC participants ( $M = 45.33$ ;  $SD = 12.17$ ) reporting higher expectations for successful performance across the two trials than GAD participants ( $M = 34.67$ ;  $SD = 11.25$ ). A marginally significant main effect

of Trial was noted in participants' ratings of the importance of performing well during the upcoming trial,  $F(1,28) = 3.78$ ,  $P < 0.06$ , with both groups evidencing increased ratings of task importance during the EXP ( $M = 44.17$ ;  $SD = 17.72$ ) vs the BSL ( $M = 39.83$ ;  $SD = 13.80$ ) trial.

### Physiological measures

A series of 2 (Group: GAD, NC)  $\times$  2 (Trial: BSL, EXP)  $\times$  2 (Trial Half: First, Second) ANCOVAs was conducted to examine physiological responses. Physiological data from the training trial was used as the covariate.

**Heart rate.** A significant main effect of Trial was noted,  $F(1,28) = 8.85$ ,  $P < 0.01$ , with participants exhibiting higher heart rate readings during the experimental vs the baseline trial (Table 1). In addition, this analysis revealed a significant main effect of Half,  $F(1,28) = 9.19$ ,  $P < 0.01$ . Participants responded with increased heart rate during the second half of both trials. Both of these main effects were qualified by a significant Trial  $\times$  Half interaction,  $F(1,28) = 5.39$ ,  $P < 0.05$ . Follow-up analyses revealed no significant heart rate differences across the first and second halves of the baseline trial. During the experimental trial, heart rate readings were significantly higher during the second vs the first half of the trial,  $F(1,28) = 15.59$ ,  $P < 0.001$ .

**EMG.** Analyses revealed a marginally significant main effect of Group,  $F(1,27) = 3.62$ ;  $P < 0.07$ . Contrary to prediction, NC participants tended to respond to the tasks with greater muscle tension than GAD participants.

### Overall trial effects for information processing measures

Data were analyzed using a 2 (Group)  $\times$  2 (Trial)  $\times$  2 (Trial Half) ANOVA. Exploratory examination of the reaction time data revealed that reaction time data were likely to result in violations of homogeneity of variance as well as normality of the distribution (using Bartlett-Box F and Shapiro-Wilks' test statistics, respectively). Consistent with the methodology of prior studies (cf. Litz, Payne & Colletti, 1987), reaction time data were logarithmically transformed prior to analyses.

**Transformed reaction time data.** A significant main effect of Trial,  $F(1,28) = 6.07$ ,  $P < 0.05$ , was noted with both groups evidencing faster reaction times during the experimental vs the baseline trial (Table 1). Furthermore, results revealed that this effect was qualified by a significant Group  $\times$  Trial interaction,  $F(1,28) = 5.73$ ,  $P < 0.05$ . Follow-up analyses yielded a simple main effect of Group during the First Half of the BSL condition,  $F(1,28) = 7.63$ ,  $P < 0.05$ , as well as a marginally significant effect of Group during the Second Half of the BSL condition,  $F(1,28) = 3.72$ ,  $P < 0.06$ . During both conditions, GAD participants evidenced longer transformed reaction time latencies than NC participants. No group differences were noted during either half of the experimental trial.

Table 1. Means (and standard deviations) of data

Measure	Baseline		Experimental	
	First Half	Second Half	First Half	Second Half
	<i>Heart rate data (bpm)</i>			
GAD	81.85 (12.30)	81.79 (11.50)	82.04 (11.45)	83.35 (11.67)
NC	76.09 (8.96)	76.75 (9.62)	77.86 (9.60)	78.87 (9.46)
	<i>EMG data (mV)</i>			
GAD	23.38 (4.68)	23.19 (4.87)	22.46 (5.58)	23.16 (4.57)
NC	24.65 (6.05)	25.09 (5.55)	24.31 (5.78)	25.71 (5.50)
	<i>Transformed reaction time data</i>			
GAD	3.02 (0.03)	3.02 (0.06)	2.98 (0.04)	2.99 (0.05)
NC	2.98 (0.04)	2.98 (0.06)	2.97 (0.04)	2.98 (0.07)
	<i>Subject sensitivity (d') data</i>			
GAD	3.49 (0.80)	3.48 (0.78)	4.15 (0.95)	3.81 (0.77)
NC	4.23 (1.15)	4.20 (1.06)	4.20 (0.99)	4.26 (1.00)

Note: bpm = beats per minute; EMG = electromyographic; mV = microvolts; GAD = generalized anxiety disorder participants; NC = normal comparison participants

*Subject sensitivity (d') data.* Analyses revealed a marginally significant effect of Group,  $F(1,28) = 3.01, P < 0.09$ , with NC participants exhibiting higher  $d'$  values, suggesting a greater sensitivity to the vowel presentations. Moreover, a significant main effect of Trial was found,  $F(1,28) = 4.81, P < 0.05$ , with both groups evidencing increased  $d'$  values during the experimental vs the baseline trial. Lastly, this analysis revealed a marginally significant Group  $\times$  Trial interaction,  $F(1,28) = 4.12, P < 0.05$ . Follow-up analyses revealed a significant group difference during the Second Half of the Baseline Trial,  $F(1,28) = 4.47, P < 0.05$ , and a marginally significant group difference during the First Half of the Baseline Trial,  $F(1,28) = 4.16, P = 0.05$ . In both instances, NC participants evidenced greater sensitivity to the vowel presentations. No group differences were noted in  $d'$  values during the experimental trial.

*Distractor effects for the information processing measures during the baseline trial*

Data were analyzed separately for the baseline and experimental trials using a 2 (Group: GAD,NC)  $\times$  2 (Trial Half: First, Second)  $\times$  3 (Distractor Type: CVC trigram presented with no distractor, CVC trigram paired with a distractor cue in the top half of the screen, CVC trigram paired with distractor cue in the bottom half of the screen) ANOVA. Examining distractor effects for each trial separately was necessary given that the second level of the distractor type (the distractor in the top position) changed across the two trials (i.e., 'XXXX' during the baseline trial and 'MISS' during the experimental trial).

*Transformed reaction time data.* A significant main effect of Group resulted,  $F(1,27) = 6.94, P < 0.05$ , with GAD participants evidencing longer latencies to respond to CVC trigrams (Table 2). Additionally, a significant main effect of Distractor Type was noted,  $F(1,27) = 4.87, P < 0.05$ . Transformed reaction latency data were significantly different for all three distractor types. Response to CVC trigrams presented without a distractor was longest and latency to respond to CVC trigrams paired with the neutral distractor ('XXXX') on the bottom half of the screen shortest, with responses to CVC trigrams presented with a neutral distractor on the top half of the screen falling in the middle. A significant Group  $\times$  Distractor Type interaction qualified the two main effects,  $F(1,27) = 4.87, P < 0.05$ . Follow-up analyses revealed a marginally significant group difference for vowels presented with no distractor,  $F(1,28) = 4.11, P = 0.05$ , and a significant group difference for vowels presented with a neutral cue on the bottom of the screen,  $F(1,28) = 7.92, P < 0.01$ . Under both conditions, GAD participants responded with significantly greater latencies to respond in comparison to NC participants. No significant group differences were noted in reaction time latencies to vowels presented with a neutral distractor on the top half of the screen.

*Subject sensitivity (d') data.* Results revealed a marginally significant effect of Group,  $F(1,28) = 3.14, P < 0.09$ . NC participants tended to exhibit higher  $d'$  values in comparison to GAD participants. In addition, a significant main effect of Distractor Type was found,  $F(1,28) = 6.16, P < 0.05$ . Subject sensitivity data were significantly different across the three dis-

Table 2. Means (and standard deviations) of reaction time data for each distractor type

Measure	First Half			Second Half		
	No Distractor	Top Distractor <sup>a</sup>	Bottom Distractor	No Distractor	Top Distractor	Bottom Distractor
Baseline Trial						
<i>Transformed reaction time data</i>						
GAD	3.03 (0.05)	3.01 (0.08)	3.00 (0.05)	3.02 (0.07)	3.00 (0.08)	3.02 (0.08)
NC	2.99 (0.06)	3.00 (0.07)	2.94 (0.07)	2.98 (0.07)	2.99 (0.10)	2.91 (0.20)
<i>Subject sensitivity (d') data</i>						
GAD	3.34 (0.75)	4.53 (1.16)	4.45 (1.76)	3.66 (1.21)	4.05 (1.54)	3.86 (2.07)
NC	4.21 (1.22)	4.89 (1.26)	4.90 (1.58)	4.38 (1.38)	4.63 (1.48)	4.85 (1.34)
Experimental Trial						
<i>Transformed reaction time data</i>						
GAD	2.98 (0.07)	2.95 (0.09)	2.97 (0.13)	2.99 (0.08)	2.97 (0.09)	2.98 (0.07)
NC	2.95 (0.05)	3.01 (0.11)	2.97 (0.09)	2.97 (0.12)	2.97 (0.07)	2.99 (0.09)
<i>Subject sensitivity (d') data</i>						
GAD	4.66 (1.23)	4.22 (1.64)	4.63 (1.54)	3.98 (1.15)	3.80 (1.91)	5.38 (1.36)
NC	4.61 (1.32)	4.49 (0.93)	5.00 (1.39)	4.72 (1.46)	4.68 (1.32)	5.02 (1.40)

Note: GAD = generalized anxiety disorder; NC = normal comparison.

<sup>a</sup>Top distractor for the baseline trial = 'XXXX'; top distractor for the experimental trial = 'MISS'

tractors. Vowels presented with the neutral distractor on top were associated with the greatest levels of *S* sensitivity and vowels presented with no distractor were associated with lowest degree of sensitivity. Sensitivity associated with neutral distractors on the bottom half of the screen fell in the middle.

#### *Distractor effects for the information processing measures during the experimental trial*

*Transformed reaction time data.* The  $2 \times 2 \times 3$  mixed-model ANOVA revealed no significant differences in reaction time data (Table 2).

*Subject sensitivity ( $d'$ ) data.* A significant main effect of Distractor Type was found,  $F(1,28) = 10.12$ ,  $P < 0.01$ , indicating a significant difference across all three distractor conditions. Vowels presented with a neutral distractor ('XXXX') evidenced the greatest degree of sensitivity and the vowels presented with a negative feedback cue ('MISS') resulted in the least degree of sensitivity. Subject sensitivity for vowels presented without a distractor fell in the middle of these two distractor conditions.

#### *Post-stimulus measures*

Analyses of all post-stimulus measures (STAI, PANAS, and self-reported worry) were conducted using  $2$  (Group)  $\times$   $2$  (Trial) ANOVAs. A significant Group effect was found for Negative Affect scores on the PANAS,  $F(1,28) = 23.40$ ,  $P < 0.001$ . Across trials, GAD participants ( $M = 23.70$ ;  $SD = 9.55$ ) endorsed greater degrees of negative affect than NC participants ( $M = 11.77$ ;  $SD = 1.77$ ). Similarly, state STAI scores revealed a significant main effect of Group,  $F(1,28) = 36.27$ ,  $P < 0.001$ , with GAD participants ( $M = 58.57$ ;  $SD = 12.97$ ) again exhibiting higher state anxiety scores than participants in the NC group ( $M = 34.00$ ;  $SD = 9.02$ ). Moreover, a significant main effect of Trial was found for STAI scores,  $F(1,28) = 5.97$ ,  $P < 0.05$ , with both groups reporting increased levels of anxiety following the EXP ( $M = 47.73$ ;  $SD = 16.72$ ) vs the BSL ( $M = 44.83$ ;  $SD = 17.18$ ) trial. Two significant main effects were found on post-stimulus measures regarding the percentage of time (0–100%) engaged in worry during the task, including Group,  $F(1,28) = 35.63$ ,  $P < 0.001$ , and Trial,  $F(1,28) = 8.60$ ,  $P < 0.01$ . Participants with GAD ( $M = 68.17$ ;  $SD = 26.58$ ) reported higher percentages of time worried during each trial than NC participants ( $M = 19.17$ ;  $SD = 17.44$ ). In addition, participants in both groups reported worrying during a greater percentage of time in the EXP ( $M = 48.83$ ;  $SD = 34.48$ ) vs the BSL trial ( $M = 38.50$ ;  $SD = 34.77$ ).

## DISCUSSION

As predicted, GAD participants tended to evidence slower reaction latencies and decreased sensitivity to vowel presentations in contrast to NC participants. Contrary to prediction, however, these differences were noted during the baseline rather than the experimental trial. In fact, no significant group differences emerged in reaction time or signal detection data for GAD vs NC participants during the experimental condition. Thus, anxious individuals only evidenced impaired performance on an attention vigilance task when neutral distractor cues were sporadically presented. This finding is consistent with data indicating that individuals with high trait anxiety are characterized by attentional hypervigilance that can result in increased distractibility to neutral cues (Eysenck, 1992; Fox, 1993).

As noted, group differences in sensitivity and reaction latency were not detected under conditions in which participants were presented negative feedback cues they were told were relevant to their performance. The main effects of Trial for both reaction time and *S* sensitivity indicated that all *S* improved performance during the experimental trial vs the baseline trial. Thus, the data indicate that GAD participants exhibited improvement during the experimental task such that their performance was equivalent to NC participants. This result is counter to the robust finding in the literature that clinically anxious participants will allocate attentional resources to threat-related vs neutral stimuli (Eysenck, 1992; Williams *et al.*, 1988).

Despite the general lack of physiological differences between the two groups, post-stimulus measures of affect across the two conditions consistently established that GAD participants



endorsed significantly greater levels of worry and negative affectivity than NC participants. The neutral attentional task paired with distracting stimuli was sufficient to result in baseline differences across the two cohorts. In addition, self-report measures of negative affect indicated a significant effect of Trial wherein participants from both groups reported experiencing significantly higher levels of negative affect during the experimental trial vs the baseline trial. This increase in negative affect during the experimental trial may be attributed to participants' belief in the evaluative nature of the second half of the assessment. In fact, all participants tended to report that they felt it was more important to perform well during this second trial.

In sum, the data indicate that GAD participants' baseline levels of heightened anxiety were associated with interference in performance whereas further increases in negative affect noted during the experimental trial were associated with improvements in task performance, such that it was no longer discriminable from that exhibited by NC participants.

#### *Distractor effects during the baseline and experimental trials*

During the baseline trial, GAD participants exhibited longer transformed reaction times and tended to show decreased sensitivity to vowel presentations. Moreover, a Group  $\times$  Distractor Type interaction indicated that GAD participants tended to evidence increased reaction latencies when no distractor was present and when a neutral distractor was presented on the bottom of the screen. No group differences in reaction time were found when the distractor cue was presented on the top portion of the screen. These findings allow only partial confirmation of the study's hypothesis. Given the noted distractibility of clinically anxious participants to neutral stimuli (Eysenck, 1992; Fox, 1993), it was expected that the presence of a distractor would disrupt the performance of GAD participants regardless of the placement of the cue. Clearly, this was not the case.

Additionally, a main effect of Distractor Type was found during the baseline trials for both reaction latency and *S* sensitivity to the CVC trigrams across all participants. Interestingly, vowels presented with no distractor were associated with the longest reaction times and the least degree of sensitivity. One possible explanation for these findings is that participants became sensitized to either distractor type as a discriminative stimulus for the subsequent presentation of a vowel. That is, 50% of the time that a distractor was presented it was followed by a CVC trigram. Thus, the presentation of a distractor may have inadvertently become a potential signal for an upcoming vowel.

If this explanation is indeed valid, it may provide some support for the magnitude of interference in performance exhibited by GAD participants. As noted above, GAD participants evidenced longer reaction time latencies only when no distractor was presented or the distractor was presented on the bottom of the screen. No group differences were noted when the neutral distractor was presented on the top half of the screen. It is possible that preference for stimuli presented in the screen's upper half may be consistent with the strategy used for reading text (Mogg, Mathews, Eysenck & May, 1991). As a result of this natural preference, the information processing differences between GAD and NC participants noted under the two distractor conditions (i.e., no distractor, distractor presented on the bottom of the screen) may have been negated in this study. Nonetheless, even when a distractor was presented on the lower portion of the screen and may have provided a good 'clue' to participants of the likelihood of an impending vowel presentation, GAD participants were unable to take full advantage of this information and evidenced longer reaction times.

As previously mentioned, a surprising lack of differences was noted across groups during the experimental trial. Main effects of Distractor Type were noted for *S* sensitivity. As might be expected, the negative feedback cues were associated with the least degree of sensitivity. Thus, there is some tentative evidence to suggest that the 'MISS' feedback had its intended potential effect; that is, it seems that the negative feedback cues were capable of interfering with participants' tendencies to respond appropriately to the trigram task. It appears then that the 'MISS' cues were able to capture attentional resources across all participants in the experimental trial, although it is contrary to the prediction that GAD participants would be more vulnerable to the effects of the negative feedback on their performance than would NC participants.

*Theoretical integration of the findings*

The processing efficiency theory developed by Eysenck and Calvo (1992) may provide an adequate framework in which to discuss the findings of the current study. Their theory asserts that individuals' performances will be determined by their level of state anxiety. In addition, Eysenck and Calvo have drawn an important distinction between performance effectiveness (how well a person performs a task) and processing efficiency (the amount of effort or processing resources that a person devotes to a task), arguing that two individuals can be objectively functioning at the same level with one devoting a much greater proportion of his or her effort to the task.

Eysenck and Calvo (1992) have further stated that although worry demands attentional resources, it may also serve a motivational function (cf. Borkovec, 1994; Tallis, Davey & Capuzzo, 1994). For example, the presence of worry may result in the devotion of increased attentional resources to the task as individuals strive to improve their performance, and thereby potentially eradicate the source of their worry. Furthermore, they have noted that generally anxious individuals may be aware that anxiety typically interferes with their performance. As a result, they may allocate additional attentional resources to the task at hand in an attempt to counteract their typical performance deficit.

It is possible that the GAD participants responded to the experimental, or high stress, condition by allocating an increased proportion of their attentional resources to the trigram task, thereby improving their performance. In fact, consistent with the predictions of Eysenck and Calvo's (1992) theory, GAD participants' expectations of successful performance on the described trigrams tasks were significantly lower than the NC participants. In addition, all participants tended to report increased estimates of the importance of performing well on the experimental vs the baseline task. Furthermore, results indicated that individuals with GAD evidenced increased worry during the experimental relative to the baseline trial at levels significantly higher than that endorsed by NC participants. Thus, under conditions of increased importance of the task with relatively lower ratings of expected performance, GAD participants reported worrying more. As noted, this increase in worry was in fact associated with better performance. It seems reasonable to suggest then that the worry of individuals with GAD may have served a motivational function as predicted by Eysenck and Calvo's (1992) theory and resulted in increased effort allocated to the trigram task, such that they improved their performance. It is possible that individuals with GAD may have been able to improve upon their performance because their cognitive capacities were not burdened by a task that required perceptual search of the entire computer screen (cf. Mathews, May, Mogg & Eysenck, 1990).

Despite the ability of GAD participants in this study to match the performance of NC participants during the experimental trial, it is important to remember that the clinically anxious cohort consistently responded to the tasks presented with significantly greater levels of worry and negative affect. Although GAD participants evidenced the expected affective effects in response to the experimental manipulation, it is unclear why they failed to exhibit physiological differences that may be expected to correspond with the exertion of increased effort. In fact, the failure of this GAD sample to respond with the characteristic physiological pattern of increased muscle tension may serve to explain why predictions consistent with Barlow's (1988) theory of anxious apprehension were not supported. According to this theory, the narrowing of attentional resources to potential sources of threat is a result of the interaction between cognitive schema and physiological arousal. In other words, physiological arousal fuels the process of anxious apprehension and its requisite attentional narrowing (e.g., self-evaluative focus, hypervigilance for threat cues). In this investigation, it may be that the lack of typical physical responsiveness in the GAD participants may have protected them from a disrupted performance. If so, then this finding would suggest that Barlow's (1988) conceptualization of anxiety as resulting from the interaction of cognitive schema as well as an arousal state should be further explored.

In sum, this study appears to be the first that has found that clinically anxious participants were able to improve task performance in comparison to a baseline task such that their performances were similar to NC participants. As noted, despite the surprising lack of group differences on a number of dependent measures, GAD participants reported greater subjective distress to the attentional vigilance task than did NC participants. Thus, the lack of detected

differences during the experimental trial did not appear to be due to the inefficacy of the experimental manipulations to create the requisite affective states. This distress, however, was not accompanied by the physiological and information processing responses characteristic of clinically anxious participants. The data from this study do suggest a potential interference effect of neutral distractors on the performance of GAD participants.

Given the results of this investigation, it would seem important to specify experimental conditions under which GAD participants may be able to increase their processing efficiency. Indeed, research that has partially failed to find information processing differences between GAD and NC individuals has served to elucidate theorizing about the necessary circumstances for attentional vigilance (cf. Mogg, Bradley, Williams & Mathews, 1993). Through this continued work, a clearer understanding of the complex relationship of cognition and emotion will be possible.

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