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Habitual suppression relates to difficulty in regulating emotion with cognitive reappraisal

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ABSTRACT

One common strategy to cope with the difficulties of daily life is suppression. Habitual users of suppression tend to suppress their feelings rather than expressing them. Although this strategy may reduce outward response to emotion, it is not thought to lessen induced negative affect. Moreover, it remains unclear whether people with high suppression scores can reduce negative affect through cognitive reappraisal. In the present study, twenty-nine healthy participants differing in suppression scores were directed to reappraise aversive stimuli during functional magnetic resonance imaging (fMRI). Results showed that higher suppression scores correlated with decreased response of dorsomedial prefrontal cortex (dmPFC) during cognitive reappraisal. Further, high suppression scores related to enhanced negative affect to stimuli with greater negative affect correlating with decreased dmPFC response during cognitive reappraisal. This study suggests that people with high suppression scores experience difficulty in reducing negative affect through cognitive reappraisal and implicates neurobiological processes that may underlie this difficulty.

1. Introduction

A wide variety of emotion regulation strategies are utilized to cope with the difficulties of daily life, including reappraisal and suppression (Gross, 1998; Ochsner & Gross, 2004). While reappraisal refers to the ability to change one's thinking towards an event, suppression describes the ability to reduce one's behavioral response. Compared to reappraisal, individuals who utilize suppression as a common method for emotional regulation experience greater negative affect, worse interpersonal functioning, and poorer overall well-being (Gross & John, 2003). Moreover, habitual use of suppression has been shown to be associated with a series of affective disorders (Abler et al., 2010; Aldao & Nolen-Hoeksema, 2010; Ehring, Tuschen-Caffier, Schnülle, Fischer, & Gross, 2010).

Neuroimaging studies have shown differing response patterns during reappraisal and suppression. In the case of reappraisal, studies link activation between the prefrontal cortex, a region responsible for cognitive control, with emotion-related structures such as the amygdala and insula (Banks, Eddy, Angstadt, Nathan, & Phan, 2007; Frank et al., 2014; Kohn et al., 2014; Ochsner, Bunge, Gross, & Gabrieli, 2002; Ochsner & Gross, 2004; Otto, Misra, Prasad, & McRae, 2014; Wager et al., 2008). In contrast, imaging studies of suppression have shown a negative association between activation of the medial prefrontal cortex and expectation of a negative stimulus; it has been proposed that this decreased anticipatory medial PFC activation might suggest a lack of emotion regulation (Abler et al., 2010). In this way, habitual suppression might relate to difficulty in recruiting the medial prefrontal cortex to down-regulate negative affect.

Studies have also shown that differences in the temporal dynamics of reappraisal and suppression. Reappraisal has showed early prefrontal cortical responses and decreased amygdala and insular responses; while suppression produced late PFC and increased amygdala and insula responses (Goldin, McRae, Ramel, & Gross, 2008). This temporal difference may reflect the different nature of these two strategies; the former asks for a new interpretation of conditions (and is therefore an early response in the experience of emotion) while the latter focuses on the controlling of inappropriate responses once the emotion is felt (Gross & John, 2003). This latter suggestion linking the relationship between sup-

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pression and inhibition of action is corroborated by increased grey matter volume in medial prefrontal cortex among frequent users of suppression strategy (Hermann, Bieber, Keck, Vaitl, & Stark, 2013; Kühn, Gallinat, & Brass, 2011).

In the current study, we explore whether people high in suppression scores can reduce negative affect effectively by cognitive reappraisal. To do so, we recruited individuals differing in habitual suppression scores and asked participants to complete a cognitive reappraisal task during fMRI. We hypothesized that individuals scoring high in suppression scores would have increased difficulty in regulating negative effect through cognitive reappraisal. We further hypothesized that brain activation of those high in suppression scores would be associated with decreased activation of PFC regions responsible for cognitive reappraisal, and associated with increased response in emotion-related structures like amygdala and insula (Ochsner et al., 2002; Ochsner & Gross, 2004).

2. Materials and methods

2.1. Participants

Thirty-three healthy volunteers participated in this study; two subjects were excluded due to excessive head motion in the scanner and another two participants were excluded due to missing questionnaire data. Twenty-nine (14 men) subjects were therefore included in the subsequent analyses (mean ± SD: age = 22.62 ± 1.59). All participants were undergraduates or graduate students recruited from Southwest University, China; and none had a history of any neurological or psychiatric illness. This study was approved by Southwest University Brain Imaging Center Institutional Review Board, and all participants signed a written informed consent in accordance with the Declaration of Helsinki.

2.2. Materials and procedure

Participants were required to fulfill a cognitive reappraisal task in the scanner. This task consisted of 30 trials lasting for a total of 10 min. Before each trial, a 2-s cue asked participants to either "reduce" or "maintain" their emotion to the upcoming aversive picture which was then presented for 10 s. Upon the disappearance of the aversive picture, participants were required to rate their current negative affect aroused by the picture using a 4-point scale (1 = none; 2 = mild; 3 = moderate; 4 = severe) before a 4-s "rest" period. Images presented were selected from the Native Chinese Affective Picture System (CAPS) to avoid cultural differences in emotion processing (Bai, Ma, Huang, & Luo, 2005). Pictures in the CAPS are defined by valence (1–9 means extremely negative to extremely positive) and arousal (1–9 means no arousal to extreme arousal). In accordance with a previous research (Campbell-Sills et al., 2011), images rated 2–3.5 on valence and 5–7 on arousal were considered for inclusion. In total, thirty pictures were selected for the cognitive reappraisal task, and ten images for a preceding practice test. They covered a variety of contents, including human activities, animals and natural scenes. Thirty target pictures in the reappraisal task were randomly assigned to either reduce or maintain condition with equal amount. Pictures in the two conditions did not differ on valence ($t\,(28) = -1.10$, $p = 0.12$) or arousal ($t\,(28) = 0.94$, $p = 0.35$), and they contained equivalent portrayals of human activities, animals and natural scenes. Pictures and corresponding cues were arranged in a pseudorandom order, with the restriction that no more than 2 consecutive trials of the same type were presented. And their order of presentation was same to all the participants.

Before scanning, participants were asked to complete the State Trait Anxiety Inventory (Spielberger, 1983), Beck Depression Inventory (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961) and the Emotion Regulation Questionnaire (ERQ) (Gross & John, 2003). ERQ offered a measure of typical use of emotion regulation strategy (Gross & John, 2003). Then an experimenter trained them how to "reduce" and "maintain" their emotion as done in a previous report (see Campbell-Sills et al., 2011). For "reduce" trials, participants were taught to generate interpretations of the showing picture that would help reduce negative affect. For example, participants may feel sad when they were shown a picture of falling building, but they could re-interpret this emotion more positively by inferring that a more modern building would replace it. Thus, participants were taught that they could make positive interpretations about the showing picture or they could find positive parts or outcomes of the picture. It was also suggested that they could try to look at the picture in a "detached" or "distant" way (i.e., third-person). In the "maintain" trials, participants were told to "notice what you are feeling without changing it" and to "maintain your emotional responses to the picture until it disappears" when they looked at the picture. For example, with the picture of falling building, participants may think, "it looks like a bomb exploded in the building and people may die in it". After a break, subjects completed the reappraisal task during scanning.

2.3. MRI data acquisition

Functional images were obtained from a 3.0-T Siemens Trio MRI scanner (Siemens Medical, Erlangen, Germany). Images were acquired with the following parameters of the gradient-echo echo planar imaging (EPI) sequences: slices = 32, repetition time (TR)/echo time (TE) = 2000/30 ms, thickness/slice gap = 3/4 mm, flip angle = 90°, field of view (FOV) = 220 mm × 220 mm.

2.4. Image processing and analysis

Functional image data was preprocessed with the data processing assistant for resting state (DPARSF) software (http://www.restfmri.net/forum/DPARSF) (Yan & Zang, 2010). The toolbox worked on SPM8 software package (Wellcome Trust Center for Neuroimaging, London, England). Images were preprocessed including slice timing, head motion correction, spatial normalization and smoothing with a 6-mm full-width-at-half-maximum Gaussian kernel.

For statistical analysis, we performed the general linear model in SPM8 as an event-related design; and the onset of each condition was modeled and convolved with the canonical hemodynamic response function. Then the effect size was estimated for each of the three conditions (reduce, maintain and rest). Also, realignment parameters were included as regressors of no interest to account for variances related to movement. According to a previous report (Campbell-Sills et al., 2011), three contrast images were acquired for each subject (reduce vs. rest; maintain vs. rest; reduce vs. maintain) corresponding to the three conditions of interest. Finally, one-sample T-tests were specified for each condition, thresholded at $p = 0.05$ using false discovery rate (FDR) approach with a cluster extent more than five voxels.

We conducted another random-effects analysis to investigate the relationship between individual difference in suppression and brain activation during cognitive reappraisal. The ERQ suppression scores were entered into a regression analysis examining the contrast between reduce and maintain negative affect, with gender, trait anxiety, depression and reappraisal as regressors of no interest. Whole brain regression analysis employed a significance threshold of $p < 0.05$, FDR corrected with a five voxel extent threshold. Also, the beta value of significant clusters were extracted and correlated to self-report negative affect during cognitive reappraisal with MarsBaR toolbox (http://www.sourceforge.