Consciousness and Cognition 20 (2011) 40–51

Contents lists available at ScienceDirect

Consciousness and Cognition

journal homepage: www.elsevier.com/locate/concog

The neural correlates of visual self-recognition ☆

Christel Devue [a,b,*], Serge Brédart [a]

[a] Centre des Neurosciences Cognitives et Comportementales, Université de Liège, Belgium
[b] Cognitive Psychology, Vrije Universiteit Amsterdam, Van der Boechorststraat 1, 1081 BT Amsterdam, The Netherlands

ARTICLE INFO

Article history:
Available online 28 September 2010

Keywords:
Self-recognition
Face perception
Self-awareness
Neural correlates

ABSTRACT

This paper presents a review of studies that were aimed at determining which brain regions are recruited during visual self-recognition, with a particular focus on self-face recognition. A complex bilateral network, involving frontal, parietal and occipital areas, appears to be associated with self-face recognition, with a particularly high implication of the right hemisphere. Results indicate that it remains difficult to determine which specific cognitive operation is reflected by each recruited brain area, in part due to the variability of used control stimuli and experimental tasks. A synthesis of the interpretations provided by previous studies is presented. The relevance of using self-recognition as an indicator of self-awareness is discussed. We argue that a major aim of future research in the field should be to identify more clearly the cognitive operations induced by the perception of the self-face, and search for dissociations between neural correlates and cognitive components.

1. Introduction

Our own face is an important component of our identity, besides other self-related information such as our own name, hometown, occupation, and preferences. However, contrary to other self-related information our face is a unique self-referential stimulus, presumably our most distinctive physical feature (Tsakiris, 2008). Indeed, our own face is a property that we do not share with other people (with the exception of twins), whereas it is quite common to share properties such as the occupation, the hometown or even the name with other people (Devue & Brédart, 2008). During the last 40 years, the ability of self-recognition in a mirror has been extensively investigated by researchers searching for signs of 'self-consciousness' or some sense of personal identity in infants and in animals (Amsterdam, 1972; Gallup, 1970; for a review see Keenan, Gallup, & Falk, 2003a). The face is often seen as the emblem of the self (McNeill, 1998), and Cole (1998) has described in his book 'About face' how life of people suffering from problems touching their own face (e.g., facial paralysis or disfigurement) is deeply affected. More recently, with the occurrence of face transplants procedures, psychologists started to consider the possible deleterious effects of such surgical procedures on the patients' sense of identity (Bluhm & Clendenin, 2009). A much more mundane but significant example of the importance of the face in defining a person is illustrated by the fact that since the propagation of photography, passports or driving licenses from all over the world contain an identity picture in addition to the owner's name.

Over the last 10 years, the interest towards visual self-recognition has grown among the neuroscientific community. One of the reasons is that a lot of researchers in that field have made the assumption that presenting people with stimuli depict-

☆ This article is part of a special issue of this journal on Brain and Self: Bridging the Gap

* Corresponding author. Address: Department of Cognitive Science, Université de Liège, Bd du Rectorat, 5 (Bât. B32), B-4000 Liège, Belgium. Fax: +32 (0)4 3662859.

E-mail address: cdevue@ulg.ac.be (C. Devue).

1053-8100/$ - see front matter
doi:10.1016/j.concog.2010.09.007

ing themselves is a clear and straightforward way to study the neural correlates of the self and of self-awareness. The present review addresses visual self-recognition and its neural correlates. More specifically, the issues of determining the hemispheric dominance of self-recognition (the lateralization issue) and determining which brain areas are consistently involved during self-recognition (the localization issue) will be examined here. Note that this topic is clearly much more restricted than ‘‘self-processing" in general. The important point of the relationship between visual self-recognition and self-awareness will be addressed in the discussion.

2. The lateralization of visual self-recognition

A number of studies compared reaction times for contralateral left or right hand use as a measure of hemispheric dominance of self-face recognition. People tend to respond faster to their own face than other familiar faces, either famous (Miyakoshi, Kanayama, Iidaka, & Ohira, 2010; Tacikowski & Nowicka, 2010) or friend's faces (Keyes & Brady, 2010; Sugiura et al., 2008; Sui, Liu, & Han, 2009; Sui, Zhu, & Han, 2006) in explicit or incidental face identification tasks. However several studies showed that this speed advantage for the self-face only occurs when participants respond with their left hand (Keenan et al., 1999; Ma & Han, 2010; Platek & Gallup, 2002; Platek, Thomson, & Gallup, 2004). Because of contralateral motor control, this finding was interpreted as reflecting right hemisphere dominance of self-face recognition. This left-hand advantage was demonstrated with another dependent measure using an innovative experimental procedure in which the participants' task was to stop a movie of a morphed face that transitioned between a famous face and self-face, or between a famous face and a co-worker's face, as soon as they thought that the image looked more like self, or the co-worker, than the famous person (Keenan, Freund, Hamilton, Ganis, & Pascual-Leone, 2000; Keenan, Ganis, Freund, & Pascual-Leone, 2000). In these studies participants stopped the ‘‘famous to self" movie sooner when responding with the left hand than when responding with the right hand. Such hand difference did not occur for the ‘‘famous to co-worker" movie. In other words, participants were more sensitive to self when they responded with their left hand than when they did it with the right hand.

Although the left-hand advantage seems to provide a first support for a preferential role of the right hemisphere in processing the self-face, other behavioral studies reported data supporting a left hemisphere bias for self-recognition. In these studies, participants were presented with composite faces of themselves and a friend. They were asked to choose which of two symmetric self-faces (one made from the left half and one made of the right half) looked more like themselves. They preferentially chose the composite made of the right half face, i.e. the half face that lies in their right visual field when they look at themselves in the mirror. When asked to choose which symmetric face was more representative of their friend, participants chose the composite made of the right half of their friend' face. This choice represents the opposite bias since that half face lies in their left visual field when they look at their friend (Brady, Campbell, & Flaherty, 2004). These results suggest that the left hemisphere is dominant for self-recognition, and the right hemisphere is dominant for the recognition of other familiar faces.

The study of split-brain patients also provided important data for the assessment of brain lateralization of self-recognition. Sperry, Zaidel, and Zaidel (1979) examined two split-brain patients and reported that both hemispheres were capable of self-recognition. More recently, several studies used the technique of presenting split-brain patients with varying levels of images of self and familiar faces being morphed together (Turk et al., 2002), or levels of self and familiar faces each being morphed with another face (Uddin, Rayman, & Zaidel, 2005b). Stimuli were presented laterally to each hemisphere. The patients' task was to choose whether a given image portrayed her/himself or a familiar person. Turk et al. (2002) found that the proportion of either self or other responses increased, until becoming excellent, as the images approached completeness (i.e. 100% of self or familiar face in the morph). This finding suggests that both hemispheres are capable of self-recognition and familiar face recognition. These authors also found that the patient's proportion of positive responses while he judged whether or not the image was self was significantly higher when the images were presented to the left than to the right hemisphere. The opposite bias was observed when the task was to determine whether the presented face was that of a familiar person. These results support the view that the left hemisphere plays a dominant role in self-recognition. Uddin et al. (2005b) also examined a split-brain patient's performances using a similar procedure but they obtained quite different results. They also found that both hemispheres are capable of self-recognition. Their results, contrary to those reported by Turk et al. (2002), showed no indication of a hemispheric specialization for self-recognition. Moreover, this patient was able to recognize the familiar face with her right hemisphere only. The same kind of task of self/other judgment from morphs was also used with another split-brain patient (Keenan, Wheeler, Platek, Lardi, & Lassonde, 2003). In that study, stimuli were presented centrally and the patient carried out the self-search and the familiar other search task with either the left or the right hand. In the self-search condition, the proportion of correct identifications was higher and the proportion of false positives was lower when responding with left hand than with the right hand. No hand advantage occurred when searching for the familiar face. These results are consistent with the hypothesis of right hemisphere dominance of self-recognition. Keenan and colleagues drew the same conclusion from another study in which patients with intractable epilepsy underwent an intracarotid amobarbital procedure (Wada test) consisting in anaesthetizing one cerebral hemisphere at a time (Keenan, Nelson, O'Connor, & Pascual-Leone, 2001). During anaesthesia, five patients were presented with a picture of their own face morphed with a celebrity's face (e.g. Marilyn Monroe). After they recovered from anaesthetization, patients were given a force-choice task in which they had to choose the picture they had been shown earlier. After anaesthetization of the right