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Research report

Virtual lesions of the inferior parietal cortex induce fast changes of implicit religiousness/spirituality

Cristiano Crescentini [a,b,*], Salvatore M. Aglioti [b,c], Franco Fabbro [a] and Cosimo Urgesi [a,*]

[a] Department of Human Sciences, University of Udine, Udine, Italy
[b] Department of Psychology, University of Rome "La Sapienza", Rome, Italy
[c] Scientific Institute IRCCS Santa Lucia Foundation, Rome, Italy

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ABSTRACT

Religiousness and spirituality (RS) are two ubiquitous aspects of human experience typically considered impervious to scientific investigation. Nevertheless, associations between RS and frontoparietal neural activity have been recently reported. However, much less is known about whether such activity is causally involved in modulating RS or just epiphenomenal to them. Here we combined two-pulse (10 Hz) Transcranial Magnetic Stimulation (TMS) with a novel, ad-hoc developed RS-related, Implicit Association Test (IAT) to investigate whether implicit RS representations, although supposedly rather stable, can be rapidly modified by a virtual lesion of inferior parietal lobe (IPL) and dorsolateral prefrontal cortex (DLPFC). A self-esteem (SE) IAT, focused on self-concepts nonrelated to RS representations, was developed as control. A specific increase of RS followed inhibition of IPL demonstrating its causative role in inducing fast plastic changes of religiousness/spirituality. In contrast, DLPFC inhibition had more widespread effects probably reflecting a general role in the acquisition or maintenance of task-rules or in controlling the expression of self-related representations not specific to RS.

1. Introduction

Religiousness and spirituality (RS) are complex multidimensional constructs including the subjective feelings, beliefs, and behaviors that reflect the ultimate concerns of people in relation to unseen realities/supernatural agents (Emmons & Paloutzian, 2003; Kapuscinski & Masters, 2010). Religiousness- and spirituality-related constructs are at least partially overlapping, with the former defined as more related to institutions and faith traditions and the latter as more subjective and experience-based, having more to do with one's personal relationships to transcendent realities, whatever this means for each individual subject (Emmons & Paloutzian, 2003; James, 2008; Piedmont, Ciarrochi, Dy-Liacco, & Williams, 2009; Wink & Dillon, 2003; Wuthnow, 1998; Zinnbauer & Pargament, 2005). Although spirituality and religiousness have been sometimes conceptualized separately in sociological studies (e.g., Fuller, 2001), it is known that most people describe themselves as both religious and spiritual so that

* *Corresponding authors*. Department of Human Sciences, University of Udine, Via Margreth, 3, 33100 Udine, Italy.
E-mail addresses: cristiano.crescentini@uniud.it, cristianocresce@hotmail.com (C. Crescentini), cosimo.urgesi@uniud.it (C. Urgesi).
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spirituality is viewed as a core function of religion (Emmons & Paloutzian, 2003; Zinnbauer & Pargament, 2005). Since it may be hard to evaluate separately religiousness and spirituality (hereinafter RS) at the subjective level (Emmons & Paloutzian, 2003; Zinnbauer & Pargament, 2005), and in keeping with previous reports (LaBouff, Rowatt, Johnson, Thedford, & Tsang, 2010), we consider RS as a single construct relative to non-RS.

While RS has attracted much interest at the very beginning of scientific psychology (James, 2008), only recently has RS become relevant for cognitive and affective neuroscience (e.g., Boyer, 2003; Cahn & Polich, 2006; Fingelkurts & Fingelkurts, 2009). Recent research in the cognitive neuroscience of the three major components of RS, i.e., beliefs, practices, and experiences regarding supernatural agents, is beginning to show that RS beliefs and concepts may manifest as a by-product of ordinary mental faculties (and neural systems). Such mental faculties relate to things like intentional agency and animacy, moral intuitions, social exchange, natural hazard, and understanding of human misfortune (Boyer, 2003; Harris et al., 2009; Schjoedt, Stødkilde-Jørgensen, Geertz, & Roepstorff, 2009; Seitz & Angel, 2012; see also Kapogiannis, Barbey, Su, Krueger, & Grafman, 2009; Kapogiannis, Barbey, Su, Zamboni, et al., 2009).

In a similar vein, the increasing number of studies concerning the basic cognitive representation of the body and the self (Berlucchi & Aglioti, 1997, 2010) parallel research on the association between RS and the boundaries between the representation of the world and of the self in transcendent contexts (Fuller, 2008; Previc, 2006). It has been argued, for example, that RS practices and experiences may involve the tendency of projecting the self into mental dimensions that transcend sensorimotor bodily contingencies (Paloutzian & Park, 2005). RS-related changes in self-awareness could thus lead to feelings of weak self-other boundaries and strong connections of the self with supernatural agents, universe, and other individuals at large (Cahn & Polich, 2006; Newberg & Iversen, 2003; Paloutzian & Park, 2005).

Neuroimaging studies in people expert in different forms of RS practices and experiences such as meditation and prayer have shown that a large cortical network is involved in RS (Cahn & Polich, 2006; Fingelkurts & Fingelkurts, 2009). For instance, activation of the dorsolateral prefrontal cortex (DLPFC) is associated with increased RS experiences, possibly reflecting the effortful intentional activity involved in most meditative practices (Lutz, Slagter, Dunne, & Davidson, 2008; Newberg & Iversen, 2003). By contrast, decreased activation of the parietal lobe is associated with increased RS experiences (Newberg et al., 2001, 2003), probably reflecting an altered sense of awareness of the self in space.

Although very valuable, fMRI studies of RS cannot generally distinguish whether changes of brain activity during RS practices and experiences are causally involved or just epiphenomenal to them. Crucially, however, only a few studies in brain damaged patients (i.e., cranial trauma or surgical ablation) (Johnstone, Bodling, Cohen, Christ, & Wegrzyn, 2012; Johnstone & Glass, 2008; Urgesi, Aglioti, Skrap, & Fabbro, 2010) have so far addressed the issue of the causal influence of specific neural structures on supposedly stable RS-related feelings and beliefs, as indexed by the self-report index of core spiritual experiences (INSPIRIT; Kass, Friedman, Lesserman, Zuttermeister, & Benson, 1991) or the Temperament and Character Inventory (TCI; Cloninger, Przybeck, Svrakic, & Wetzel, 1994) questionnaires. For instance, in one of these studies it was demonstrated that surgical ablation of the inferior parietal lobe (IPL) brought about an increase in patients' RS transcendental feelings and beliefs (Urgesi et al., 2010). However, it should be noted that RS changes occurred in this previous study after very invasive manipulations in brain tumor-patients. What remains to be determined is thus whether similar effects can be found in healthy subjects undergoing targeted non-invasive procedures for reversibly interfering with neural activity in specific regions.

Moreover, it is relevant here that meditation, prayer, and self-report questionnaires have been the primary types of RS beliefs, practices and experiences considered by scholars when trying to delineate the neurocognitive bases of RS. Unfortunately, self-report explicit measures are susceptible to desirable responding and clearly subjective in nature (LaBouff et al., 2010; Schwarz, 1999).

In the present research, we combined interferential Transcranial Magnetic Stimulation (TMS) with an implicit measure of RS, in order to assess in healthy adults the causal role of specific brain regions (IPL and DLPFC) in determining short-term functional reorganization and plasticity of self-referential RS representations. With the aim of providing an objective measure of RS, we designed a novel RS Implicit Association Test (IAT; Greenwald, McGhee, & Schwanz, 1998) which capitalized on the only existing previous RS-IAT (LaBouff et al., 2010), with respect to which the variety of the stimuli employed was increased and the psycholinguistic features of the stimuli further characterized. The IAT is one of the most frequently used implicit tests to measure the strength of automatic concept-attribute associations, that may underlie specific aspects of personality (Greenwald & Farnham, 2000; Schnabel, Asendorpf, & Greenwald, 2008), including RS (LaBouff et al., 2010). Through performance in an IAT measure people's implicit attitudes can be inferred indirectly; relative to self-report questionnaires and scales used to directly measure explicit attitudes, implicit tests such as the IAT are indeed more difficult to control or to fake and do not require self-reflection or the intent to self-evaluate on the part of the respondent (Greenwald & Farnham, 2000; Greenwald et al., 1998). The main assumption of the IAT is that strongly associated concept-attribute pairs are easier to classify together (i.e., by pressing the same response key) than are weakly associated pairs.

The use of an RS-IAT test allowed us to measure the strength of automatic concept–attribute associations between two distinct groups of target words (referring to the concept of self *vs* other) and words that were or were not related to RS dimensions (RS *vs* Non-RS). The association was tested in both congruent (self + religious–spiritual; other + non-religious–non-spiritual) and incongruent (self + non-religious–non-spiritual; other + religious–spiritual) conditions. An RS-IAT effect (better performance reflected in shorter response latency and/or higher rate of correct response in congruent than incongruent conditions) would mean that a person automatically perceives the self as more religious–spiritual than non-