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Body image distortions in healthy adults

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ABSTRACT

Distortions of body image have often been investigated in clinical disorders. Much of this literature implicitly assumes healthy adults maintain an accurate body image. We recently developed a novel, implicit, and quantitative measure of body image — the Body Image Task (BIT). Here, we report a large-scale analysis of performance on this task by healthy adults. In both an in-person and an online version of the BIT, participants were presented with an image of a head as an anchoring stimulus on a computer screen, and told to imagine that the head was part of a mirror image of themselves in a standing position. They were then instructed to judge where, relative to the head, each of several parts of their body would be located. The relative positions of each landmark can be used to construct an implicit perceptual map of bodily structure. We could thus measure the internally-stored body image, although we cannot exclude contributions from other representations. Our results show several distortions of body image. First, we found a large and systematic over-estimation of width relative to height. These distortions were similar for both males and females, and did not closely track the idiosyncrasies of individual participant's own bodies. Comparisons of individual body parts showed that participants overestimated the width of their shoulders and the length of their upper arms, relative to their height, while underestimating the lengths of their lower arms and legs. Principal components analysis showed a clear spatial structure to the distortions, suggesting spatial organisation and segmentation of the body image into upper and lower limb components that are bilaterally integrated. These results provide new insight into the body image of healthy adults, and have implications for the study and rehabilitation of clinical populations.

1. Introduction

The brain contains a number of body representations for interpreting sensory information and interacting with the environment. Head and Holmes (1911) provided the classic description of different 'schemata' representing the body: a 'postural schema' maintaining a continuously-updated representation of current body posture, and a 'superficial schema' mediating localisation of touch onto the body surface. There is also evidence of lexical-semantic (Schwoebel & Coslett, 2005) and topological (Pick, 1922) representations of the body, which can be selectively impaired in some cases of focal brain damage (Schwoebel & Coslett, 2005). A further representation of the body, though, is the so-called "body image", a conscious representation that is commonly thought to rely predominantly on visual information, and represents the sizes and shapes of body parts and their arrangement to form a whole (Gallagher & Cole, 1995). The body image reflects what the body is perceived to be like (Longo, Azanon, & Haggard, 2010). Note that the use of the term "body image" need not include emotional and aesthetic elements, although metric aspects of the body are often associated with these aspects (Schilder, 1935).

There has been a range of research into how we represent the size and shape of our bodies. Scientists and artists, for example, have explored what body shape we find most attractive (e.g., Fan, Dai, Liu, & Wu, 2005; Fan, Liu, Wu, & Dai, 2004; Holliday, Longe, Thai, Hancock, & Tovee, 2011; Singh, 1993; Sorokowski, 2010). Another strand of research has investigated altered body image in clinical populations, notably individuals with eating disorders (e.g., Garner, Garfinkel, & Bonato, 1987; Molinari, 1995; Probst, Van, Vandereycken, & Goris, 1992; Slade & Russell, 1973).

Interestingly, few studies have investigated body image in the normal population, and very few of those have used quantitative measures. As a result, relatively little is known about the brain's conscious representation of the body as a physical object. Many studies of body image involved participants' adjusting the size of an image to match their actual body size (e.g., Allebeck, Hallberg, & Espmark, 1976; Bell, Kirkpatrick, & Rinn, 1986; Freeman, Thomas, Solyom, & Hunter, 1984; Glucksman & Hirsch, 1969; Probst et al., 1992; Shafran & Fairburn, 2002; Traub & Orbach, 1964). These tasks are limited in that they only provide an estimate of the explicitly perceived overall size of the body, and do not assess the various parts of the body individually. The same limitation is true for many computerised tests, such as the Body Virtual Image

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Realty Scale (Riva & Melis, 1997). The Body Image Testing System (Schlundt & Bell, 1993), a computer-graphic technique developed by Benson, Emery, Cohen-Tovee, and Tovee (1999), and the Body Image Assessment Software (Letosa-Porta, Ferrer-Garcia, & Gutierrez-Maldonado, 2005) both allow size estimates of individual body parts, but these estimates are made on an image of the entire body. This kind of presentation presumably favours comparative judgements (e.g., is the foot larger or smaller than the face), rather than testing representation of each part individually.

Other tasks have focused on metric size estimates of individual body parts, predominantly with a moving calliper or an adjustable light beam (Gleghorn, Penner, & Schulman, 1987; Slade & Russell, 1973; Thompson & Spana, 1988). These methods of adjustment are problematic because the initial size that is shown significantly influences participants' responses, and the bias is not even across estimates that require increasing and decreasing adjustments (Ferrer-Garcia & Gutierrez-Maldonado, 2008). The Image Marking Procedure avoids these problems by asking participants to mark the perceived size of individual body parts on a sheet of paper (Askevold, 1975). However, this method does not allow assessment of the spatial organisation of the body. On the other hand, the Body Scheme Task provides information about the spatial organisation of the body but not the size of its parts (Daurat-Hmeljiak, Stambak, & Berges, 1978). In this task, participants place an image of an individual body part (e.g., the arm) relative to an anchor part (e.g., the head) shown on a piece of paper to indicate the relative positions of these parts in their own body.

Body Image Tasks divide into *depictive* methods, in which the participant compares their body to a visual image, and *metric* methods, in which the participant simply compares some spatial measure of their body to some standard (Longo & Haggard, 2012). Meta-analyses of the literature on eating disorders have suggested that depictive methods elicit both larger (Cash & Deagle, 1997) and more consistent (Smeets, Smit, Panhuysen, & Ingelby, 1997) body image distortions than metric methods. Intriguingly, Longo and Haggard (2012) found the opposite pattern for healthy participants in the case of the body image of the hand. When participants compared their hand to distorted photographs of hands (a depictive task), their responses were quite accurate; when they compared the length of each finger to the length of a line (a metric task), however, they showed large distortions. This discrepancy can be explained by contrasting explicit access to the body image representation for depictive tasks, with implicit access for metric tasks (Longo & Haggard, 2010). In a previous study, Longo and Haggard (2010) investigated implicit body representations underlying position sense by asking participants to point towards the location of several landmarks on their occluded hand. By comparing the relative judged locations of each landmark, perceptual maps of represented hand size and shape could be calculated and compared to actual hand shape. The task can be considered implicit because individual judgements refer only to the locations of body parts, although the map that finally emerges is a depiction of the whole hand. These maps revealed a highly stereotyped pattern of distortions, in which the hand was misrepresented as wide and the fingers as short. These distortions did not appear when participants made explicit judgments about whether images of their hand were presented at the correct aspect ratio or not.

We recently developed a similar approach to test the implicit perceived size of body parts and overall body configuration — the Body Image Task (BIT) (Fuentes, Pazzaglia, Longo, Scivoletto, & Haggard, 2013). In this task, participants are shown a single body part on a monitor as an anchor stimulus and are asked to judge the relative location of several other body parts by clicking on the corresponding location on the monitor. Like the map of hand position sense (Longo et al., 2010), this task is implicit in the sense that participants do not see images of their body or body parts but are instead asked to indicate the position of a number of different landmarks with respect to an anchor. This task was inspired by the Body Scheme Task of Daurat-Hmeljiak et al. (1978), described above. Importantly, however, by having participants indicate locations using a mouse click rather than by arranging an icon, the BIT allows more precise measurement of the represented metric properties of the body and allows the represented size, position, and orientation of multiple body parts to be assessed.

Thus, the BIT allows us to quantitatively study the body image without explicitly asking about body size and shape. In the present study we tested two large samples of healthy adults using the BIT as well as a template matching task providing a more explicit measure of perceived body shape.

2. Methods

2.1. Participants

Seventy-eight participants took part in the study in person (in-person group): 41 females and 37 males. Ages ranged from 18 to 72 years, with a mean of 27 years (±10 year standard deviation). A further online experiment included data from 274 participants (online group): 209 females, 63 males, and 2 who did not report their gender. Ages ranged from 18 to 51 years, with a mean of 27 years (±7 year standard deviation). No participant was part of both test groups. With this additional dataset of online participants we had an independent, large sample that we could compare to our smaller in-person sample. We were also able to increase the sample size to a level that allowed for multivariate analyses. Finally, we could assess whether an online version of the BIT is a valid method of data collection for future large-scale studies.

All participants gave informed consent: in-person participants gave written consent and online participants gave electronic consent. All experiments were approved by the local ethics committee at University College London.

2.2. Body Image Task (BIT)

2.2.1. Procedure

Participants in both versions of the experiment were given the same written instructions (see Supplementary Material). The instructions invited them to locate a named body landmark relative to an anchor part (the head) shown on the screen. Twelve body parts were tested: left shoulder, right shoulder, left elbow, right elbow, left hand, right hand, left hip, right hip, left knee, right knee, left foot, and right foot.

On each trial, participants saw the name of a body part on the top of the screen and the outline of a head in one of four positions near the top of a boxed area (see Fig. 1). The screen advanced to the next trial when participants clicked the mouse to respond. Each of the 12 body parts was judged five times in a pseudo-random order, for a total of 60 trials. Participants completed a three-trial practice before starting the experiment.

Participants who did the BIT in person also had a front-view photograph taken while they stood with their arms outstretched at their sides. For body parts that were hidden from view by clothing (e.g., the hips), stickers were placed on participants' clothing to indicate locations.

2.2.2. Analysis

For each participant, we calculated the average reported position of each body part. Responses that clearly confounded the left and right sides of the body or were beyond two standard deviations of the participant's mean for the given body part were excluded from analysis. On average, 2% of trials per participant were excluded.

For our first analysis, average reported body part positions were transformed into a common space by expressing them as a proportion of judged height using the two-point registration procedure in which two landmarks are selected to have coordinates (0,0) and (0,1), respectively, with all other points scaled accordingly (Bookstein, 1991). The point midway between the location of the two feet was defined as