

Chapter 1

A Cognitive Neuroscience Approach to Self and Mental Health

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ABSTRACT

Elucidating the neural mechanisms underlying cognitive processes related to self has been a promising approach to enhancing the scientific knowledge of mental health and mental disorders. However, relevant data from functional neuroimaging studies have not yet converged. The multi-layered model of self-processing proposed here reconciles these seemingly controversial findings by assuming there are three layers of self, including the physical self, interpersonal relationships, and social value. A schema that associates the representations of output and feedback in different cortical networks was conceptualized for each layer of self. The concepts of self-related cognition and mental disorders may be reconstructed based on this three-layer structure. The brain regions that accommodate the proposed schema are assumed to respond during the detection of error relative to a prediction; consequently, this neural response may be used for diagnosis and evaluation of mental disorders and health.

INTRODUCTION

The cognitive construct of ‘self’ is related to our health in many ways. Different aspects of self-cognition are key manifestations of some mental disorders, such as the impaired self-other attribution of sensation, action, and thought in schizophrenia (Sass & Parnas, 2003), the impaired recognition of the mental state of self and others

in autism (Williams, 2010), excessive negative self-evaluation in social anxiety (Hirsch & Clark, 2004), and altered identity in dissociation or borderline personality disorders (Korzekwa, Dell, & Pain, 2009). Across the definitions of mental health, the concepts related to self-cognition, such as self-regulation, interpersonal relationships (i.e., between self and other), and self-actualization, are commonly used as key aspects (Vaillant, 2003). Empirical studies have provided evidence that the personality traits related to self and interper-

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sonal relationships affect stress-coping abilities (Folkman, Lazarus, Gruen, & DeLongis, 1986), resilience against adversity (Jacelon, 1997), health management behavior (Marks, Allegrante, & Lorig, 2005), and long-term health and social outcomes (Ayduk et al., 2000).

Despite its apparent importance, the study of self-cognition in mental health and disorders has been limited, likely due to the elusiveness of self-related cognitive concepts. For example, it is unclear if self-evaluation, self-esteem, and self-efficacy are different or similar concepts. In addition, how these concepts may be related to the physical self or identity remains unknown. A cognitive neuroscience approach to self-cognition, in terms of neural substrates and their objective measure based on neural activation, may provide new and less ambiguous answers.

BACKGROUND

There is some neuropsychological evidence for the neural underpinnings of self-processing. Several cases of brain-damaged patients have reported abnormal self-processing, such as the out-of-body experience (Blanke, Landis, Spinelli, & Seeck, 2004), an impaired self-attribution of one's own actions (Spence, 2002), and an impaired self-face recognition (Gallois, Ovelacq, Hautecoeur, & Dereux, 1988). In addition, an impaired visual self-recognition has been observed in patients with severe dementia (Breen, Caine, & Coltheart, 2001).

The cognitive neuroscience approach to self-cognition was initially driven by the assumption that the self is a unitary construct. Many evolutionary psychologists have noted visual self-recognition as the representation of a special social ability present only in socially evolved brains. The ability of self-recognition through a mirror-reflection has been demonstrated in a limited species of animals that have large brains relative to the size of their body (Gallup, 1982;

Marino, 2002; Shoshani, Kupsky, & Marchant, 2006). These animals show complex social behaviors that require empathy and perspective taking (Gallup, 1982; Marino, 2002; Plotnik, de Waal, & Reiss, 2006). In human infants, self-directed behavior in front of a mirror typically appears in the second year of life, and it coincides with the emergence of the empathic behavior (Gallup, 1982; Zahn-Waxler, Radke-Yarrow, Wagner, & Chapman, 1992).

THE COGNITIVE NEUROSCIENCE OF SELF

No Unique Brain Network is Dedicated to the Self

The concept of a unique self-processing-specific brain network has been suggested, yet remains unsupported, by cognitive neuroscience research. The issue of hemispheric dominance of the visual self-recognition process has not reached a consensus; in fact, some researchers argue for right-hemisphere dominance (Feinberg & Keenan, 2005; Keenan, Nelson, O'Connor, & Pascual-Leone, 2001), while others insist on the opposite (Brady, Campbell, & Flaherty, 2004; Turk et al., 2002). The detailed functional organization of visual self-recognition in the brain has been addressed using functional brain imaging techniques, but a neural structure dedicated to self-processing across different self-domains has not been identified. Specific activation of brain regions during recognition of the physical self, such as the face (Morita et al., 2008; Sugiura, Watanabe et al., 2005; Uddin, Kaplan, Molnar-Szakacs, Zaidel, & Iacoboni, 2005), body (Sugiura et al., 2006), and voice (Nakamura et al., 2001), typically consists of sensory-motor integration in the right lateral cortices (Figure 1a). When subjects are expected to be self-conscious of the attention of others (Jeong et al., 2011; Kampe, Frith, & Frith, 2003; Rilling, Sanfey, Aronson, Nystrom, & Cohen, 2004),

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