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# Minding gaps on the skin: Opposite bisection biases on forehead and back of one's head

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ABSTRACT

Humans perceive the world from an egocentric perspective, while being able to mentally take a third person's perspective. Graphesthesia tasks revealed that letters written on the back of one's own head are consistently perceived from an embodied perspective, while the perspective on one's front is less consistent and often disembodied. We developed a cutaneous gap bisection task as a more discrete measure of the perspective on the body. In analogy to a visual pseudoneglect, we expected bisections to deviate toward the left ear when perceived from an embodied perspective. While this hypothesis was confirmed for gap bisections on the back, the results on the front suggest overall a disembodied perspective. Contrary to our expectation, this pattern was not predicted by the spontaneous perspective participants took in a graphesthesia task, indicating different cognitive mechanisms. We discuss these findings in the frame of the current literature on spatial attention and perspective taking.



## 1. Introduction

A central aspect of human *self-consciousness* is our stable embodied first person perspective on the world (e.g. Blanke, 2012). In contrast, a central aspect of human *social life* is the ability to mentally simulate another person's perspective (e.g. Costantini, Committeri, & Sinigaglia, 2011) albeit it is hotly debated to what extent such process is automatic or rather effortful (e.g. Arnold, Spence, & Auvray, 2016; Cole, Atkinson, Le, & Smith, 2016). Such dyadic perspective exists not only for the space around us, but also for our own body and self, linked to the perception of the self as a subject ("I") or as an object ("me").

One task that has widely been used to investigate the spontaneous perspective on one's own body surface is a graphesthesia task (Natsoulas & Dubanoski, 1964), in which letters or numbers are drawn on body parts of a blindfolded participant, who is required to identify the orientation of the stimulus. During this task the letter "b" drawn by an experimenter on the front, for example, can either be perceived as a "d" (embodied perspective) or as a "b" (disembodied perspective). An early, but thorough investigation by Stracke (1947) suggested that signs drawn on the back are perceived as they are drawn by the experimenter (i.e. from an embodied perspective), while those on the front are rather perceived as mirror-inverted, i.e. as if the participant "looked" through the head on the number ("frontal plane hypothesis" (Duke, 1966)), suggesting an embodied perspective as well. Yet, already Stracke (1947) noticed that participants were slower and less consistent in their responses

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for drawings on the front than an on the back. And while the results on the back of the head are consistent across subjects and studies (Duke, 1966; Parsons, 1987; Stracke, 1947), the results on front stimulation are much less consistent and have been shown to depend for example on the participant's gender (Duke, 1966), body posture (Stracke, 1947), on the currently available vestibular input (Ferrè, Lopez, & Haggard, 2014) and, in a slight task modification, on the participant's momentary self-focus (Hass, 1984).

This suggests that in graphesthetic perception on body parts with which we typically face other people in social interactions (i.e. front face), we more readily take the observer's perspective, while both situational and inter-personal aspects might play a role to what extent we spontaneously do so. There are, however, two important limitations to this often-used task: first, the participant's responses allow only a dichotomous classification into perception as mirror-inversed (embodied perspective) or not (disembodied perspective), not allowing for any intermediate state. Second, the task involves writing and reading, which is a special situation that strongly involves communicative and social aspects, which are mostly not controlled for (see e.g. Arnold et al., 2016; Hass, 1984 for exceptions). Participants might thus more or less explicitly take into account the experimenter's perspective to solve the task. Here, we used an alternative, purely spatial task with a continuous measure to investigate the perspective on the own body. We used a *cutaneous gap bisection task* on healthy participants' front and back, which required them to bisect the empty space between two endpoints of a line (Bradshaw, Bradshaw, Nathan, Nettleton, & Wilson, 1986).

In the visual domain, it has been shown that in healthy, right-handed participants, bisections of a visible line from a first person perspective are slightly, but consistently shifted toward the left of the objective midpoint, a phenomenon termed "pseudoneglect" (Bowers & Heilman, 1980). Bisecting the empty space between two visually presented endpoints of a line ("gap bisection") leads to similar, albeit smaller (left-sided) lateral displacements (Bradshaw et al., 1986; McIntosh, McClements, Dijkerman, & Milner, 2004). Whether a comparable pseudoneglect exists in the tactile domain as well (bisection of felt distances on the skin) has been studied much less systematically. Some previous investigations described a leftward shift of the subjective meridian when participants were asked to point to the body midline (Richard, Honoré, & Rousseaux, 2000; Spidalieri & Sgolastra, 1997). Spidalieri and Sgolastra (1999) found a leftward displacement of the anterior head midline, yet they did not test midline pointing on the back of the head. A proper characterization of pseudoneglect in the somatosensory modality has, however, never been provided, and was one of the aims of the present study.

We investigated healthy subjects' pointing biases to the spot laying halfway between two touch stimuli applied simultaneously to either the forehead or, in separate trials, to the back of the head. We generally assumed an existence of a pseudoneglect in the somatosensory modality. Thus, we predicted a leftward deviation relative to the actual midpoint on the back (i.e. a pseudoneglect from an embodied perspective, see Fig. 1). For the front we predicted that participants using spontaneously a disembodied perspective in a graphesthesia task, which requires writing letters on one's forehead (Shimojo et al., 1989; Hass, 1984), would show a *right*ward bias, while those using an embodied perspective should also show a *left*wards bias.

## 2. Methods

### 2.1. Participants

The 40 subjects (20 women) had a mean age of 37.5 years (SD = 6.2 years) and an average educational training of 14.8 years (SD = 1.4 years). All subjects were right-handed (Chapman and Chapman, 1987), and none had a history of

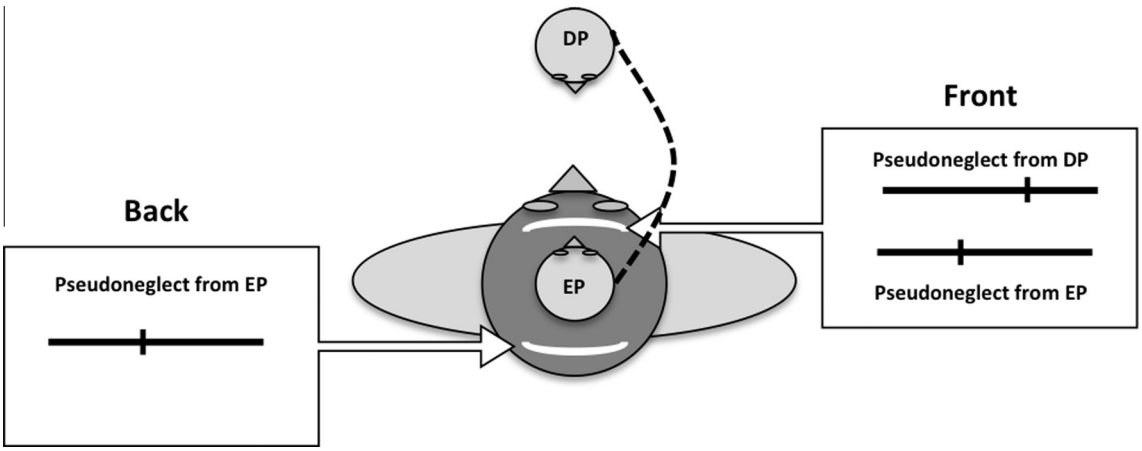


**Fig. 1.** Schematic illustration of the different perspectives and the predicted deviation. Predicted deviation from the midline if a somatosensory pseudoneglect exists for the different perspectives on ones own body described in the literature. EP = embodied perspective, DP = disembodied perspective. While graphesthesia tasks on the back are consistently done from a EP perspective, those on the front might either be done from an EP or a DP.