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The neural basis of perceiving person interactions

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ABSTRACT

This study examined whether the grouping of people into meaningful social scenes (e.g., *two people having a chat*) impacts the basic perceptual analysis of each partaking individual. To explore this issue, we measured neural activity using functional magnetic resonance imaging (fMRI) while participants sex-categorized congruent as well as incongruent person dyads (i.e., two people interacting in a plausible or implausible manner). Incongruent person dyads elicited enhanced neural processing in several high-level visual areas dedicated to face and body encoding and in the posterior middle temporal gyrus compared to congruent person dyads. Incongruent and congruent person scenes were also successfully differentiated by a linear multivariate pattern classifier in the right fusiform body area and the left extrastriate body area. Finally, increases in the person scenes' meaningfulness as judged by independent observers was accompanied by enhanced activity in the bilateral posterior insula. These findings demonstrate that the processing of person scenes goes beyond a mere stimulus-bound encoding of their partaking agents, suggesting that changes in relations between agents affect their representation in category-selective regions of the visual cortex and beyond.

1. Introduction

Whether people shake hands, have a chat, a fight, or a dance, go out for a drink, or wave goodbye, they are frequently seen in each other's company. Witnessing such person interactions and making sense of them, an activity sometimes referred to as people-watching, not only allows for an entertaining everyday distraction but also poses an impressive social-cognitive feat. Initial social-psychological work indicates, for instance, that observers of person dyads portrayed in brief video clips easily decipher whether interacting people are friends, romantic partners, or work colleagues (Costanzo & Archer, 1989). Similarly, a brief look at static photographs of person dyads provides sufficient information to determine whether two people are teasing or fighting each other (Sinke, Sorger, Goebel, & de Gelder, 2010) or whether they interact for instrumental or socio-emotional reasons (Proverbio et al., 2011). The neurofunctional stage at which sensitivity to meaningful person interactions arises in the person construal process, however, remains largely unknown.

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Contemporary work on person perception and person inferences focuses mainly on the processing of single individuals (see Ames, Fiske, & Todorov, 2011; Leising & Borkenau, 2010; Macrae & Quadflieg, 2010; Overwalle & Baetens, 2009; Zaki, 2013). As a result, theories on how we encode and integrate visual information involving several people remain poorly developed. In the field of object perception, however, numerous studies suggest that the encoding of visual information comprising several distinct entities depends crucially on how they relate to one another. For instance, when objects are portrayed in a meaningful rather than a meaningless interaction (e.g., a pitcher positioned to be pouring into a glass versus away from the glass), neuropsychological patients (Riddoch, Humphreys, Edwards, & Willson, 2003; Riddoch et al., 2011; Wulff & Humphreys, 2013), as well as healthy adults (Green & Hummel, 2006; Mudrik, Breska, Lamy, & Deouell, 2011; Roberts & Humphreys, 2011) display facilitated object recognition.

A likely neural substrate to underlie this facilitation effect is the lateral occipital cortex (LOC; Malach et al., 1995), a brain region that has previously been linked to object shape processing (e.g., Grill-Spector et al., 1999; Kourtzi & Kanwisher, 2001). Not only is there evidence that average activity in the LOC differentiates between meaningful and meaningless object interactions (Kim & Biederman, 2011; Roberts & Humphreys, 2010), but also that neural patterns in this region as examined using multi-voxel pattern analysis (MVPA) capture the different types of object scenes (Baeck, Wagemans, & Op de Beeck, 2013). Additional data demonstrate that disrupting LOC's normal functioning by transcranial magnetic stimulation (TMS) abolishes the interaction-based facilitation effect (Kim, Biederman, & Juan, 2011). In summary, these findings suggest that the grouping of objects into a conceptual unit modulates even basic mechanisms of object perception.

If the same mechanism holds true in the realm of person perception, the grouping of several people into one scene may also impact perceptual encoding of human faces and bodies (Hirai & Kakigi, 2009; Neri, Luu, & Levi, 2006). Such encoding is thought to occur in the so-called *core neural network of person perception* (Gobbini & Haxby, 2007; Rossion, Hanseeuw, & Dricot, 2012; Weiner & Grill-Spector, 2010), a system that comprises several brain regions, including the occipital face area (OFA), fusiform face area (FFA), posterior superior temporal sulcus (pSTS), extrastriate body area (EBA) and fusiform body area (FBA). All five regions act in concert to extract the structural and dynamic representation of an individual's facial and bodily appearance (Gobbini & Haxby, 2007; Grosbras, Beaton, & Eickhoff, 2012; Pavlova, 2012; Peelen & Downing, 2007; Weiner & Grill-Spector, 2010). When their interplay gets disturbed – through brain damage, repetitive TMS, or intracerebral electrical stimulation – face and body recognition skills decline, indicating the network's necessity for adequate person perception (e.g., Barton, Press, Keenan, & O'Connor, 2002; Grossman, Battelli, & Pascual-Leone, 2005; Jonas et al., 2012; Pitcher, Garrido, Walsh, & Duchaine, 2009; Sorger, Goebel, Schiltz, & Rossion, 2007; Urgesi, Candidi, Ionta, & Aglioti, 2007).

While initial neuroimaging work suggests that perceiving multiple people recruits brain areas dedicated towards person perception as well as mentalizing and action understanding (Hooker, Verosky, Germine, Knight, & D'Esposito, 2010; Iacoboni et al., 2004; Sinke et al., 2010; Wagner, Kelley, & Heatherton, 2011; Walter et al., 2004), it remains uncertain at what stage in the neural processing cascade a differentiation of meaningful from meaningless person interaction occurs. Only few studies have compared the neural responses elicited by meaningful person interactions to person dyads in which both agents acted independently from each other (Centelles, Assaiante, Nazarian, Anton, & Schmitz, 2011) or systematically faced away from one another (Kujala, Carlson, & Hari, 2011). The neural differences observed across these different types of person dyads are hard to interpret, however, due to the presence of additional low level visual confounds. For instance, agents shown in these studies held different bodily postures during interactions and control scenarios, were in closer spatial proximity to each other during the former than the latter, and/or displayed mutual eye gaze and/or touch during real person interactions only.

Taking into account these limitations, the current functional magnetic resonance imaging (fMRI) study addressed the question whether the type of social relations between people can modulate the encoding of visual person information, ensuring that low-level visual differences are strictly controlled for. Specifically, participants were asked to view a series of person dyads comprising *congruent person interactions* (i.e., two agents acting in a related manner and facing each other), *incongruent person interactions* (i.e., two agents acting in an unrelated manner and facing each other), and so-called *non-interactions* (i.e., two agents acting in a related manner but facing away from each other). To ensure that perceivers held identical processing goals across all three types of dyads, a basic categorization task – judging whether the depicted agents matched with regard to sex – was used throughout the experiment. Finally, to identify critical components of the core person perception network for each participant (i.e., FFA, FBA, OFA, EBA, pSTS), a well-controlled functional localizer was administered (Quadflieg et al., 2011). In line with previous reports of perceptual incongruency in person perception, we anticipated that activity in the core network would be modulated by dyad type, such that perceiving incongruent person interactions and non-interactions would elicit enhanced neural processing compared to congruent interactions (cf. Egner, Monti, & Summerfield, 2010; Quadflieg et al., 2011; Zaki, 2013).

2. Methods

2.1. Participants

Twelve Caucasian volunteers (5 males), aged between 21 and 31 years (mean: 26.0 years), participated in the study. All volunteers reported normal or corrected-to-normal vision. Eleven participants were right-handed, one participant left-handed as determined by the Edinburgh Handedness Inventory (Oldfield, 1971). None of the participants had a history of neurological or neuropsychiatric disorders or was currently taking psychoactive medications. Informed consent was obtained from all individuals.

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