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Processing Facial Emotion: Can it Occur without Attention?

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Abstract

The processing of facial emotion is important for social situations. Research has shown that the presence of emotionally threat-relevant stimuli (i.e., angry or fearful faces) enhances the processing of subsequent non-emotional stimuli. In these studies, the emotional stimuli were typically presented at the focused attention. Thus, it is not clear whether the processing efficiency provoked by emotional stimuli would still occur when these stimuli were outside of focused attention. Furthermore, no studies have examined whether target difficulty modulates processing of emotional faces. To examine these issues, the present study used a spatial cuing paradigm. A letter "T" with some distractors was presented to the left or right visual field. An emotional face was presented simultaneously with the target letter but in the opposite visual field. Participants were asked to determine the orientation of the letter "T" while ignoring an emotional face. The critical manipulation was whether the location of the emotional face was cued (the attended condition) or not (the unattended condition). Results showed that emotional faces did not affect the processing of the target letter in both the attended and unattended conditions. In addition, this pattern was not modulated by the task difficulty. These findings suggest that emotional faces are not unconsciously perceived when presented as task irrelevant stimuli.

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Humans are social beings. Everyday our lives are filled with interactions with various people in numerous contexts. The interpretations of such encounters are highly influenced by the emotional content that is perceived. The reading of emotions becomes important in social situations as correct interpretation can mean the difference between understanding and misunderstanding. Faces are an excellent example of emotional conveyers. Recognizing and understanding facial emotion is therefore an important evolutionary mechanism as it helps prepare a person for potential survival situations. Recent studies have found that through our evolutionary history neural systems have developed to rapidly detect and interpret emotionally significant which lend credence to the theory that recognization of fearful and threatening emotions are important in survival contexts events (e.g., Suslow et al., 2006). Some studies particularly have found that the presence of fearful faces enhances the processing of subsequent non-threat-relevant stimuli (e.g., Becker, 2009; Phelps, Ling, & Carrasco, 2006).

Due to the sheer number of emotional faces people encounter everyday, it is likely that emotion perception is automatic and does not require attentional resources. There has been little consensus in the psychological community on the role of central attention (i.e., attentional resources for decision making, response selection, etc.) in emotional expression processing (see, Holmes, Vuilleumier, & Eimer, 2003; Tomasik, Ruthruff, Allen, & Lien, 2009). Other studies have attempted to determine whether visual-spatial attention (i.e., the mind's eye, perception outside of foveal attention) is needed to perceive emotions (see Eimer, Holmes, & McGlone, 2003), but firm conclusions have yet to be drawn. The present study used a cuing paradigm to find further evidence for the role of visual-spatial attention in emotional perception. In addition,

the present study examined whether the allocation of visual attention to emotional faces is influenced by task difficulty.

Emotional Perception and Attention

One highly debated question on emotional perception is whether the processing of emotional expression requires central attentional resources (i.e., attentional resources for decision making, response selection, etc.). Some studies have suggested that processing of emotion expressions is done on an unconscious level (e.g., Morris, Öhman, & Dolan, 1998). Other studies, however, have suggested otherwise. Tomasik et al. (2009) used a psychological refractory period paradigm to examine whether the perception of emotional faces requires central attention by manipulating the stimulus onset asynchrony between a Task 1 tone and a Task 2 emotional face. Participants made speeded responses identifying the tone or noise, and then were asked to make a speeded response to the emotion (happy or angry) on the face. They found that central attentional resources are necessary for emotional perception suggesting that emotional perception is not automatic (see also Erthal, Oliveira, Mocaiber, Pereira, & Machado-Pinheiro, 2005). Although there is a large body of evidence for either claim, it is still unclear whether emotional perception can occur when spatial attention is allocated to somewhere else (i.e., at the unattended location).

Spatial attention is critical for processing important stimuli at a given moment. There have been many different paradigm to study the allocation of spatial attention to emotional faces, which include: visual search paradigms (e.g., Eastwood, Smilek, & Merikle, 2001; LoBue, 2009; Lundqvist & Öhman, 2005), temporal order judgment paradigms (e.g., West, Anderson, & Pratt, 2009), inhibition of return paradigms (e.g., Theeuwes & Van der Stigchel, 2006), flicker

paradigms (e.g., Ro, Russell, & Lavie, 2001), and oculomotor capture paradigm (e.g., Hunt, Cooper, Hungr, & Kingstone, 2007).

A common finding in these studies is that threatening faces, when compared to neutral faces, captured people's attention involuntarily (i.e., automatically) and thus subsequently influence the performance on the primary task. Lipp, Price, & Tellegen (2009) demonstrated that angry faces, and to a lesser extent sad faces, were more quickly determined to be different when in a sea of happy or neutral faces than when a happy or neutral face was in a crowd of angry or threatening faces (see also Becker, 2009; Phelps et al., 2006). In addition, LoBue (2009) found that children could quickly and accurately pick out a threatening face from a crowd of happy faces faster than a single happy face in a crowd of threatening faces. This finding suggests that our predisposition for emotionally significant faces to capture attention begins and is developed at a young age. Almost all research on facial attention has involved threatening faces.

The look of fear on an individuals face can alert others to potentially dangerous situations, perhaps suggesting that it can capture attention more so than a threatening face. However, there have been very few studies that have looked at the effect of fearful faces on attention. One such study by Georgiou et al. (2005) found more robust response time cost for fearful faces than negative faces in general. Eimer and Kiss (2007) also examined the effect of fearful faces on spatial attention. Participants were instructed to look for luminance changes in the fixation cross while ignoring fearful faces in a crowd of neutral faces, or a neutral face in a crowd of fearful faces. They found that on trials without a luminance change fearful faces generated an increased negativity of brain potentials over posterior scalp contralateral to the face

location allocation of spatial attention and processing, indicating spatial attention to the face stimuli.

The Present Study

The present study aims to determine whether the processing of emotional perception is modulated by special attention. In particular, I used a spatial cuing paradigm to examine whether salient, irrelevant emotional face stimuli capture attention involuntarily even when spatial attention is allocated to a different location. The target and face stimuli were presented side-by-side for 200 msec to avoid the saccadic movement (see Rayner, 1983). Participants were asked to ignore a face (neutral, threatening, happy, or fearful) presented on the right or left side of a central fixation cross and determine the orientation of the target letter "T," which was either upright or inverted on the opposite side of the fixation cross. Each face was presented an equal number of times. The location of the target was cued with an arrow pointing to the left or right. In 80% of the trials, the arrow cue pointed towards the target location (a valid trial). In the remaining 20% of the trials, the arrow pointed towards a face (an invalid trial). In valid trials, the face was unattended, that is, participants did not directly focus their attention on it. The goal of this study was to determine whether unattended faces would capture spatial attention and affect performance on the orientation task. In an invalid trial the face stimulus was attended which would suggest that, when compared to neutral faces, threatening and fearful faces should have higher RT for the orientation task (an emotional perception effect).

The present study also aimed to understand the effect of task difficulty on the allocation of spatial attention. To manipulate task difficulty two conditions were created. In the hard condition, the target "T" was surrounded by 8 "+" symbols. The easy condition presented the target alone. Both conditions were used evenly across all trials. One would expect that for a

difficult task spatial attention is "stuck" on the target and less likely to be captured by irrelevant stimuli. Thus, I predict that in valid, difficult tasks the emotional perception effect would negligible compared to a valid, easy condition.

Method

Participants

A total of 32 participants (17 female) ranging in ages from 18 to 24 ($M = 19.875 \pm 1.62$ years) participated in the experiment in exchange for course credit. A convenience sample was taken from the Oregon State University student body, all of whom had normal or corrected-to-normal vision. Data for 3 participants were excluded from final data analysis due to accuracy scores under 80%.

Materials

The experiment was conducted on a PC computer with a 17-inch Dell monitor. Participants sat in a small room with a single, moderately bright light. A trial consisted of two boxes, one located to the left of a central fixation point and one to the right. Each trial randomly had a target letter T either upright or inverted in one box, and an emotional face in the opposite box. Both appeared simultaneously for 200 msec, followed by the fixation screen until a response was made. A cue signaled the following trial. Response time and accuracy was measured and recorded by the computer. Each face was presented in black and white, and was standardized in size (1.5 inches in height, 1.25 inches in width; see Appendix). The faces were rated on a scale of one to ten in terms of their emotions by four preraters (2 female, 2 male). Mean scores are as follows: angry faces averaged a 7.4, fearful faces were 6.8, neutral faces were 8.7, and happy faces were 8.4 (Cohn, Zlochower, Lien, & Kanade, 1999).

Procedure

Participants were told that they were performing a visual-spatial task of identifying the orientation of the letter "T." Each was instructed to keep their eyes on the central fixation point. Half of the time the T was upright, and on the other half of the trials the "T" was upside down. In addition, half of the trials had 8 "+" symbols inside of the box surrounding the upright or inverted "T." Participants were told to ignore the distractors, a face that was presented in the box opposite the target and the "+" symbols surrounding the "T." Faces displayed one of four emotions: happy, angry, fear, or neutral. Faces were drawn from the Carnegie Mellon facial database (Cohn et al., 1999). At the beginning of each trial the participant saw a central fixation cross for 500 msec. The cross was replaced by a cue pointing to either the left or right box, lasting for another 200 msec (see Figure 1). In the valid trials, the cue pointed to the box displaying the target letter. Invalid trials consisted if a cue pointing to the box with a face. Valid trials occurred 80% of the time, the other 20% were invalid trials. The cue frame was followed by an interstimulus interval (ISI) consisting of the same fixation cross for an additional 50 msec. The target was then flashed for 200 msec after which the fixation screen was shown again. Participants were instructed to press the "Z" key for an upright "T," and the "M" key for an inverted "T." The next trial began immediately after a response was recorded. A practice block consisting of 12 trials was run, followed by 6 blocks of 80 trials each. Participants were told to respond as quickly and accurately as possible in each trial. Response times (RT) and accuracy was recorded by the computer.

Results

A 3x2x2 within-subjects analysis of variance (ANOVA) was conducted as a function of: distractor condition (easy and hard), cue validity (valid and invalid), and emotional face (angry,

fearful, happy, and neutral). Analysis on RT revealed that there was a main effect of the distractor condition, $F(1,28) = 151.01$, $p < .0001$, indicating a 27 msec RT cost for the hard condition compared to the easy condition. There was no main effect for cue validity, $F(1,28) = 0.62$, $p = 0.4369$. The invalid cue condition produced only a 3-msec cost on RT compared to the valid cue condition, suggesting that although participants were forced to attend to the emotional face, they were able to easily disengage and not fully process it. In addition, there was no main effect of facial emotion, $F(1,28) = 0.95$, $p = 0.4115$. Mean response times for the faces are as follows: happy, 517 msec; angry, 516 msec; fearful 515 msec; and neutral, 513 msec.

The distractor condition and cue validity had no significant interaction, $F(1,28) = 0.60$, $p = 0.4451$. This suggests that participants were able ignore (did not attend to) the task irrelevant faces no matter if they were forced to attend to them (invalid cue) irrespective of task difficulty. Distractor condition and emotional face also had no significant interaction, $F(3,84) = 0.16$, $p = 0.9203$, suggesting that emotional faces produced similar RTs for easy and hard tasks. Mean response times for faces and distractor condition are as follows: happy/easy, 505 msec; happy/hard, 530 msec; angry/easy, 503 msec; angry/hard, 530 msec; fearful/easy, 501 msec; fearful/hard, 529 msec; neutral/easy, 501 msec; neutral/hard, 526 msec (see Figures 2 and 3). The data analyses revealed that there was no significant interaction between cue validity and facial emotion, $F(3,84) = 0.68$, $p = 0.5646$. This suggests that participants did not attend to the emotional faces, even when a cue guided their attention towards the emotional face. Finally, tests revealed that there was no significant three-way interaction between the variables, $F(3,84) = 0.65$, $p = 0.5879$, allowing us to conclude that cue validity and task difficulty had no effect on emotional face processing.

General Discussion

The present experiment was designed to examine whether the perception of emotional faces occurs outside of spatial attention. That is, I asked whether a task irrelevant face would be attended unconsciously when determining the orientation of the letter "T" in the opposite viewing field. Contrary to my hypothesis, emotionally significant faces (i.e. angry and fearful) did not produce a response time cost, suggesting that they did not pull attention away from the target. This finding implies that attentional resources are needed to process an emotional face. That is, emotional faces are not processed automatically. This finding is not consistent with previous research, where emotional faces did unconsciously pull attention away from the target (e.g., Lipp et al., 2009; Morris et al., 1998).

Task difficulty did have a significant effect on RT. The hard condition had a 27 msec cost on RT compared to the easy condition. The discrepancy in RT could be due to the eight distractor "+" signs surrounding the target "T". However, an alternate explanation could be that the emotional face was consuming all attentional resources. This hypothesis does not seem likely because of the lack of significant main effects and interactions. This finding is a good starting point for further research, and could lead to further answers about the role of central processing in emotional perception.

A possible explanation for the lack of significant results could be due to the multitude of emotional expressions used. This study was unique in that it used both angry and fearful faces to see if one produced unconscious capture more so than the other. However, happy and neutral faces were also used to create a baseline. It is possible that there might not have been enough trials using each face to create significant results. A possible follow up study could involve removing the happy face condition, and comparing the RT for fearful and angry faces with the neutral face.

Another possible limitation of the study is that only Oregon State University students were used in the sample. These students were drawn from a pool of introductory psychology classes and participated in exchange for extra credit. It is entirely possible that the participants were sensitized to the experiment by participating in similar experiments during the two-hour psych night. In addition, the sample was not a perfect representation of a normal population. That is, age groups were restricted to 18-24 year olds, which does not take into account elderly individuals. It could be that elderly people are more in tune when processing emotional stimuli because of their added years of experience in differentiating between expressions.

Each of the four emotional face conditions had eight females and eight males. They were also presented in black and white, and were standardized in size. It is possible that participants were not fully able to process the emotional faces due to their clashing with the black background of the screen. In addition, the face sizes possibly might not have been large enough for participants to see. Although appropriate steps were taken to make sure that each face represented a distinct emotion, it could be possible that they were not true representations. That is, it is possible that an angry face was too much like a fearful face, or a happy face was too similar to a neutral face.

The present study lays out the groundwork for future research in emotional face perception. As stated earlier, very few studies have looked at both fearful and angry faces together. Although no significant effects were found, it is still entirely possible that fearful faces are able to unconsciously capture attention more so than an angry face. In addition, further research should take into account target difficulty to see whether central resources are needed for processing of the irrelevant face. Finally, gender could play a key role in how emotional faces

are perceived. Specifically, it could be possible that an angry female face is less likely to be attended to than an angry male face, or vice versa.

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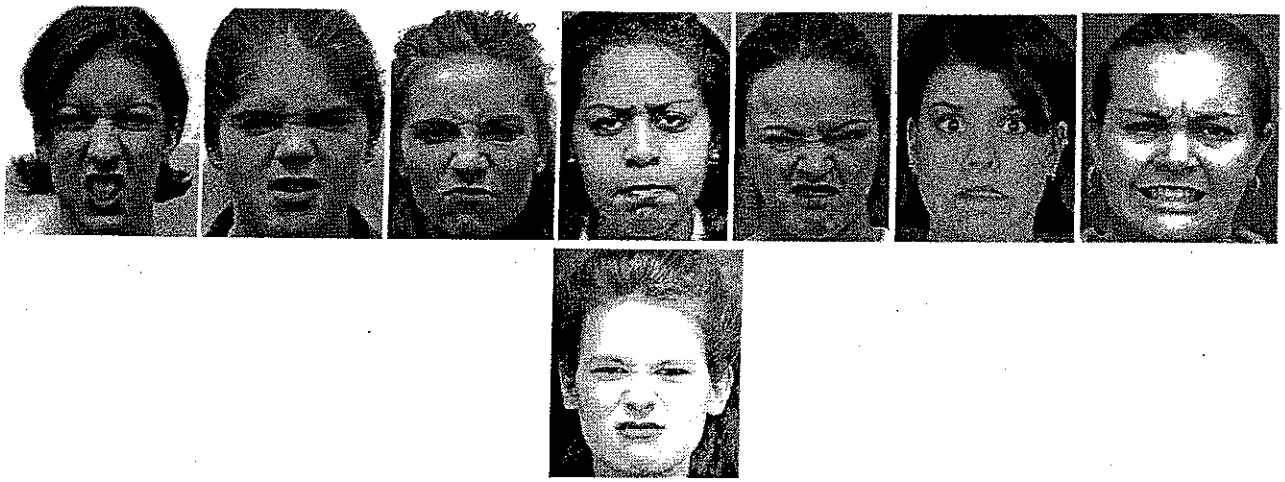
Appendix

Emotional pictures used in the present study.

Female Angry



Female Fearful

Female Happy

Female Neutral

Male Angry

Male Fearful

Male Happy

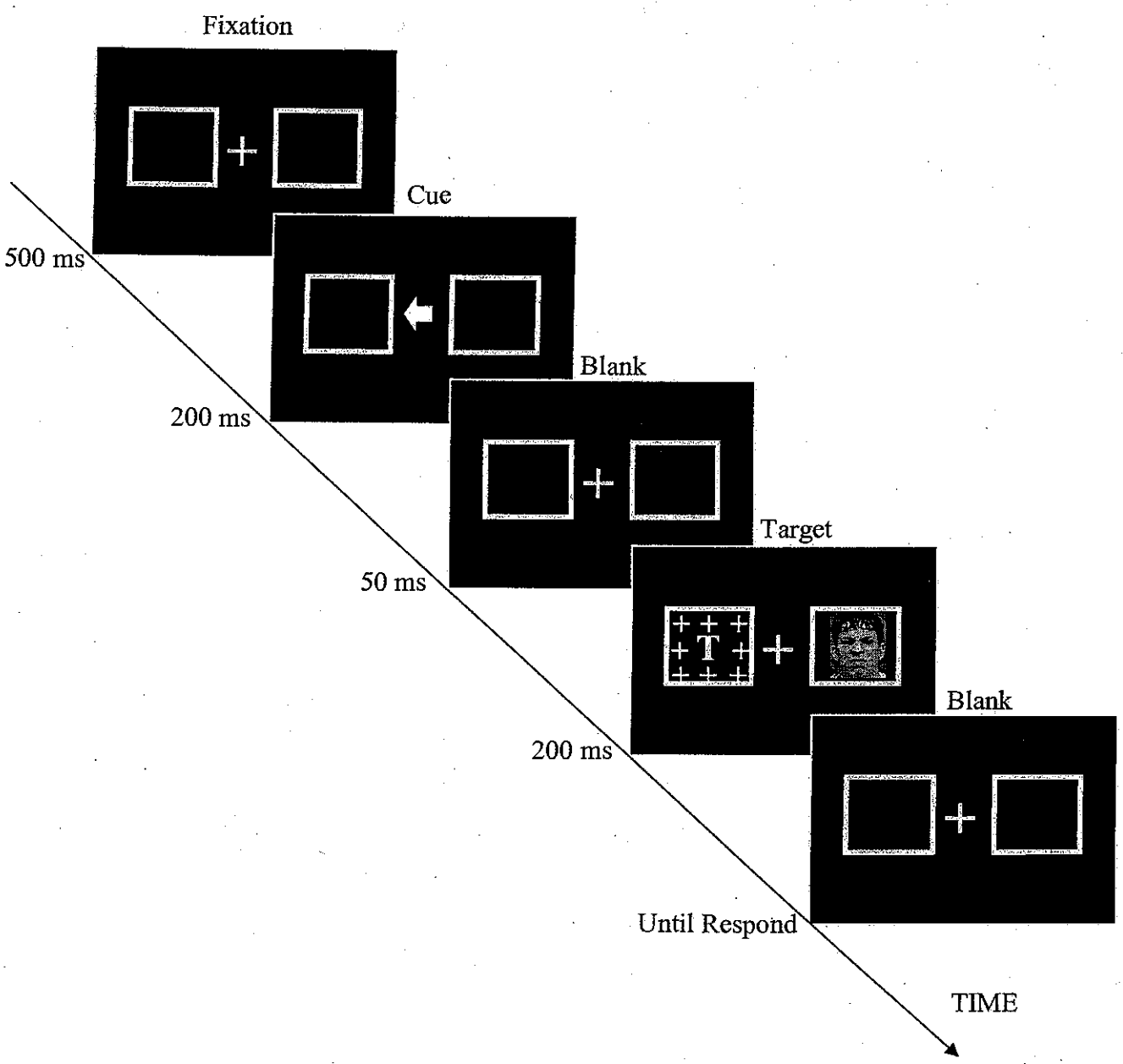
Male Neutral

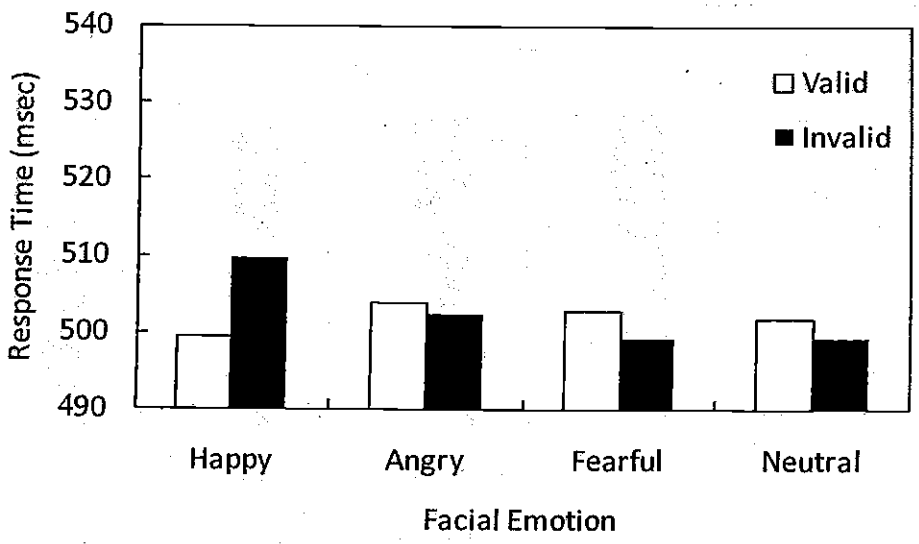
Figure Captions

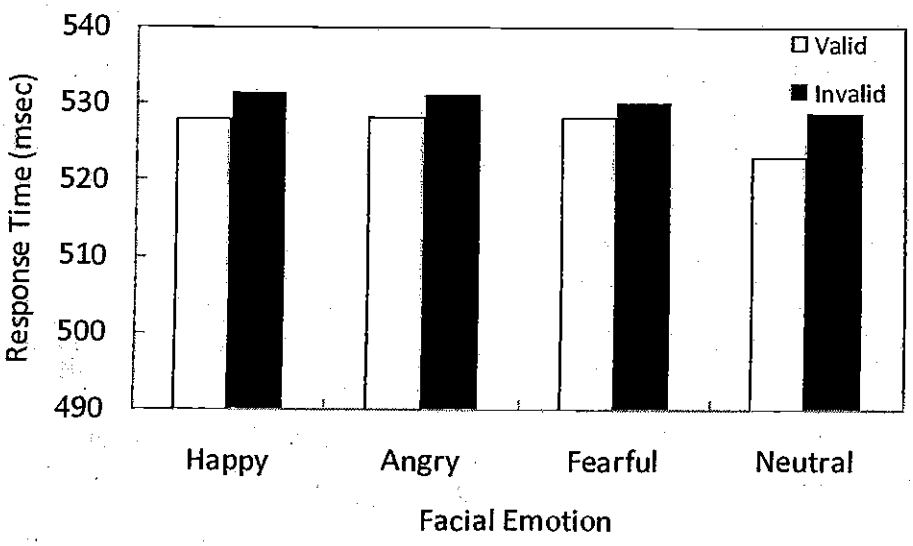
Figure 1. An example event sequence in the experiment. In this example, the cue was valid. That is, the cue correctly pointed to the target location.

Figure 2. Easy distractor condition response time for valid and invalid cues as a function of facial emotion.

Figure 3. Difficult distractor condition response time for valid and invalid cues as a function of facial emotion.


Fixation
Cue
500 ms
Blank
200 ms
Target
50 ms
Blank
200 ms
Until Respond
TIME


540
530
520
510
500
490
Response Time (msec)
Valid
Invalid
Happy
Angry
Fearful
Neutral
Facial Emotion


540
530
520
510
500
490
Response Time (msec)
Valid
Invalid
Happy
Angry
Fearful
Neutral
Facial Emotion