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## The person in the mirror: Using the enfacement illusion to investigate the experiential structure of self-identification

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### ABSTRACT

How do we acquire a mental representation of our own face? Recently, synchronous, but not asynchronous, interpersonal multisensory stimulation (IMS) between one's own and another person's face has been used to evoke changes in self-identification (*enfacement* illusion). We investigated the conscious experience of these changes with principal component analyses (PCA) that revealed that while the conscious experience during synchronous IMS focused on resemblance and similarity with the other's face, during asynchronous IMS it focused on multisensory stimulation. Analyses of the identified common factor structure revealed significant quantitative differences between synchronous and asynchronous IMS on self-identification and perceived similarity with the other's face. Experiment 2 revealed that participants with lower interoceptive sensitivity experienced stronger enfacement illusion. Overall, self-identification and body-ownership rely on similar basic mechanisms of multisensory integration, but the effects of multisensory input on their experience are qualitatively different, possibly underlying the face's unique role as a marker of selfhood.

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## 1. Introduction

Nothing provides so strong a sense of self as seeing one's own face reflected in a mirror. The familiarity and ease of everyday self-recognition masks the sophistication of this ability, and how rare it is in the animal kingdom. The face is the most distinctive feature of our physical appearance, and one of the key ways by which we become known as individuals, both to ourselves and to others. Traditionally, the ability to recognize oneself in a mirror is taken as evidence of a basic form of self awareness in non-human primates (de Waal, Dindo, Freeman, & Hall, 2005; Gallup, 1970) and human infants (Bertenthal & Fischer, 1978). This ability for self-recognition is claimed to be especially fundamental to the awareness of being a self among others like us (Zahavi & Roepstorff, 2011), upon which more complex forms of self-identity are built, such as a diachronic sense of self (Povinelli & Simon, 1998).

At the ontogenetic level, the formation of a mental representation of what we look like poses two challenges. The first challenge relates to how a mental representation of facial appearance is acquired in the first place. Given that the infant cannot have a priori knowledge of her appearance, the infant encountering a mirror for the first time must succeed in matching her sensorimotor experience with the observed sensorimotor behavior of the object seen inside the mirror. This matching between felt and observed sensorimotor signals will lead to the formation of a mental representation of visual appearance (i.e., "that is my body reflected in the mirror; therefore that is what I look like"). This process of self-identification allows successful performance in the classic 'rouge' task of mirror self-recognition, in which infants are exposed to their mirror

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reflection and their response to a spot of rouge covertly applied to their nose is registered (e.g., they might respond by touching their own nose; see Lewis & Brooks-Gunn, 1979). Second, as our physical appearance changes over time, the mental representation of what we look like should possess sufficient plasticity to ensure both the assimilation of changes and a sense of continuity over time. It is therefore important to distinguish between three key processes: (1) *self-identification*, which allows for the construction and acquisition of a mental representation of appearance; (2) *self-recognition*, which allows for the maintenance of a stored mental representation; and (3) *self-updating*, which allows for assimilation of physical changes that will eventually be reflected in the mental representation.

While the question of maintenance of a self-face representation has been addressed in several studies with adults (see Devue & Brédart, 2011, for a review), the neurocognitive mechanisms that allow us to acquire, maintain and update a mental representation of our own face remain incompletely understood. Typically, in self-recognition studies, participants are asked to judge the identity of a static visual stimulus, often a morphed face that contains different percentages of self and other. This process requires a comparison between the static viewed picture and a stored visual representation of one's own face. However, at the ontogenetic level, the initial acquisition of a mental self-face representation cannot be explained by this process of comparing an external stimulus to a mental representation because a mental representation of what we look like does not exist a priori. Instead, it is the infants' ability to integrate online sensorimotor signals with visual feedback during mirror exposure that allows them to realize that the face with the rouge spot that they see in the mirror is their own. Thus, the mental representation of what we look like is given to us by the continuous integration and match of what we feel on our face with what we see on the reflected face. Accumulative multisensory experiences during mirror exposure may allow for the update of the mental representation of our own face as we age, although the continuity and plasticity of self-face representations as we age are issues that remain to be explored. How is a mental representation of one's own face acquired, maintained and updated over time?

Recent studies (Sforza, Bufalari, Haggard, & Aglioti, 2010; Tajadura-Jiménez, Grehl, & Tsakiris, 2012; Tsakiris, 2008) have capitalized on the known role of multisensory integration for body-awareness (for a review see Tsakiris, 2010) to investigate the effect of on-line multisensory stimulation on self-face representations. Seeing another person's face being touched at the same time as one's face, evokes a change in the mental representation of one's face, which can be measured by performance on a self-face recognition task. Synchronous, but not asynchronous, visuo-tactile stimulation between the two faces changes the categorical boundary between self and other, by shifting it towards the other's face, so that a higher percentage of the other face is assimilated in the mental representation of one's face. This "enfacement illusion" has been shown to be dependent on empathic traits, such as the ability to adopt the point of view of others and to share their emotions (Sforza et al., 2010), as well as to influence social cognition processes, such as those involved in inference and conformity tasks (Paladino, Mazurega, Pavani, & Schubert, 2010).

While these studies present converging evidence in favor of the effect of multisensory stimulation on self-face representations, a systematic investigation of the experience of identifying oneself with a face is still lacking. The aforementioned studies have shed some light on this question by suggesting that I identify with the face I see, not only because it matches a stored visual representation of my face, but also because I see the face being touched when I feel touch myself. Still, we know little about how one consciously perceives these different aspects of identifying with one's face in the mirror.

### 1.1. Present study

We consider the enfacement illusion to be a model instance of self-identification, in an analogous way to the phenomenology of embodiment in illusions of body-ownership, such as the Rubber Hand Illusion (RHI; Botvinick & Cohen, 1998). Understanding the experience of self-identification as studied in the enfacement illusion can shed light on the processes by which we come to *acquire* and *update* a mental representation of our physical appearance.

Thus, our first aim was to apply a rigorous psychometric method to decompose the conscious bodily experience of self-identification during enfacement into theoretically useful and distinct subcomponents. The experimental manipulation of the temporal correlation of visuo-tactile stimulation allows for controlled investigation of the phenomenology of self-identification. In Experiment 1, we adopted the psychometric approach of Longo, Schüür, Kammers, Tsakiris, and Haggard (2008) that has been previously used to characterize the alteration of the conscious bodily experience as a function of the pattern of multisensory stimulation in the rubber hand illusion. Our aim was to investigate the changes in the experience of self-identification caused by multisensory stimulation, in order to understand the psychological construct of a mental representation of one's face and to motivate future research on the malleability of self-representations.

We also aimed to investigate the effect of individual differences such as age on the strength of the enfacement illusion. The mental representations of one's face are acquired and updated through accumulative multisensory experiences during mirror exposure. Therefore, it might be hypothesized that the plasticity of self-face representations might depend on the number of mirror experiences and/or on the frequency of body changes experienced by a person, which are age-related. The little evidence available on the rate of changes in facial appearance suggests that larger changes occur during adolescence and into early adulthood, and then again in later adulthood (after 40 years old; see Bishara, 2000; Farkas et al., 2004). Larger changes in facial appearance may require a higher degree of plasticity in the mental representation of one's face that would allow the assimilation of these changes. Even though no studies have reported the effect of age on

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