Neuropsychologia 47 (2009) 1745–1755

Contents lists available at ScienceDirect

Neuropsychologia

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

Heterotopagnosia: When I point at parts of your body

Laurent Cleret de Langavant[a,b,c,d], Iris Trinkler[a,b], Pierre Cesaro[a,c,d], Anne-Catherine Bachoud-Lévi[a,b,c,d,*]

[a] INSERM U955, Equipe 1, "Neuropsychologie Interventionnelle", Institut Mondor de Recherche Biomédicale, Créteil, France
[b] Ecole Normale Supérieure, Département d'Etudes Cognitives, Paris, France
[c] Université de Paris 12, Faculté de Médecine, Créteil, France
[d] AP-HP, Henri Mondor Hospital, Service de Neurologie, Créteil, France

ARTICLE INFO

Article history:
Received 12 October 2008
Received in revised form 3 February 2009
Accepted 8 February 2009
Available online 14 February 2009

Keywords:
Heterotopagnosia
Pointing disorder
Grasping
Self-referencing
Body knowledge disorder theory
Brain lesion

ABSTRACT

Heterotopagnosia is the acquired inability of brain-lesioned patients to point at someone else's body parts when prompted. The cognitive basis of this disorder is unclear. It might result from a biological function deficit critical for communication in human beings; alternatively, it could result from the disruption of a body representation. Here, we report three patients with heterotopagnosia following a recent left parieto-occipital stroke and a previous insular lesion. The patients were tested on their ability to name, point out and grasp several targets including body parts (own, real others' and figurative others'). Language, visuo-spatial deficits or any confounding neuropsychological disorders were controlled for. We found that the patients erroneously pointed to their own body parts when asked to point at someone else's. Strikingly, their ability to grasp someone else's body parts was largely unimpaired. The dissociation between their grasping and communicative pointing abilities supports the hypothesis that heterotopagnosia is a disorder of communicative function conveyed by pointing but not by grasping. In addition, pointing performance in our patients varied according to the target: the more similar the target was to a real person, the worse the patients' pointing performance. We suggest that communicative pointing might require a specific representation of the addressee's body and point of view, a heterocentric representation. In the patients described here this phenomenon resulted from a combined insulo-parietal lesion, which may explain why, in contrast to other patients described previously, the heterotopagnosia was long-lasting.

1. Introduction

Pointing is universally used by human beings to direct the attention of others towards an object or a location in the world (Kita, 2002). Like speaking, pointing is addressed to somebody else and refers to the outside world. The subject who points identifies an addressee in order to interact with him or her about a visual target. The pointing capacity demonstrates the ability to share attention with an addressee about an object in order to communicate about it. Thus, pointing disorders should offer valuable clues about non-verbal communication.

Developmental studies suggest that pointing is of considerable importance in humans (Baron-Cohen, 1995; Charman, 2003; Kita, 2002; Liszkowski, Carpenter, Henning, Striano, & Tomasello, 2004; Tomasello, 1999) and meets all the criteria of a marker of biological function: it is acquired without learning, at a young age and is universally used by humans (Mehler & Dupoux, 1990). It appears following a pre-determined time-course independent from any explicit learning (Carpenter, Nagell, & Tomasello, 1998). Infants produce pointing gestures from the end of the first year of age, using it for two different purposes. In proto-imperative pointing, infants direct their arms, hands, fingers and gaze towards a desired object and make use of another person as a means of obtaining something (Bates, Camaioni, & Volterra, 1976). In proto-declarative pointing, starting at 12–13 months of age, infants still point at the object whilst their gaze is directed towards the addressee and they share the experience of the object with another person (Bates et al., 1976; Liszkowski et al., 2004). Whereas proto-imperative pointing has been observed in great apes (Gómez, 2005; Leavens, Hopkins, & Bard, 1996), proto-declarative pointing is only very occasionally, if ever (Gómez, 2005; Leavens et al., 1996), encountered in enculturated non-human primates living in captivity (Tomasello & Call, 2004; Tomasello & Carpenter, 2005). In contrast, both proto-declarative and proto-imperative pointing are systematically encountered in humans during typical child development (Bates et al., 1976; Carpenter et al., 1998; Liszkowski et al.,

* Corresponding author at: Service de Neurologie, Département des Neurosciences, Hôpital Henri Mondor, 51 av. du Maréchal Delattre de Tassigny, 94010 Créteil, France. Tel.: +33 1 49 81 23 01; fax: +33 1 49 81 23 26.
E-mail address: bachoud@gmail.com (A.-C. Bachoud-Lévi).

0028-3932/$ – see front matter © 2009 Elsevier Ltd. All rights reserved.
doi:10.1016/j.neuropsychologia.2009.02.016

2004). Importantly, pointing fails to be acquired in developmental disorders of social cognition such as autism (Baron-Cohen, 1989; Charman, 2003; Mundy, Sigman, & Kasari, 1990) as a consequence of the defect of a shared attention mechanism (Baron-Cohen, 1995, 2005). Indeed, both pointing and shared attention abilities correlate with later development of language and theory of mind abilities (representing one's own and another person's mental states) (Charman, 2003).

Given its importance in development, it is rather intriguing that acquired pointing disorders are so rarely encountered in brain-lesioned adults. In addition, when acquired pointing disorders are reported in adults they usually occur while pointing at body parts, favoring the interpretation of a body knowledge disorder rather than a communication disorder as in infants. For example, in finger agnosia (Gerstmann, 1942), patients classically mislocate fingers (they point at the thumb instead of the index) but correctly name fingers after the examiner points at them. In autotopagnosia (Pick, 1922), subjects are unable to point at their own body parts or at the body parts of others[1] (Felician, Ceccaldi, Didic, Thinus-Blanc, & Poncet, 2003; Gerstmann, 1942). In heterotopagnosia, patients point to the corresponding part on themselves when they are asked to point to body parts of somebody else, as if they were their own (Degos, Bachoud-Lévi, Ergis, Petrissans, & Cesaro, 1997; Felician et al., 2003).

In these syndromes, a disorder of a segregated representation of body knowledge has been suggested to explain the patients' disorder (Coslett, 1998; Sirigu, Grafman, Bressler, & Sunderland, 1991). This explanation will be referred to as the body knowledge disorder theory (BKDT). The disruption of the semantic and lexical information about body parts and their functional relation could explain body part naming disorders. Impairment of the "emergent body reference system" (Sirigu et al., 1991), broadly equivalent to the so-called "body schema" (Coslett, 1998), may explain difficulties in representing the moving body in space. Impairment of the visuo-spatial and structural description of human bodies might explain why patients with autotopagnosia or somatotopagnosia cannot draw or assemble puzzles representing human bodies and make contiguity errors when locating body parts on human figures (Schwoebel & Coslett, 2005; Sirigu et al., 1991). This visuo-spatial and structural representation was recently extended to the existence of a specific map of the human body dedicated to an other, the disruption of which could cause heterotopagnosia (Felician et al., 2003).

Most certainly, body representations must be activated when pointing to body parts, however, alternative explanations have been proposed to account for acquired pointing disorders. For example, some reports of autotopagnosia show that the pointing disorder could extend to complex objects (like bicycles). This suggests an incapacity to "analyze wholes into parts" to account for the patient's deficit, in contradiction with the BKDT (De Renzi & Scotti, 1970; Poncet, Pellissier, Sebahoun, & Nasser, 1971). In addition, the inability of allotopagnosic patients to point to all types of extrapersonal targets (objects or body parts) with spared pointing at one's own body parts (Degos et al., 1997) also goes beyond the BKDT. Strikingly, heterotopagnosia often follows allotopagnosia which suggests that the BKDT cannot account for heterotopagnosia. Indeed, patients do not produce contiguity errors, pointing at another person's nose instead of the forehead for example. Their deficit is selective for pointing at another person's body parts: they correctly point at any object, even located on another person's body. Patients are able to look at and name the targets they cannot point at. They show the very striking and almost systematic behavior of self-referencing, pointing at their own nose instead of another person's nose. In addition, patient case 9 of the first series of nine patients with allotopagnosia and heterotopagnosia (Degos et al., 1997) showed almost normal grasping performances when asked to grasp the body parts he could not point at.

This last argument is presumably the strongest in order to disentangle the BKDT and a theory of non-verbal communication in heterotopagnosia. As goal-directed gestures, both grasping and pointing share similar visuo-motor resources and activate body representations when performed (Droulez & Berthoz, 1988; Milner & Goodale, 1995). Yet, in grasping an agent relates to a target without any communicative intention whereas pointing is addressed to somebody else. The first-person "I" (the subject, the one who speaks or points to), addresses "you" (the addressee, the second-person, the one I am speaking to or pointing for) in order to share information about "him", "her" or "it" (the third-person or the pointed object the communication is about). Pointing imposes the identification of a conspecific as a potential addressee and the setting up of a communicative relationship with this addressee about an object. Thus, grasping is a two-way gesture, while pointing shares with speaking the three-way structure that underlies human referential communication (i.e. communication that is about a distant object) (Benveniste, 1966). Thus, if this incidental dissociation between grasping and pointing ability is confirmed in heterotopagnosia, it would suggest that heterotopagnosia is due to disruption of the three-way relationship of non-verbal communication.

Here, we report an extensive study of three cases of long-lasting heterotopagnosia. To further establish that heterotopagnosia is a disorder of the basic three-way relationship of non-verbal communication and to rule out the BKDT, we assessed both grasping and pointing to the same body parts and explored the limits of the self-referencing pattern with regard to the type of human figure proposed as a target. The study was conducted with three patients with heterotopagnosia, including case 9 from our previous study (Degos et al., 1997). All patients displayed a left parietal and an insular lesion. We propose a new hypothesis to account for their pointing behavior and set it in relation to the localization of the patients' brain lesions.

2. Methods

2.1. Case reports

Between 1993 and 2000, pointing disorders were systematically assessed in patients with vascular brain lesions admitted to the Neurology Department of the Henri Mondor Hospital. Patients were requested to point to the ceiling, the window, their nose and the nose of the examiner, and then to name the same objects or body parts for the examiner. Three out of hundreds of patients were studied because their pointing disorder was severe, long-lasting, and sufficiently isolated to resist explanation by any other instrumental disorder after general cognitive testing. At the time of examination, all patients were functioning normally in daily life and had normal relationships with others.

General assessment of cognitive functions included those classically associated with lesions of the parietal lobe of the dominant hemisphere. Calculation was tested by asking the patient to solve simple numerical operations (10 additions and 10 subtractions) under oral or written presentation. Left–right distinction was assessed by asking the patient to name the side of body parts on himself or on the examiner. Spelling was tested by asking the patient to write some sentences such as "birds are singing in the trees". Spatial localization of the fingers was tested by asking the patients to point to their fingers and then to name them. Gestural abilities were tested by asking the patient to execute 10 symbolic gestures (e.g. "good-bye"), to imitate 10 meaningless gestures, 10 pantomimes (e.g. "to play violin"), and 10 object uses (e.g. "to light a match"). Language was tested through general comprehension in conversation and picture naming using various validated sets of pictures (Table 1). Attention and verbal working memory were assessed by using forward and backward digit span. Attention to space was tested with the bell cancellation task (Gauthier, Dehaut, & Joanette, 1989). Additionally, one of the patients was tested with the orientation of lines (Benton, Hamsher, Varney, & Spreen, 1983) and the Corsi blocks memory task. Two of the patients were tested with the Visual Object and Space Perception (VSOP) battery (Warrington & James, 1991) and a French adaptation of the Free and Cued Selective

[1] Some authors restrict the use of the term "autotopagnosia" to deficits in pointing at one's own body and "somatotopagnosia" for deficits in pointing at all bodies, either one's own or others'.