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Different mechanism of visual attention in anxious and non-anxious population

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Using a modified Posner's cue-target paradigm, we investigated whether negative cues attract more attention than neutral cues in anxious people. Previous studies used commonly an unbalanced proportion of valid and invalid trials (75% vs. 25% respectively). But in the present study, an equivalent proportion of valid and invalids trials was used for measuring detection speed of cues without participant's expectancy caused by the unbalanced proportion. Emotional words (Experiment 1) and facial expressions (Experiment 2) were used as cues for target locations. The result of Experiment 1 and 2 showed that threatening cues facilitated target detection in valid trials and interfered with it in invalid trials in anxious participants and a reverse response patterns were found in non-anxious participants. This indicates that threatening cues attract more attention to the cued location in anxious people and in contrast, non-anxious people avoid threatening stimuli. In Experiment 3, we investigated the difference of validity effect across anxiety levels. The results showed that anxious participants gave less attention to cued location when the cues were non-informative whereas non-anxious participants gave more attention to cued locations in the same condition. We discussed two kinds of cognitive bias caused by anxiety levels: attentional bias and proportion related bias.

Keywords : emotion; attentional engagement; attentional disengagement; anxiety; avoidant processing; vigilant processing.

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A considerable number of studies have been reported to analyze the characteristics of anxiety on the basis of attentional mechanism. One of the most important findings in this domain is incontestably the fact that clinical or sub-clinical anxiety is associated with an attentional bias for threat-related stimuli (Wells & Matthews, 1994 Williams, Watts, MacLeod, & Mathews, 1997). Anxious individuals often favor the processing of the anxiety-related information (generally negative or threatening stimuli) rather than that of neutral information, and this occurs in relatively early, automatic or pre-attentive aspects of processing (Mogg & Bradley, 1998; Öhman, 1996).

Usually, emotional Stroop task, dot-probe detection tasks, and their modified versions were most frequently used in this domain. The general results of the emotional Stroop task showed that the color-naming in the presence of a threat-related stimulus was slowed down. This indicates that the processing priority is given to the detection of threatening content rather than the color patch of target (e.g., Mathews & MacLeod, 2002). The results of dot-prove detection task showed faster RTs when targets appeared in the location of threatening cues than when they appeared in the location of neutral cues. This suggests that the initial orienting of attention tends to threat-related stimuli rather than neutral ones only in anxious individuals (e.g., Mogg, Mathews, & Eysenck, 1992). Although there were many important findings using these two experimental paradigms, they have some limits for showing where the attentional bias was caused in spatial processing of attention (shifting, engagement, disengagement, and finally, inhibition of return).

Recently, using a new experimental method, an alternative account of attentional biases was proposed by several studies (e.g., Fox, Russo, Bowles, & Dutton, 2001; Fox, Russo, & Dutton, 2002 Georgiou et al., 2005). They used a modified Posner's cue-target paradigm in which facial expressions or affective words (angry, happy, and neutral) were presented as peripheral cues for target locations and found two important effects. First, on invalid trials in which targets appear in uncued locations, threat-related cues slowed down RTs to targets in comparison with neutral cues in participants with high anxiety scores. Fox et al. (2001, 2002) noted that anxious individuals take longer to disengage their attention from threatening cues. Second, they found no difference of RTs on valid trials between two conditions of threatening and neutral cueing. With this result, Fox and her collaborators proposed that *the engagement component of attention may be encapsulated, and not influenced by higher-level variables (e.g., meaning or valence of a cue), whereas the disengage component of attention is not encapsulated and could be influenced by semantic material* (Stolz, 1996 cited in Fox et al., 2001). According to this account, the phenomenon of attentional bias in anxious individuals is based on the disengagement component rather than the engagement component of attention. In the present study, we addressed the validity of this assumption. Specifically, we asked whether the engagement component of attention is really encapsulated and cannot be affected by anxiety.

In the literature, there is clear evidence supporting the speeded detection of threat-related stimuli in comparison with neutral stimuli in anxious individuals. For example, Byrne and Eysenck(1995) found that high trait-anxious participants were faster to find angry faces than happy ones among same neutral faces presented for distracters. Similar results were reported in the studies of Gilboa-Schechtman, Foa, and Amir (1999) with participants with social phobia, and Rinck, Reinecke, Ellwart, Heuer, and Becker, (2005) with spider phobia patients. The effects observed in these studies cannot be easily explained by Fox and her colleague's hypothesis.

In the present study, we replicate the study of Fox et al. (2001) using some different parameter because we thought that there was a methodological problem in Fox et al., (2001) to conclude that the attentional bias is based on only the engagement component of attention. The problem is the proportion of valid and invalid trial. The proportions of valid and invalid trials in the task used in Fox et al., (2001, 2002) were 75% and 25% respectively (they did not address the reason why they used this proportion). In the original Posner's cue-target paradigm, benefits and costs of attentional orienting can be estimated by comparing the difference of response latencies on valid and invalid trials. The usual finding is that it takes less time to respond to a target presented at the cued location (i.e., valid trials) and more time to respond to a target presented at an uncued location (i.e., in valid trials) (Posner, 1988 Posner & Peterson, 1990). But we can modify this effect by changing the proportion of valid and invalid trials. For example, if targets appear at the cued locations on 80% of trials, the cues could be informative and motivate subjects to attend to the cued location because the target usually appears at the cued location. In this case, the performance can be improved by focusing attention onto the cued location.

This indicate that the results of Fox et al.(2001) observed in valid trails were confounded with participants intention. That is, Fox et al.(2001) found no difference of response latency between trials with negative and those with neutral cues in valid trial and concluded that the detection time of cue is automatic and encapsulated and could not be changed by the content of cue such as neutral or negative stimuli. But the RTs were the results confounded by participant's top-down control and expectancy for target location.

In order to study the automatic capture of attention by the cue, uninformative cues are commonly more useful. That is, when targets appear with equal probabilities in cued or uncued locations (50% of valid and 50% of invalid trials), the cues do not reliably predict the location of target and any allocation of attention to the cued location is presumed to be unintentional (Luck, Vecera, 2002, for the review). Even when the cues are uninformative or harmful to performance, the benefits and costs of attentional orienting occur (Cheal & Lyon, 1991 Eimer, 1997; Jonides, 1981; Yantis, 1996). Maybe, if we focused on the response latency of invalid trials (disengage component of attention), the proportion of valid and invalid trials is not likely to be so important because we measure the time of attentional shifting from cues to target (from disengagement from cues to engagement to cue). But if we focused on the response latency of valid trials, the proportion is very important because it change the level of voluntary attention to cue and the intention influence on the detection time of cue.

The present study reexamined whether threat-related cues attract more attention using an equivalent proportion of valid and invalid trials. We focused on the difference of RTs between trials with negative cues and those with neutral cues in valid trials. The main propose of the present study is to verify whether the attention bias in high anxiety population is caused by speed detection of threatening stimuli, by disengagement component of attention proposed by Fox et al.(2001) or by both of components.

Experiment 1

The main aim of Experiment 1 is to determine whether threat-related words are more potent than neutral or positive words in the attentional engagement on their own location. On the basis of the literature reviewed earlier (e.g., Rinck et al., 2005), we predicted that threat-related words is more effective (shorter reaction times) than neutral or positive words in attracting visual attention in participants with high anxiety. In addition, we analyzed the validity effect (score subtracting the mean of RTs on valid trials from that on invalid trials) to examine the difference of disengagement component of attention across the emotional valence (negative, neutral and positive) and the anxiety levels. The validity effect reflects the difference in times taken from disengaging the visual attention from a cue to detecting a target on the uncued location.

The task used in the present study is the same as that of Fox et al (2001, 2002) except the proportion of valid and invalid trials and several details. Neutral, positive, and threat-related words were used for peripheral cues.

Method

Participants

Twenty four (14 female, 10 male) undergraduate students at the University of

Daejeon volunteered to participate in the experiment. First, 28 students were pre-selected from a pool of 81 students by the score on the basis of Spielberger trait-anxiety scale (STAI; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983) tested in class rooms: those scoring at or above 50 (n = 15) for high trait-anxious group and those scoring at or below a score of 40 (n = 13) for low trait-anxious group. The mean score of total participants (n =80) was 44.6. Twenty four students were selected from these students on the basis of Spielberger State-Anxiety scale (1983) tested just before the experiment: those scoring at or above a score of 47 (n = 12) for low state-anxious participants and those scoring at or below a score of 40 (n = 12) for high state-anxious participants. All were aged between 19 and 27 years (mean =22).

Materials and apparatus

The attentional task was adapted from the traditional cue-target paradigm (Posner, 1988) and run on an Apple Mackintosh computer (7200/120) and a 15 inch monitor positioned 55cm from participants. All stimulus presentation and data collection were controlled by Psyscope version 1.2.5. (Cohen, MacWhinney, Flatt, & Provost, 1993). Cue words consisted of 12 threatening, 12 neutral, and 12 positive Korean words (see appendix 1). The words were selected from the study of Kim, Jong, Ko, Shin, Yang, & Sohn (2002). There were no significant difference in terms of word frequency and word length (all words had two syllables) across three emotional valence. The cue words and targets (asterisk *) were presented at the visual angle of 4.3° and 0.8° respectively. The visual angle from the fixation point to the center of the peripheral cue was 6.5°.

Procedure

Participants were brought into a testing room and completed the STAI state-anxiety questionnaire and moved to a computer screen. They were asked to indicate whether the target (*) appeared on the left or right by pressing one of two response buttons ('z' for left and '/'for right) as quickly and correctly as possible. Participants executed six practice trials and 144 main trials divided by two blocks. The sequence of each trial was as follows: A fixation point (+) was presented at the center of screen for 700ms. Immediately after the fixation point, a cue was presented either in the right or the left side of fixation point for 100ms. After the offset of the cue, a target was presented in the cued location (valid trial) or in the opposite location (invalid trial) until a participant responded. The cue-target interval (CTI) was 100ms.

Each participant completed two blocks consisting of 72 trials. Six threatening, six neutral, and six positive words for the first block and the same number of cue words for the second block were used. All words were presented four times (one for left and one for right side on the valid trial and the same as on the invalid trial).

Design

A 2 (Anxiety: high and low) x 2 (Cue Validity: valid and invalid) x 3 (Affective Valence of Cue: threat, neutral and positive) analysis of variance (ANOVA) factorial design was used. The Anxiety was a between-subjects factor, and the Cue Validity and Affective Valence of Cue were within-subjects factors.

Results

Group difference

Two groups differed significantly, in the expected directions, on trait anxiety, $t(24) = 12.7$, $p < .001$, and state anxiety, $t(22) = 8.7$, $p < .001$. The high anxiety group scored higher on measure of trait and state anxiety (M = 54.92 and 53.91, S.D. = 4.63 and 6.78, respectively) than the low anxiety group (M = 35.25 and 32.91 and S.D. = 2.70 and 4.93, respectively).

Response time

The RT data were filtered by removing all error trials and data points less than 150ms or greater than RT calculated by a following equation: third quartile +3*(third quartile - first quartile). This filtering procedure was used in all subsequent experiments in this study. 23 of 3456 cases were eliminated (.03%). Errors tended to be very infrequent in Experiment 1 and subsequent experiments and therefore the analysis was focused on RT data only and not on error rates. Mean RTs for valid and invalid trials were presented in Table 1. RTs were analyzed using a 2 Anxiety (high and low anxiety) x 2 (Cue Validity: valid and invalid) x 3 (Affective Valence of Cue: threat, neutral and positive) ANOVA. No main effect was found. There was only a significant two-way interaction between Cue Validity and Anxiety level, $F(1, 22) = 19.38$, $MSE = 401.94$, $p < .001$. Further analysis revealed that non anxious participants responded more rapidly on valid (342ms) than invalid trials (353ms), *F*(1,

Table 1. Mean RTs (in millisecond) for valid and invalid trial as a function of Affective Valence of Cues and Anxiety in Experiment 1.

	Valence of cue		
Validity of trial	Threat	Neutral	Positive
		Low anxiety	
Valid trials	341(40)	338(38)	348(39)
Invalid trials	355(47)	354(47)	353(53)
		High anxiety	
Valid trials	322(24)	330(25)	326(28)
Invalid trials	310(21)	309(22)	306(23)

Note. Standard deviations in parentheses.

11) = 4.86, *MSE* = 498.97, $p < .05$, and inversely, anxious participants responded more slowly on valid (325ms) than invalid trials(308ms), $F(1, 11) = 18.74$, *MSE* = 305.01, $p < .01$.

Valid trials (Engagement component of attention)

In order to investigate the engagement component of attention, we examined the data for valid condition only. As expected, there was a Anxiety x Affective Valence of Cue interaction, $F(2, 44) = 4.02$, *MSE* = 77.39, $p < .05$. Further analyses showed that highly anxious participants responded more rapidly with threat-related cues than neutral cues, $t(11) = 2.48$, $p < .05$ and low anxious participants responded more slowly with positive cues than with neutral cues, $t(11) = 2.2$, $p < .05$ (see table 1).

Validity effects (Disengagement component of attention)

Validity effects of each condition were calculated by subtracting the mean RTs of each condition on valid trials from the mean RTs of the same condition on invalid trials as shown in Figure 1. Two groups differed significantly, $F(1, 22) = 19.39$, *MSE* = 803.88, $p < .001$. The high anxiety-group (-17.8ms) showed an inversed validity effect (faster RTs in invalid than valid condition), whereas the low anxiety-group showed the expected validity effect (11.6ms). There was no interaction between Anxiety and Affective Valence of Cue, $F(2, 44) = 1.49$, ns. Planned contrasts reveals that the cue validity effect tended to be shorter with positive cues (5ms) than that with neutral cues (15ms) in the low anxiety group, $t(11) = 1.9$, $p = .08$, whereas in the high anxiety group, it tended to be larger with threat-related cues (-12ms) than that with neutral cues (-21ms), $t(11) = 1.7$, $p = .10$.

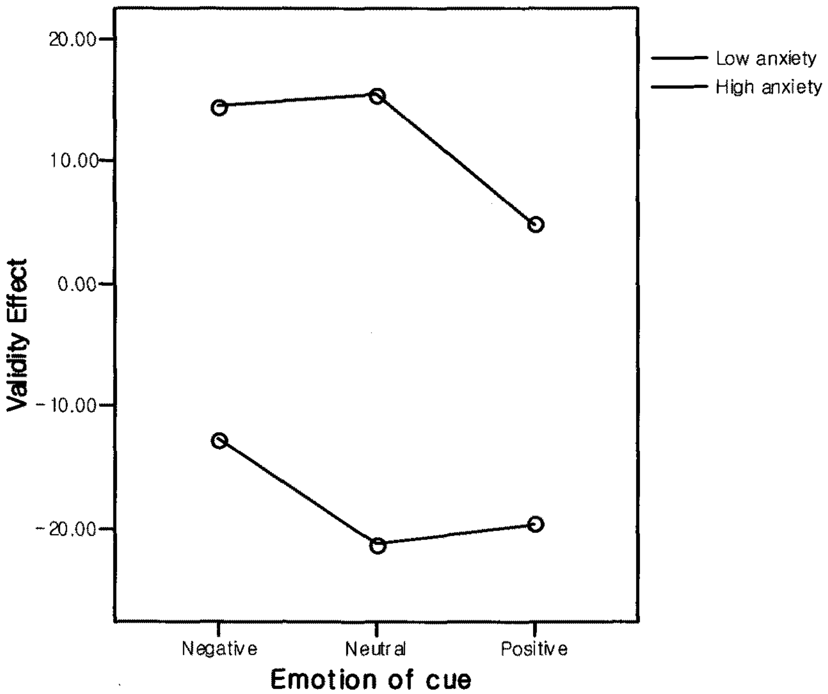

Figure 1. Validity effect (in milliseconds) as a function of emotional valence and anxiety group.

Discussion

As shown in Table 1, Experiment 1 supported the prediction that the detection speed of cues could be modulated by anxious levels and emotional valence of cues. On valid trials, the high anxious group responded more rapidly on threat-related cues than neutral cues. This effect disappeared in low anxious participants. This suggests that threat-related cues attract more attention than do neutral cues only in high anxious individuals. Surprisingly, low anxiety group showed an expected validity effect but high anxious group showed inverse validity effect. This result supposes a possibility that attentional engagement system in anxious individuals is different from that of low anxious people. There were weak inferences and so we tested directly in Experiment 3. However, the negative cues attracted more attention in anxious individuals as shown in the results of valid trials.

With regard to validity effect, the inverse effect in high anxious individual makes us difficult to interpret the disengagement component of attention because it is not clear that the disengagement from cues *per se* occurs. However, it seems to be true that threatening stimuli interfere more with target detection in invalid trials as shown in Figure 1. This supposes that the threatening stimuli can influence continuously target processing after their appearance. And it supports the study of Fox at al., (2001). Finally, the present results support both accounts; speed detection of threatening cue and difficulty to disengage attention from threatening cues.

The results observed in Experiment 1 showed different patterns from those of Fox et al., (2001, 2002) in which there was no interaction between anxiety levels and affective valence of cues on valid trials. But the most results observed in Fox et al. (2001, 2002) were obtained by using faces. One possibility of the results of Experiment 1 might be from the difference of the materials between faces and words as well as the difference of the experimental treatment between the present study and Fox et al.(2001, 2002). And if the difference of detection speed to threat-related cues is not limited to the word cues and this is general across different types of stimuli such as faces, the same pattern of detection speed found in Experiment 1 will be shown using faces as cues. Actually, facial expressions can have stronger attentional effect because they are more biologically relevant emotional stimuli (see Fox et al., 2001, 2002; Mogg & Bradley, 1999). In Experiment 2, emotional faces were used for cues of target locations.

Experiment 2

As in the prediction and the results of Experiment 1, if the attentional bias in high anxious individuals occurs at the engagement stage of attention, it is reasoned that the high anxious individuals will show faster detection with threat-related cues than neutral ones in valid trials. The purpose of Experiment 2 is to examine whether the results of Experiment 1 is universal across different types of stimuli.

Method

Participants

Twenty two (10 female, 12 male) undergraduate students at the University of Daejeon were selected from a pool of 33 students by the score of Spielberger state-anxiety scale tested in class rooms: those scoring at or above 48 (n = 13) for high trait-anxious participants and those scoring at or below a score of 43 (n = 9). All were aged between 19 and 28 years (mean = 22).

Materials and apparatus

Two schematic faces (negative and positive) were taken from the study of Lundqvist, Esteves, and Öhman (1999) (see appendix 1). A neutral face was designed by a pictorial software on the basis of two previous faces.

Procedure

Identical to those in Experiment 1.

Design

Identical to those in Experiment 1.

Results

Group difference

The groups differed significantly in the expected direction on state anxiety, $t(20) = 5.3$, $p < .001$ and trait anxiety $t(20) = 8.4$ $p < .0001$. The high anxiety group scored higher on measure of state and trait anxiety (M = 53.5, 53.6, S.D. = 8.9, 8.1) than the low anxiety group (M = 34.8, 34.4 and S.D. = 6.7, 2.7), respectively.

Response time

The RTs were filtered by removing all error trials and the RTs less than 150ms or greater than RTs calculated by the following equation: third quartile +2*(third quartile - first quartile). RTs were analyzed using a 2 (High and Low Anxiety Group) x 2 (Cue Validity: valid and invalid) x 3 (Affective Valence of Cue: threat, neutral and positive) ANOVA. High Anxious Group showed faster RTs than Low Anxiety Group, $F(1, 20) = 5.11$, $MSE = 8578.24$, $p < .05$. No other main effect was found. There was a significant two-way interaction between Cue Validity and Anxiety Group, F(1, 20) = 4.99, MSE = 679. 86, p < .05. Low level anxious group showed faster RTs on valid (359ms) than invalid trials (374ms), whereas high level anxious group showed faster RTs on invalid (326ms) than valid trials (332ms). Finally, there was a significant three-way interaction between Anxiety Group, Affective valence of Cue, and Cue Validity $F(1, 20) = 4.88$, $MSE = 66.77$, $p < .05$.

Valid trials (Engagement component of attention)

In order to break down the interaction, we examined the data for valid and invalid trials separately and mean RTs are presented in Figure 2. For valid trials, there was a Anxious Group x Affective Valence of Cue interaction, $F(2, 40) = 7.36$, $MSE = 89.58$, $p < .01$. In further analysis, there was a main effect of Affective Valence of Cue in High Anxious Group, $F(2, 24) = 5.13$, $MSE = 88.28$, $p < .01$. RTs with angry (328ms) and happy cues (329ms) were faster than RTs with neutral cues (339ms), $t(12) = 10.42$, $p < .05$ and $t(12) = 10.00$, $p < .05$, respectively.

In Low Anxious Group, the main effect of Affective Valence of Cue was marginally significant, Pillais $F(2, 24) = 3.45$, $MSE = 91.54$, $p < .09$. A contrast analysis revealed that RTs with angry cues (361ms) were slower than RTs with neutral cues (353ms), $t(8) = 8.74$, $p < .05$.

Validity effect (Disengagement component of attention)

The validity effect is presented in Figure 3. Two anxiety groups differed significantly in validity effect, $F(1, 20) = 4.99$, $MSE = 1359.72$, $p < .05$. Participants with high anxiety (-6.2ms) did not show the validity effect (faster RT in invalid condition), whereas individuals with low anxiety (14.4ms) presented the usual validity effect. There was a significant interaction between Affective Valence of Cue and Validity effect, $F(2, 40) = 4.87$, $MSE = 130.41$, $p < .01$ (see Figure 2). We examined the data for High Anxiety Group and Low Anxiety Group separately. The validity effects were different across the affective valence of cues, in Low Anxiety Group Pillais $F(2, 16) = 8.58$, $p< .01$ and in High Anxiety Group, $F(2, 24) = 3.5$, $MSE = 110.59$, $p < .05$.

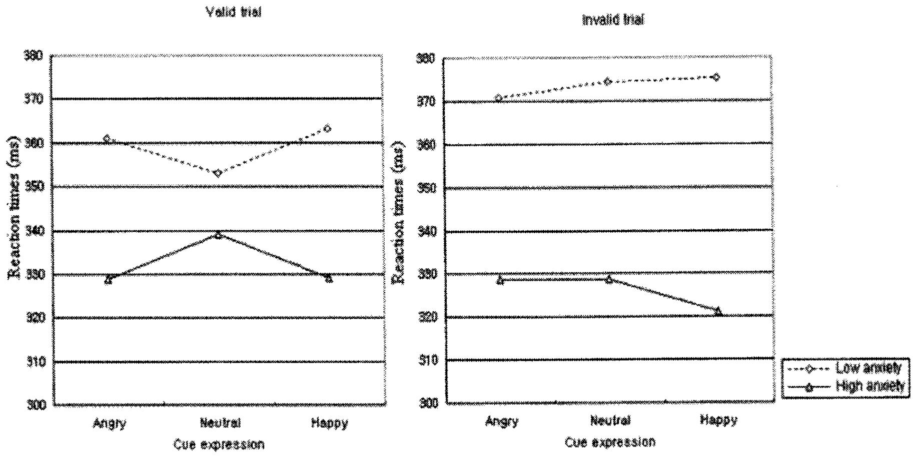

Figure 2. Mean RTs (in millisecond) for valid and invalid trial as a function of affective valence of cues and anxiety group in Experiment 2.

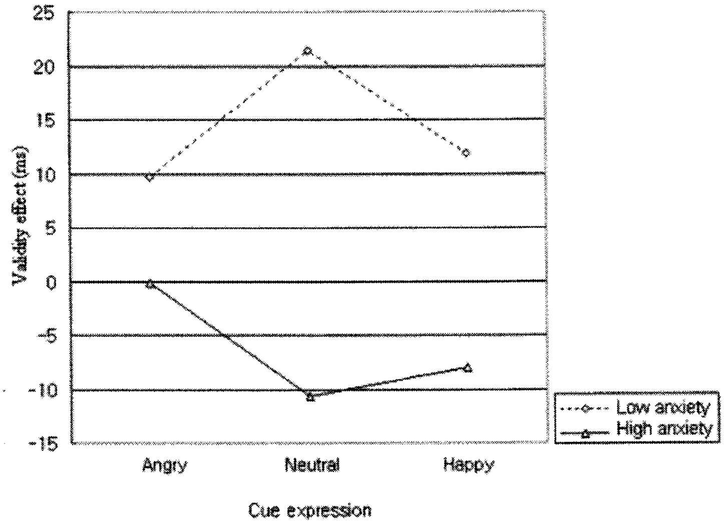

Figure 3. Validity effect (in milliseconds) as a function of affective valence of cues and anxiety group.

Discussion

Facial expressions are more likely to be influential in attentional bias than affective words presented in the previous section. As shown in Figure 2, the speed of attentional engagement was influenced differently across affective contents of cues and levels of anxiety. Participants with high anxiety responded more rapidly on valid trials, when the cues were angry or happy than when they were neutral. Whereas, those with low anxiety responded more slowly when the cues were angry or happy than when they were neural. The enhanced attentional speed with happy faces in participants with high anxiety was unexpected. But the general emotionality effect has been sometimes reported in literature (e.g., Russo, Patterson, Roberson, Stevenson, & Upward, 1996). However, these results indicate that the attentional bias to the affective cues occurs at both the engagement stage of attention in high anxious participants. Also, the results exhibited a different validity effect across anxiety levels. In low anxiety group, the disengagement of attention from threat-related cues was easier than those from neutral cues. In contrast, participants with high anxiety showed exactly an inversed pattern. As interpreted in Experiment 1, threatening cues facilitated the detection of target in valid trials and interfered with target detection in comparison with neutral cues in high anxious participants.

Another interesting effect was the avoidant pattern shown in low anxious participants. Contrary to anxious participants, in low anxious participants, threatening stimuli interfere with target detection in valid trials and facilitated it in invalid trials in comparison with neutral stimuli. This result is consistent with Experiment 1. In the literature, several studies using dot probe detection task showed that normal participants orient their attention away from negative stimulus (Bradley, Mogg, White, Groom and Bono, 1995 Bradley et al., 1997 Bradley, Mogg and Miller, 2000 Yiend and Mathews, 2001). But unfortunately, these studies were not designed for showing the avoidant processing mode in low anxious individuals. Avoidant processing mode has fairly weak inferences, however, and additional evidence will be necessary to reach a firm conclusion about avoidant processing in low anxious participants.

To sum up, Experiment 1and 2 showed that threatening cues facilitated the target detection in valid trials and disturbed it in invalid trials in anxious participants and an inverse pattern in low anxious participants. Finally, the engagement component of attention can be modified by interaction of emotional content of cue and anxious level of individual.

Experiment 3

The different validity effect between anxious and non-anxious participants was unexpected according to common results of previous studies. Low anxious participants showed usual pattern of response latency (faster RTs in valid than invalid trials) but High anxious group showed inverse pattern. One possibility of this effect might be from the use of emotional materials. So, in Experiment 3, we used only neutral stimuli such as diagrams (circle, square, pentagon, and hexagon) as cues for target location. The purpose of Experiment 3 is to examine whether the different validity effect across anxiety levels is universal regardless of emotional content of cues.

Method

Participants

Nineteen (12 female, 7male) undergraduate students at the University of Daejeon were selected from a pool of 41 students by the score of Spielberger trait-anxiety scale tested in class rooms: those scoring at or above 50 (n = 9) for high trait-anxious participants and those scoring at or below a score of 40 (n = 10). All were aged between 19 and 29 years (mean = 22).

Materials and apparatus

The stimuli used for cues were circles, squares, pentagons, and hexagons. They were designed using a pictorial software. Target stimulus and other conditions were identical to those in Experiment I.

Procedure

Identical to those in Experiment I.

Design

A 2 (Anxiety: High and Low anxiety) x 2 (Cue Validity: Valid and Invalid) analysis of variance (ANOVA) factorial design was used. Anxiety was a between-subject factor, and Cue Validity was within-subject factor. The prediction is a two-way interaction effect between anxiety and cue validity.

Results and discussion

Groups differed significantly in state anxiety, $t(16) = 4.0$, $p < .001$ and in trait anxiety, $t(16) = 10.0$, $p < .0001$. The mean of state and trait anxiety were 34, and 35 in Low Anxiety Group and 53 and 56 in High Anxiety Group respectively.

The data of a participant were removed because of too high rate of errors (41%). Participants showed faster RTs on valid (321ms) than invalid trials (328ms), $F(1, 16) = 4.60$, $MSE = 87.94$, $p < .05$. There was a significant interaction between Cue Validity and Anxiety Level, $F(1, 16) = 6.29$, $p < .023$ (see Figure 4).

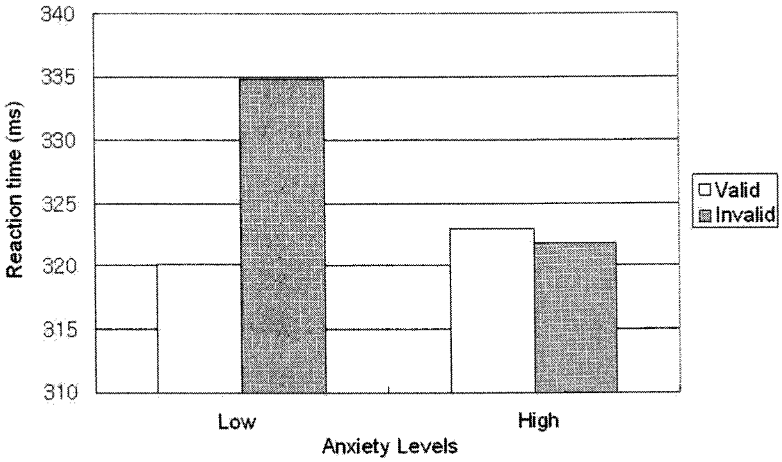

Figure 4. Mean RTs (in millisecond) as a function of validity and anxiety level.

In the planned comparison, the low anxiety group responded faster on valid (320ms) than invalid trials (335ms), $t(9) = 2.90$, $p = .017$. But no difference was found in the high anxiety group. As shown in Figure 4, a large validity effect appeared in the low anxiety group but not in the high anxiety group. This result supposes that the different validity effect was caused by anxiety levels rather than the emotional contents of cues used in Experiment 1 and 2.

According to Figure 4, anxious individual seem to attend not only to cued location but also to uncued location while low anxious individual attend more to cued location than to uncued location. Theoretically, it is not possible that the inhibition of return occurs in anxious people because the presentation time of cues was 100ms in all tasks used in the present study. One possible explanation is the bias about proportion of valid and invalid trials. Because the inverse validity effect occurs commonly when valid trials are less than invalid trials, we can reason that anxious participants underestimate the validity of cues. We discussed more detail in general discussion.

General discussion

The main goal of the present study was to investigate whether threatening cues attract more attention in anxious people. Fox et al. (2001, 2002) proposed an excellent method to analyze multiple components of attention to threat-related stimuli. Using a modified Posner's cue-target paradigm, Fox et al. (2001, 2002) found no difference of detection speed between threatening and neutral stimuli and concluded that threatening stimuli could not modulate the engagement component of attention in anxious individuals but they could modulate the disengagement component of attention.

Fox et al.(2001) have employed an unbalanced proportion of valid and invalid trials; the proportions of valid and invalid trials were 75% and 25%, respectively. This can make cues informative and participants give voluntarily more attention to cues, because the cues predict target locations with high probability. As a result, we can guess that the response latency in valid trials is confounded by participant's voluntary allocation of attention to cues. (Of course, this experimental design has no problem when we want to investigate the response latency of invalid trials).

In the present study, we focused on valid trials to investigate whether the detection speed of threat-related cues is faster than that of neutral cues using an equivalent proportion of valid and invalid trials. This experimental design can eliminate participant's voluntary attention to cues. The analysis of valid trials in Experiment 1 and 2 showed consistent interactions effect between anxiety levels and affective valence of cues. These results supported that the engagement component of attention could be modulated by the affective content of cues. Especially, using more potent and ecological stimuli such as emotional faces, the results exhibited a clearer pattern of attentional allocation to the threat-related stimuli. But the present study exhibited an unexpected effect related to level of anxiety and make the results, somewhat, difficult to be interpreted. There was no problem in interpreting the results of low anxious participants and we discussed it after the results of anxious individuals. The problem was the results of high anxious participants. They did not show validity effect appears usually in non-anxious participants. This absence of validity effect was common across the different types of stimulus in the present study and so, it is not likely to be an artifact. This suggests, however, that anxious participants attend more to uncued locations. It is possible that anxious people are biased toward invalid trials because the inverse validity effect commonly appears when valid trials are less than invalid trials.

Nevertheless, the fact that threatening cues facilitate target detection in valid trials and interfere with it in invalid trials indicates that threatening cues attract more attention to the cued location. The problem is what the attentional engagement to cues occur in general very weakly because anxious participants give more attention to uncued location. It seems to be a problem occurred when we use the equivalent proportion of valid and invalid trials. Finally, we can't insist that the fast engagement to threatening cues occurs but whether anxious participants attend to cued location or uncued location, it is clear that threatening cues attract more attention to the cues locations than neutral cues because the threatening cues facilitated more target detection than neutral cues in valid trials. In the case of non-anxious people, the interpretation of results is clear because the expected validity effect occurred. The threatening cues interfered with target detection in valid trial and facilitated it in invalid trials. These results indicate that the attentional engagement to threatening cues is slower than the engagement to neutral cues in non-anxious individuals and the attentional disengagement of threatening cues is faster than that of neutral cues. Non-anxious individuals are likely to avoid threatening cues. Though this avoidant processing pattern against threatening stimuli in normal participants have not been systematically investigated, some similar result has been reported in several studies. Using dot probe detection task, Bradley, Mogg and Lee (1997), Bradley, Mogg and Miller (2000), and Yiend and Mathews (2001), showed that normal participants orient their attention away from threatening or negative stimulus. These studies suggest explicitly the qualitative difference of processing mode between non-anxious and anxious individuals.

Though the present study exhibited somewhat different outcomes from what we expected in the beginning, the results of the present study point out some important aspects. First, as noted above, we could not analyze our results by the term of attentional components proposed by Posner (Posner, 1988 Posner & Peterson, 1990) (engagement and disengagement) but our results showed clearly that anxious people give more attention to threatening cues while non-anxious people give less attention to them. And the different distribution of attention to threatening cues is likely to occur independently to disengagement component of attention proposed by Fox et al. (2001). Concerning only the results of non-anxious participants, the attentional engagement to cues could be modulated by emotional content of the cues and we can address that the assumption of Fox et al. (2001) in which the engagement of attention is encapsulated is wrong.

Second, the present study provides another existence of cognitive bias caused by anxious levels. According to the results of the present study, anxious people are likely to underestimate the validity of cues in comparison with non-anxious people. The cues are non informative in the condition of equivalent proportion for valid and invalid trials. None the less, Non-anxious people have a tendency to give more attention to cued location than uncued location but anxious individuals exhibited a reverse pattern. They showed a tendency to give more attention to uncued locations than cued location as if they thought that invalid trials are more than valid trials. More systematic researches will be needed but our results provide a new hypothesis that anxiety affects not only the processing mode of negative or threatening stimuli but also other processing style such as top-down strategy.

References

Bradley, B. P., Mogg, K. & Lee, S. (1997). Attentional biases for negative information in induced and naturally occurring dysphoria. *Behavior Research and Therapy, 35*, 911-927.

Bradley, B. P., Mogg, K., & Millar, N. H. (2000). Covert and overt orienting of attention to emotional faces in anxiety. *Cognition and Emotion, 14,* 789-808.

Byrne, A., & Eysenck, M. W. (1995). Trait anxiety, anxious mood, and threat detection. *Cognition and Emotion, 9*, 549 - 562.

Cheal, M. L., & Lyon, D. R. (1991). Central and peripheral precueing of forced-choice discrimination, *Quarterly Journal of Experimental Psychology. 43A,* 859 - 880.

Cohen, J. D., MacWhinney, B., Flatt M., & Provost, J. (1993). PsyScope: A new graphic interactive environment for designing psychology experiments. *Behavioral Research Methods, Instruments, and Computers, 25(2)*, 257-271.

Cohen, J. D., MacWhinney, B., Flatt, M., & Provost, J. (1993). PsyScope: An interactive graphic system for designing and controlling experiments in the psychology laboratory using Macintosh computers. *Behavior Research Methods, Instruments, and Computers*, *25,* 257-271.

Eimer, M. (1997). An event-related potential (ERP) study of transient and sustained visual attention to color and form. *Biological Psychology*, *44*, 143-160.

Fox, E., Russo, R., Bowles, R., Dutton, K. (2001). Do threatening stimuli draw or hold attention in sub clinical anxiety? *Journal of Experimental Psychology: General 130,* 681 - 700.

Fox, E., Russo, R., Dutton, K. (2002). Attentional bias for threat: evidence for slowed disengagement from emotional faces. *Cognition and Emotion 16*, 355 - 379.

Georgiou, G.A., Bleakley, C., Hayward, J., Russo, R., Dutton, K., Eltiti, S and Fox, E. (2005) Focusing on fear: Attentional disengagement from emotional faces. *Visual Cognition, 12* (1), 145-158.

Gilboa-Schechtman, E., Foa, E. B., & Amir, N. (1999). Attentional biases for facial expressions in social phobia: The face-in-the-crowd paradigm. *Cognition and Emotion, 13,* 305 - 318.

Jonides, J. (1981). Voluntary versus automatic control over the mind's eye movement. In J.B. Long & A.D. Baddeley (Eds.), *Attention and performance IX* (pp. 187 - 203). Hillsdale, NJ: Erlbaum.

Kim, Y. H., Jong, E. H., Ko, M. H., Shin, H. S., Yang, K. H., & Sohn, J. H. (2002). The neural network of attentional shifts for emotional-provoking words. *Korean Brain Society, 2(2)*, 137-146.

Kitayama, S. (1990). Interaction between affect and cognition in word perception. *Journal of Personality and Social Psychology, 58,* 209 - 217

Lundqvist, D., Esteves, R., & Öhman, A. (1999). The face of wrath: Critical features for conveying facial threat. *Cognition and Emotion, 13,* 691 - 711.

Mathews, A. & MacLeod, C. (2002). Induced processing biases have causal effects on anxiety. *Cognition and Emotion, 16,* 331-354.

Mogg, K. & Bradley, B. P. (1999). Orienting of attention to threatening facial expressions presented under conditions of restricted awareness. *Cognition and Emotion, 13,* 713-740.

Mogg, K., & Bradley, B. P. (1998). A cognitive-motivational analysis of anxiety. *Behaviour Research and Therapy, 36*, 809 - 848.

Mogg, K., Mathews, A., & Eysenck, M. (1992). Attentional bias in clinical anxiety states. *Cognition and Emotion, 6,* 149-159.

Öhman, A. (1996). Preferential preattentive processing of threat in anxiety: Preparedness and attentional biases. In R. M. Rapee (Ed.), *Current controversies in the anxiety disorders.* New York: Guilford Press.

Posner, M. I. (1988). Structures and functions of selective attention. In: Boll, T.K., Bryant, B.K. (Eds.), *Clinical Neuropsychology and Brain Function: The Master Lecture Series.* American Psychological Association, Washington, DC.

Posner, M. I., Peterson, S. E. (1990). The attention system of the human brain. *Annual Review of Neuroscience. 13*, 25 - 42.

Rinck, M., Reinecke, A., Ellwart, T., Heuer, K., & Becker, E. (2005). Speeded detection and increased distraction in fear of spiders: Evidence from eye movements. *Journal of Abnormal Psychology, 114*, 235-248.

Russo, R., Patterson, N., Roberson, D., Stevenson, N., & Upward, J. (1996). Emotional value of information and its relevance in the interpretation of homophones in anxiety. *Cognition and Emotion, 10,* 213-220.

Spielberger, C. D., Gorsuch, R. L., Lushene, R., Vagg, P. R., & Jacobs, G. A. (1983). *State Trait Anxiety Inventory for adults manual.* Palo Alto, CA: Consulting Psychologists Press.

Wells, A., & Matthews, G. (1994). *Attention and emotion: A clinical perspective*. Hillsdale, NJ: Erlbaum.

Williams et al., 1988 Williams, J. M. G., Watts, F. N., MacLeod, C., & Mathews, A. (1988). *Cognitive psychology and emotional disorders.* Chichester: Wiley.

Williams, J. M. G., Watts, F. N., MacLeod, C., & Mathews, A. (1997). *Cognitive Psychology and Emotional Disorders*, second ed. Wiley, New York.

Yantis, S. (1996). Attentional capture in vision. In A. F Kramer, M. G. H. Coles, & G. D. Logan (Eds.), *Converging operations in the study of visual selective attention* (pp. 45-76). Washington DC: APA.

Yiend, J. & Mathews. A. (2001). Anxiety and attention to threatening pictures. *Quarterly Journal of Experimental Psychology, 54(3),* 665-681.

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요 약

부정자극 지각에 관련된 불안인과 정상인의 공간 주의 비교연구

최 문 기[1]　구 민 모[1]　박 건 우[2]　남 기 춘[1]
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많은 연구들은 부정과년 자극의 처리가 그 처리자의 정서 상태에 따라 다른 처리가 이루어진다는 것을 주장하였다. 정서 정보 지각의 특성은 크게 두 가지 가정에 의해 논의되었다: 주의 결속(attentional engagement)에서의 차이와 주의해제(attentional disengagement)에서의 차이. 본 연구는 Posner의 cue-target 실험 패러다임을 이용하여 정서 정보 지각이 일반 자극의 지각과 어떠한 위치에서 차이가 나는지를 규명하고자 하였다. 단어 자극을 사용한 실험1과 얼굴 자극을 사용한 실험 2 모두에서 기존의 Fox(2001)에서 나온 결과와는 다르게 정서 자극의 지각이 일반자극의 지각에 비해 주의 결속에서 빠른 반응을 나타냈으며, 이런 경향성은 불안 수준이 높은 피험자에게서만 관찰되었다. 또한, 불안 수준이 높은 피험자들은 일반 피험자들 보다 단서와 목표자극이 일치되는 조건에서 느린 반응을 보였다. 실험 1과 2의 결과가 이 효과와 정서의 혼입되어 나온 결과인가에 대한 통제 실험을 시행한 실험 3에서는 정서 자극 제시 없이 일치 불일치에 대한 결과만을 보았다. 실험 3의 결과는 실험 1과 2가 정서와 피험자의 정서 상태에 의한 결과임을 지지하였다. 따라서 본 연구는 불안이라는 정서 상태가 부정적인 자극에 대한 지각을 빠르게 하는 이유가 정서 자극에 대한 빠른 주의결속이 있기 때문임을 지지하고 있다.

주제어 : 정서, 주의결속, 주의 해제, 불안증, 주의 경계 모드, 주의 회피 모드.

Appendix 1.

1. The words used in Experiment 1.

Korean words Negative	Meaning	Korean word Neutral	Meaning	Korean words Positive	Meaning
구타	Beating	간판	Signboard	칭찬	Praise
이별	Separation	고무	Rubber	선물	Present
배신	Betrayal	구두	Shoes	소풍	Picnic
고통	Pain	바지	Pants	사랑	Love
무시	Neglect	소금	Salt	친구	Friend
포기	Abandonment	비누	Soap	생일	Birth
납치	Kidnapping	온도	Temperature	미소	Smile
사형	Death penalty	시계	Watch	기쁨	Pleasure
시체	Dead body	우산	Umbrella	결혼	Marriage
강도	Burglar	종이	Paper	우정	Friendship
마약	Narcotic	의자	Chair	애인	Fiancé(e)
사망	Death	이마	Brow	희망	hope

2. The emotional faces used in Experiment 2.