

NEURAL CIRCUITS ASSOCIATED WITH POSITIVE AND NEGATIVE SELF-APPRAISAL

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Abstract—Self-worth is particularly influenced by self-appraisal, which is negatively biased in many psychiatric disorders. Positive and negative self-appraisals also shape current emotional states or even evoke defensive reactions, when they are incongruent with a subject's current state. Prior studies have mainly used externally given evaluative appraisals. In this study, 30 subjects used individual negative and positive self-appraisals during functional magnetic resonance imaging. We additionally investigated the effects of such self-appraisals onto the subsequent perception of photos of the individual subjects. Both self-appraisal conditions activated dorsomedial and dorsolateral prefrontal cortex compared to the neutral condition. Positive self-appraisal evoked stronger activity than negative self-appraisal in the amygdala, ventral striatum and anterior cingulate cortex, whereas negative self-appraisal was associated with increased activity in the occipital regions. Positive self-appraisal had no effect on the perception of a photo of oneself, whereas negative appraisal increased activity in the anterior insula and parietal regions. Overall, positive self-appraisal activated more emotion-related brain regions, whereas negative self-appraisal had a relatively stronger influence on perception-related brain activity. These findings could on the one hand explain the effect of negative self-appraisal on the behavior in the real world and on the other hand support a stronger focus of

psychotherapy on enhancing positive self-appraisals. © 2014 IBRO. Published by Elsevier Ltd. All rights reserved.

Key words: self-reference, self-worth, emotion, fMRI, amygdala, insula.

INTRODUCTION

Self-worth or state self-esteem is supposed to be an important aspect of health and well-being. According to the top-down theory of self-worth or state self-esteem (Brown et al., 2001; Brown and Marshall, 2006), self-worth is particularly influenced by self-evaluative emotional and cognitive reactions (Brown and Mankowski, 1993; Brown and Dutton, 1995; Brown et al., 2001). In contrast, trait or global self-esteem is seen as a stable view of oneself in general, which develops early in life (Brown et al., 2001). Modulations of self-worth provoke emotional and motivational responses (Leary, 1999; Crocker and Park, 2004), as it is a fundamental aspect of human nature to feel good about oneself (James, 1890, cited in Leary, 1999).

Self-appraisals and self-validations influence state self-esteem and shape the actual emotional state and vice versa (Beck, 1976; Crocker and Park, 2004; Wood et al., 2009): When I am confident in myself, I feel good; if not, I feel bad. These affective reactions to self-appraisals and self-worth manipulations further influence one's perception, experience and memory of general events (recent studies: e.g. Bouhuys et al., 1995; Coupland et al., 2004; Lupyan and Swingley, 2012; review: Mathews and MacLeod, 1994) as well as performance and motivation (Rosin and Nelson, 1983; Senay et al., 2010). Typical examples of positive and negative self-appraisals are inner speech phrases such as 'I am a looser' or 'I am competent'.

In mental disorders, self-esteem is reduced in general (e.g. Silverstone and Salsali, 2003), but the distinction between trait- and state-effects in vulnerability and remission is not yet totally clear (Butler et al., 1994). In hypomanic states, views of the self are typically inflated, whereas depression is characterized by a negative perspective on the self (Beck, 1967; Beck and Dozois, 2011). In major depressive disorder and in social anxiety disorder, negative self-evaluations are particularly prominent (Beck, 1976; Cox et al., 2000; Michalak et al., 2011).

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Abbreviations: ACC, anterior cingulate cortex; ANOVA, analysis of variance; DLPFC, dorsolateral prefrontal cortex; DMPFC, dorsomedial prefrontal cortex; EPI, Echo-planar imaging; fMRI, functional magnetic resonance imaging; MPFC, medial prefrontal cortex; ng, negative; nt, neutral; PCC, posterior cingulate cortex; pre-SMA, pre-supplementary motor area; ps, positive; ROIs, regions of interest; sap, self-appraisal; SDS, Self-Rating Depression Scale; STAI, State-Trait Anxiety-Inventory; TE, echo time; TR, repetition time; VLPFC, ventrolateral prefrontal cortex.

From a theoretical perspective, the self is a multidimensional phenomenon (Neisser, 1997; Gallagher, 2000; Damasio, 2003) with at least two different concepts, one referring to the self as experiencing subject (first person perspective), the other to the self as an object of reflections and evaluations (third person perspective, Legrand, 2003). Compared to the first person perspective, the third person perspective has been projected rather onto dorsally located cortical midline structures (Vogelely et al., 2004; Esslen et al., 2008). In general, tasks addressing self-esteem involve a strong verbal-reflective and third person perspective (e.g. I am capable of ...), paralleled by according neural findings (e.g. Fossati et al., 2003; Frewen et al., 2013).

Brain regions typically activated in self-referential tasks comprise cortical midline structures such as dorso- and ventromedial prefrontal cortex and the pre-supplementary motor area (pre-SMA), the anterior and posterior cingulate cortex (ACC, PCC), and medial parietal regions (e.g. Fossati et al., 2003; Somerville et al., 2010, meta-analysis: Northoff et al., 2006). These midline structures are strongly associated with self-reference, but are also activated in for instance emotion regulation (e.g. Diekhof et al., 2011). Furthermore, different self-referential tasks detected activations in ventral and dorsal lateral prefrontal regions (Moran et al., 2006; D'Argembeau et al., 2012), insula (Fossati et al., 2003; D'Argembeau et al., 2012) and, when emotional valence was included, in the amygdala (Frewen et al., 2013). The insula has also been linked to interoceptive self-awareness (Simmons et al., 2013).

The so-called sociometer hypothesis is another, partly conflicting theory on state self-esteem or self-worth (Leary, 1999). This hypothesis emphasizes the importance of acceptance or rejection by others and the striving to be accepted by the social environment (Leary, 1999). A number of studies have shown that social exclusion or rejection activated brain regions such as dorsal anterior cingulate cortex (ACC) and anterior insular cortex, which are known to be associated with distress and even physical pain (e.g. Eisenberger et al., 2003; Pan et al., 2009; Somerville et al., 2010). Activation in dorsal ACC was in other studies correlated with trait rejection sensitivity (Burklund et al., 2007) and greater self-reported social distress (Eisenberger et al., 2007).

However, investigations on the effect of evaluations by others on self-esteem have shown that, depending on current self-esteem, incongruent evaluations can rather provoke defensive reactions than influence feelings of self-worth (e.g. Brown, 2010). Self-evaluations, however, play a major role in changes of feelings of self-worth (e.g. Steele, 1988; Dutton and Brown, 1997).

The current study aimed therefore, and because of the clinical relevance of self-appraisal, at investigating (a) the neural correlates of short negative and positive self-appraisals/evaluations, which are short manipulations of self-worth, and (b) the effects of these self-appraisals on the neural correlates of the perception of photos of oneself. The short self-evaluations used here are more common in day-to-day mental self-talk than the typically longer mood induction procedures such as the Velten

mood induction procedure (Velten, 1968) in self-esteem research (e.g. Brown and Mankowski, 1993).

In this study we investigated the neurobiological background of self-appraisals. Understanding the neural mechanisms may serve to better understand the mechanisms of the application of self-appraisal as a self-regulating or psychotherapeutic technique as proposed by positive psychology (Seligman et al., 2006; Sin and Lyubomirsky, 2009), and it may provide a method to investigate the respective pathophysiological circuits in heightened or depressed moods.

In this study, participants were instructed to make themselves aware of own positive and negative aspects and to tell themselves individual self-talk sentences such as “I am good (at...)”, “I will manage XX” or “I am a loser”, “I will never manage YY” (the sentences were not revealed to the experimenters). These self-appraisal conditions were each followed by photographs of the participants to investigate the influence of self-appraisal and respective self-worth manipulations on the perception of these pictures.

We expected the self-appraisal to trigger valence-congruent affective reactions and to influence the perception of photos of oneself accordingly, i.e. after boosting self-worth a more positive view of oneself than after challenging and perhaps diminishing self-worth. On the neurobiological level, we hypothesized brain regions activated, which are associated

- (a) with self-reference (particularly third person perspective self-reference), such as dorsomedial prefrontal cortex (DMPFC, Northoff and Bermpohl, 2004; Herwig et al., 2010b, 2012),
- (b) with evaluation/appraisal, such as dorsolateral prefrontal cortex (DLPFC, e.g. MacDonald et al., 2000; Longe et al., 2010), and ACC (Carter and van Veen, 2007), as well as
- (c) with emotion processing, such as the amygdala (Baxter and Murray, 2002; Pessoa and Adolphs, 2010), insula (Craig, 2009; Paulus and Stein, 2010) and ventral striatum (McClure et al., 2004).

In these regions and additionally in the whole-brain, the effects of self-appraisal itself and on the subsequent perception of photos of the participant were analyzed.

EXPERIMENTAL PROCEDURES

Participants

Thirty healthy subjects (age between 20 and 50 years, mean 32 years; 19 females, all consistently right-handed according to a handedness questionnaire (Annett, 1970), mainly students of psychology or medicine or health care professionals) were included in this study. As assessed with semi-structured interviews according to DSM-IV and checklists performed by an experienced psychiatrist (ABB), the exclusion criteria comprised prior and current neurological or psychiatric illnesses, pregnancy, intake of medication or psychotropic substances including the excessive consumption of alcohol, cigarettes and caffeine, and general contraindications related to

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