Neural correlates of context-independent and context-dependent self-knowledge

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ABSTRACT

The self-concept consists of both a general (context-independent) self-representation and a set of context-dependent selves that represent personal attributes in particular contexts (e.g., as a student, as a daughter). To date, however, neuroimaging studies have focused on general self-representations, such that little is known about the neural correlates of context-dependent self-knowledge. The present study aimed at investigating this issue by examining the neural correlates of both kinds of self-knowledge. Participants judged the extent to which trait adjectives described their own personality or the personality of a close friend, either in a specific context (i.e., as a student) or in general. We found that both kinds of self-judgments were associated with common activation in the medial prefrontal cortex (MPFC), as compared to judgments about others. Interestingly, however, there were also notable differences between self-judgments, with context-independent judgments being associated with higher activity in the MPFC, whereas context-dependent judgments were associated with greater activation in posterior brain regions (i.e., the posterior cingulate/retrosplenial cortex). These findings show that context-independent and context-dependent self-referential judgments recruit both common and distinct brain regions, thereby supporting the view that the self-concept is a multi-dimensional knowledge structure that includes a general self-representation and a set of context-specific selves.

1. Introduction

The notion of self is a complex, multi-dimensional construct that has been much discussed and investigated in philosophy, psychology and, more recently, neuroscience (Conway, 2005; Damasio, 1999; Gallagher, 2000; Klein & Gangi, 2010; Leary & Tangney, 2003; Neisser, 1988; Northoff & Bermpohl, 2004). One particular aspect of the self that has attracted growing theoretical and empirical attention is the self-concept or self-schema, which refers to the collection of representations that an individual has about his or her personal characteristics and attributes (Brewer, 1988; Markus, 1977; Renoult, Davidson, Palombo, Moscovitch, & Levine, 2012).

The self-concept is most frequently investigated using trait judgment paradigms in which participants are asked to decide whether a given trait describes their personality (e.g., Kelley et al., 2002; Rogers, Kuiper, & Kirker, 1977). Recent neuroimaging studies have shown that this kind of self-referential judgment activates cortical midline structures (CMS), including the medial prefrontal cortex (MPFC) and posteromedial cortices (for meta-analyses, see Araujo, Kaplan, & Damasio,

2013; Murray, Schaer, & Debbané, 2012; van der Meer, Costafreda, Aleman, & David, 2010; Van Overwalle, 2009). It remains unclear, however, whether these brain regions are specialized in self-related cognition or play a broader role in person knowledge (Wagner, Haxby, & Heatherton, 2012; Welborn & Lieberman, 2015). Furthermore, the role of CMS in representing different facets of the self-concept remains to be investigated in detail.

The self-concept is both stable, in the sense that diverse self-aspects are integrated in a coherent long-term representation, and variable, in the sense that self-representations can vary across time and contexts (Baumeister, 2011; Markus & Wurf, 1987; McConnell, Shoda, & Skulborstad, 2012; Prebble, Addis, & Tippett, 2013). To account for this unity and multiplicity of self-views, it has been suggested that the self-concept consists of both a general self-representation and a set of context-dependent selves (Schell, Klein, & Babey, 1996). This view holds that self-knowledge is organized in memory in a hierarchical fashion: the top of the hierarchy includes a general (context-independent) representation of the self, which branches into more specific self-aspects that represent personal attributes in particular contexts

(e.g., as a student, as a daughter, when meeting new people, and so on). General self-knowledge consists of abstract summary representations of one's personal attributes that have emerged, but are represented independently, from past experiences in multiple contexts (Klein & Lax, 2010; Schell et al., 1996). By contrast, context-dependent self-views are more specific representations of one's personal attributes that serve to guide one's behavior in particular contexts (McConnell, 2011). These self-representations are thus more likely to include knowledge of specific behaviors one has performed in particular settings (Schell et al., 1996), although they typically describe attributes (e.g., traits) that have been derived from multiple personal experiences in a given context (e.g., "As a student, I am conscientious"; McConnell, 2011). While behavioral data provides support for this hierarchical model of self-knowledge (Schell et al., 1996), little is known about the neural correlates of context-dependent self-knowledge.

A recent meta-analysis by Martinelli, Sperduti, and Piolino (2013) has revealed that the retrieval of self-knowledge is associated with a shift from posterior to anterior structures with increasing abstraction of self-representations. More specifically, these authors found that abstract self-representations (i.e., trait self-knowledge and semantic knowledge of facts about one's life) mainly recruited medial prefrontal structures, whereas memories for specific past experiences were associated with additional activations in posterior regions (including the medial temporal lobes). According to the authors, this may be due to the involvement of posterior regions in recollection processes, whereas medial prefrontal regions are involved in self-referential assessment (Martinelli et al., 2013).

Previous neuroimaging studies thus suggest that abstract self-knowledge and memories for specific experiences are associated with different patterns of activation along anterior/posterior brain structures. It remains unknown, however, whether different levels of abstraction within the self-concept (i.e., general versus context-specific self-knowledge) are associated with a similar shift in the recruitment of anterior and posterior structures. One possibility is that context-dependent self-knowledge relies on specific event representations (e.g., memories of one's behavior in specific situations) to a greater extent than context-independent self-knowledge (Schell et al., 1996), thus recruiting posterior brain regions involved in episodic memory retrieval. Another possibility would be that both kinds of self-knowledge rely on an abstract knowledge base that is independent of memories for specific past events. On this latter view, context-independent and context-dependent self-knowledge would both depend on semantic memory representations (i.e., context-dependent self-knowledge would involve descriptive attributes that have been abstracted from a number of specific episodes within a given context; McConnell, 2011), and thus should not recruit posterior structures involved in episodic remembering.

To test these hypotheses, we conducted an fMRI study in which participants were instructed to reflect on their own traits and those of a close friend, either in general or in a specific context; a control condition, in which participants judged the valence of traits, was also included. This allowed us (1) to identify brain regions that are activated by each of the four trait judgment conditions compared to the control condition; (2) to determine what brain regions are involved in making self- versus other-referential judgments in general and in a specific context; and (3) to investigate whether context-independent and context-dependent self-judgments are associated with differential brain activation, notably in posterior structures supporting episodic memory.

2. Material and methods

2.1. Participants

Data were acquired from 20 right-handed French-speaking young adults (12 women; mean age = 22 years, SD = 2, range: 19 to 26 years) who were all students at the University of Liège. Five additional participants were excluded from the analysis due to excessive motion in the scanner (two participants), a very low correlation (i.e., < 0.40; two participants) between trait descriptiveness ratings obtained during the scanning and post-scan sessions (suggesting that their judgments were not reliable; all other participants had correlations > 0.60), or felt dizzy in the scanner (one participant). Prior to their inclusion, written informed consent was obtained from all the participants enrolled in the study. None of them had any history of neurological or psychological disorder. This study was approved by the Ethics Committee of the Faculty of Medicine of the University of Liège.

2.2. Tasks and procedure

Before the experiment, participants were asked to identify someone they personally know well (a close friend) and whom they see at the university. This person was used when it was requested to judge personality traits in reference to a close friend during the scanning session.

In the scanning session, participants were instructed to make different types of judgments on a series of adjectives describing personality traits. First, as in previous studies about the neural correlates of trait self-knowledge, participants made some general self-referential judgments. In this condition, they were asked to evaluate the extent to which each presented trait describes their personality in general, that is, their usual way of being, thinking and behaving, independently of the specific context or situation in which they find themselves (e.g., "In general, I am courageous"). Similar general judgments were also made in reference to their friend (e.g., "In general, Sarah is courageous"). Second, participants made a series of context-specific self- and other-referential judgments. Given that all participants were university students, the context of the university was considered as an ideal and well-defined setting for making context-specific judgments. Accordingly, for context-specific self-referential judgments, participants were required to evaluate the extent to which each presented trait describes them at the university, that is, their way of being, thinking and behaving in the specific context of the university (e.g., "At the university, I am courageous"). Similar context-specific judgments were also made in reference to their friend (e.g., "At the university, Sarah is courageous"). Finally, a control condition was included in which participants were invited to judge to what extent each adjective referred to a positive trait. This control condition required to process the semantic meaning of the stimuli without reflecting on the psychological characteristics of a particular individual.

In all five conditions, the same set of 40 trait adjectives was used (20 positive and 20 negative traits selected from Anderson (1968), and translated into French; e.g., sincere, reliable, lazy). All trials were presented in a single session, using a block design (with 10 blocks per condition) and a different random order for the five conditions was generated for each participant. Each block started with a brief instruction screen informing participants about the type of judgment they had to make (1500 ms). Then, four adjectives were successively presented for 3500 ms each (with a variable inter-stimulus interval of 750–1250 ms). For each adjective, participants were required to make their judgment by pressing one of four buttons (1 = "not at all", 2 = "a little", 3 = "quite well", 4 = "completely"). Between each block, a fixation cross appeared on the screen for a variable duration between 1000 and 3000 ms. Before the scanning session, participants performed practice trials (with different traits) in order to become familiar with the task.

Immediately following the scanning session, participants completed a series of post-scan judgments on a computer in a quiet room. The same trait adjectives were presented and, for each trait, participants were asked to perform the same descriptiveness judgments as in the scanning session (i.e., they were required to evaluate the extent to which each presented trait describes themselves or their close friend, in the context of the university or in general). In addition, they were asked to perform two other kinds of judgments: first, they rated the difficulty