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Relations among EEG-alpha asymmetry and positivity personality trait

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ABSTRACT

The present study investigates cortical structures associated with personality dimension of positivity (POS) by using a standardized low-resolution brain electromagnetic tomography (sLORETA), which provides EEG localization measures that are independent of the recording reference. Resting EEG and self-report measures of positivity, self-esteem, life satisfaction, and optimism were collected from 51 female undergraduates. EEG was recorded across 29 scalp sites. Anterior and posterior source alpha asymmetries of cortical activation were obtained by using sLORETA. Based on previous research findings, 10 frontal and 6 parietal regions of interest (ROI) were derived. Alpha asymmetry in the posterior cingulate (i.e., BA23 and BA31) was uniquely associated with both POS scores. These areas are, hypothetically, part of a complex default-mode neural network (DMN). The activity in the DMN usually increases during tasks that invoke self-referential processing, such as responding to statements describing one's personality, attitudes, or preferences. Importantly, the cortical structures associated with POS were different from those associated with indicators. Indeed, measures of "optimism" failed to maintain a significant correlation with any of the previously significant ROI, but "self-esteem" and "life satisfaction" revealed robust associations with alpha asymmetry at the precuneus (i.e., BA7), after controlling for POS residual scores. In conclusion: Present findings support the assumption that POS is a basic disposition that reflects the concerted activity of brain structures that are essential for integrating self-referential thought and autobiographical memories and for assigning a positive valence to one's experience and attitude toward the future.

1. Introduction

Interest in the positive features of individual functioning has gained attention over recent decades due primarily to the contributions of the positive psychology movement (Seligman & Csikszentmihalyi, 2000). This movement has generated a call for strongly committed scholars and practitioners to identify major determinants and proper indicators of optimal functioning. In this regard, several authors at different times have pointed to variations in individual tendencies to approach experiences with a positive outlook. Scheier and Carver (1993) suggested that positive thinking is at the core of individuals' confidence in their future. Kozma, Stine, and Stones (2000) described positivity as a general dispositional determinant of subjective well-being (SWB), which operates much like a trait and may account for variation and stability in individuals' happiness despite environmental change. Diener, Napa-Scollon, Oishi, Dzokoto, Suh (2000) referred to positivity as a propensity to evaluate aspects of life in general as good.

Previous findings from cross-cultural and twin studies led Caprara, Steca, Alessandri, Abela, and McWhinnie (2010) to identify a common latent factor underlying self-esteem, life satisfaction, and optimism, that was finally named positivity (POS; Alessandri, Caprara, & Tisak, 2012a, 2012b; Caprara, Alessandri, & Barbaranelli, 2010; Caprara, Alessandri, Trommsdorf, et al., 2010; Caprara, Steca, et al., 2010; Caprara et al., 2009). Whereas self-esteem, life satisfaction, and optimism were traceable to the same latent construct across a variety of groups that differed in age, language, and culture, other models relating constructs, such as general self-efficacy, extraversion, and resiliency showed worse fit (Caprara et al., 2012). Longitudinal findings have shown that life experience viewed with a positive outlook attests to a self-evaluative basic trait, which is part of the common core of self-esteem, life satisfaction, and optimism. When estimated, heritability accounted for at least 55% of POS variance, whereas unshared environment accounted for the remainder (Caprara, Steca, et al., 2010; Fagnani, Medda, Stazi, Caprara, & Alessandri, 2014).

Reasonably, positivity has a fundamental biological function because people cannot face the experience of aging and death or cope with adversities and losses in life, unless equipped with the basic belief that they are worthy of regard, that life is worth living,

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and that the future is promising (Caprara et al., 2009). Likewise individual differences in positivity may play a pivotal role in granting the best match between conservative and aversive tendencies in the service of adaptation (Caprara et al., 2012). Whereas the lack of positivity makes people vulnerable to depression, excessive positivity may include overconfidence that leads to especially risky behavior. Moderate to moderately high positivity, however, is beneficial to well-being as it helps to draw the best from one's potential and from situational opportunities (see Caprara, Alessandri, Trommsdorff, et al., 2010; Caprara, Steca, et al., 2010; Caprara et al., 2012).

A direct measure of positivity that is highly correlated with the statistically derived, indirect measure of positive orientation is a questionnaire used in prior work, which has been recently made available and appears to be valid across different cultures and languages (i.e., Germany, Italy, Japan, Poland, Serbia, Spain, and U.S.; see Caprara et al., 2012; Heikamp et al., 2014). Caprara et al. (2012) showed how POS contributes to chronic positive affect over the course of development. Alessandri et al. (2012a, 2012b) found that POS predicted work performance, psychological well-being, and health with little residual variance accounted for by self-esteem, life satisfaction, and optimism. Thus, POS appears to play a primary role in predisposing individuals to experiences and habits that promote happiness and foster success. Despite the biological function of POS and twin studies attesting to its strong genetic basis, no published reports have directly explored cortical functioning associated with POS.

Viewing POS as a trait that makes people more favorably inclined toward life and novel experiences may make one wonder whether there is a significant positive association between higher levels of POS and greater left-sided, frontal, cortical activation, as expressed by frontal alpha asymmetry, given the association between left lateralization and approach tendencies (see e.g., De Pascalis, Variale, & D'Antuono, 2010).

Indeed, a vast EEG literature has implicated asymmetric activation of the prefrontal cortex (PFC) in the major phenotypic expressions of POS. De Raedt, Franck, Fannes, and Verstraeten (2008) reported a significant positive association between higher relative left versus right frontal brain activity and self-esteem. De Pascalis, Cozzuto, Caprara, and Alessandri (2013) reported an association between higher activation of the left superior frontal gyrus (BA10) and of the right posterior cingulate cortex (BA31) and optimism.

Urry et al. (2004) reported an association between greater left frontal brain activity and life satisfaction. However, the extent to which POS is pervasively associated to the brain structures that have also been associated with self-esteem, optimism, and life satisfaction and the extent to which certain structures are distinctive or specific to each of them is an area worth investigating.

Other findings have also been reported by the functional neuroimaging (fMRI) studies carried out Somerville, Kelley, and Heatherton (2010) and Sharot, Korn, and Dolan (2011). Somerville et al. (2010) reported a detailed association between self-esteem and the activation of anterior regions of the cortex. Sharot et al. (2011) found that individuals who scored high and low on trait optimism had the left inferior frontal gyrus highly activated when presented with good news, while highly optimistic individuals had reduced tracking of estimation errors that called for negative updates to the right inferior prefrontal gyrus. These findings indicate that optimism is tied to selective update failure and diminished neural coding of undesirable information regarding the future. Interestingly, more recent findings of this research group demonstrated that optimistic bias can be temporarily reduced after suppression of the function of the left (but not right) inferior frontal gyrus by means of transcranial magnetic stimulation, since this treatment enhances participants' ability to incorporate unfavorable information into beliefs about vulnerability (Sharot et al., 2012).

Accordingly, the overall aim of the present study is to clarify the neural structures associated specifically with POS. The lack of data on the neural underpinning of POS represent a gap in current literature, which has mainly focused on its assessment, its correlates, or its developmental trajectories. Thus, in this study, we used a standardized low-resolution brain electromagnetic tomography (sLORETA) to unravel the brain areas that originate the EEG activity associated with POS. Based on the reasoning expounded upon above, we hypothesized there would be a significant association of POS with the activation of the left-frontal lobe. Given previous studies that regarded the possibility to empirically distinguish the correlates of POS from those of its first-order indicators (i.e., self-esteem, life satisfaction, and optimism), in this study, we further investigated (1) the zero-order association of self-esteem, life satisfaction, and optimism with EEG asymmetry and, most important for our purposes, (2) the residual association of these with EEG asymmetry when partialized with POS. With regard to the first point, we expect to replicate previous results attesting to significant associations of self-esteem and optimism with anterior regions of the cortex. With respect to the second point, we expect to show that, after controlling for POS, measures of self-esteem, life satisfaction, and optimism (which represent their common core, see Alessandri et al., 2012a) will no longer be correlated with any ROI with which POS is correlated.

2. Methods

2.1. Participants and procedure

The sample consisted of 51 right-handed, healthy, women psychology students (age range of 20–34 years, $M = 24.1$, $SD = 3.7$) who were recruited through advertisements. Since recent studies have demonstrated a specific gender difference in oscillatory activity during cognitive tasks (Kamarajan et al., 2008), only women were invited to participate in the study. We excluded individuals with hearing or visual impairment, severe medical conditions that might interfere with vigilance and task performance, neurological and psychiatric illnesses, and drug or alcohol dependence. Subjects were rescheduled if they were on their menstrual cycle or were on any medication that could interfere with EEG recording. All participants were required to avoid the use of caffeine, tobacco, or alcohol on the morning of their test. Before beginning the EEG recordings, participants signed informed consent forms. Experimental procedures and ethical guidelines were in accordance with approval from the institution's local ethics committee.

At the beginning of the session, each participant was seated in an electrically-shielded EEG booth and electrodes were applied to measure EOG and EEG. Eight 1-min intervals of EEG were recorded. Participants were instructed to keep their eyes open for four 1-min intervals and closed for four 1-min intervals, in an order that was counterbalanced across participants. They were instructed to remain quiet and to inhibit blinks or eye movements during each recording period. During the eyes open condition, participants had to fixate on a white cross displayed in the center of a computer monitor that was 1.2 m distant from their head. Resting EEG data are derived from a previous study on EEG-alpha asymmetry and personality published elsewhere (De Pascalis et al., 2013).

2.2. Instruments

2.2.1. Self-esteem ($\alpha = .84$)

Participants' self-esteem was assessed using 10 items from the Rosenberg (1965) General Self-esteem Scale. In general, this scale