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The Time Course of Attentional Disengagement from Angry Faces in Social Anxiety

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Abstract

While impaired attentional disengagement from threatening stimuli is thought to enhance social anxiety, it is unclear when the impaired disengagement occurs accurately. We used a gap task (Experiment 1) and an overlap task (Experiment 2) to reveal the impaired attentional disengagement from angry faces in socially anxious people with non-treatment seeking undergraduates. High (N = 17 in Experiments 1 and 2) and low socially anxious people (*N* = 17 in Experiment 1 and 19 in Experiment 2) were asked to fixate on an angry or neutral face presented at the center of a screen. Then, they discriminated the peripheral target stimuli. When there was a temporal gap between the face and target in Experiment 1 (gap task), the reaction times (RTs) for angry and neutral faces did not differ for all participants. However, when there was no gap and the face continued to appear in Experiment 2 (overlap task), the RTs for angry faces in high socially anxious people were longer than those for neutral faces after presentation times of 300 ms or longer. In low socially anxious people, the RTs following the angry and neutral faces did not differ. These results suggest that high socially anxious people face difficulty in disengaging attention from angry faces after recognizing them.

Key words: social anxiety, disengagement, angry faces, gap-overlap task

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1. Introduction

Previous studies have revealed that individuals suffering from anxiety are sensitive to threatening stimuli (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007; Cisler & Koster, 2010; MacLeod, Mathews, & Tata, 1986; Mogg & Bradley, 1998; Yiend, 2010). When neutral and threatening stimuli (e.g., threatening facial expressions) were presented simultaneously, people with high trait anxiety or generalized anxiety disorders directed their attention to the threatening stimuli (Bradley, Mogg, Falla, & Hamilton, 1998; Bradley, Mogg, White, Groom, & de Bono, 1999). Moreover, it has been elucidated that attention to threatening stimuli enhances anxiety, while attention away from threatening stimuli decreased anxiety by several methods (Amir, Beard, Burns, & Bomyea, 2009; MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002). Amir et al. (2009) demonstrated that participants with generalized anxiety disorders, who were trained to decrease attention to negative words, showed a decrease in anxiety.

In social anxiety disorders, the cognitive behavioral model also emphasizes the importance of selective attention to threatening stimuli, especially socially threatening stimuli (e.g., angry, disgusted faces, socially threatening words), and selective attention might be an important factor for continuing anxiety (Bögels & Mansell, 2004; Rapee & Heimberg, 1997). For example, people with social anxiety disorders detected angry faces faster than they did happy faces in a crowd of neutral faces (Eastwood et al., 2005; Gilboa-Schechtman, Foa, & Amir, 1999). Their attention was also directed to angry faces when the faces were simultaneously presented with neutral faces (Mogg, Philippot,

& Bradley, 2004). This attentional bias is also found in non-clinical samples who had enhanced attention to the threatening faces in high socially anxious people (Mogg & Bradley, 2002). As with generalized anxiety disorders, in social anxiety disorders, disengagement from negative social cues decreased social anxiety (Schmidt, Richey, Buckner, & Timpano, 2009). These attentional biases to threatening stimuli are assumed to play an important role in anxiety and social anxiety.

However, selective attention to threatening stimuli may not necessarily be specific to anxious people. It is known that regardless of the degree of anxiety, everyone attends to threatening stimuli (Öhman, 2005). According to the evolutionary theory, people have evolved in the environment, which has included many dangerous situations. Detecting dangerous events or rapidly directing attention toward them is evolutionally adaptive for the improvement of the survival rate (Öhman & Mineka, 2001). In a visual search task, threatening stimuli (e.g., angry faces, snakes), crowded with neutral distractors, were detected faster than positive or non-threatening stimuli in non-clinical participants (Eastwood, Smilek, & Merikle, 2001; Öhman, Flykt, & Esteves, 2001). The reaction times (RTs) for detecting threatening stimuli were not affected by the number of distractors (Öhman et al., 2001). Some studies revealed that rapid attentional bias to highly threatening pictures was independent from anxiety (Koster, Verschuere, Crombez, & van Damme, 2005). When a threatening picture was presented with a neutral picture, not only high anxious people but also low anxious people rapidly directed attention to the threatening stimuli. These results support the concept of adaptive attentional bias to threatening stimuli.

While some previous studies showed that only anxious or socially anxious people directed attention to a threat, some others revealed that all people (not just the

anxious ones) rapidly attended to a threat. Why do the results of the previous studies differ? One of the reasons for this is the time course of attention (Fox, Russo, & Dutton, 2002; Yiend, 2010). According to the evolutionary theory, when threatening and neutral stimuli are presented, all people first direct their attention to the threatening stimuli. After attending to the threatening stimuli, the attentional mechanisms of anxious and non-anxious people may differ. Previous studies have shown that anxious people focus on threatening stimuli and face difficulty in disengaging their attention from the stimuli (Amir, Elias, Klumpp, & Przeworski, 2003; Fox, Russo, Bowles, & Dutton, 2001; Fox et al., 2002; Georgiou et al., 2005; Koster, Crombez, Verschuere, & de Houwer, 2004; Moriya & Tanno, 2007; Yiend & Mathews, 2001). For example, in Fox et al. (2001), an emotional word (i.e., neutral, positive, or threatening word) was presented as a cue stimulus at the center of a screen for 600 ms. Then, a target stimulus appeared either above, below, to the left, or to the right of the word. The participants were instructed to voluntarily attend to the emotional word and respond to the target stimulus as accurately and quickly as possible. The result revealed that the high anxious people took a longer time to respond to the target when they attended to a threatening word as compared to when they attended to either a neutral or positive word. It was concluded that anxious people had difficulty in disengaging attention from a threatening stimuli and focused on the stimuli. However, the non-anxious people could disengage their attention from the threatening stimuli.

The impaired attentional disengagement from threatening stimuli may also be a problem for socially anxious people; however, few studies have focused on attentional disengagement in social anxiety (Amir et al., 2003; Moriya & Tanno, 2007). In the field of social anxiety, avoidant behavior in social situations or avoidance of eye contact has

been studied as important characteristics of social anxiety (Dell'Osso et al., 2003; Horley, Williams, Gonsalvez, Gordon, 2003). Therefore, it is appropriate for researchers to assume that socially anxious people do not focus on a threat but direct attention away or disengage from it. However, behavior and attention are not necessarily the same aspect of social anxiety. In the present study, we investigated attentional disengagement from threatening stimuli in high socially anxious people, where the participants were undergraduate students. We used angry faces as threatening stimuli because some studies have shown that socially anxious people are sensitive to angry faces (Mogg et al., 2004; Phan, Fitzgerald, Nathan, & Tancer, 2006).

In previous studies on attentional disengagement in people with anxiety and social anxiety, at least two inadequacies were found. First, in some studies, an overlap task was used to investigate attentional disengagement from threatening stimuli (Fox et al., 2001; Georgiou et al., 2005); however, this task could not exclusively measure attentional disengagement. Moreover, the task included the effect of other attentional components. In the overlap task, a cue stimulus is presented first and continues to appear when a target stimulus is presented. This task could measure not only the disengagement from the cue stimulus but also the attentional shift and engagement to the target stimulus (Fisher & Weber, 1993; Gómez et al., 1998). According to Posner and Petersen (1990), spatial attention has not one but three components—disengagement, shift, and engagement, that is, disengaging attention from a stimulus, a transient shift of attention to a new stimulus, and engaging attention with the stimulus, respectively. Therefore, individual differences in attentional shift and engagement might influence the RTs in the overlap task. On the other hand, in the gap task, the cue stimulus disappears before the target stimulus is presented. This task could

measure the attentional shift and engagement to the target stimulus but could not measure disengagement from the cue stimulus. The appearance of the cue stimuli in the overlap task reinforces attentional engagement to the cue stimuli and results in the inhibition of disengagement, while the offset of the cue stimuli in the gap task enables attention to be disengaged before the target stimuli appear (Fisher & Breitmeyer, 1987; Fisher & Weber, 1993). It is known that the offset of the cue stimuli facilitates eye movement or attentional shift and decreases the RTs to the target stimuli (Fisher & Weber, 1993; Gómez et al., 1998; Mackeben & Nakayama, 1993; Pratt & Nghiem, 2000; Tanaka & Shimojo, 2001). In order to reveal the impaired attentional disengagement from threatening stimuli in socially anxious people, it is necessary to show that the RTs do not differ between threatening and neutral cue stimuli in the gap task. Moreover, studies should show that in the overlap task, the RTs are longer when directing attention to threatening stimuli than when directing attention to neutral stimuli.

Second, it is unclear as to when socially anxious people are unable to disengage their attention from threatening stimuli. Moriya and Tanno (2007) revealed that socially anxious people could disengage from socially threatening words at 100ms stimulus onset asynchrony (SOA[1]). However, the impaired attentional disengagement from the threatening words was found at 800ms SOA. These results might imply that impaired attentional disengagement depends on semantic processing or on the recognition of the threatening stimuli. The emotional value of facial expressions would be processed before 100 ms post-stimulus (Williams, Palmer, Liddell, Song, & Gordon, 2006) and would be discriminated as early as 200 ms (for a review, see Palermo & Rhodes, 2007; Vuilleumier & Pourtois, 2007). When using facial expressions as the cue, the impairment of attentional disengagement in socially anxious people might be found

at a short SOA (e.g., 100 ms).

In the present study, we also investigated whether selective attention to threatening stimuli was a unique function in social anxiety. Comorbidity, which is the tendency for mental disorders to co-occur at higher-than-chance rates, is the important feature among anxiety, depression, and social anxiety (Mineka, Watson, & Clark, 1998; Zimmerman, Chelminski, & McDermut, 2002). Previous studies have revealed that impaired attentional control was especially associated with social anxiety and not trait anxiety and depression (Moriya & Tanno, 2008). It is possible that impaired disengagement from threatening stimuli is specific to social anxiety.

The aim of the present study was to investigate whether socially anxious people have difficulty in disengaging attention from angry faces, and if this is true, to investigate when the impaired disengage from angry faces has occurred. We used a gap task in Experiment 1 and an overlap task in Experiment 2.

2. Experiment 1

The aim of the gap task in Experiment 1 was to investigate the attentional shift and engagement to the target stimulus but not attentional disengagement. The RTs indicate this process in the gap task. Given that the overlap task used in Fox et al. (2001) and Georgiou et al. (2005) reflect not only attentional disengagement from threatening stimuli but also attentional engagement and shift to non-threatening stimuli, it is important to confirm the ability of attentional engagement and shift in high and low social anxiety groups.

2.1 Method

2.1.1 Participants.

The participants were asked to complete an informed consent form before

participating in the study. The participants included 34 Japanese undergraduate students (18 females and 16 males) ranging in age from 18 to 21 years. All had normal or corrected-to-normal vision. They completed the Japanese version of the Brief Fear of Negative Evaluation Scale (BFNE; Leary, 1983; Sasagawa et al., 2004), which assesses apprehension or distress caused by others' negative evaluations. The participants were classified into high and low social anxiety groups by using a median split on the BFNE[2]. Seventeen participants (7 females and 10 males) who scored above 46 were classified as the high social anxiety group, and 17 participants (11 females and 6 males) who scored below 45 were classified as the low social anxiety group. The participants also completed the Japanese version of the State-Trait Anxiety Inventory-Trait Form (STAI-T; Shimizu & Imae, 1981; Spielberger, Gorsuch, & Lushene, 1970) and the Japanese version of the Self-Rating Depression Scale (SDS; Fukuda & Kobayashi, 1973; Zung, 1965). The Japanese version of BFNE, STAI-T, and SDS have high internal consistencies (Cronbach's alphas were .92 and .85 in BFNE and STAI-T, and Spearman-Brown split-half coefficient was .73 in SDS) and test-retest reliabilities (r = .74, .80, and .85, respectively).

2.1.2 Materials and apparatus.

Photographs of neutral and angry faces were selected from Ekman and Friesen (1976)[3]. The set included 8 unique exemplars of each of the two emotion categories (consisting of 4 female and 4 male faces) in a total of 16 unique facial stimuli. Each face was 2.5° in width × 3.1° in height. The target stimuli were the capital letters X and N, which were 0.6° in width × 0.7° in height. The target stimuli were presented 3.8° to the right or left of the face stimulus presented at the center of a screen. The viewing angle of the facial size and the location of the target stimuli corresponded with previous

studies (Bradley et al., 1998; Fox et al., 2001, Experiment 5).

All stimuli were presented on an Epson Endeavor MT7500 computer with a 17-inch Sony CPD-E230 screen. We wrote our experiments in Matlab using the Psychophysics Toolbox extensions (Brainard, 1997; Pelli, 1997). The participants' heads were fixated using a chin rest at a distance of 60 cm from the monitor. The participants' RTs and accuracy were obtained from their keyboard responses.

2.1.3 Procedure.

The participants were seated in front of the monitor in a dark room. A fixation cross appeared at the center of the screen, and white squares were presented to the right and left of the fixation cross. The participants were asked to fixate on the fixation cross. After a duration of 500 ms, a face was presented at the center of the screen for 100, 200, 300, 500, 700, or 1000 ms, which was followed by its disappearance. The temporal gap time between the offset of the face and the onset of the target stimulus varied within a range of 140 to 200 ms, which made the onset time of the target stimulus unpredictable. The target stimulus (X or N) appeared in the right or left white square. The participants were asked to press the right arrow key for X (go trials) and not to press the key for N (no-go trials) as soon as they discriminated the target stimulus. The target stimulus remained on the screen until the participants responded or 1000 ms had elapsed. There were inter-trial intervals of 500 ms.

Each participant completed 192 trials. The ratio of the go and no-go trials was 3:1. The angry and neutral faces appeared in an equal number of trials. The frequency of the appearance of the target letter with each type of facial expression, during each presentation time, and in each target location, was equal. All the conditions were presented in a different random order for each participant.

2.2 Results

The high and low social anxiety groups differed significantly in social anxiety, trait anxiety, and depression (Table 1). For each participant, we excluded the incorrect responses and the RTs that fell outside 3 standard deviations from the mean in the go trials. The average outliers in the high and low social anxiety groups were 1.27% and 1.31% respectively, and there was no significant difference between them, t (32) = .14, *ns*.

The mean error rates (%) in the high and low social anxiety groups are shown in Table 2. A 2 (trial: go and no-go trials) × 2 (social anxiety: high and low social anxiety groups) mixed model ANOVA revealed a main effect of trial, F (1, 32) = 45.94, $p < .001$, $\eta^2_p = .59$. The error rates in the no-go trials were higher than those in the go trials. However, there were no main effect of social anxiety and interaction.

The mean RTs in the go trials in the high and low social anxiety groups are shown in Figure 1. A 2 (social anxiety) × 2 (facial expression: angry and neutral faces) × 6 (presentation time of the face: 100, 200, 300, 500, 700, and 1000 ms) mixed model ANOVA was used for the RTs. The three-way ANOVA revealed the main effects of social anxiety, F (1, 32) = 6.35, $p < .05$, $\eta^2_p = .17$, and presentation time, F (5, 160) = 3.95, $p < .01$, $\eta^2_p = .11$. However, the main effect of facial expression was not significant, which revealed that the RTs for angry and neutral faces might not differ regardless of social anxiety. The RTs in the high social anxiety group were shorter than those in the low social anxiety group. The RTs at the 100-ms presentation time were longer than those at the 200-ms and 300-ms presentation times; however, there were no differences between the RTs at other presentation times; there were no significant interactions.

2.3 Discussion

In Experiment 1, we investigated the attentional shift and engagement to the target stimuli by using the gap task. The results showed that the RTs following the presentation of the angry and neutral faces did not differ between the high and low socially anxious people. Since the gap task could measure the processes of attentional shift and engagement to the target stimuli, this result reflects that these processes were not affected by attending to the neutral or angry faces in both high and low socially anxious people. In contrast, the results showed that high socially anxious people responded to the target stimuli faster than low socially anxious people.

The rapid attentional shift and engagement to the target stimuli in high socially anxious people was unexpected. Rapid engagement to threatening stimuli in anxious people was found in many previous studies (MacLeod et al., 1986; Mogg & Bradley, 1998); however, few studies focused on the relationship between anxiety and attentional mechanisms for neutral stimuli. It is possible that the enhanced attentional shift and engagement enables anxious people to detect the stimuli and rapidly discriminate whether or not the stimuli were threatening. Moriya and Tanno (2009) showed that socially anxious people were sensitive to salient non-emotional stimuli and directed attention to them automatically. Therefore, it is possible that high socially anxious people rapidly shift and engagement to non-emotional targets because of sensitivity to salient stimuli in the present study. Further studies should be conducted to investigate the ability of attentional shift and engagement not only to emotional stimuli but also to non-emotional stimuli in socially anxious people.

3. Experiment 2

The overlap task in Experiment 2 examined whether socially anxious people

had difficulty in disengaging their attention from angry faces. In the overlap task, the RTs indicate the process of attentional disengagement from the cue stimuli and the attentional shift and engagement to the target stimuli. Since Experiment 1 showed that the attentional shift and engagement to the target stimuli were not affected by attending to the neutral or angry faces, the overlap task could reveal the disengagement difficulty affected by the facial expressions. In other words, the different RTs by facial expressions reflect the effects of attentional disengagement. Considering the rapid attentional shift and engagement to the target stimuli in high socially anxious people in Experiment 1, the RTs of high socially anxious people might be shorter than those of low socially anxious people. We also consider the impaired attentional disengagement from threatening stimuli in high socially anxious people. Considering that the emotional value of facial expressions would be processed before 100 ms post-stimulus and discriminated as early as 200 ms (Palermo & Rhodes, 2007; Vuilleumier & Pourtois, 2007; Williams et al., 2006), it is possible that impaired attentional disengagement from threatening stimuli in high socially anxious people might be observed rapidly after the stimuli is presented. In addition, according to the specificity of impaired attentional control in social anxiety (Moriya & Tanno, 2008), it is possible that impaired disengagement from threatening stimuli might be associated with social anxiety and not with trait anxiety and depression. Therefore, we proposed the following hypotheses.

Hypothesis 1: The RTs of high socially anxious people might be shorter than those of low socially anxious people.

Hypothesis 2: In high socially anxious people, the RTs following the presentation of angry faces might be longer than those following the presentation of neutral faces; however, the difference in the RTs between the angry and neutral faces

might not be observed in low socially anxious people.

Hypothesis 3: The RTs following the presentation of angry faces might be longer than those following the presentation of neutral faces at a short SOA (e.g., 100 ms) in high socially anxious people.

Hypothesis 4: Delayed RTs from angry faces relative to those from neutral faces might be positively correlated with social anxiety and not trait anxiety and depression.

3.1 Method

3.1.1 Participants.

The participants were asked to complete an informed consent form before participating in the study. The participants were 40 Japanese undergraduate students (22 females and 18 males), ranging in age from 18 to 21 years. All had normal or corrected-to-normal vision. They were classified into high and low social anxiety groups by using a median split on the BFNE. Seventeen participants (6 females and 11 males) who scored above 47 were classified as the high social anxiety group, and 19 participants (13 females and 6 males) who scored below 45 were classified as the low social anxiety group. Further, the 4 participants (3 females and 1 male) who scored 46 were excluded because this was the median score. The participants also completed the Japanese version of the STAI-T and SDS.

3.1.2 Materials and apparatus.

The materials and apparatus of Experiment 2 were identical to those used in Experiment 1.

3.1.3 Procedure.

The procedure was identical to that of Experiment 1, with the exception of the

following modification: after the cue face was presented at the center of the screen for 100, 200, 300, 500, 700, or 1000 ms, the target stimuli (X or N) appeared in the right or left white square, while the face continued to appear until the participants responded or 1000 ms had elapsed after the target was presented.

3.2 Results

The high and low social anxiety groups differed significantly in social anxiety, trait anxiety, and slightly in depression (Table 1). For each participant, we excluded the incorrect responses and the RTs that fell outside 3 standard deviations from the mean in the go trials. The average outliers in the high and low social anxiety groups were 1.18% and 1.17%, respectively, and there was no significant difference between them, t (34) = .05, *ns*.

The mean error rates (%) in the high and low social anxiety groups are shown in Table 2. A 2 (trial) × 2 (social anxiety) mixed model ANOVA revealed a main effect of trial, F (1, 35) = 47.32, $p < .001$, $\eta^2_p = .59$. The error rates in the no-go trials were higher than those in the go trials. However, there were no main effect of social anxiety and interaction.

The mean RTs of the correct responses in the go trials in the high and low social anxiety groups are shown in Figure 2. A 2 (social anxiety) × 2 (facial expression) × 6 (presentation time of the face) mixed model ANOVA was used for the RTs. The three-way ANOVA revealed main effects of facial expression, F (1, 34) = 4.54, $p < .05$, $\eta^2_p = .12$, and presentation time, F (5, 170) = 40.71, $p < .001$, $\eta^2_p = .55$. There was also significant social anxiety × facial expression interaction, F (1, 34) = 9.69, $p < .01$, $\eta^2_p = .22$; facial expression × presentation time interaction, F (5, 170) = 2.33, $p < .05$, $\eta^2_p = .06$; and social anxiety × facial expression × presentation time interaction, F (5, 170)

= 2.96, $p < .05$, $\eta^2_p = .08$. The interaction between social anxiety and facial expression showed that in the high social anxiety group, the RTs for angry faces were longer than those for neutral faces ($p < .001$). The interaction between facial expression and presentation time showed that the RTs for angry faces were longer than those for neutral faces at 500 ms ($p < .05$), 700 ms ($p < .001$), and 1000 ms ($p < .05$).With respect to the three way interaction, the follow-up tests for simple effects were two-tailed t-tests, to which Bonferroni corrections were applied. In neutral faces, the RTs in the high social anxiety group were marginally shorter than those in the low social anxiety group at 300 ms ($p = .090$) and 700 ms ($p = .080$). In addition, in the high social anxiety group, the RTs for angry faces were longer than those for neutral faces at 300 ms ($p = .096$), 500 ms ($p < .01$), 700 ms, ($p < .001$), and 1000 ms ($p < .01$). In the low social anxiety group, the RTs for angry faces did not differ from those for neutral faces.

To investigate whether impaired attentional disengagement from angry faces was specific to social anxiety, we calculated attentional disengagement indices and analyzed the correlations between the indices and each questionnaire in the case of all the participants. The attentional disengagement indices were calculated by subtracting the mean RTs of the correct responses in the go trials for neutral faces from the mean RTs of the correct responses in the go trials for angry faces at each presentation time, based on Georgiou et al. (2005). A positive score indicates a slower response to the angry face than to the neutral face; this indicates impaired attentional disengagement from angry faces. The results revealed that social anxiety was positively correlated with the attentional disengagement indices at the 300-, 500-, and 1000-ms presentation times, and slightly correlated at the 700-ms presentation time (Table 3). However, depression and trait anxiety were not correlated with the attentional disengagement indices.

3.3 Discussion

In Experiment 2, we investigated attentional disengagement from angry or neutral faces by using the overlap task. The results showed that the RTs for neutral faces in high socially anxious people were marginally shorter than those in low socially anxious people at the 300- and 700-ms presentation times. This was partially consistent with hypothesis 1 of rapid attentional shift and engagement to the target stimuli in high socially anxious people. In addition, the RTs for angry faces in high socially anxious people were longer than those for neutral faces, consistent with hypothesis 2. These delayed RTs for angry faces were observed when the presentation time of the faces were more than 300 ms, and not observed at a short SOA (i.e., 100 and 200 ms), which is not consistent with hypothesis 3. Since Experiment 1 showed that attentional shift and engagement to the target were not affected by facial cues, the present result indicates impaired attentional disengagement from angry faces in high socially anxious people. The correlation analysis of disengagement indices also revealed that impaired attentional disengagement from angry faces was specific to social anxiety, which is consistent with hypothesis 4.

The impaired attentional disengagement from angry faces was not observed at a short SOA but were seen at a long SOA (i.e., more than 300 ms) in high socially anxious people. Since previous studies, which showed impaired attentional disengagement in anxious people, used presentation times of more than 300 ms for the cue stimuli and not short presentation times (Fox et al., 2001; Georgiou et al., 2005; Yiend & Mathews, 2001), it is not clear when socially anxious people have difficulty in disengaging attention from threatening stimuli. While the emotional value of facial expressions would be processed before a 100 ms post-stimulus and would be

discriminated as early as 200 ms (Palermo & Rhodes, 2007; Vuilleumier & Pourtois, 2007; Williams et al., 2006), it may take from 200 to 300 ms for subsequent processes to consciously recognize these facial expressions (Treisman & Kanwisher, 1998). The present result proposed that impaired attentional disengagement in socially anxious people was associated with the recognition of threatening faces.

4. General Discussion

The two experiments were performed to investigate impaired attentional disengagement from threatening stimuli in high socially anxious people and the time course of attentional disengagement. These experiments presented four conclusions: (1) attentional shift and engagement to the target were faster in high socially anxious people than in low socially anxious people, (2) attentional shift and engagement were not affected by attending to the cue faces in all the participants, (3) impaired attentional disengagement from angry faces was observed in high socially anxious people following 300 ms from the onset of the faces, and (4) impaired attentional disengagement from the angry faces was specifically associated with social anxiety and not with trait anxiety and depression.

Previous studies revealed impaired attentional disengagement from threatening stimuli in anxious and socially anxious people (Fox et al., 2001; Georgiou et al., 2005; Moriya & Tanno, 2007; Yiend & Mathews, 2001). However, these results did not differentiate between the effects of attentional disengagement, shift, and engagement. The present study has clearly revealed impaired attentional disengagement from angry faces in high socially anxious people by using the gap-overlap task, and these results were independent from the effects of attentional shift and engagement. These results could assertively elucidate impaired attentional disengagement in high socially anxious

people.

Although in previous studies, attentional biases to threatening stimuli were observed in state or trait anxiety (Fox et al., 2001; Georgiou et al., 2005; Mogg, Bradley, de Bono, & Painter, 1997; Yiend & Mathews, 2001), the present study showed the specificity of impaired attentional disengagement in social anxiety. The impaired attentional disengagement from angry faces was not associated with trait anxiety or depression but with social anxiety. Some studies have also revealed that impaired attentional control was prominently observed in people with social anxiety (Moriya & Tanno, 2008). These differences might partially be due to different emotional stimuli. Schematic faces or threatening words might pose a threat to all participants regardless of anxiety types. However, real angry faces in the present study might be specifically threatening to socially anxious people, who are afraid of others' evaluations of them, because people might find an association between angry faces and negative evaluations. Georgiou et al. (2005) showed impaired attentional disengagement from fear faces. However, fearful faces, as compared to angry faces, might be weakly associated with negative evaluations.

An obvious and important question concerns the implications of the impaired attentional disengagement from threatening stimuli. We assume that the impaired attentional disengagement induces stress in socially anxious people and increases anxiety. In other words, they might have difficulty in receiving positive information from other stimuli because of difficult disengagement from threatening stimuli, and maintaining negative information might enhance their stress. Considering that involuntary attention to the threatening stimuli increased anxiety (MacLeod et al., 2002), the maintenance of attention to the threatening stimuli could enhance anxiety. It is well

known that socially anxious people interpret ambiguous social situations as negative or threatening (Amin, Foa, & Coles, 1998; Hirsh & Clark, 2004). These negative interpretation biases might be derived from impaired attentional disengagement, which prevents the individuals from receiving much information. To reduce anxiety, it is necessary for socially anxious people to control and disengage attention from threatening stimuli.

We assume that there are some issues to be solved in further studies. First, in the present study, we used angry faces as socially threatening stimuli; however, it is unclear whether other emotional expressions affect attentional disengagement in people with social anxiety. Some studies showed that socially anxious people were sensitive to angry faces (Mogg et al., 2004; Phan et al., 2006). However, considering that socially anxious people are afraid of rejection and negative evaluation from others, they may even find disgusted or contemptuous faces threatening. These faces often convey revulsion to people. Some studies showed that socially anxious people were extremely sensitive to disgusted and contemptuous faces (Amir et al., 2005; Stein, Goldin, Sareen, Zorrilla, & Brown, 2002). In further studies, we should investigate which facial expressions affect the impaired attentional disengagement in socially anxious people. Second, it is unclear whether the present results are applicable to clinical samples. Few studies elucidated the impaired attentional disengagement in social people with social anxiety disorders (Amir et al., 2003). In the present study, we did not select extremely socially anxious students. However, the average scores of BFNE in the high social anxiety group were extremely high as compared with people suffering from social anxiety disorders, who scored 49.3 on an average (Okajima & Sakano, 2008). Therefore, in clinical samples, impaired attentional disengagement from threatening stimuli might

be observed. Further studies should reveal the impaired attentional disengagement by gap-overlap tasks in clinical samples. Third, since the gap and overlap tasks were examined separately and the participants were not the same in both tasks in the present study, the RTs in the overlap task were not necessarily longer than those in the gap task for some presentation times. Further studies should use the gap-overlap task in the same block. Fourth, the sample size is not enough to consider correlations between social anxiety and impaired attentional disengagement in the present research. Further studies should include a larger number of participants and investigate the relationships between them again. Fifth, the go/no-go task reflects not only the attentional system but also inhibitory control (Menon, Adleman, White, Glover, & Reiss, 2001). Further studies should use other tasks (e.g., detection or discrimination tasks) and concern impaired attentional disengagement in social anxiety.

In summary, the present research investigated attentional disengagement from angry faces in social anxiety with non-treatment seeking undergraduates. While the ability of attentional shift and engagement to the target was not affected by attending to the angry and neutral faces in both high and low socially anxious people, attentional disengagement from angry faces were impaired in high socially anxious people following 300 ms from the onset of the faces. In addition, the impaired attentional disengagement from angry faces was specific to social anxiety.

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Footnotes

[1] This is the time between when a cue stimulus (i.e., socially threatening stimulus) is shown and the target is presented.

[2] Some studies classified the participants into high and low anxiety groups by a quartile or tertile (Bradley et al., 1998; Koster et al., 2005). On the other hand, there are also many studies that use a median split to classify participants (Mogg, Bradley, de Bono, & Painter, 1997; van Honk, Tuiten, de Haan, van den Hout, & Stam, 2001). Dichotomizing single independent variables, as the present study does, leads to a more conservative bias (Maxwell & Delaney, 1993). We used a median split to increase the size of groups and to analyze the correlations between questionnaires and behavioral performance.

[3] Previous studies showed that the judgements of emotional categories from facial expressions are universal (Ekman & Friesen, 1971; Ekman, Sorenson, & Friesen, 1969). Matsumoto et al. (2002) revealed that there were no cultural differences in the categorical judgments of Japanese and Caucasian faces as observed by Americans and the Japanese.

Figure Captions

Figure 1. Mean correct reaction times at each presentation time and for each facial expression in the high and low social anxiety groups in Experiment 1

Figure 2. Mean correct reaction times at each presentation time and for each facial expression in the high and low social anxiety groups in Experiment 2

Fig 1

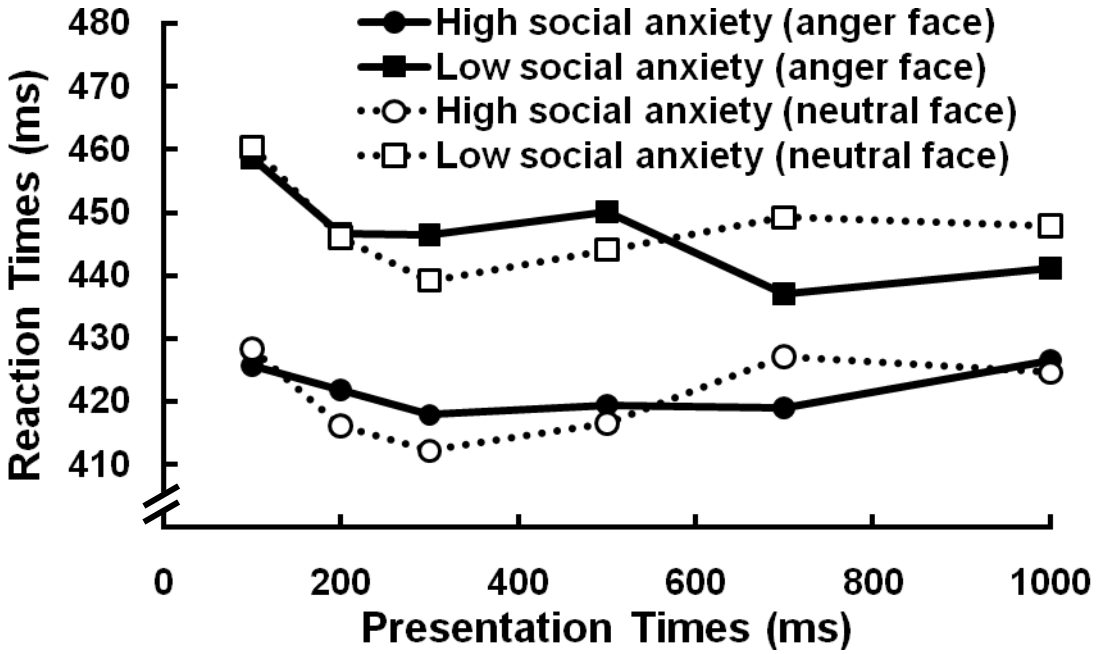
High social anxiety (anger face)
Low social anxiety (anger face)
High social anxiety (neutral face)
Low social anxiety (neutral face)
Reaction Times (ms)
480
470
460
450
440
430
420
410
0
200
400
600
800
1000
Presentation Times (ms)

Fig 2

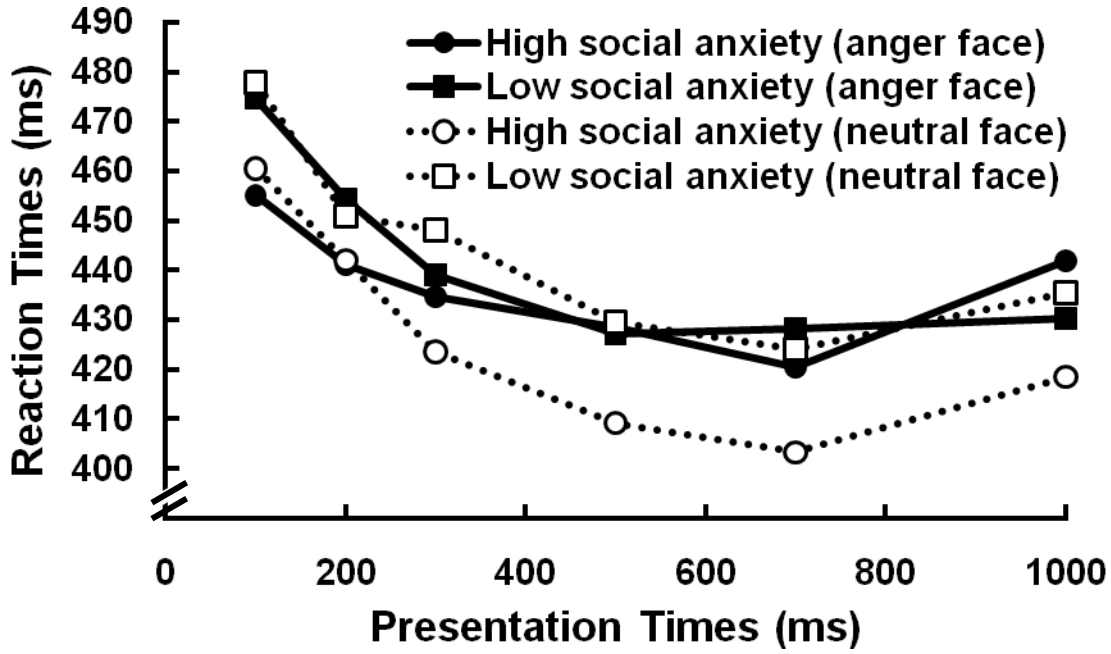
490
480
470
460
450
440
430
420
410
400
Reaction Times (ms)
High social anxiety (anger face)
Low social anxiety (anger face)
High social anxiety (neutral face)
Low social anxiety (neutral face)
0
200
400
600
800
1000
Presentation Times (ms)

Table 1

Mean and Standard Deviation for Scores on Each Questionnaire in High and Low Social Anxiety Groups in Experiment 1 and 2

	High social anxiety	Low social anxiety		
	M (*SD*)	*M* (*SD*)	*t*	*d*
Experiment 1				
N	17	17		
Age	19.3 (0.7)	19.0 (1.0)	0.96	0.33
BFNE	52.0 (3.2)	35.8 (6.7)	9.03***	3.10
STAI-T	55.1 (7.6)	42.4 (9.2)	4.35***	1.49
SDS	45.7 (7.0)	39.9 (8.1)	2.20*	0.75
Experiment 2				
N	17	19		
Age	19.4 (0.7)	19.1 (0.9)	0.89	0.30
BFNE	51.6 (3.3)	36.2 (6.4)	8.91***	3.03
STAI-T	53.7 (9.0)	42.9 (9.7)	3.43**	1.15
SDS	44.8 (7.0)	40.0 (8.1)	$1.91^{\dagger}$	0.64

Note. BFNE: Brief Fear of Negative Evaluation Scale, STAI–T: State Trait Anxiety Inventory–Trait Form, SDS: Self-Rating Depression Scale

***$p < .001$, **$p < .01$, *$p < .05$, $^{\dagger}p = .065$

Table 2

Mean and Standard Deviation for Error Rates (%) in High and Low Social Anxiety Groups in Experiment 1 and Experiment 2

	High social anxiety		Low social anxiety	
	M (SD)		*M (SD)*	
Experiment 1				
Go trial	0.08	(0.23)	0.12	(0.27)
No-go trial	11.89[a]	(10.90)	12.13[a]	(9.64)
Experiment 2				
Go trial	0.37	(0.70)	0.07	(0.22)
No-go trial	13.97[a]	(12.77)	11.19[a]	(8.34)

[a] indicates significant effects of the pairwise comparisons with Go trial conditions ($p < .001$).

Table 3

Correlations between Each Questionnaire and Attentional Disengagement Indices at Each Presentation Time

	100 ms	200 ms	300 ms	500 ms	700 ms	1000 ms
BFNE	–.02	–.13	.33*	.33*	.27†	.39*
STAI-T	–.26	–.12	.14	.20	.05	.25
SDS	–.17	–.25	.13	.25	.01	.13

Note. *$p < .05$, †$p = .092$