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Brief report

Face processing in depersonalization: An fMRI study of the unfamiliar self

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ABSTRACT

Depersonalization disorder (DPD) is characterized by a core sense of unfamiliarity. Nine DPD participants and 10 healthy controls underwent functional magnetic resonance imaging while viewing self and unfamiliar faces. Compared with control subjects, the DPD group exhibited significantly greater activation in several brain regions in response to self vs. stranger faces. Implications are discussed.

1. Introduction

Two core clinical features of DSM-IV-TR depersonalization disorder (DPD) are a subjective sense of hypoemotionality and unfamiliarity, despite intact reality testing. *Corticolimbic disconnections* (Sierra and Berrios, 1998) involving heightened prefrontal cortical activation and reciprocal limbic inhibition may account for the hypoemotionality and has largely been the focus of neuroimaging studies (Medford, 2012). Knowledge of the neural correlates of unfamiliarity in DPD (feeling separate from oneself, unreality of the self), on the other hand, is limited. One positron emission tomography study suggested that disruptions in posterior sensory associative cortical functioning may mediate multimodal perceptual disturbances leading to altered self-perception (Simeon et al., 2000).

The self-face paradigm has been used to examine the neural basis of the self. A review of neuroimaging studies indicates a right-dominated yet distributed network of self-processing with consistent involvement of the left fusiform gyrus, bilateral middle and inferior frontal gyri, and parietal cortical regions (Devue and Brédart, 2011). Further studies reveal that the superior parietal lobe, right inferior temporal gyrus and the occipital face area, consisting of the superior parietal lobule and the inferior occipital gyrus, are associated with self-face recognition in healthy populations (Uddin et al., 2005; Apps et al., 2012). There is also an evidence for a left-hemisphere-dominated network for self-face recognition when viewing a self-face transitioning to a familiar face (Turk et al., 2002). Activation in the medial prefrontal cortex (MedPFC) is consistently reported in neuroimaging studies of self vs. other judgments, yet the precise role of this region is unclear. Greater activity in ventral MedPFC was shown during trait judgments of self vs. other (Kelley et al., 2002), and MedPFC regions involved in making judgments for self and other may overlap (Ochsner et al., 2005). Activation has been found in the right prefrontal cortex during explicit discrimination between self and other (Platek et al., 2006). Furthermore, the right anterior cingulate and bilateral prefrontal cortices were found to activate during active vs. passive self-face processing (Sugiura et al., 2000).

To date, there are limited neuroimaging studies examining self-recognition in patient populations. One study highlights the neural systems underlying shared representation of self and other in children with autism (Uddin et al., 2008). In response to a self-recognition task involving morphed images, the right frontal region was activated in typically developing children for self and other faces. This region was activated for self faces, but not for other faces, suggesting that children with autism lack a shared neural representation for self and others.

Interpreting and integrating these activations have proved difficult due to varying control stimuli (e.g., familiar, unfamiliar, famous, romantic partner face, and trait judgments) and experimental tasks (e.g., photograph content, stimuli presentation, and implicit vs. explicit tasks). Most neuroimaging research on self to date involves supraliminal or explicit tasks. Recent research on

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self-processing at multiple levels of awareness, using both subliminal and supraliminal self-face stimuli, shows that self-related stimuli enjoy the self-advantage of a more robust neural response even when processed subliminally (Geng et al., 2012).

The present functional magnetic resonance imaging (fMRI) study is the first to examine unfamiliarity of self in DPD during implicit self vs. other (stranger) face processing. We hypothesized that DPD participants would demonstrate altered activation in “self” brain regions compared with healthy controls reflecting altered implicit self-processing, in the presence of intact supraliminal self-recognition.

2. Methods

2.1. Participants

The study was approved by the institutional review board at Mount Sinai School of Medicine. Participants were medically and neurologically healthy right-handed adults aged 18–55. The DPD participants, $n=9$, were assessed by structured interviews (SCID-I/P, First et al., 2002; SCID-II, First et al., 1997) for Axis I and II disorders, and SCID-D (Steinberg, 1994) for dissociative disorders. Control participants, $n=10$, scored <10 on the Dissociative Experiences Scale (Bernstein and Putnam, 1986) and had no lifetime Axis I or II disorders. All participants provided written informed consent.

2.2. Task

Participants underwent fMRI while viewing photographs of their own faces and a stranger's face. Participants' photographs were facing forward and at a 45° angle with neutral expression and cropped above the shoulders using Adobe Photoshop. Stranger's photos, matched for gender, race, age, facial expression, and angle, were found via internet search. Two 6-min runs were conducted, each presenting twenty 18-s blocks consisting of six self and stranger facial stimuli in pseudo-random order. Participants judged whether faces were facing the camera via a button press.

2.3. MRI acquisition

Neuroimaging data were collected using a 3T GE Siemens Allegra MR scanner. See Supplementary materials for data-acquisition parameters.

2.4. Image processing and analyses

Images were processed as follows: (1) realigned correct for head motion and coregistered to their respective T2 image; (2) spatially normalized to a standard template (MNI: Montreal Neurological Institute) using a 12-parameter affine registration algorithm; and (3) smoothed with an $8 \times 8 \times 8$ mm^3 Gaussian kernel. Experimental condition effects were estimated according to the general linear model using a canonical hemodynamic response function. Fixed effects models (Friston, 1994) were used at the individual subject level of analysis, and random effects models (Holmes and Friston, 1998) were used for group level analyses. On an individual subject level, t-contrast images (fixed effects) were calculated based on the difference between the self and stranger conditions (self > stranger). To determine areas that were significantly different between groups, a two-sample t-test (random effects) was performed. All fMRI analyses were corrected for multiple comparisons. For whole-brain analyses, we corrected for multiple comparisons using AFNI's 3dClustSim based on 1000 Monte Carlo simulations; with the use of a combined height ($P<0.001$) and spatial-extent (93 voxels) threshold, the significance level was established at $P<0.05$ corrected. Imaging analyses were performed with SPM 5 (Wellcome Department of Imaging Neuroscience, London, UK) in MATLAB 7.0 (Mathworks, Natick, MA).

Additionally, we conducted exploratory Pearson's correlation analyses between the Cambridge Depersonalization Scale (total CDS score) (Sierra and Berrios, 2000) and reactivity to self vs. stranger within the areas of interest using a combined $P=0.005$ (uncorrected), and a 20-voxel extent threshold (Lieberman and Cunningham, 2009).

3. Results

The two groups did not significantly differ in gender ($\chi^2=1.82$, $P=0.188$) or age (DPD: $M=33.2$, $SD=11.2$, HC: $M=31.9$, $SD=11.8$, $t(15)=0.54$, $P=0.466$). The two groups did not differ in reaction time when viewing self, $t(15)=1.66$, $P=0.18$, or stranger, $t(15)=1.77$, $P=0.10$, or in response accuracy for self, $t(14)=-1.3$, $P=0.21$, or stranger, $t(14)=1.40$, $P=0.18$.

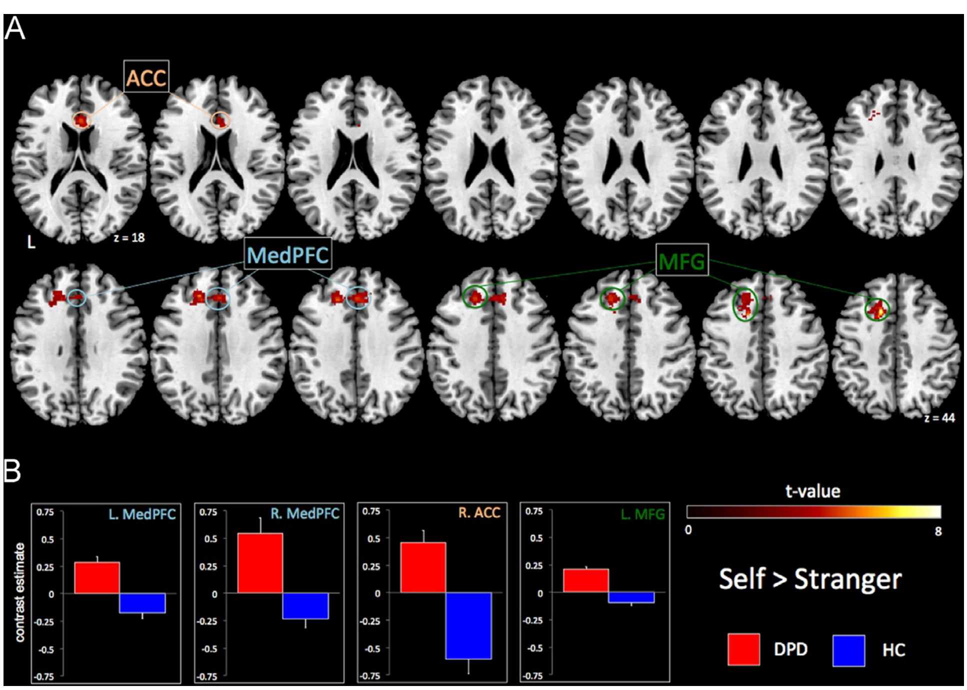

Fig. 1. Areas of significantly greater response to self vs. stranger processing in depersonalization personality disorder (DPD) as compared to healthy controls (HC). Areas of significant activation (A), using a whole brain analysis, are overlaid on a standardized template brain, in neurological orientation, on axial slices ranging between $z=18$ to $z=44$ (MNI). Plots (B) present mean contrast estimates for the comparison between self vs. stranger processing, for each group. Error bars represent standard error from the mean. L=Left, R=Right; MedPFC=medial prefrontal cortex, ACC=anterior cingulate cortex, MFG=middle frontal gyrus.

Compared with controls, DPD participants exhibited greater response to self vs. stranger processing within two large clusters (Fig. 1A). One cluster was located within the right anterior cingulate (124 voxels) (ACC, BA 24; $z=4.45$; peak voxel: MNI: 2, 24,16). The second cluster extended into three brain regions: left MedPFC (469 voxels) (L. MedPFC, BA 6/9; $z=4.26$; peak voxel: MNI: −18, 32, 34), right medial prefrontal cortex (R. MedPFC; BA 6/9; $z=3.92$; peak voxel: MNI: 2, 30, 36) and left middle frontal gyrus (L. MFG; BA 6; $z=5.15$; peak voxel: MNI: −12, 16, 46). Standardized contrast estimates extracted from the peak voxel for each brain region are presented in Fig. 1B. There were no areas of significantly greater response to self vs. stranger processing in controls compared with the DPD group.

Within the DPD group, higher CDS scores were positively correlated with reactivity to self vs. stranger faces in the left MedPFC (peak voxel: MNI: −12, 10, 54; 63 voxels; $t=7.13$; $P<0.001$) and the left Middle FG (peak voxel: MNI: −24, 38, 22; 119 voxels; $t=7.10$; $P<0.001$).

4. Discussion

DPD participants exhibited greater response to self vs. stranger processing within the right ACC, bilateral MedPFC, and left middle frontal gyrus, and depersonalization severity was significantly associated with activation in the latter two regions. Broadly, findings are consistent with a reported positive correlation between depersonalization severity and right frontal cortex and ACC activation in healthy individuals with intravenous tetrahydrocannabinol-induced depersonalization (Mathew et al., 1999). Findings are also consistent with increased ACC and right prefrontal and frontal activation in PTSD patients experiencing an imagery-induced dissociative state (Lanius et al., 2002). Explanations of our findings not related to self-processing cannot be excluded. The two groups could be demonstrating different brain activations secondary to different cognitive task demands. However, the comparable reaction times and recognition accuracy in the two groups make this explanation less likely. Furthermore, the positive relationship between depersonalization severity and brain activation in the MedPFC also points to a deficit in implicit self-processing.

Another alternative interpretation of the findings related to ACC activation could involve a conflict between conscious and unconscious processing of self in DPD. Although individuals with DPD have no difficulty in recognizing the self-face at the conscious level, this could be coupled with an unconscious response of "not-knowing" the self, thus activating conflict detection and resolution in the ACC (Botvinick et al., 2004), as has been shown in another dissociative condition, conversion disorder (van Beilen et al., 2010).

Finally, the two core features of depersonalization, hypoemotionality and unfamiliarity, may be interrelated. Neural pathways for perceptual recognition are likely be linked to parallel pathways for assigning emotional content to percepts. As such, abnormal self-face processing may underlie the lack of emotional resonance. The association between hypoemotionality and unfamiliarity in depersonalization warrants further investigation.

There are limitations to this initial study, which necessitate and motivate further investigation, including the small sample size, the task used, and the control condition. The use of a famous, vs. a stranger, face as a control would address familiarity as a confounding factor. The subtraction method presumes that self-face minus stranger indicates self-face activation; however, related cognitive processes may be activated during control.

Understanding the neural underpinnings of unfamiliarity holds the potential to inform novel treatment approaches for DPD. Target sites for repetitive transcranial magnetic stimulation treatment have been selected based on prior neuroimaging findings (Mantovani et al., 2011). Further investigation of the neural basis of the depersonalized self-experience is warranted.

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Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.pscychresns.2014.02.003.

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