Introduction

Gauging people's mental state and intentions in their surroundings is a very important skill humans have adopted, as it can hint at whether somebody is looking at a positive or negative thing. As people look towards what they like while looking away from what they dislike, this helps us in identifying their focus of interest and likeness. Similarly, observing the other person's facial expressions, state of mind, intentions and emotions can be inferred. However, facial expressions can change quickly and be misleading. Hence, it is likely that our cognitive system relies on multiple information available. Neuroimaging studies have also shown interconnection between the inferior parietal sulcus & superior temporal sulcus involved in perceiving facial feature variation[1] and spatial attention system recruitment, and the amygdala & fusiform gyrus involved in perceiving emotional expressions[2,3]. Based on this, one could expect interaction between the processing of facial expressions and gaze direction. However, unfortunately, behavioral evidence of the combined effect of facial expression and gaze direction on cueing spatial attention is mixed.

A study using faces displaying angry, neutral, and happy expressions with direct or averted gaze revealed spatial cueing effects solely attributable to eye gaze, without any interactive influence of facial expression and gaze direction[4]. In contrast, a study using dynamic stimuli reported an interactive effect, with larger gaze cueing when faces changed expression from neutral to fearful compared to neutral to happy. However, a similar experiment using dynamic change in both emotional expression and gaze direction reported no behavioral interactive effect[5].

Although it is hard to make clear conclusions from earlier studies considering methodological differences and mixed patterns of results, a thorough review suggests that the interactive effect of facial expression and gaze direction might emerge when participants have to make evaluative judgments. Therefore, a hypothesis that could be tested is whether attentional shifts are influenced by processing facial expression and gaze direction, particularly when the task demands adopting an evaluative objective. In this study, this hypothesis was tested using various faces with directed/averted gaze and positive/negative words, and participants performed an evaluation of the word as positive or negative.

Methods

Eight pictures from "Pictures of Facial Affect"[6] depicting happy, disgusted, afraid and neutral faces were modified for contrast, color, and gaze direction (left & right) and were sorted into equal numbers of positive and negative images (Figure 1(A)). From "Affective Norms for English Words," 288 target words were chosen based on arousal and valence (Figure 1(B)). Each word (font size 18) was presented with a face picture for valid (same target and cue direction) and invalid-gaze-cued (different target and cue direction).

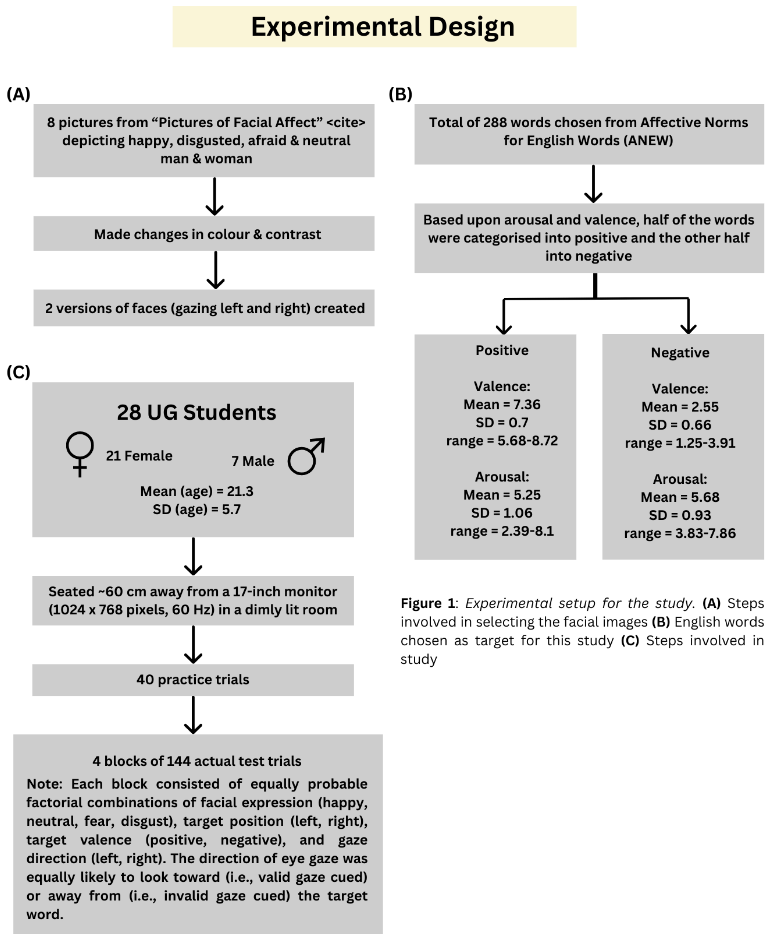

Figure 1: *Experimental setup for the study.* **(A)** Steps involved in selecting the facial images **(B)** English words chosen as target for this study **(C)** Steps involved in study

Each participant (with informed consent) performed 40 trials to familiarize themselves with the process and then did 576 trials spread over four blocks of 144 trials each. Each block had the same probability of facial expressions, target position, target valence, and gaze direction and was explicitly informed to participants (Figure 1(C)). Each trial showed a fixation point (~1000ms) followed by a face for 250ms. Subsequently, a target word in either direction was presented, and the screen remained until either response was given or 3000ms, followed by presenting feedback for 250ms (Figure 2). These trials were random for every participant. The time difference between two consecutive trials was anywhere between 500-1250ms. Keys U and B were selected to represent positive (P) and negative (N).

The mean Reaction time (RT) was computed for every condition. Trials that had a 1% error and RT faster than 100 or slower than 1500 ms were not considered when analyzing the data.

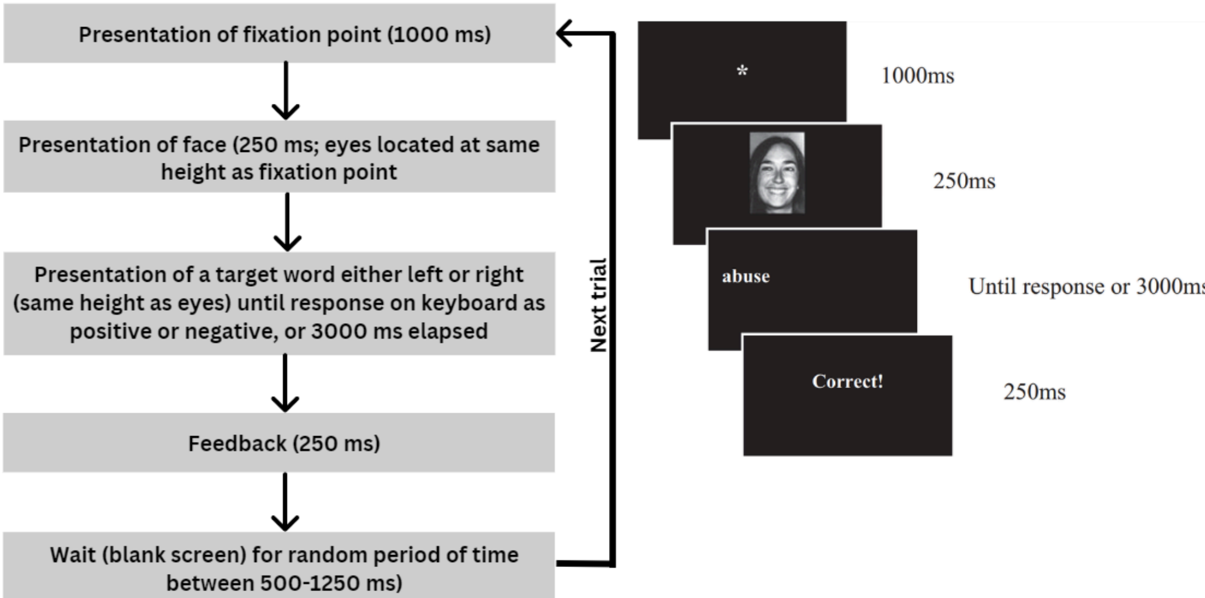

Figure 2: Sequence of steps in spatial cueing task

Results

Analysis of variance results showed that RTs were longer for the faces having a negative expression than for happy or neutral emotions.

The effects of gaze cue and target valence can be noticed significantly with longer RTs in identifying targets when target was present at cued locations than at invalid cued locations and longer RTs for target words that were negative as compared to positive.

When a negative word was presented with a negative expression, the RT was longer than when presented with a neutral expression. In contrast, when positive words were presented with a happy expression, RTs were shorter than neutral.

When analyses were done individually on each facial expression, it was observed that spatial cueing effects were found only for negative facial expressions. RTs were shorter when target words matched the gaze direction of fearful faces compared to when they did not.

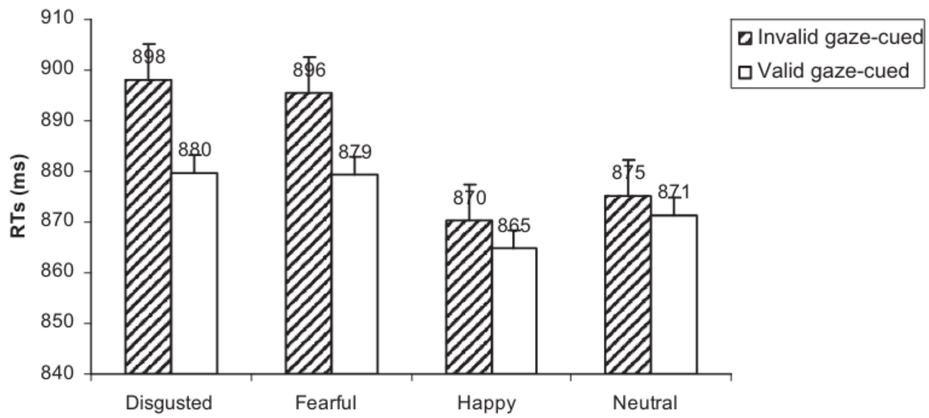

Figure 2. Mean reaction times (RTs), and standard errors, to target words on valid gaze-cued and invalid gaze-cued trials as a function of facial expression for Experiment 1 (evaluative task).

Discussion

Through the findings of the experiment, researchers analyzed that when participants responded based on target valence, spatial attention was impacted by negative facial expressions and gaze direction.In the experiment it was observed that negative emotional states conveyed by facial expressions, such as disgust and fear, interact with gaze direction to have a larger effect of spatial cueing when participants have an evaluative goal, unlike happy and neutral faces that had no effect. Specifically, targets looked at with disgusted or fearful faces showed an advantage of approximately 18 ms and 16 ms, respectively. The present findings also explain the inconsistency observed in past studies regarding the greater gaze cueing effects with fearful faces in anxious or fearful traits which could be linked to their tendency to prioritize processing information related to anxiety and fear. This idea is supported by the recent findings that the amygdala is involved in processing incoming information depending on the alignment between the current processing goal and specific aspects of the stimulus. These findings hint towards interconnections between the superior temporal sulcus and intraparietal sulcus, as these are involved in processing social cues and the amygdala[7].

Your Take

The findings of the present study confirms previous research indicating that the involvement of both facial expressions and gaze direction might not be evident during non-evaluative tasks but becomes apparent in tasks involving evaluation. Since facial cues can be sometimes manipulated to deceive in social interactions, this effect's conditional nature may prevent attentional shifts induced by misleading social signals and can also help in understanding social cognition processes and their impact on attention and behavior that can be further used in understanding cognitive deficits like autism spectrum disorder or social anxiety.

References

1. Haxby, J. V., Hoffman, E. A. & Gobbini, M. I. The distributed human neural system for face perception. *Trends Cogn. Sci.* **4**, 223–233 (2000).
2. Adams Jr., R. B., Gordon, H. L., Baird, A. A., Ambady, N. & Kleck, R. E. Effects of gaze on amygdala sensitivity to anger and fear faces. *Science* **300**, 1536–1536 (2003).
3. Wicker, B., Perrett, D. I., Baron-Cohen, S. & Decety, J. Being the target of another's emotion: A PET study. *Neuropsychologia* **41**, 139–146 (2003).
4. Leppänen, J. M. & Hietanen, J. K. Positive facial expressions are recognized faster than negative facial expressions, but why? *Psychol. Res.* **69**, 22–29 (2004).
5. Putman, P., Hermans, E. & van Honk, J. Anxiety meets fear in perception of dynamic expressive gaze. *Emot. Wash. DC* **6**, 94–102 (2006).
6. Ekman, P. & Friesen, W. V. Measuring facial movement. *Environ. Psychol. Nonverbal Behav.* **1**, 56–75 (1976).
7. Cunningham, W. A., Van Bavel, J. J., & Johnsen, I. R. (2008). Affective flexibility: Evaluative processing goals shape amygdala activity. Psychological Science, 19, 152–160.