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Psychiatry Research

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

Tactile mental body parts representation in obesity

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ARTICLE INFO

Article history:

Received 12 February 2014

Received in revised form

8 August 2014

Accepted 10 August 2014

Available online 6 September 2014

Keywords:

Obesity

Body representation

Somatosensory input

Size perception

Mental imagery

ABSTRACT

Obese people's distortions in visually-based mental body-parts representations have been reported in previous studies, but other sensory modalities have largely been neglected. In the present study, we investigated possible differences in tactilely-based body-parts representation between an obese and a healthy-weight group; additionally we explore the possible relationship between the tactile- and the visually-based body representation. Participants were asked to estimate the distance between two tactile stimuli that were simultaneously administered on the arm or on the abdomen, in the absence of visual input. The visually-based body-parts representation was investigated by a visual imagery method in which subjects were instructed to compare the horizontal extension of body part pairs. According to the results, the obese participants overestimated the size of the tactilely-perceived distances more than the healthy-weight group when the arm, and not the abdomen, was stimulated. Moreover, they reported a lower level of accuracy than did the healthy-weight group when estimating horizontal distances relative to their bodies, confirming an inappropriate visually-based mental body representation. Our results imply that body representation disturbance in obese people is not limited to the visual mental domain, but it spreads to the tactilely perceived distances. The inaccuracy was not a generalized tendency but was body-part related.

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1. Introduction

The body may be considered the object about which we constantly receive information, from vision, touch, and proprioception, and from the vestibular and the interceptive systems (De Vignemont, 2011). All of these different sources of information interact with each other to build up our “body representation” (De Vignemont, 2010; Serino and Haggard, 2010). There is a growing consensus that there are (at least) two distinct types of body representation, the body schema and the body image (De Vignemont, 2010). The body schema (Head and Holmes, 1911; Paillard, 1999; Gallagher, 2005) is responsible for the construction of a dynamic representation of one's own body (Dijkerman and De Haan, 2007; Sedda and Scarpina, 2012), which consists of sensorimotor body representations that guide actions (De Vignemont, 2010). The body image (Head and Holmes, 1911; Paillard, 1999; Gallagher, 2005), on the other hand, includes all the representations about the body that are not used for action, whether they are perceptual, conceptual, or emotional (De Vignemont, 2010). These

representations can be updated selectively (De Vignemont and Farnè, 2010); they also influence each other (Dijkerman and De Haan, 2007) but still further research is needed to clarify where these two representations cross-talk in the brain (Sedda and Scarpina, 2012). Their reciprocal influence would depend on the task that subjects are required to solve and the modalities (tactile or visual, action- or perception-related) to perform it (Cardinali et al., 2011). Not only perceptual (visually or tactilely perceived) dimensions of body parts or whole part sizes are shared between the two representations, but also knowledge, beliefs, and attitudes related to the body (De Vignemont et al., 2005; Gallagher, 2005; Dijkerman and De Haan, 2007; Longo et al., 2010) enabling the construction of an integrated sense of one's own body in a dynamic environment (Dijkerman and De Haan, 2007). Indeed emotions about the body (in which one's body is the object of the emotions) are frequently expressed in terms not only of whole body size but also of certain body parts' sizes (Longo et al., 2010); thus when people are asked to respond about specific parts of their bodies, feelings and cognitive concepts relative to those body parts are activated (Shontz, 1969).

In eating disorders, the visual component is traditionally the most investigated sensory source relative to the mental whole-body representation (Glucksman and Hirsch, 1969; Slade and Russell, 1973; Garner et al., 1976; Wingate and Christie, 1978; Kalliopuska, 1982; Bell et al., 1986; Collins et al., 1987; Probst et al., 1992;

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Valtolina, 1998; Docteur et al., 2010), assuming that the distortion of perceptual dimension is of the same magnitude for all parts of the body (Slade and Russell, 1973), and relative to the mental representation of specific body parts (Gardner et al., 1987; Yamokoski, 1975; Pearson et al., 1981; Fisher, 1986; Cafri and Thompson, 2004). Three different patterns relative to the perceptual estimation of body image in obese individuals have been reported (Schwartz and Brownell, 2004): they seem to (1) overestimate (Garner et al., 1976; Collins et al., 1987; Gardner et al., 1989; Docteur et al., 2010), (2) underestimate (Bell et al., 1986; Valtolina, 1998) or (3) be accurate (Schwartz and Brownell, 2004) regarding whole body-size estimation. About body-parts estimation, it has also been reported that obese people are generally less accurate than people of healthy-weight (Fisher, 1986; Cafri and Thompson, 2004); specifically, they generally showed a trend of overestimation (Yamokoski, 1975; Gardner et al., 1987). On the other hand, similarities in obese and healthy-weight people's performance in size judgments of separate body parts have also been observed (Gardner et al., 1987), and differences have appeared to be related to gender (Pearson et al., 1981).

There is a growing interest about the investigation into how the body or body parts are perceived in obesity (Schwartz and Brownell, 2004). Obesity cannot be defined merely as a medical-physiological phenomenon, but its manifestations extend also to the psychological and cognitive domain (Kreidler and Chemerinsky, 1990; Friedman and Brownell, 1995). About the former, even though the causal relationship among obesity, mood disorders, and general medical illness is far from being completely understood (see McElroy et al. (2004) for a review), in obese patients a negative body image appeared to be related to significant psychological problems, including depression, low self-esteem and a non-functional quality of life (Friedman and Brownell, 1995; Friedman et al., 2002). Lo Coco et al. (2014) suggested that obesity is strictly correlated with body image dissatisfaction, that has been indicated as a potential mediator of the relationship between dysphoric psychological states and obesity (Friedman and Brownell, 1995; Legenbauer et al., 2011; Nicoli and Junior, 2011; Lo Coco et al., 2014). Cognitive manifestations of obesity include transformations in the form and function of the mental body representation (Kreidler and Chemerinsky, 1990). It was reported that the overestimation of shape and weight appeared to be not only related to the frequency of binge-eating episodes, but also strictly connected with general psychological distress (Grilo et al., 2012). Obese individuals that overestimate or distort the size of their body are more dissatisfied and preoccupied with their appearance and tend to avoid more social interactions because of their appearance than healthy-weight individuals do (Gardner et al., 1987; Tiggeman and Rothblum, 1988; Cash, 1990); moreover, most of them were likely to drop out of treatment (Collins et al., 1987). On the other hand, one effect of clinical treatment for obesity was reported to be a decrease in the overestimation pattern of body size by obese women: this phenomenon was linked to increased self-efficacy and a positive self-image (Bell et al., 1986; Valtolina, 1998).

In previous studies, sensory modalities other than vision seemed to have been mostly neglected in the assessment of body parts representation in obesity. However, mental body representation is constructed on the basis of multiple sources (De Vignemont, 2010; Serino and Haggard, 2010): not only visual and tactile sensations, but also cues from other sensory modalities, such as proprioceptive, auditory, and vestibular cues, do contribute to complete this representation (Serino and Haggard, 2010). Thus in the present study, we aimed to test obese and healthy-weight subjects in a task in which the subjects infer a perceptual dimension of two body-part sizes based on tactile judgment; moreover, we sought to investigate the relationship between this judgment and the visual dimension of body image. Based on

previous results about distorted body image representation in obesity, we hypothesized that obese people would show a distortion of the tactile distances perceived on their body, conveying an inaccurate body-parts representation. Based on the lack of previous research in this specific domain, we could not hypothesize *a-priori* regarding the question if obese people would tend to overestimate or underestimate the tactilely perceived distance; however, we reasoned that the distortion would be associated with an inaccurate visually-based mental body representation.

In order to investigate our hypothesis, we borrowed the experimental methodology from Keizer et al.'s (2011) study in which the authors investigated mental body-parts' representation in anorexia nervosa patients through a tactilely-based estimation task. Participants were required to estimate the distance between two tactile stimuli presented simultaneously on body-part surfaces (Keizer et al., 2011; Taylor-Clarke et al., 2004); two body parts were stimulated, the abdomen, as a likely high-concern body part, and the arm, as a likely neutral body part (Keizer et al., 2011). Perceptual judgment depends not only on the neurophysiologic characteristics of the touched body parts, but also on the internal model of its physical size (Serino and Haggard, 2010). Since the task required to refer implicitly to the size of the touched body part (Serino and Haggard, 2010; Longo et al., 2010), the subjective judgment would be directly influenced by the mental body-part representation (Serino and Haggard, 2010; Spitoni et al., 2010). Keizer et al. (2011) suggested that this task would measure the tactilely-perceived body image, thus enabling the indirect link between the judgment of a distance perceived by touch and the characteristics of mental body-part reconstruction. We also explored the visual aspects of body image by a visual imagery task that allowed us to assess spatial relationships between distances on an individual's body (Smeets et al., 2009). The assumption behind this task is that topological relationships between an object's parts, and even the object's metric information, are preserved in the mental image as they are physically in the object (Kosslyn, 1980; Denis, 2008; Smeets et al., 2009). In this task, we asked participants to mentally assess two distances on their bodies and to decide which one was longer or shorter as quickly as possible (Smeets et al., 2009). The targets were divided into two groups, body parts that are sensitive to preoccupation about size and shape (Molinari, 1995; Smeets et al., 2009) and insensitive body parts. Smeets et al. (2009) suggested that: (1) people who have inappropriate body images reported different levels of accuracy and reaction times with respect to controls and (2) more deeply, body parts that are sensitive to body-shape concerns require more time to be scanned than insensitive body parts do. For its characteristics, this task can be assimilated with the classical methodologies used to assess body representation in cases of eating disorders, such as distorting photographs (Glucksman and Hirsch, 1969; Garner et al., 1976; Collins et al., 1987; Docteur et al., 2010), videos (Probst et al., 1992), silhouette charts (Bell et al., 1986), and drawings (Wingate and Christie, 1978; Kalliopuska, 1982; Valtolina, 1998). However, these techniques would present some critical issues. First, there is an implicit distinction based on the stimulus between the different tasks: the crucial distinction seems rather to be whether the stimulus being compared to the body is a depiction of a body ("depictive" methods) or merely a metric standard ("metric" methods) (Longo and Haggard, 2012). Selecting a silhouette or a photograph that represents the subjects' perceived dimensions of his or her body would require spatial abilities as well as perceptual interpretations and productions (Bell et al., 1986). Indeed people's perceptual judgments of their own bodies are based on external frames that are not body-integrated and that require complex cognitive processes to be applied; subjects have to create a mental image of their body parts and inspect them for size in order to judge if

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