

Body

The body is widely regarded as a template for spatial cognition, and since topology has been treated as a basis for mereological relations (Casati & Varzi 1999) the body would appear a paradigm source for deriving mereological structure. Recent linguistic work suggests, however, that the cross-cultural conception of the body (as reflected in language) does not display multi-level or otherwise rich mereological structure. The linguistic findings accord better with what is known from cognitive science about the multiple perceptual sources for segmentation of the body and relational organization of its segments.

There are at least three distinct types of representation contributing to an overall mental representation of the body: (1) a structural representation of the body based primarily on visual information that encodes parts and their topographic relations; (2) a dynamic representation based on sensory and motor inputs that encodes the on-line positions of body parts in relation to one another; and (3) a semantic-conceptual representation (Sirigu, Grafman, Bressler, & Sunderland 1991). The structural and dynamic representations provide some determination of parthood, but they do not provide any uniform or consistent principles for relations between parts.

Visual recognition of the body proceeds through a number of processing stages, each of which provides a distinct representation of the body. Low spatial frequency information provides a global representation. At progressively finer levels of resolution, parts can be identified, for example, the head, trunk, arms and legs, followed by hands and feet as distinct parts, then fingers, and so forth

(Marr 1982; Palmer 1977). As well as being an object of external perception through vision, the body is uniquely apprehended internally through somesthetic and proprioceptive input. The primary somatosensory cortex provides a map of the body's surface, but this is an undifferentiated, continuous representation. The primary motor cortex, however, is segmented according to the joints of the body (de Vignemont, Tsakiris & Haggard 2006). These body segmentations correspond quite well to the parts identified by vision, since the joints also provide image discontinuities relevant for visual segmentation.

Parts of the body, then, can be identified through perception but the *relations* between parts are not so simply adduced. Gestalt principles of grouping – continuity, connectedness, closedness, proximity, similarity – all play a role in vision (Palmer 1977), thus are all candidate principles for determining conceptual relations in organization of the body part domain (cf. Palmer & Nicodemus 1977). Consistent with this, patients with autotopagnosia (an inability to localize or orient correctly to parts of the body) make errors based on these general principles, i.e., when asked to point to a specific body part these patients often mistakenly point instead to a part that is contiguous (e.g., wrist-elbow), or that shares functional similarity (e.g., knee-elbow; see Sirigu et al. 1991). These principles also operate in the conceptual organization of body parts in normally developing children (Crowe & Prescott 2003).

Turning to the linguistics of the body and its parts, cross-linguistic work by Brown (1976) and Anderson (1978) compared terms for the body and its parts in a wide range of the world's languages and suggested an important role for mereological structure in body part nomenclature. There were three core claims: (1) the

'body' constitutes the 'whole' from which parts are recognized; (2) mereology is the core semantic principle structuring the relation between parts; and (3) there is a deep nested hierarchy, with up to 6 levels (e.g., 'fingernail-crescent' is part of 'fingernail' is part of 'finger' is part of 'hand' is part of 'arm' is part of 'body'). Subsequent work has challenged all three claims.

First, linguistically, the superordinate entity for a system of body part terms need not be 'body', but may be 'person' instead. Some languages appear not to distinguish clearly between body and person (or 'soul'; see discussion of Kuuk Thaayorre language in Majid, Enfield & van Staden 2006). The distinction between body and person has implications for other judgments about parts too. For example, ordinary language still allows meaningful talk about dismembered body parts. After van Gogh cut off his ear, the detached ear was still an ear (Cruse 1986). But the dismembered ear is no longer part of van Gogh's body, although it may still be part of van Gogh the person.

Regarding claim (2), mereology is just one of a number of possible types of conceptual relation between parts of the body, and there may be sub-types within mereology itself. Cruse (1986) distinguishes between *segmental parts* of the body, which have a greater degree of spatial cohesiveness (e.g., 'head', 'arm', 'leg') and *systemic parts*, which have a greater functional unity but may be spatially non-cohesive (e.g., 'muscles', 'nerves'). Most cross-linguistic studies have focused on identifying segmental parts, and their relations.

Swanson and Witkowski (1977) argue on the basis of data from Hopi that possession, rather than part, is the key relation between segments of the body ('his arm', 'the hand has fingers'). Palmer and Nic-

odemus (1985), with data from Coeur d'Alene argue that spatial relations, such as contiguity, organize the domain ('the hand is *connected to* the arm'). A collection of in-depth profiles of body part nomenclature in a range of languages (Majid et al. 2006) similarly casts doubt on the claim that body part nomenclature is organized mereologically to any significant extent. Possession plays a key role for some languages, such as Tidore, while various spatial relations hold for others, such as Punjabi. Mereological structure was found to play a role in a few languages, but it was marginal, only applying between terms referring to the limbs (which constitute only a fraction of the 100-plus inventory of terms for parts of the body).

Finally, regarding claim (3) above, none of the languages investigated in Majid et al. (2006) yielded deep or systematic hierarchies of the kind predicted by Brown and Anderson.

The cognitive and linguistic coding of the body and its parts sheds light on some core properties of mereology. For example, whether a part is named or not can make a difference. When English speaking children are asked to make mereological judgments between labeled and unlabeled parts (in the latter case by touching the lower arm and asking 'Is this part of my arm?'), only parts that are not labeled are accepted as being in a part-whole relationship; labeled parts tend not to be accepted as being sub-parts of the whole (Johnson & Kendrick 1984).

Another problem is transitivity. If we take the three key properties of the part relation to include irreflexivity (nothing is a part of itself), asymmetry (if A is part of B, then B is not part of A) and transitivity (if A is part of B, and B is part of C, then A is part of C – see, for example, Simons 1987) then only the

first two hold in the domain of the body, while transitivity appears not to. Adults experience uncertainty and a sense of absurdity when contemplating relations between parts. Brent Berlin nicely sums up the problem with making transitivity judgments: “while a finger nail is part of the finger and finger is part of the hand and hand is part of the arm, for most speakers of English it is not the case that a finger nail is part of the arm. In fact, to suggest that the finger is part of the arm is also a bit spooky” (quoted in Werner & Begishe 1970, p. 252). Thus, failure of transitivity is observed not only because of the shallowness of hierarchies in the domain of parts of the body, but also due to peculiarities of inference where such hierarchies do exist.

From the preceding considerations can conclude that – perhaps surprisingly – part-whole relations play a marginal role, if any, in how people conceptualize relations between parts of the body. Instead, parts of the body may be seen as related to each other in a range of ways (e.g., mereology, possession, contiguity), and languages appear to differ considerably. This is predicted by cognitive studies, which reveal multiple distinct sources of mental representation in segmentation of the body. Fittingly, there does not appear to be a single, unifying principle of relational organization among elements of body part nomenclature across languages. If such principles exist, we suggest that they are more likely to be limited to distinct sub-systems such as the face, internal organs, or limbs. Further research aimed at extracting general principles in how parts of the body are related to one another will have to be more attentive to the large size and internal complexity of systems of body part nomenclature than studies available to date.

Bibliographical remarks

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References and further readings

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Boethius

In addition to his classic *The Consolation of Philosophy*, Anicius Manlius Severinus Boethius (born ca. 475-77 CE, died ca. 524-26) translated and commented on much of Aristotle's logic. He was also the author of several important syntheses of ancient logic and of five short theolog-

ical treatises, which applied Greek philosophical principles to the Incarnation and the Trinity. Given that much of Aristotle's work was unavailable in Latin until the end of the twelfth century, Boethius's works were indispensable to early medieval thinkers as they explored topics in logic and metaphysics. Two of Boethius's syntheses, *On Division* (1998) and *On Topical Differences* (1990), were routinely parts of the later medieval logical curriculum (Marenbon 2003, pp. 168-70). These two handbooks, as well as his commentary on Cicero's *Topics* (1833), were major sources for medieval mereological principles.

Types of wholes and parts. In *On Division* Boethius surveyed the many modes of division. Two of these modes are relevant for Boethius's mereology. One is the mode of dividing a whole into its parts, the other is the mode of dividing a genus into its species.

Boethius noted that there are many types of *whole* (1998, pp. 38-40). Some wholes are continuous (e.g. bodies and lines); some are non-continuous (e.g. flocks and armies). Boethius also claimed that a universal, in so far as it is divisible into particulars, is a whole. And, finally, there are some wholes – most notably the soul – which consist of 'powers' (*virtus* or *potentiae*).

In order to make an appropriate division of a whole, Boethius insisted, one should start by dividing the whole into "those parts out of which this very whole is perceived to consist" (1998, p. 38; cf. 1833, p. 334). In 'manifold' (*multiplex*) objects, this first division will likely be a division of the whole into heterogeneous parts. For example, a human body is divisible into the head, hands, chest, feet, and so forth. Yet, given that these wholes are manifold, they can be divided into other parts. A human body can also be divided either into homogenous parts