



Research report

Virtual lesion of right posterior superior temporal sulcus modulates conscious visual perception of fearful expressions in faces and bodies



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ABSTRACT

The posterior Superior Temporal Sulcus (pSTS) represents a central hub in the complex cerebral network for person perception and emotion recognition as also suggested by its heavy connections with face- and body-specific cortical (e.g., the fusiform face area, FFA and the extrastriate body area, EBA) and subcortical structures (e.g., amygdala). Information on whether pSTS is causatively involved in sustaining conscious visual perception of emotions expressed by faces and bodies is lacking. We explored this issue by combining a binocular rivalry procedure (where emotional and neutral face and body postures rivaled with house images) with off-line, 1-Hz repetitive transcranial magnetic stimulation (rTMS). We found that temporary inhibition of the right pSTS reduced perceptual dominance of fearful faces and increased perceptual dominance of fearful bodies, while leaving unaffected the perception of neutral face and body images. Inhibition of the vertex had no effect on conscious visual perception of neutral or emotional face or body stimuli. Thus, the right pSTS plays a causal role in shortening conscious vision of fearful faces and in prolonging conscious vision of fearful bodies. These results suggest that pSTS selectively modulates the activity of segregated networks involved in the conscious visual perception of emotional faces or bodies. We speculate that the opposite role of the right pSTS for conscious perception of fearful face and body may be explained by the different connections that this region entertains with face- and body-selective visual areas as well as with amygdalae and premotor regions.

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1. Introduction

Information conveyed by emotional expressions is of crucial importance for social interactions. Studies of category-specific visual perception indicate that the selective processing of neutral bodies and faces occurs in dedicated regions of the occipito-temporal cortex (Occipital Face Area, [Peelen & Downing, 2005]; Extrastriate Body Area, [Downing, Jiang, Shuman, & Kanwisher, 2001; Urgesi, Berlucchi, & Aglioti, 2004; Urgesi, Candidi, Ionta, & Aglioti, 2007]; Fusiform Face Area, [Haxby, Hoffman, & Gobbini, 2000; Kanwisher, McDermott, & Chun, 1997]; Fusiform Body Area, [Moro et al., 2012; Schwarzlose, Baker, & Kanwisher, 2005]). A recent MEG study indicates that these regions process facial and body images at different timings as early as 100 msec after image presentation (Meeren, de Gelder, Ahlfors, Hämäläinen, & Hadjikhani, 2013). The specificity of body and face processing extends to the posterior Superior Temporal Sulcus (pSTS [de Gelder & Partan, 2009; Pinsk et al., 2009; Tsao, Moeller, & Freiwald, 2008]), which is a crucial node of the visual system that functions as a hub for the processing of socially relevant stimuli (Lahnakoski et al., 2012). There is substantial neuro-imaging evidence in support of the role of the pSTS in socially relevant processes. This region is also activated during the processing of others' intentions and mental state attributions, even irrespective of the affective content of the observed actions (David et al., 2006; Lahnakoski et al., 2012; Saxe & Kanwisher, 2003). Many studies have demonstrated that pSTS is involved in the processing of facial and bodily postures, movements and emotions (Allison, Puce, & McCarthy, 2000; Baseler, Harris, Young, & Andrews, 2013; Candidi, Stienen, Aglioti, & de Gelder, 2011; Grèzes, Pichon, & de Gelder, 2007; Kret, Pichon, Grèzes, & de Gelder, 2011; Pichon, de Gelder, & Grèzes, 2009; Puce, Allison, Bentin, Gore, & McCarthy, 1998; Vuilleumier & Pourtois, 2007; Zhu et al., 2012). This fundamental role of STS is possibly dependent on its functional connections with medio-temporal structures (amygdala) (Amaral, Behnia, & Kelly, 2003; Catani, Jones, Donato, & Ffytche, 2003; Furl, Henson, Friston, & Calder, 2013) and with parieto-frontal areas (Rizzolatti & Matelli, 2003; Seltzer & Pandya, 1994) which are also causally involved in the perception of neutral postures (Avenanti, Candidi, & Urgesi, 2013; Urgesi, Candidi, & Avenanti, 2014). Despite its activation during conscious perception of emotional face and body images, it is presently unknown whether the pSTS plays a specific causal role in sustaining conscious perception of neutral and emotional faces and bodies.

Important information on the neural correlates of conscious visual perception has been obtained by using binocular rivalry paradigms where two different images, each steadily displayed to one eye, compete over time for perceptual dominance (Tong, Meng, & Blake, 2006). Direct recordings from cortical cells of monkeys and neuroimaging studies in humans have described activity of both monocular and binocular cells correlating with subjective perception during rivalry (Leopold & Logothetis, 1996; Logothetis, Leopold, & Sheinberg, 1996; Polonsky, Blake, Braun, & Heeger, 2000; Tong, Nakayama, Vaughan, & Kanwisher, 1998; Wunderlich, Schneider, & Kastner, 2005). Other studies found that conscious perception

of the rivaling stimulus correlated with the activity of high-order, category-specific regions involved in the processing of visual stimuli (i.e., faces and places) (Tong et al., 1998; Wilson, 2003; Williams, Morris, McGlone, Abbott, & Mattingley, 2004).

Previous brain stimulation studies explored the neural correlates of interocular competition of low-level visual stimuli (Carmel, Walsh, Lavie, & Rees, 2010; Kanai, Bahrami, & Rees, 2010; Kanai, Carmel, Bahrami, & Rees, 2011; Zaretskaya & Bartels, 2013). However, no information on the causal role of the pSTS in conscious perception of higher-order, category- and emotion-specific stimuli is currently available. We explored whether conscious visual dominance of socially relevant stimuli such as emotional expressions displayed by faces and bodies is supported by activity in high-order visual areas (right pSTS) possibly through its connections with lower-level, category specific visual areas, as well as with the amygdalae and fronto-parietal regions. To address this issue we applied off-line, inhibitory repetitive Transcranial Magnetic Stimulation (rTMS) to the right pSTS in healthy participants and measured the time of conscious dominance of emotional and neutral faces and bodies that rivalled a neutral, non-body, control stimulus (house) (Figs. 1 and 2). The vertex was used as control site. If inhibition of the right pSTS induces similar effects on emotional or neutral face and body processing this would suggest that this region has the same role in supporting the perceptual dominance of these stimuli. By contrast, finding category- and emotion-specific different effects would suggest that the right pSTS plays a different role in the networks underpinning emotional face and body expression processing respectively.

2. Method

2.1. Participants

Sixteen right-handed healthy volunteers (Mean age = 23.8 years, SD = 1.9) (Briggs & Nebes, 1975) with normal or

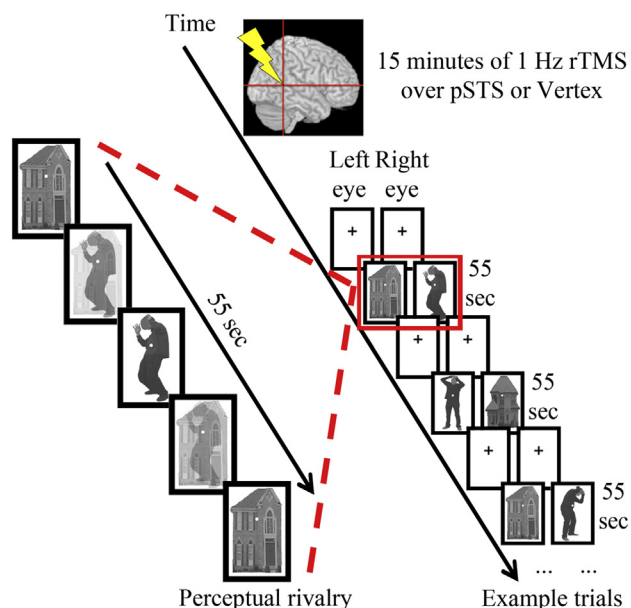


Fig. 1 – Timeline of the experimental trial and experimental set-up.

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