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Dissociation between emotion and personality judgments: Convergent evidence from functional neuroimaging

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Cognitive neuroscientists widely agree on the importance of providing convergent evidence from neuroimaging and lesion studies to establish structure–function relationships. However, such convergent evidence is, in practice, rarely provided. A previous lesion study found a striking double dissociation between two superficially similar social judgment processes, emotion recognition and personality attribution, based on the same body movement stimuli (point-light walkers). Damage to left frontal opercular (LFO) cortices was associated with impairments in personality trait attribution, whereas damage to right postcentral/supramarginal cortices was associated with impairments in emotional state attribution. Here, we present convergent evidence from fMRI in support of this double dissociation, with regions of interest (ROIs) defined by the regions of maximal lesion overlap from the previous study.

Subjects learned four emotion words and four trait words, then watched a series of short point-light walker body movement stimuli. After each stimulus, subjects saw either an emotion word or a trait word and rated how well the word described the stimulus. The LFO ROI exhibited greater activity during personality judgments than during emotion judgments. In contrast, the right postcentral/supramarginal ROI exhibited greater activity during emotion judgments than during personality judgments. Follow-up experiments ruled out the possibility that the LFO activation difference was due to word frequency differences. Additionally, we found greater activity in a region of the medial prefrontal cortex previously associated with "theory of mind" tasks when subjects made personality, as compared to emotion judgments.

Keywords: Simulation; Social cognition; Mentalizing; Personality attribution; Emotion recognition; Double dissociation; Lesion overlap; Pointlight walkers; Biological motion

Introduction

In everyday reasoning about other minds, observers frequently appeal to both the target's emotional states ("she smiled because she was happy") and her enduring personality traits ("she smiled because she's friendly"). These processes share some apparent similarities: both emotion recognition and personality attribution depend on serial processes, with both rapid, relatively automatic components and more effortful, conscious components (Fiske, 1993; Gilbert, 1998; Macrae and Bodenhausen, 2000; Adolphs, 2002). However, results from developmental psychology suggest that these two processes rely on distinct psychological mechanisms. Emotions are among the first mental states that young children attribute to other people (Wellman and Bartsch, 1988), with 2-year-olds able to correctly select an appropriate facial expression for a character in a vignette (Wellman and Woolley, 1990). In contrast, children do not appear to understand the relationship between personality traits and typical behaviors before age 5 (see review by White, 1995).

Two processes may develop sequentially and yet come to rely on the same psychological and neural mechanisms in the adult mind and brain. However, a recent lesion overlap study (Heberlein et al., 2004) suggests that in this case, the processes remain at least partially distinct into adulthood. Heberlein et al. showed that different neural regions are critically involved in attributing emotional states vs. personality traits: lesions in a region overlapping right postcentral and supramarginal gyri produced abnormalities in attributing emotions, whereas lesions around the left frontal operculum led to deficits in attributing personality traits, based on the same body movement stimuli.

Normal adult observers can reliably make both emotion judgments and personality trait judgments based on static or brief dynamic stimuli depicting nonverbal behavior (Ekman

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and Friesen, 1971; Scherer, 1986; Ambady and Rosenthal, 1992; Wallbott, 1998). One form of nonverbal cue, body movement, can be minimally portrayed using point-light walkers, created by affixing small lights to an actor's body and filming him moving in the dark (Johansson, 1973). From the movements of 8–12 such moving dots, observers readily recognize biological motion (the characteristic articulated motion of a human body), and can also recognize gender (Kozlowski and Cutting, 1977), the identity of familiar individuals (Cutting and Kozlowski, 1977; Loula et al., 2005), emotion (Dittrich et al., 1996; Makeig, 2001; Pollick et al., 2001), and even personality traits (Gunns et al., 2002; Heberlein et al., 2004).

Most investigations of the neural substrates of biological motion have focused on the recognition of biological motion per se (e.g., Grossman et al., 2000; see review in Allison et al., 2000), or on the perception of intentional actions (Bonda et al., 1996), rather than on the attribution of higher-level social and emotional information. In the current study, we sought converging evidence from fMRI for the findings of Heberlein et al. (2004), i.e., that emotion and personality trait judgments from body movement cues rely on at least partly distinct neural circuitry. We examined the neural activity in neurologically normal subjects making, by turns, emotion and personality trait judgments about the same set of point-light walker stimuli. This study is, to our knowledge, the first attempt to use fMRI to distinguish the neural substrates of two different kinds of social attributions based on the same biological motion cues.

Materials and methods

Subjects

Seven healthy right-handed adults (5 women) participated for payment. All subjects had normal or corrected-to-normal vision and gave informed consent to participate in the study as approved by the local Internal Review Board.

Stimuli

Construction of point-light stimuli

12 small lights were attached to the major joints and the head of a male actor. He was filmed moving in a dark room, while portraying specific emotions and personality traits (see examples at http://ccn.upenn.edu/farahlab/andrea/). Twelve stimuli were chosen that had been used in the prior lesion study, and that elicited strong inter-subject reliability on both emotion and personality attribution tasks. Stimuli were edited so that all were 6 s long, by looping shorter stimuli and cropping the beginning and end of longer stimuli as needed. They were played in pseudorandom order, counterbalanced across subjects.

Task

Subjects were first told about the two types of judgments they would be asked to make: emotions and personality traits. They were then trained on the probe words: four emotion words (happy, sad, angry, afraid[2]) and four personality trait words (trustworthy, outgoing, friendly, adventurous[3]), and learned three-letter codes for each. While being scanned, subjects first saw a cue telling them what judgment they were to make, then a single 6-s point-light walker stimulus, and finally the three-letter code for the probe word (e.g., "hap"). During the presentation of the three-letter code, subjects were asked to rate the fit of the emotion or trait word to the stimulus they had just seen on a 4-point Likert scale, corresponding to four buttons on a button box. Each trial, consisting of the task cue, stimulus, and probe, was treated as a block. All movies were rated in both task conditions, and task conditions alternated, interleaved with fixation; the first task was counterbalanced between subjects and across runs within subjects.

fMRI data acquisition and analysis methods

Subjects were scanned in the Siemens 1.5 T scanner at the MGH NMR center in Charlestown, MA, using a head coil. Standard echoplanar imaging procedures were used (TR = 2 s, TE = 30 ms, flip angle 90°). Twenty 5 mm thick axial slices covered the whole brain, excluding the cerebellum.

MRI data were analyzed using SPM 99 (http://www.fil.ion.ucl.ac.uk/spm/spm99.html) and in-house software. Each subject's data was motion corrected and then normalized onto a common brain space (the MNI template). Data were then smoothed using a Gaussian filter (Full Width Half Maximum = 8 mm), and high-pass filtered during analysis. Every experiment used a blocked design, and was modeled using a boxcar regressor.

Individual subjects' ROIs were defined anatomically. Based on sulcal and gyral landmarks, spheres of 3 mm radius were centered on the anatomical location in each subject's brain most closely corresponding to the peaks of lesion overlap derived from the previous lesion study (Heberlein et al., 2004). A very small radius was chosen to maximize anatomical specificity.

Within the ROI, the average Percent Signal Change (PSC) relative to fixation baseline (PSC = 100 * raw BOLD magnitude for (condition − fixation) / raw BOLD magnitude for fixation) was calculated for each condition (averaging across all voxels in the ROI, all TRs in the block, and all blocks of the same condition). This calculation yielded a single grand average PSC value per ROI for each condition. These values were then entered into repeated measures statistical tests. Because the definition of the ROIs was independent from the data used in the repeated measures statistics, Type I errors were drastically reduced.

[2] The prior lesion study had used these four words, with an additional option of 'neutral', in a forced-choice task. These are four of the 6 Ekman (Ekman and Friesen, 1971) "basic emotions"; the other two, disgust and surprise, are not well conveyed by body movement and so were not used.

[3] Note that each of these four words represents one end of a continuum loosely based on four of the "big five" personality traits (McCrae and Costa, 1987), specifically Reliability, Extraversion, Warmth/Agreeableness, and Novelty Seeking. While the words we chose may not exactly capture these dimensions, they nevertheless were reliably interpreted as stable traits by subjects. Because our goal was independent of the validity of these constructs, it was important to us only that the trait words we chose were recognizable exemplars of qualities generally agreed upon to be more stable over time than the basic emotion words we used. We used four, and not five, to match the number of emotion words.