Does emotion systematically influence visual perception?

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Previous research has shown that visual sensitivity to a human action is defined by an observer's motor and visual experience with that action. The goal of the current research is to examine whether another factor, namely, emotional processes, also shape visual sensitivity to human action. The potential impact of emotional processes on action perception is suggested by several neurophysiological findings which indicate that: (1) The neural circuitry involved in emotion perception (e.g., Heberlein, Adolphs, Tranel, & Damasio, 2004) overlaps with the neural areas involved in the visual analysis of human motion in the Superior Temporal Sulcus or STS (e.g., Puce & Perrett, 2003), (2) STS activity is modulated by angry facial expressions, and (3) numerous feedback and feedforward pathways connect the STS and emotional centres in the amygdala (Adolphs, 1999; Baron-Cohen, 1995; Brothers, 1997). To the extent that these connections serve functional purposes, we hypothesize that emotional processes might shape the visual detection of human action in profound ways. This hypothesis is tested in the psychophysical studies described below. Specifically, we examine whether an observer's ability to detect an action is modulated by the emotional content of that action.

In Experiment 1, two professional actors individually walked within a motion capture system while expressing a variety of emotions. The resultant spatiotemporal coordinates were converted into 3 s point-light movies of human gait. Each point-light walker displayed one of five possible emotional

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states: neutral, sad, happy, afraid, and angry. The point-light movies were shown to eight naïve observers who categorized each action as one of the five possible emotions. Overall, observers were able to categorize the emotional expression of the walkers with a mean accuracy of 79% correct ($SD = 0.41$, chance = 20%). This replicates previous findings that observers are able to determine an actor's emotional state from point-light displays of bodily motion (Atkinson, Dittrich, Gemmell, & Young, 2004; Dittrich, Troschianko, Lea, & Morgan, 1996). The results of Experiment 1 allowed us to identify those movies that reliably conveyed a particular emotion by computing the interobserver agreement for each stimulus. We selected a set of 15 walker stimuli, three instances for each of the five emotional classes, for which interobserver agreement was at least 83%. This set of stimuli was used in subsequent action detection studies.

In Experiment 2, we used the above stimulus set to conduct a standard psychophysical discrimination task. Our goal was to test whether the emotional content of a human movement affects the detection of that movement. For each stimulus, a mask of positionally scrambled but otherwise identically moving points was created. For each stimulus, the same motions made up both the walker and the mask. Therefore, the presence of a walker could only be determined from a global analysis of the relative locations of the points. Two types of trials were designed. In the walker-present trials, a coherent walker was present in the mask. In the walker-absent trials, the points defining the walker were scrambled. Thirteen naïve observers watched each movie on a 14-inch computer monitor. Following a within-subjects design, each subject saw 120 3-s displays in each of two blocks. Each block contained walker-present and walker-absent trials in equal presentations for all five emotional states. Point-light actors appeared to walk towards, away, leftward, and rightward relative to observers. Observers reported, by pressing one of two buttons, whether or not a walker was present in the mask. The results were analysed for sensitivity to the signal (d-primes computed as the relative difference between the standardized hit rate minus standardized false alarm rate), response bias (C), and response latency (reaction time). Importantly, walker detection was found to be emotion dependent, $F(4, 12) = 2.925$, $MSE = 0.216$, $p < .05$. Observers were significantly more likely to detect the presence of angry walkers ($p < .05$). Furthermore, a five-level (walker emotional state) repeated measures ANOVA indicated that decision criteria, c, were significantly shifted for angry displays, $F(4, 12) = 5.786$, $MSE = 0.11$, $p < .05$, as a result of the high rate of false alarms in the angry walker condition, all ps $< .001$ (Figure 1). A 5 (emotional states) $\times$ 2 (trial types) repeated measures ANOVA on the reaction time data suggests that participants' response times were significantly modulated by emotion,

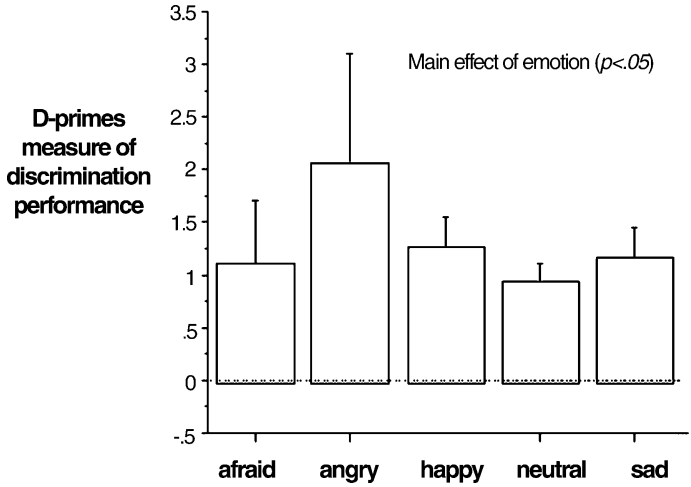

Figure 1. The accuracy results of Experiment 2. Detection accuracy presented as a sensitivity measure in *d*-primes, broken down by emotion, collapsed across all subjects. Emotional content modulates detection accuracy. The error bars represent the standard error.

$F(4, 24) = 3.046$, $p < .05$, as angry walkers were relatively quickly detected. These results suggest that action detection is emotion dependent.

Because life-sized point-light walkers might be perceived as potentially more interactive and thus engaging, we hypothesized that walker size might modulate walker detection. Therefore, Experiment 3 replicated the previous experiment with life size displays. Observer stood 2 m from a rear projector screen and performed the same walker detection task. When analysed for overall sensitivity, the results indicate no modulation of walker detection by emotion. However, when examined with respect to the direction in which each point-light actor walked relative to the observer, detection sensitivity is significantly enhanced to the angry people walking toward the observer, $F(4, 96) = 5.107$, $p < .05$. A 5 (emotional states) $\times 2$ (trial types) repeated measures ANOVA on the reaction time data suggests that participants' response times were significantly modulated by emotional information in the gaits, $F(4, 24) = 2.804$, $p < .05$. These results are consistent with the finding that STS responsiveness can be coded in an observer relative coordinate space (Puce & Perrett, 2003).

Taken together, these data support a significant interdependence of action perception and emotion analyses and may reflect the substantial interconnections between higher order visual processes in the STS and the limbic system. The amygdala is involved in the perception of threat (e.g., Anderson, Christoff, Panitz, de Rosa, & Gabrieli, 2003). Angry people, especially when they approach an observer, are clearly threatening. Enhanced detection of

threatening actions may represent an important condition under which emotional processes impact perceptual analyses.

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Recognizing novel deforming objects

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Visual object perception is dynamic as the result of an active observer or movement in the environment. Nonetheless, contemporary theories of object

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