

## How many peripersonal spaces?

F. de Vignemont<sup>a,\*</sup>, G.D. Iannetti<sup>b</sup>

<sup>a</sup> Institut Jean Nicod, ENS – EHESS – CNRS, France

<sup>b</sup> Department of Neuroscience, Physiology and Pharmacology, University College London, UK

### ARTICLE INFO

#### Article history:

Received 3 June 2014

Received in revised form

17 October 2014

Accepted 15 November 2014

#### Keywords:

Peripersonal space

Defence

Goal oriented actions

Reaching space

Anxiety

Goal

Tool

Multisensory attention

### ABSTRACT

Several studies in humans and non-human primates have explored and characterised the features of the cortical representation of the portion of space immediately surrounding the body – the peripersonal space. In this paper we ask the following question: is it legitimate to assume that there is a single representation of peripersonal space? This issue has rarely been addressed in the literature, leading to much confusion, especially when one compares results reported in social psychology and in cognitive neuroscience. Indeed, studies in both fields explore and refer to more or less the same portion of space, but the terminology used to describe it differs greatly. Therefore, the definition of this portion of space immediately surrounding the body has remained quite vague, allowing for many variations. Here, we propose a dual model of peripersonal space, based on a clear functional distinction between *bodily protection* and *goal-directed action*. We argue that the two functions of peripersonal space require distinct sensory and motor processes that obey different principles. Furthermore, we highlight that the effects of anxiety and tool use on peripersonal space provide empirical support to our distinction.

© 2014 Elsevier Ltd. All rights reserved.

### 1. Introduction

It is now well accepted that the central nervous system represents differently and separately sensory stimuli happening on the body, in the space immediately surrounding the body, and in the space beyond reach, in which the individual navigates. Hence, objects and events are processed differentially depending on where they are located in the environment. Interestingly, there may be different ways for the location of objects and events to be represented in each of these three spatial domains – let us call them *bodily space*, *peripersonal space*, and *extrapersonal space*. This has already been shown for objects and events located in bodily space and extrapersonal space. Indeed, in bodily space sensory events can be represented in at least two different ways: in relation to action (i.e. body schema) or in relation to perception (i.e. body image). In extrapersonal space sensory events can be represented within an egocentric frame of reference (i.e. in relation to oneself), or within an allocentric frame of reference (i.e. in relation to other objects or events). An interesting question now is whether there are also distinct ways to represent object and events in the third spatial domain – the *peripersonal space* (hereafter PPS).

This has rarely been addressed in the literature, leading to much confusion, especially when combining results reported in

social psychology and in cognitive neuroscience. Both fields refer to more or less the same spatial area, namely, the space immediately surrounding the body. However, the terminology used to describe it varies greatly (e.g. flight zone, personal space, peripersonal space, reaching space). Therefore, the definition of this portion of space remains vague, allowing for many variations. There are, for example, variations in its spatial extent: more or less close to the body, between few and 50 cm. There are also social differences: the space of preys, predators, and objects. There are, finally, functional differences: the space for protection, joint action, and goal-directed action. All these differences urge us to ask the following questions: is it legitimate to assume that there is a single type of PPS representation? If there are more, what distinguishes them?

Unfortunately, the available empirical evidence is not sufficient to answer. In that respect, this paper will be mainly exploratory and speculative. Our objective is only to lay the groundwork in the analysis of possibly distinct types of PPS. Further experimental evidence will be required to validate or invalidate the hypotheses we will make here. We will propose a dual model of PPS, with a clear functional distinction between *protection of the body* and *goal-directed action*. We will argue that the two functions of PPS require distinct processes that obey different principles. Furthermore, we will analyse the effect of anxiety and the effect of tool use on PPS, and suggest that they might offer some empirical support to our distinction.

\* Corresponding author.

E-mail address: [frederique.de.vignemont@ens.fr](mailto:frederique.de.vignemont@ens.fr) (F. de Vignemont).

## 2. Definitional issues

In their seminal paper describing neurons activated both by tactile and visual stimuli presented in the space surrounding the body of a monkey, Rizzolatti et al. (1981) first coined the term “peripersonal space”. However, the idea that there is a special zone surrounding the body can already be found in the work of the Swiss biologist Heini Hediger (1955), the director of the Zurich zoo, who noted that animals display different behaviours depending on the proximity of other animals. Typically, when a potential predator is close to the animal, entering what is known as its *flight distance*, the animal flees or withdraws. But a tame animal will have a flight distance of zero. Even when the other animal belongs to the same species, there is a distance, what Hediger called the *personal distance*, at which the proximity of conspecifics becomes no longer tolerable.

Since Hediger and Rizzolatti, numerous studies in monkeys and humans, in both healthy and pathological states, have explored the functional features of this specific area close to the body (for review, see Brozzoli et al. (2012)). These features can be summarised as follows:

- (i) Bodily reference frame: the PPS is anchored to specific body parts, and moves when the body parts move.
- (ii) Multisensory vigilance: the perception of objects and events occurring in PPS triggers the allocation of multisensory attention.
- (iii) Sensorimotor relevance: objects and events perceived in PPS are represented in terms of possible actions.
- (iv) Plasticity: the boundaries of PPS are flexible.

Based on these functional features, the PPS has been defined as follows:

“Peripersonal space contains the objects with which one can interact in the here and now, specifies our private area during social interactions and encompasses the obstacles or dangers to which the organism must pay attention in order to preserve its integrity” Coello et al. (2012, p. S131)

This summary reveals the complexity of PPS, and perhaps, the confusion that surrounds this notion. Indeed, it assumes that a

single PPS can subserve diverse functions. But is this assumption justified? An urgent question is indeed to what extent those functions require distinct types of PPS representations. We will first isolate the two major functions highlighted in this definition of PPS: (i) to take advantage of opportunities within the PPS (e.g., to grasp food and useful objects) and (ii) to protect the body from potential threats occurring within the PPS (e.g., to avoid a bee flying towards the face). We will then discuss the implications that the functional distinction between goal-directed and protective actions has on way the brain represents PPS. More specifically, two alternative hypotheses must be teased apart: one and the same peripersonal representation subserving both goal-directed and protective actions versus two distinct peripersonal representations, one for each of these two functions.

In several cognitive domains it has been observed that differences in function correspond to differences in information processing. The most well known functional distinction is between the two anatomical pathways of visual processing for perception and for action: the ventral pathway for visual judgement and the dorsal pathway for sensorimotor control (Milner and Goodale, 1995). Another example of the application of such Perception-Action model can be found in the case of body representation. Indeed, some taxonomies propose that there are at least two types of body representations, some dedicated to action (i.e. body schema) and others to perceptual judgments (i.e. body image, which includes body structural description and body semantic) (Schwoebel and Coslett, 2005; de Vignemont, 2010; Dijkerman and de Haan, 2007; Paillard, 1999). We do not suggest that one can simply apply the Perception-Action model to PPS. Both functions of PPS are action-oriented, whether for object grasping or for body protection. Hence, the representations of PPS are sensorimotor regardless of the purpose of the final motor output. Nevertheless, the Perception-Action model can be taken as an example that functional differences can have strong implications for the way the world is represented. How the brain uses the available sensory information can partly determine how it encodes it. It is thus appropriate to ask how many peripersonal representations exist. Here we will consider two explanatory models, which we call the *Swiss army-knife model* and the *Specialist model* (Fig. 1).

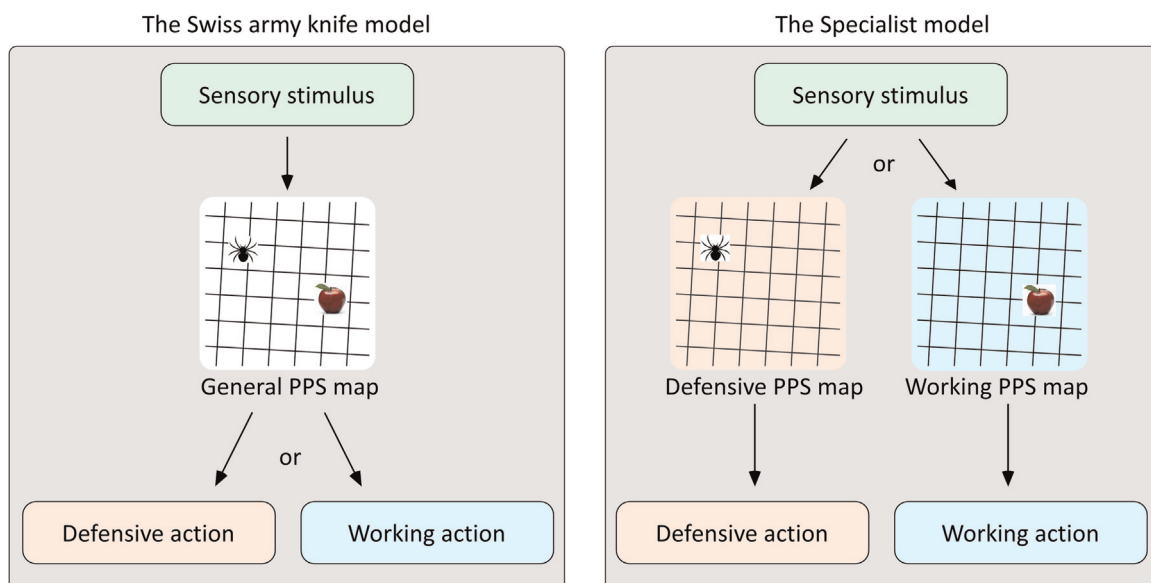


Fig. 1. Two models of peripersonal space.

Download English Version:

<https://daneshyari.com/en/article/7320209>

Download Persian Version:

<https://daneshyari.com/article/7320209>

[Daneshyari.com](https://daneshyari.com)