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14 Geometric and image-schematic patterns in gesture space

Irene Mittelberg

1 Introduction

The human body exists, moves, interacts, and communicates in space and time. Inseparable from the human body, manual gestures, too, unfold and vanish in space and time. They derive their meaning in part from the coinciding speech and in part from particular combinations of hand shapes, hand motions, and their location in gesture space. Over the last few decades, research on co-speech gesture and signed languages has shown that these dynamic visuo-motor modalities do not only exploit various dimensions of physical space as their articulatory medium, but that they can also provide a window into how physical, conceptual, social, and discourse spaces interact (e.g., Emmorey and Reilly 1995; Liddell 2003; Kendon 2004; McNeill 1992, 2000, 2005; Müller 1998; Núñez and Sweetser 2006; Parrill and Sweetser 2004; Sweetser 2007; Taub 2001; Wilcox 2000; Wilcox and Morford 2007).

Within cognitive linguistics, gesture data from typologically different languages have proven to be a valuable source of multimodal evidence for conceptual metaphor and particularly for spatial metaphor. A considerable body of research done on metaphorical gestures, e.g., representations of abstract ideas and structures, has demonstrated their capacity to reveal source domain information not necessarily captured by concurrent verbal expression (Bouvet 2001; Cienki 1998a, 1998b; Cienki and Müller to appear; McNeill 1992, 2005; Mittelberg to appear; Müller 1998, 2004b; Núñez 2004; Sweetser 1998, 2007; *inter alia*). Moreover, a recent experimental study (Cienki 2005) suggests that basic image and force schemas manifest themselves in gesture. Due to their specific materiality and logic, gestures are particularly apt at depicting spatial and dynamic properties of conceptual structure and processes, thus supporting the theory of the embodied mind (Gibbs 1994, 2003, 2006; Lakoff and Johnson 1980, 1999).

Indeed, basic physical activities that involve hand motions and/or bodily movement through space – such as walking, grasping, touching, pointing, placing, and exchanging physical objects – exhibit metaphorical correspondences in the domains of thought and speech: we understand something if we can ‘grasp’ it, we ‘walk’ people through texts, ‘point out’ certain aspects, ‘push an issue’, or try to ‘get ideas across’ to our interlocutors (cf. Sweetser 1992). Exploring how such habitual actions play out in gesture, the aim of this paper is to offer insights into the ways in which scholars employ gestures to

illustrate their discourse about abstract knowledge domains. On the basis of academic discourse videotaped in linguistics courses, I will show how gestural depictions may bring intangible subject matters into physical existence that can be shared by professors and their students. The main point of interest here is the spatialization of abstract information pertaining to grammatical concepts and theories. I will demonstrate that the prominent hand shapes and motion patterns that were found to recur across subject matters and speakers form a set of patterns which are reminiscent of simple geometric figures (e.g., squares, triangles, cubes, circles), as well as image and motor schemas proposed in the cognitive linguistics literature (e.g., object, path, balance, support, container, rotation; cf. Hampe 2005; Johnson 1987; Lakoff 1987; Mandler 1996, 2004; Talmy 1988). The term *geometric* here refers to basic shapes evoked by constellations of arms and hands and by forms resulting from imaginary lines drawn in the air. It will be suggested that a kind of 'common-sense geometry' (Deane 2005:245) may be, among other kinds of conceptual structures and motor routines, one of the factors that motivate what have turned out to be fairly systematic representations of linguistic form, grammatical categories, and syntactic relations. In view of the important role such embodied schemas have been found to assume in language acquisition (Mandler 1996, 2004), language per se (Talmy 1988), and also in the visual arts (Johnson 1987; Mittelberg 2002, 2006, in prep.), it might not be all that surprising to also see some of them reflected in gesture. The aim here is to show that discerning them in this dynamic bodily modality is useful in diagnosing less monitored aspects of cognition during communication.

While the work presented here is part of a larger study investigating how such patterns play into the iconic, metaphorical, and metonymic meaning construction in multimodal discourse (Mittelberg 2006, 2007, 2008), the discussion below will focus almost exclusively on the material side of the semiotic processes that seem to ground abstract thought in the speakers' bodies and the surrounding space.¹ This paper is thus about how abstract information is spatially represented through gesture – and not about the gestural depiction of spatial concepts or scenes per se (see Sweetser 2007 for an overview).

Before moving into the heart of the study, let us look at an example from the data in order to get a first impression of how gestures may ascribe meaning to chunks and regions of space. In the sequence from which the image below is taken (Figure 1), the speaker talks about the difference between main verbs and auxiliaries. During his explanation leading up to this particular gesture, he points to instances of both verb types contained in sentences projected onto the screen behind him. He then goes on to say that auxiliaries such as 'have', 'will', 'being' and 'been', 'must all belong to some subcategory'. Upon mentioning 'some subcategory', he produces the gesture shown below, consisting of two hands that seem to be loosely holding an imaginary object. The extended arms and almost flat hands jointly evoke two diagonally descending lines.

The meaning of the term 'subcategory' is effectively represented by a gesture that is produced in a comparatively low region of gesture space, low not only in relation to

the speaker's body, but also in relation to preceding and subsequent gestures. In fact, the hand configuration appears well below the region where this speaker and also the other subjects of the this study produce the majority of gestures referring to grammatical categories and sentence structure. It is thus an unusual, marked usage of space (Waugh 1982), which receives some of its semantic properties in relation to the unmarked region of gesture space (in front of the speaker's torso) which indirectly functions as a point of reference.



Figure 1. Gesture representing 'subcategory' placed comparatively low in gesture space

If one were to accompany the same term ('subcategory') with the same object gesture but located, say, in front of one's chest, the effect of the gestural illustration would not be as insightful. And, if one were to produce the same gesture on the mention of a word referring to a concrete item, it would express that concrete entity and not, as in this case, an abstract category. Here, the abstract category is metaphorically represented in terms of an imaginary physical object (or container) that fills the space between the two hands. It can be seen as reflecting the metaphorical concept *IDEAS ARE OBJECTS* or *CATEGORIES ARE CONTAINERS* (Lakoff and Johnson 1980). At the same time, a second spatial metaphor is evoked: the 'subcategory' is literally placed underneath the superordinated category it relates to. In the course of the paper, we will explore various ways in which space becomes meaningful in gestural representations of grammar.

The structure of the chapter is as follows: section 2 describes the data and methodology of this study. Section 3 presents the results of the form analysis, providing an overview of the prominent hand configurations and motion patterns. In section 4, the findings are discussed in light of A) image and motor schemas proposed in the cognitive linguistics literature and B) issues of object representation and spatial relations more generally. The chapter concludes with a summary of the main characteristics of the gestures discussed and suggestions for further research.

2 Data and methodology: discourse genre, transcription, and coding parameters

2.1 Corpus

The corpus designed for this research comprises twenty-four hours of naturalistic academic discourse and co-speech gestures produced by four linguists (all native speakers of American English; three females and one male). The subjects were videotaped while lecturing in introductory linguistics courses at two American universities. The focus of attention is on the communicative behavior of the professor lecturing; student behavior and teacher–student interaction are not considered here. Topics covered include general aspects of morphology, syntax, and phonology as well as different linguistic theories: generative grammar, emergent grammar, and relational grammar. Correspondingly, a major part of the discourse revolves around the introduction of new concepts and technical terms. In this highly specialized type of multimodal discourse, the objects referred to are for the most part abstract entities and structures: linguistic units (morphemes, words, phrases, etc.), grammatical categories (verb classes, cases, semantic roles, etc.), syntactic structures (clauses, sentences, etc.), as well as operations (the active-passive transformation, subordination, reiteration, etc.). In search for multimodal representations of these entities, the corpus was assessed from a thematic point of view, selecting and capturing episodes in which gestures portraying grammatical phenomena occurred. Such ‘referential gestures’ may depict, according to Müller’s functionalist typology of gestures (1998:110–113), objects, attributes of objects and people, actions, behaviors, etc. Müller further distinguishes referential gestures of concrete entities from gestures depicting abstract entities. As most of the gestures discussed here refer to abstract phenomena, they can be said to be essentially metaphorical in nature. In each semiotic act different iconic and indexical (i.e., metonymic) modes were found to interact to different degrees, but we will not be able to go into these issues of interpretation here (see McNeill 1992, 2005 on gesture categorization and Mittelberg 2008 and Mittelberg and Waugh 2009 for more details on the interaction of metaphor and metonymy in meta-linguistic gestures).

Not only the subject matter talked about, but also cultural practices and pedagogical routines influence the kinds of gestures that accompany meta-linguistic discourse. Given that in Western cultures language is represented as horizontally oriented strings of written words, habits of writing and reading from left to right and filling text spaces from top to bottom can be expected to motivate, among other factors, the graphic representation of language and grammar in gesture. Common practices in grammar and linguistics courses also need to be taken into account, such as diagramming sentence structure and dissecting sentences into functional parts (see Jakobson 1966 for an account of why grammatical patterns lend themselves so well for graphic representation). These factors as well as the use of mediational tools such as blackboards, whiteboards, overhead projectors, and laptops influence the kinds of gestural signs produced in this

specific context as well as their exact execution in relation to the technical equipment and the spatial environment of the classroom.

Working with multimodal usage data involves a series of steps which will be only briefly sketched here. First, the speech of each segment was transcribed adapting the discourse transcription convention provided by Du Bois and colleagues (Du Bois et al. 1993). Then, the gestures were coded according to their kinetic features (see section below) and, in relation to the concurrent speech, the exact speech–gesture synchrony was documented in annotated transcripts.² To this end, the course of each gestural movement (which may include onset, preparation, peak, hold, and return to rest) gets translated into typographic representations, superimposed on the transcribed speech. Each gesture was traced from the moment the articulators (here hands and arms) begin to depart from a rest position until the moment when they return to rest or relaxation. Such a full movement excursion (Kendon 2004:111) is called a gesture-unit (G-unit): ‘The G-unit is defined as the period of time between successive rests of the limbs; a G-unit begins the moment the limb begins to move and ends when it has reached a rest position again’ (McNeill 1992:83). Only gestures articulated with hands and arms were taken into account, leaving aside facial expressions, gaze, self-grooming, and movements of the head and torso (for more details on methods and sample transcripts see Mittelberg 2007).

2.2 Physical gesture features: hand shape, palm orientation, and movement

In gesture research, the most widely used coding parameters are *hand presence* and *hand dominance*, *hand shape*, *palm orientation*, *movement* (trajectory and type), and the *location* in gesture space where a gesture is performed (cf. McNeill 1992, 2005; Kendon 2004; Müller 1998, 2004; Webb 1996). These kinetic features were also used to describe the referential gestures in the present corpus, thereby determining those qualities of a gesture gestalt that contribute most significantly to its meaning and function. For example, in certain cases, the movement proved to be more salient with respect to the meaning of a gesture than the particular shape of the hand performing the movement (e.g., in certain pointing gestures it did not matter whether the hand pointing was a relaxed flat hand or whether the index finger was extended); in other cases, the hand shape is more salient than the contextual movements (e.g., in the case of hands forming a closed fist); and in yet other cases, both dimensions are significant (e.g., a push with an open palm facing the addressee, thus building a barrier and evoking the idea of ‘stop’ or ‘rejection’). As we saw in the subcategory example above, the location in which the gesture is produced may also significantly contribute to its meaning and function.

In order to categorize the *hand shapes*, a data-driven typology of manual signs was developed.³ The data were searched for hand shapes and arm configurations that recurred across speakers and contexts, and a label was assigned to each prominent form. For example, one of the most frequently used hand shapes is a flat open hand with the palm turned upwards, thus building a sort of surface. Here it seemed worthwhile to

build on conventions introduced by Müller (2004) in her study of forms and functions of the palm-up open hand gesture (hereafter referred to as 'puoh'). Each variant of the open hand gesture that occurred in the data was given an abbreviation such as 'puoh', indicating the *orientation of the palm*, plus a short name evoking the degree of openness of the hand ('tray', 'cup', 'lid', etc.) as well as an indication of which hand performed the gesture. For instance, 'puoh-tray-lh' stands for a flat palm-up open hand, produced with the left hand, evoking the shape of a tray. Or, 'pcoh-box-bh' stands for another frequent gesture consisting of two hands held apart, with both palms being held vertically and facing each other and thus pointing to the center of gesture space (i.e., 'pcoh' stands for palm-center open hand and the 'center' denotes the direction that the palm is facing). A variant of this gesture was discussed above in the subordination example (Figure 1).

Gestures typically involve some sort of *movement* through space and are as such a comparatively fluid medium: they usually vanish as quickly as they emerge, often melting into one other. Describing such manual actions entails the range and *trajectory* of the performed motion (for example, along horizontal, vertical, or diagonal axes) as well as the *manner* of the movement (straight line, wave, rotation of the wrist, etc.). When a gesture appeared unusually forceful, the energy level with which the movement was carried out was taken into account. Instances in which a movement is discontinued or a configuration is being held (e.g., the so-called gesture hold, cf. McNeill 1992) were also recorded. In keeping with the notational conventions used for hand shapes, the prominent movement patterns were given labels that inform about their trajectory and manner. For example, 'vert-trace-rh' signifies a line that is traced vertically with the right hand, and 'wrist-rotal-lh' refers to a wrist rotation performed with the left hand.

2.3 Location in gesture space

Manual gestures take shape in physical space. The range, organization, and preferred use of a person's gesture space is conditioned by factors such as age (children vs. adults), cultural background, and personal style, among others (cf. Calbris 1990; Goldin-Meadow 2003; Kendon 2004; McNeill 1992; Müller 1998). Not surprisingly, the space parameter has entered gesture research in various ways, shedding light on spatial cognition, culturally-determined conceptualizations of space, etc. (cf. Haviland 2000; Levinson 1997, 2003; Núñez and Sweetser 2006; Sweetser 2007). Gesture space is relative to, and constituted by, the position and posture of the speaker-gesturer who, in each communicative instance, sets up the coordinates of gesture space around her, according to the dimensions and movements of her body, her gestural articulators (here arms and hands), her physical environment, and, if applicable, also according to the interpersonal, social space spanning between herself and her interlocutor(s). The location of a gesture can be described from various angles: relative to the gesturer's body, relative to previously or subsequently produced gestures, or relative to the addressee's gesture space. In gesture, space is exploited to indicate and describe the location of objects, people, places, events, and ideas, as well as the spatial relationships among entities and persons, a task that

is generally more difficult to master with purely linguistic means (cf. Emmorey 1996; Emmorey and Reilly 1995 regarding the use of space in signed languages).

In terms of the perspective from which a scene or an object may be described in a given speech event, the speaker-gesturer can represent alternate viewpoints: observer viewpoint, character/participant viewpoint, as well as the addressee's viewpoint (cf. McNeill 1992:118–25; Sweetser 2007). It is probably a matter of teaching experience and pedagogical awareness whether a teacher assumes her or his own point of view or the audience's perspective. In any event, these considerations determine how the use of gesture space is organized. When freely gesturing (and not pointing at information on the blackboard or screen), the professors videotaped for the present study were most of the time facing their student audience, and both observer viewpoint and addressee's viewpoint could be made out in their gestural descriptions of grammatical categories and structures. For example, the subjects alternatively illustrated the word order in a sentence by drawing an imaginary line starting either on the left side and ending on the right side of their body, or in the opposite direction, from the students' left to the students' right side. Some cognitive and perceptive flexibility thus needs to be assumed at both ends of the speech and gesture event (for a discussion of frames of reference in ASL see Emmorey 1996; Liddell 2003; Wilcox and Morford 2007).

To document the locations where gestures occur and the trajectory they trace, gesture researchers have developed systems to compartmentalize gesture space into sectors. For example, McNeill established a shallow disk consisting of concentric squares superimposed on a drawing of a seated person, thus reflecting the semi-experimental set-up in which speakers were asked to retell animated cartoons (McNeill 1992:86–89, 2005:274). Since the conditions under which the present data were collected were not controlled in any way, and since teachers tend to walk around in the classroom and constantly change their position and the angle with which they turn towards the audience, blackboards, overhead projectors, laptops, etc., there were no stable space coordinates. Instead of investigating the relative density of occurrence of certain gesture types in particular sectors of gesture space (e.g., in relation to different body parts), or correlating gesture location and discourse function, which are possible ways to exploit the space factor in gestural communication (cf. McNeill 1992: 88ff.), one of the main interests here was to determine the ways in which the speakers' use of gesture space could reveal aspects of their spatial representations of abstract phenomena. This is, as will be shown below, where different geometric and image-schematic representations of linguistic form and structure come into play.

3 Study: prominent hand configurations and motion patterns in meta-grammatical gestures

The aim of this section is to provide an overview of the prominent gestural forms that were found to illustrate verbal explanations of linguistic form, grammatical relations and syntactic functions. The point of departure here was the physical forms of gestures exhibited in the data (i.e., hand figurations, manual actions, or imaginary lines drawn

in the air). Only then did the analysis turn to the abstract ideas and structures which gestural signs stand for in a given moment, taking into account the concurrent speech. Since the scope of the paper does not allow for a detailed account of the cross-modal distribution of semantic features and pragmatic functions, the discussion below will be mainly restricted to the material properties of the gestures (see Mittelberg 2006, 2008 and Mittelberg and Waugh 2009 for detailed content analyses).⁴

3.1 Prominent hand and arm configurations

The gestalt of a given gesture relies on the semiotic collaboration of several parameters, of which the hand shape is only one. Yet, the hand shape and/or arm configuration can be said to be salient in a gesture if it is the most notable feature in the process of its articulation. While most of the gestures to be discussed below involve some kind of movement, it is the hand shapes and arm configurations that, especially when being held for a moment, tend to stand out perceptually. As in the example discussed above (Figure 1), the movement leading up to the object-holding gesture is not as perceptually and semantically salient as the bimanual configuration produced on the mention of the term 'subcategory'. Factoring in the speech content it becomes evident that both the specific hand and arm configuration plus its location contribute key qualities to the bi-modally achieved message.

Across the four subjects, the data show recurrent representations of linguistic units as readily manoeuvrable objects. There are several different ways of holding and manipulating such imaginary items, some of which allude to the geometry and/or size of the object, while in other cases no or very little information about the size or form of the object can be inferred. One way to refer to an abstract item is to seemingly hold something placed on a palm-up open hand (puoh). The degree to which the hand is flat, relaxed, or cupped varies from case to case. The potential functions of this basic hand shape have been matched with the actions of holding, presenting, or offering an imaginary object for inspection, and these functions have been observed in diverse contexts (Müller 2004). Variants of the palm-up open hand gesture, also called 'palm presentation' gestures (Kendon 2004) or 'conduit gesture' (McNeill 1992, 2005), were frequently observed in the teaching contexts under investigation here, especially when professors talk about abstract categories or linguistic examples not visibly present in the immediate environment (an alternative would be to point to words written on the blackboard).

The following list comprises the different open-hand variants found in the data, some of which will be illustrated and discussed in more detail below. As indicated in the methods section above, each type was assigned an abbreviation referring to the openness and orientation of the palm (such as 'puoh') plus a 'name' and an indication of which hand was used (some of the palm-up open hand abbreviations follow Müller 2004). Finally, an abbreviation signals which hand was used. While, theoretically, the hand shapes listed below could be produced simultaneously by each hand, they were for the most part observed to be executed with only one hand at a time.

Single open and closed hands

rh: right hand; lh: left hand

A. puoh-tray-lh/rh	hand as flat surface, supporting imaginary objects
B. puoh-cup-lh/rh	hand with curled fingers, forming a receptacle
C. pfoh-stop-lh/rh	'f' stands for 'front', palm facing audience
D. pdoh-lid-lh/rh	'd' stands for 'down', flat hand
E. pdoh-claw-lh/rh	open hand facing down, fingers curled
F. pcoh-blade-lh/rh	'c' stands for palm facing center of gesture space
G. fist-lh/rh	closed fist

The last gesture type listed above is in fact the opposite of an open hand: it is a closed hand forming a fist. Other hand shapes involving specific finger configurations include 'measure' (thumb and index finger are stretched apart, tips pointing upwards, similar to the way one might take measure in inches), 'pinch' (the tips of index finger and thumb are pressed against one another), and 'scrunch' (fingers are held closely together, facing audience, tips pointing towards the floor).

Specific finger configurations

H. t-i-measure-lh/rh	't' for thumb, 'i' for index
I. pinch-lh/rh	fingertips of index and thumb pressed together
J. scrunch-lh/rh	similar to pinch, but different orientation and finger configuration, back of hand facing audience, tips pointing towards floor

Another category of gestural shapes engages not only hands but also parts of a speaker's arm(s). Most of the observed pointing gestures fall into this category, as they are usually produced with both an extended arm and hand, exhibiting either an extended index finger ['ind-index'] or the entire, mostly relaxed hand ['hand-index']. Together, hand and arm build a vector, or a path, leading to the targeted referent (e.g., an object, a person, information written on the blackboard, or to certain locations in gesture space right in front of the speaker). In addition, there were arm configurations depicting chunks of a syntactic tree diagram by mirroring the triangle-like shape of such diagonally downward branching structures ['diag-arm'].

Pointing gestures and other kinds of arm configurations

K. ind-index-lh/rh	[pointing with generic extended index finger]
L. hand-index-lh/rh	[pointing with full, relaxed hand]
M. diag-arm-lh/rh	[arm held diagonally, forming a triangle-like shape if both arms are involved]

Other gestures observed in the data are always performed with two hands, evoking an internal structure, or what has been called ‘syntax’ (cf. Kendon (2004:275ff.) on Open Hand Supine gestures with lateral movement). Examples are the gesture mentioned above in which the imaginary object is held between two hands, or a gesture conveying the idea of a balance by seemingly weighing two things, with two palm-up open hands moving alternately up and down, one on each side of the body.

Open hand variants performed with both hands (bh)

N. puoh-tray-lateral	[balance]
O. puoh-cup-lateral	[balance]
P. puoh-sym-offshoot	[hands thrown laterally up into the air, from center outward]
Q. pcoh-box-bh	[refers to an elongated object held between both hands]

The data were searched for instantiations of each of these identified shapes (and movement patterns, to be discussed below) across topics and speakers. For most of these forms, several instances were identified and assessed with regard to the concurrent speech content and the overall meaning of the multimodally achieved representation. Below, a selected set of these hand shapes will be illustrated and discussed in more detail.

3.1.1 Single open and closed hands: surfaces and containers for abstract entities

Comparatively small linguistic units, such as morphemes, words, and categories were represented as objects seemingly resting on a variant of the palm-up open hand gesture or inside a closed fist. The gestures shown in Figures 2 and 3 are instances of palm-up open-hand gestures with a flat palm or cupped hand evoking a kind of surface or a receptacle where items can be placed (i.e., imagined) and presented to the audience. From just looking at the hand shape it might not be clear whether the action the hand is performing represents an act of offering, receiving, showing, or requesting an item. In conjunction with the speech content, however, it turns out that the gesture in Figure 2, for instance, represents the action of receiving. It denotes a technical term, namely the semantic role ‘recipient’, by showing an open hand ready to receive an object. A similarly shaped gesture fulfills a different function in Figure 3, where the speaker is explaining the fact that an idea can materialize in discourse in the form of a noun or a verb. On the mention of ‘a noun’ she creates a sort of tray on which the emerged form is being presented to the audience.



Figure 2. puoh-cup stands for recipient



Figure 3. puoh-tray stands for a noun

By seemingly handling small imaginary objects, linguistic units are thus reified and made graspable for the mind. Flat open hands provide surfaces, planes, or, put more generally, support structures, exposed to the eye of the addressee, on which the item referred to in the speech modality can be imagined. Alternatively, the absence of an entity or the expectation to receive something can be signaled. Similar functions can be performed by cupped hands (with clearly curled fingers), building a sort of open container (see Figure 12 below). While the focus here is on the formal properties of open hand gestures, it needs to be kept in mind that the meaning of a gesture results from both its form and the function it plays in a given speech event (see Müller 2004 for a detailed account of forms and uses of the palm-up open hand gesture and also Kendon 2004). Abstracting from these pragmatic considerations, the central point here is that these open hand gestures seem to embody the image schemas SUPPORT (Mandler 1996) and CONTAINMENT (Johnson 1987; Lakoff and Johnson 1980) respectively.

As the next examples suggest, imaginary small objects can also be held in tightly closed hands. In Figure 4, the speaker refers to grammatical 'knowledge' while forming a fist (left hand) and to the idea that 'knowledge becomes automatized' with usage when forming a second fist (right hand). While talking about the fact that the word 'teacher' consists of two parts (the morphemes 'teach-' and '-er'), the speaker in Figure 5 encloses each component in a fist: the right hand holds the lexical morpheme 'teach-' and the left hand the grammatical morpheme '-er'. The spatial difference between the two hands evokes the conceptual difference between the two functionally distinct elements forming one word, thus instantiating the metaphorical concept PHYSICAL DISTANCE IS CONCEPTUAL DISTANCE (Sweetser 1998). At the same time, the two hands jointly allude to the internal structure of the word 'teach/er'. In both cases, the fists are first formed successively and then held simultaneously, as shown in the figures below (see Mittelberg 2008 on diagrammatic iconicity holding between the two hands).



Figure 4. Fist(s) for knowledge (grasp/mastery)



Figure 5. Fists containing morphemes (teach-er)

While here, too, the image schema CONTAINMENT manifests itself in these gestural representations, the fist seems to have, compared to the open hand variants, a different semantic import. It evokes the idea of having, literally and metaphorically, captured a concept, of having a firm grasp of it: one knows how to handle a certain phenomenon. Inside the closed hand, there is no space for maneuvering. At the same time, the object enclosed in the hand container is invisible and not much information about it is accessible, which stands in contrast to exposing an idea on an open hand for inspection and commentary, or alluding to the fact that one does not have an answer and is thus 'empty-handed' (cf. Müller 2004).

3.1.2 *Different amounts of space between the articulators*

We will now look at some hand shapes where the configuration of individual fingers and the existence or nonexistence of space between the articulators play a significant role. The two examples below represent cases of what was called a pinch in the list provided above. A pinch involves the index finger and thumb pressed together. For example, the gesture shown in Figure 6 expresses the idea of a precise list of categories in the theory of relational grammar, by drawing, with the index finger and thumb pressed together (indicating the idea of 'precise') a vertically descending line (depicting the idea of a 'list'). In a similar fashion, the gesture in Figure 7 features no space between the fingertips. However, unlike the gesture in Figure 6, it bears a stronger resemblance to what is generally known as the ring gesture due to the slightly more rounded fingers; this gesture occurs across cultures and contexts with different coded meanings, ranging from tangibility, to precision and perfection (Kendon 2004; McNeill 2005; Müller 1998). Here, in the context of a syntax lecture, it has a different designation: it co-occurs with the mention of the technical term 'node' which is a juncture point at the top of a branching structure in tree diagrams used in the framework of generative grammar.



Figure 6. Pinch indicating precise list of categories **Figure 7.** Pinch/ring indicating 'node'(tree)

An alternative way to refer to small items is to seemingly hold them between the tips of thumb and index finger, as if one were taking measure. In other words, there is some space between the two fingers, which might suggest a virtual object filling the space. For example, in Figure 8, the small space between index finger and thumb indicates the compact nature of the pronoun 'it', alluding to the placement and function of such minimal forms in phrasal verb constructions. The gesture in Figure 9 stands for a verb form ('fell') at the end of a sentence ('Diana fell').



Figure 8. Measure representing pronoun 'it'

Figure 9. Measure representing verb 'fell'

A gesture heavily used to represent parts of speech, words, phrases, and sentences depicts a comparatively bigger imaginary object as being held by two, relatively relaxed, open hands with palms facing each other. The examples below show two of the more expansive versions in which speakers hold the hands relatively far apart to represent

a sentence (Figure 10) or a constituent (Figure 11). These gestures can also be said to reflect the image schema CONTAINMENT or, if one focuses on the fact that phrases and sentences have a beginning and an end, by the SOURCE-PATH-GOAL schema (Johnson 1987; Lakoff and Johnson 1980, 1999).



Figure 10. pcoh-box representing a sentence



Figure 11. pcoh-box representing a constituent

In view of the representations discussed so far, space seems to carry meaning in specific ways. Although there is no direct correspondence between the amount of space extending between the articulators and the physical characteristics of the elements referred to, there is a tendency for smaller individual linguistic units to be represented as being held in one hand (Figures 2, 3, 5, 8, 9) and for comparably more complex constructs such as entire phrases or sentences to be represented by objects held (or space extending) between both hands of the speaker (Figures 10 and 11). In the latter cases, the geometry of the objects held between two hands is specified to a higher degree than the shape of objects seemingly sitting on open hands and remains rather undefined. In both scenarios, however, the mind needs to fill in information according to the cues provided by the hand constellations as well as the concurrent speech content (see Mittelberg and Waugh 2009). It should be noted that it is difficult at times to decide whether one can assume objects or whether it is rather about delineating the space extending between fingers or hands.

3.1.3 *Pointing gestures and specific arm configurations*

While parts of the speakers' arms were involved in different fashions in many of the gestures discussed above, we now turn to configurations in which arms are instrumental in the gestural sign formation. As we will see, arms may be recruited to build signposts in pointing gestures or to directly stand for elements of the object they depict (cf. Müller's (1998) modes of gestural representation).

The spatial orientation and angle of pointing gestures depend each time on the location of the object towards which they are directed. Through the act of pointing at something in the proximity of the speaker (e.g., on the mention of a demonstra-

tive pronoun) the object is established via a vector consisting of a path evoked by the extended arm and hand and its virtual extension leading to the targeted object. Such deictic gestures highlight spatial relationships between the speaker and objects, locations, or people, whether they are present in the environment, imagined, or previously introduced in the unfolding discourse (cf. Fricke 2002, 2007; Furuyama 2001; Kita 2003; McNeill 1992, 2005; McNeill et al. 1993; Sweetser 2007; Williams 2004).

To illustrate and anchor their explanations, the speakers frequently point to information presented on blackboards, whiteboards, or overhead screens. An example of this is given below (Figure 12). Talking about the difference between main verbs and auxiliary verbs, the speaker points with his right hand to words projected onto the screen behind him (on the mention of 'there is'), thus creating a vector between the position of his body (i.e., the deictic center or *origo* of the speechact, according to Bühler 1934) and the referent of the concurrent deictic expression. It can also be taken as an instantiation of the SOURCE-PATH-GOAL schema with the path leading the interpreting mind to the object referred to. Completing his sentence (started with 'there is'), the speaker forms with the left hand a cupped palm-up open hand gesture (on the mention of 'the main verb;'). A concrete example of a 'main verb' is being pointed at on the screen ('taught'), while the abstract category as such is to be imagined as being inside the cupped hand directed towards the student audience.

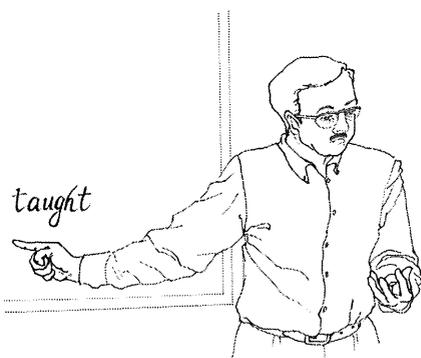


Figure 12. Index('there is') plus cup 'the main verb' **Figure 13.** Semantic roles 'bounce around'

Another way of assigning meaning to space is to virtually place things in gesture space or to simply point to locations in space, for instance when enumerating a list of things. In the example above (Figure 13), the speaker talks about the different 'semantic roles that bounce around in linguistics,' and represents each type of semantic role with a different gesture produced in a different place. The gesture shown here is made on the mention of the term 'agent' (we already looked at the gesture for 'recipient', cf. Figure 2). Metaphorically speaking, this gesture can be interpreted to reflect the metaphor IDEAS ARE LOCATIONS; it can also be seen as an instance of metonymy of place (PLACE FOR OBJECT). By dispersing categories in space, the physical distance between the assigned locations represents the conceptual distance between the different semantic roles and

their respective functions (agent, patient, goal, recipient, experiencer) thus evoking the metaphorical mapping CONCEPTUAL DISTANCE IS PHYSICAL DISTANCE (Sweetser 1998).

As for gestural constellations involving both arms, let us look at Figure 14. Here the speaker illustrates a part of a syntactic tree diagram by forming a triangle-like shape, achieved with the fingertips touching at the center top and both forearms held diagonally with elbows pointing outwards. Mirroring a part of the diagram on the blackboard behind the speaker, the evoked pyramid directly imitates a tree chunk. Put differently, the arms of the speaker embody conceptual structure. Such depictions provide more substance than lines quickly traced into the air and lend, as such, otherwise relatively fleeting representations a higher degree of stability in space and time.



Figure 14. Phrase structure as a lateral diagonally branching tree chunk



Figure 15. index pointing to ground: subordination

Illustrating the idea of subordination, the speaker in Figure 15 combines a pointing gesture with a representational gesture that can also be interpreted as standing for a tree branch descending to the right lower side of her body. She indicates that there are certain cases in which embedded sentences go 'all the way down', at which point she directs her fully extended right arm towards the floor and points with her index finger straight to the ground. As it was the case in the subcategory example discussed above (Figure 1), the descending arm evokes a spatialization of the idea of subordination by reaching into comparably low regions of gesture space. Alternatively, the speaker drew the same kind of geometric configurations in the air, tracing either only a single diagonal line or two diagonal lines downward, one to each side of her body (see also Figure 14). This kind of dynamic representation serves as a bridge into the section below where motion patterns will be discussed.

3.2 Motion patterns

In gesture, form can be created not only by hand and arm constellations, but also by fleeting hand movements that draw simple lines or contours of objects in the air, thus leaving imaginary traces in gesture space. Identifying significant motion patterns recurring in the data entailed determining for each dynamic gestural gestalt those qualities that contribute most significantly to its meaning. Again, this can ultimately only be done in correlation with the concurrent speech content and particularly with those speech segments that coincide with the peak, or 'stroke' phase, of a gesture (McNeill 1992). In most cases, hand shape and movement do interact in one way or another; yet, the discussion below concentrates on the different trajectories and/or manners of those hand motions that appear constitutive of the gestural signs (which in turn stand for the abstract ideas and structures they convey).

One can generally distinguish between several types of gestural movements. For example, the movement of a hand can result in the evocation of a form (such as the size and shape of a guitar). It may also be influenced by the object that is involved in the action imitated by the hand movement (such as the unlocking of a door with an imaginary key), or it can simply imitate a manual action (such as waving at somebody) or the manner and/or speed of a movement executed by a person or an object (for research on motion events and the description of movement and manner in gesture see McNeill 1992, 2000; Müller 1998; Slobin 2003). The hand movements observed in the present data were also found to exhibit several intrinsic logics: first, movements carried out by hands tracing straight lines or curved lines imitating the shape of a wave, circle, or arch (these movement types bring to bear the different planes in the gesture space such as horizontal, vertical, and front-back); second, there are pointing gestures whose direction and range depend on the location of the object or person pointed at (cf. section 3.1.3); third, object-oriented actions such as placing something; and fourth, basic motor actions with no object involved, such as two hands rotating around each other. These distinctions concur with previously made observations that a large number of gestural shapes and movements originate in concrete object manipulation and are abstracted from and structured by routinized interactions between the human body and the physical and social world. Accounting for the noted variety, Müller's (1998) system of modes of gestural representation include manual actions such as drawing, molding, enacting or embodying (see also Calbris 2003; LeBaron and Streeck 2000; Streeck 2002). Although the schematic representations and drawings provided below only render frozen visualizations of dynamic gestural gestalts, and while this sort of qualitative approach needs to be complemented by quantitative investigations across subject matters and speakers, the identified patterns offer a window into some of the ways in which hand movements unfolding in a teacher's gesture space may reveal aspects of the underlying conceptualizations of abstract concepts and structures. The following typology of gestural motion patterns was established:

Linear movements (horizontal/vertical/diagonal)

A. hori-trace-lh/rh	horizontal line	
B. vert-trace-lh/rh	vertical line	
C. diag-trace-rh	diagonal line	
D. diag-trace-ll	diagonal line	
E. diag-trace-lat	lateral diagonal line	
F. scale-lh/rh	hand trace vertically organized steps/levels	
G. hori-join-lat	horizontal line drawn with both hands going inward or lateral inward movement or a more forceful push	
H. hori-part-lat	horizontal line drawn with both hands, (lateral outward movement)	
I. push-lh/rh/bh	push away from body along a straight line, not curved (exploiting depth along sagittal axis)	
J. pull-lh/rh/bh	pull toward body along a straight line, not curved (exploiting depth along sagittal axis)	

While the movements listed above exhibit linear trajectories along the major axes, non-linear representations along the horizontal and the vertical axes also occurred; additional non-linear configurations include both half and full circles:

non-linear traces

K. hori-wave-lh/rh	wavy line traced in the air, along a horizontal axis	
L. diag-wave-lh/rh/	wavy line traced in the air, along a diagonal axis	

curves and circles

M. curve-up-lf/rh	hand(s) move(s) along upper half of circle	
N. curve-dn-lf/rh	hand(s) move(s) along lower half of circle	
O. circle-lh/rh/bh	hand(s) complete(s) one full cycle, rotation	

Other motor actions of hands, not involving simple traces of the manipulation of imaginary objects, include the following two types of rotations:

- P. rotation-lateral both hands (and arms) draw circles repeatedly rotating around one another
- Q. wrist-rotation-lh/rh/bh wrist rotation, occurs with different orientations

Below, I will discuss several examples of hand movements that evoke dynamic images of abstract entities and processes – even if it is just via an imaginary trace left in the air (the dynamic nature of the movements can unfortunately not be fully appreciated without viewing the video clips).

3.2.1 *Linear movements (horizontal and vertical traces)*

Sentences and other sequences of linguistic units were found to be represented by movements tracing the horizontal alignment of words from the left to the right of the speaker ('hori-trace'), or, if the viewpoint of the audience was assumed, from right to left. A slight variation of such schematic representations of sentence structure is shown in Figure 16 below, where the gesture starts out with both hands joined at the center of gesture space, right in front of the upper torso of the speaker. Subsequently, the hands move laterally outward until both arms are fully extended, as if they were tracing, as mentioned in the concurrent speech, 'a string of words' ('hori-part').



Figure 16. A sentence as a string of words



Figure 17. The infix goes into the middle of another morpheme

The gesture in Figure 16 depicts 'a sentence' as a 'string of words' drawn horizontally in the air, with both hands starting in front of the speaker's chest and being pulled outward to each side of the body. A vertically descending line was already shown in the gesture representing a list of categories (Figure 6); it also underlies the gesture whose beginning

point is illustrated in Figure 17 above. After setting the stage by mentioning that words in English may have prefixes and suffixes, the speaker explains the position infixes take in the structure of a complex word. In the moment captured above, the speaker is just about to insert an infix into a word stem. The idea of insertion is depicted by a well-defined vertical trajectory traced by the hand (executed on the mention of ‘morphemes that go right into the middle of another morpheme’), until the hand seems to hit the base form which he quickly sketches as a container by drawing its horizontal base line and then alluding to its two outer sides with a bimanual palm-center open hand gesture.

In addition to horizontal lateral outward movements such as the string depicted in Figure 16, the data also exhibit lateral inward movements that are executed with a higher energy level. For example, as shown in Figure 18, the idea that, according to the theory of emergent grammar, boundaries between grammar and language use are ‘blurred’ is illustrated by a gesture that starts out with two hands apart, palms facing each other, but the palms then get suddenly pushed towards each other to convey the idea of fusion. Similarly, the speaker in Figure 19 talks about the behavior of words that like to ‘go together’ and ‘travel together to the front of the sentence’, which is portrayed by two fists being quickly and repeatedly brought together. In both cases, physical closeness signals conceptual closeness and is achieved through physical forceful action. We can thus observe an interaction between image and force schemas.



Figure 18. ‘hori-join’, blurring boundaries



Figure 19. ‘hori-join’, words go concepts together (travel)

3.2.2 *Non-linear traces*

Let us now look at some non-linear motion patterns. The first two images below show instances of wave-like motions along a horizontal axis. In Figure 20, the speaker draws, on the mention of ‘non-linearity’, a wave-like graph consisting of a first curve going

down and a second one going up. The speaker in Figure 21 makes an almost identical motion to represent the concept of 'intonation contour', except that the motion goes in the opposite direction.



Figure 20. Horizontal wave for 'non-linearity'



Figure 21. Horizontal wave for 'intonation contour'

There are also instances of larger arch-like structures that are executed with both hands. The following gestural demonstration, taken from a morphology lecture, provides an example of the understanding that the two elements that jointly build a circumfix (by surrounding the word stem) seem to be attached at a level above the word level. In her attempt to illustrate the hidden organization of such complex morphological structure (or, the strings attached), the speaker makes an arch-like gesture whose initial phase is captured in the image below (Figure 22). After holding both hands above head level, the speaker simultaneously draws them down to waist level, one hand to the left and one to the right of her body. The idea that the 'circumfix encompasses the front and back of the word' is subsequently represented by a bimanual palm-center open hand gesture (not shown here; it resembles the gesture in Figure 11). Her two hands seem to be holding the entire morphological structure by its front and back, where the indications 'front' and 'back' do not refer to spaces closer to or farther away from the speaker's body (which would refer to the sagittal axis that runs through her body from the space behind her back to the space in front of her). Rather, the front of the word is located to the left of the speaker and the back of the word to her right, in accordance with the conceptualization of written words and sentences as extending from left to right in front of the speaker/reader/writer (in Western cultures).



Figure 22. Circumfix as arch gesture

Another kind of arch-like gesture was found in the context of teaching the framework of relational grammar. Whereas the gesture in Figure 22 is a spontaneous depiction of morphological structure, other arch-like gestures have been observed that were motivated by a standardized diagram used in the framework of relational grammar (the diagrams are often compared to igloos or umbrellas). For example, a speaker explains the concept of ‘multi-attachment’ (i.e., the idea that subject and reflexive pronoun refer to the same person) as follows: first, the right (dominant) hand rises to head level and comes down making a slight arch-like swing to the right. Then, the left hand rises and makes a similar arch-like movement downward (this gesture is not reproduced here). In the videotape one sees the corresponding diagram on the blackboard in the background of the speaker; it shows exactly the kind of lines that the speaker draws in the air. Correspondingly, this gesture visualizes syntactic relations in terms of spatial structure: schematic arch-like lines cutting through several zones layered on top of each other.

It is important to keep in mind that some of the gestures discussed above are informed by a particular theoretical view of grammatical concepts and relations (i.e., generative grammar or relational grammar). Without the relevant theoretical background it would probably be difficult to make sense of such gestural diagrams. They are dynamic renditions of hypothesized conceptual relations translated into spatial configurations; without any kind of visual support, their adequate description in solely linguistic terms would probably be less economic and also less effective (see Mittelberg 2008 for a Peircean approach on image and diagrammatic iconicity in such metaphoric gestures). What all these gestures have in common is that they are based on theories that rely on a specific set of metaphors representing different understandings of language and grammar.

To conclude this section, we can say that some of the geometric gestural representations (diagonals, triangles, and arches) are in fact not the spontaneous creations of the speakers, but they instead are rooted in scientific conventions. The manual routine of literally drawing diagrams on paper or blackboards is likely to influence how speakers represent connections between words or grammatical constituents via hand movements through space. Those shapes and motion patterns that are created ad-hoc seem to be motivated, at least in part, by object-oriented actions (such as drawing, writing,

and manipulating objects), and specific motor actions (e.g., wrist rotation). In all the cases, however, the anchor points for these representations are the human body and its articulators' range of possible movements as well as the dimensions constituted by the physical classroom setting and teaching tools. Embodied practices are exploited to fleetingly visualize conceptual images of abstract entities and structures in terms of physical objects, bodily actions, and locations in space. These forms of mediation between the conceptual and the embodied may offer insights, as will be detailed below, into the central role played by image and motor schemas (and their metaphorical projection) which seem to motivate and structure, at least partly, gestural representations of abstract knowledge domains and other types of intangible things such as values and beliefs in a systematic way.

4 Discussion: dynamic manifestations of geometric and image-schematic patterns

The gestures examined here are ephemeral and partial representations of objects and actions that metaphorically refer to abstract entities and operations. As the spectrum of emergent patterns discussed above suggests, some of the gestural forms and movements indeed reflect geometric and image-schematic representations of grammatical concepts and structures. Due to the fluid character of the gestural medium, the schematic images are never fully visible at once; they may find expression in a virtual trace left by a hand movement or by invoking the manual action of holding an object. It is left to the mental eye of the addressees, or to their own bodily experience with such actions, to fill in the missing pieces. In what follows, I will take these observations a step further and address some of their implications in terms of image and motor schemas (section 4.1) and regarding geometric representations of objects and spatial relations more generally (section 4.2).

4.1 Gestural instantiations of image and motor schemas

As we have seen above, hand shapes and movements collaborate in building holistic gestural gestalts. The study presented here has revealed some of the ways in which the salient properties of such multidimensional figurations give minimal information that may evoke full schemas of objects and actions. In what follows, I would like to elaborate the idea that the prominent patterns identified in the data can be recruited as tangible, non-verbal evidence for image schemas which are assumed to be part of the 'cognitive unconscious' (Lakoff and Johnson 1999:9–15). Rereading Johnson's (1987:XIV) original definition of image schemas as 'recurring, dynamic patterns of our perceptual interactions and motor programs that give coherence and structure to our experience' with gesture in mind, reinforces the assumption that gesture is a crucial source of manifestations of such embodied patterns and that in order to account for

their dynamic nature one needs to consider not only visual but also kinesthetic aspects of image schemas (see also Cienki 1998 a/b, 2005 and Sweetser 1998, 2007).

Based on gestural representations of grammar, the present work offers support for the 'semiotic reality of image schemas' (Danaher 1998:190). In particular, the following correspondences between gestural patterns (cf. section 3) and basic image schemas are suggested (cf. Johnson 1987; Lakoff and Johnson 1980, 1999; Mandler 1996, 2004):

SUPPORT	('puoh-tray', 'puoh-cup')
CONTAINMENT	('puoh-cup', 'fist')
OBJECT	('puoh-tray', 'puoh-cup', 'pcoh-box', 'fist')
SOURCE-PATH-GOAL	('hori-trace', 'vert-trace', 'diag-trace', deictics such as 'hand-index', 'ind-index', 'diag-arm')
EXTENSION	('hori-trace', 'vert-trace', 'diag-trace', deictics such as 'hand-index', 'ind-index', 'diag-arm')
BALANCE	('puoh-tray-bh', 'puoh-cup-bh', 'fist-bh', 'sym-offshoot')
SCALE	('scale')
CENTER-PERIPHERY	('sym-offshoot', 'hori-join', 'hori-part')
CYCLE	('circle-bh', 'wrist-rotation', 'rotation lateral')
ITERATION	('wrist-rotation', 'rotation lateral')
FRONT-BACK	('push', 'pull')
FORCE	('push', 'pull', 'hori-join', 'sym-offshoot')

The schemas PART-WHOLE, LINK, CONTACT, and ADJACENCY are not discussed here, yet contiguity relations (i.e., metonymy) proved to be particularly relevant for representing relationships between individual elements jointly constituting an entire phrase or sentence (cf. Mittelberg 2008 and Mittelberg and Waugh 2009). Furthermore, basic geometric shapes (e.g., circles, semi-circles, triangles, rectangles, squares) were identified as well as straight and curved lines traced along horizontal, vertical, and diagonal axes, as well as the sagittal axis (front-back). Perhaps not too surprisingly, the list above contains for the most part spatial and spatial relations image schemas which are assumed to structure systems of spatial relations cross-linguistically (Lakoff and Johnson 1999:35). In his experimental study on image schema manifestations in co-speech gesture, Cienki (2005) tested the potential of image schemas (i.e., PATH, CONTAINER, CYCLE, OBJECT, and FORCE) as descriptors for several types of gestures accompanying discourse on matters of honesty. Results suggest that 'image schemas are readily available, indeed "on hand" for recruitment as gestural forms' (Cienki 2005:435); they may be represented in the gesture modality as either static entities or dynamic processes. Cienki also found that gestures can invoke different schemas than the accompanying linguistic track, thus providing additional information to discourse participants.

The array of image schemas Cienki (2005) employed in his experimental study as well as the above list of image-schematic patterns found in the present discourse data contains some of the schemas that belong, according to Mandler (1996:373-8), to the preverbal, spatially structured meaning system: SUPPORT, CONTAINMENT, PATH, and CONTACT. Mandler maintains that these image schemas are spatial representa-

tions, or spatial abstractions, that result from perceptual analysis, which in the development of infants comes before object manipulation.⁵ Moreover, such spatial analyses performed by the infant are supposed to be important in learning the relational aspects of language, e.g., the meaning of verbs and locative prepositions such as ‘on’ and ‘in’ (cf. Bowerman 1996; E. Clark 1973; H. Clark 1973). Although no conclusive statements can be made on the basis of the observations presented here, Mandler’s assertions are relevant regarding the spatialization of grammatical relations in a modality that is utilized for communication by infants prior to language (cf. Goldin-Meadow 2003 on gesture and language development). Mandler also concedes that dynamics and internal feelings would be more difficult to analyze. Here, too, gesture research promises to further augment our understanding of the bodily logic of image and particularly of force schemas (Talmy 1988).

Recent work on image schemas comprises a variety of understandings and definitions (see contributions in Hampe 2005), but overall the notion of embodiment seems to be taken more and more literally: there is a tendency towards the realization that the human body’s intuitive expressions and culturally-shaped practices represent a rich source of insight into how higher cognitive activities may be grounded in dynamic patterns not only of bodily perception and movement, but also of social behavior. Johnson (2005) strongly advocates the importance of putting flesh on image-schematic skeletons and of trying to account for the felt qualities of meanings and situations (see also Cienki 2005; Deane 2005; Gibbs 2005; Zlatev 2005). One of the central questions still seems to be how multi-faceted meanings, especially in abstract reasoning, emerge from embodied experience:

But let us not forget that the truly significant work done by image schemas is tied to the fact that they are not merely skeletons or abstractions. They are recurring patterns of organism-environment interactions that exist in the felt qualities of our experience, understanding, and thought. Image schemas are the sort of structures that demarcate the basic contours of our experience as embodied creatures. [...] Their philosophical significance, in other words, lies in the way they bind together body and mind, inner and outer, and thought and feeling. They are an essential part of the embodied meaning and provide the basis for much of our abstract inference. (Johnson 2005:31)

In view of Johnson’s (2005:31) exhortation to ‘analyze various additional strata of meaning, such as the social and affective dimensions, to flesh out the full story of meaning and thought’, it seems safe to say that bodily semiotics generally bear the potential to inform us about qualities that are difficult to access via purely linguistic inquiry. Gesture data remain a promising source to explore both structured and intuitive aspects of how we make meaning and also of how we make sense of what others try to convey. In light of these considerations, we can perhaps better appreciate the extent to which the present gesture data bring out the dynamic and embodied aspects of image-schematic and geometric representations of abstract objects and structures: gestures are not simply visual, but visuo-motoric and a bodily medium; hence, they have the capacity to shed

additional light on the assumed multi modal character of concepts and image schemas (cf. Evans and Green 2006). Contrary to static visual representations of words, sentences, and diagrams captured on paper or blackboards, these gestures afford a 'representation of abstract processes as dynamic patterns' (Kendon 1997:112) through a 'dynamic visuo-spatial imagery' (McNeill et al. 2001:11). Linguistic form and structure seem to come to life: branches branch out, words move or travel together to the front of a sentence, and boundaries between concepts get blurred. Instrumental hand actions seemingly manipulating items highlight the process character of operations such as prefixation, suffixation, infixation, or the construction of a sentence. In addition, grammatical operations such as 'reiteration' and 'recursion' were found to be represented by the rotation of a single hand or by two hands revolving around each other, and a similar motor schema was observed to signify the function of a morphological case or the idea of active language use as opposed to the knowledge of grammar. In gesture research, the 'bodily basis of meaning, imagination and reason', the title of Johnson's (1987) ground-laying book, may be taken literally, thus trying to illuminate not only the relationship between the gesturer's body and the imaginary objects and forces it interacts with, but also to explore how meanings are conveyed through minimal movements or forceful hand actions.

4.2 Dynamic representations of objects in places: some preliminary considerations on the 'what' and 'where' in gesture space

Being aware of the preliminary character of the following reflections, I would like to draw together two central aspects that make co-speech gesture a promising source of insights into the relationship between cognition, space, and language: its spontaneous, unreflective character on the one hand and its tendency to reflect schematic imagery and basic geometric forms on the other.

Due to the attention gesture draws to what I like to think of as the 'ex-bodiment' (Mittelberg 2006, 2008) of internalized imagery and experiences with the physical and social world, and due to its propensity to directly portray spatial and sensory-motor aspects of concepts and source domains of metaphorical mappings, gesture research has yielded insights into our understanding of abstract knowledge domains (Calbris 2003; Cienki 1998, 2005; McNeill 1992; Müller 1998, 2004; Sweetser 1998, 2007; Núñez 2004; Taub 2001). Since gestures unfold in space, they are naturally apt at illuminating spatial metaphor, not only regarding linguistic form and structure, but also regarding, for instance, the spatial representation of moral concepts (Cienki 1998 a/b), mathematical thought (McNeill 1992; Núñez 2004; Smith 2003), and concepts belonging to the domain of speech communication (Sweetser 1998).

It is because of their unreflective character that gestural representations of abstract phenomena can offer fresh insights into the metaphorical nature of the conceptual system and, more generally, into less monitored aspects of cognition during communication. Crucially, in the present data, metaphorical understandings of abstract entities are frequently expressed in the gesture modality even if the accompanying

speech is non-metaphorical. The technical term 'subcategory' (shown in Figure 1) is a good example of this kind of multimodal representation of abstract concepts: the metaphorical understanding of a category in terms of a container or object is conveyed only in the gesture modality, not in speech. Other examples would be technical terms such as 'noun', 'constituent', 'node', 'sentence', and 'morpheme' or words or parts of words such as 'fell', 'teach-', and '-er'. In contrast to carefully planned and executed pictorial metaphors deployed in advertisements, cartoons, and paintings, spontaneous metaphorical gestures may provide more intuitive renditions of mental imagery, created locally and online (see Mittelberg and Waugh 2009 and Müller and Cienki 2009 on multimodal metaphor).

Arguing in favor of a multimodal approach to spatial representations, Deane (2005:245) discusses instances in which spatial prepositions evoke a 'common-sense geometry'; he asserts that 'the same spatial relation may receive distinct representations in multiple representational modalities' (p. 247). In view of the configurations observed in the present gesture data, it seems that the speakers do apply a sort of common-sense geometry when ascribing basic shapes to linguistic entities (e.g., in the form of bounded objects) and structures (e.g., in the form of lines and diagrams, the latter exploiting both horizontal and vertical axes to spatially portray hierarchical relations).

A question that poses itself here concerns the degree to which the imaginary metaphorically construed objects are geometrically specified. Talmy (1983) suggested universal constraints as to how figure object and ground object are geometrically schematized in locative expressions; he noted an asymmetry to the effect that the figure object tends to be relatively shapeless and the ground object tends to be more precisely defined (cf. Landau 1996:321ff.; Landau and Jackendoff 1993). Investigating how the visual-spatial modality might condition descriptions of the relation between two objects, Emmorey (1996:175–9) found the tendencies identified by Talmy to hold in ASL, where, in fact, 'the use of space to directly represent spatial relations stands in marked contrast to spoken languages' (p. 175). She also found that signers tend to express the ground first and then the figure object, conceiving of the figure as a point with respect to a more complex ground (p. 179). In the present data, this process was found in gestural descriptions in which, for instance, a string of words (as in Figure 16) was first drawn in the air and subsequently functioned as a sort of virtual reference structure in which the word order of particular linguistic units was pointed out. The same is true in regard to tree diagrams which, once they are sketched out in air, provide slots where elements such as embedded clauses may be placed (cf. Mittelberg 2006). However, much more research is needed to develop a better understanding of the mechanisms of what one could call, with recourse to Landau and Jackendoff (1993), the 'what' and 'where' in gesture space.

Now, if we wanted to describe the relationship between objects and gestural articulators in light of figure/ground relationships as well as the relative specification of objects in terms of their geometry, we could, in a first approach, say the following: in cases where an imaginary object (i.e., the figure) is sitting on a palm-up open hand (i.e., the ground), it exhibits a less specific geometry than the hand itself (see Figures 2, 3, 12). In most of these scenarios, details of size or shape are not provided for the figure object, except for the fact that a single hand cannot hold a very large object. In gesture, space may carry

meaning in various ways, and, as we saw above, the different amounts of space between hands or fingers may signify linguistic units of different degrees of complexity (e.g., a morpheme in Figure 9 vs. a sentence in Figure 10). The object/box gestures (Figures 1, 10, 11) seem to be more strongly profiled in terms of their size and volume and might thus qualify as geometrically idealized representations of objects, i.e. manifestations of what Talmy (1983) referred to as the 'flexible schematizing of objects' (Landau 1996:319). By contrast, different kinds of pointing gestures were found to simply assign a location, but no shape, to grammatical categories (such as semantic roles; see Figure 13). Here, we could conceive of the space in front of the speaker as the ground, this time rather vaguely defined. One could argue that these objects do not receive much specification because they signify imaginary abstract entities and that, since that which they stand for is revealed in the concurrent speech, it might be sufficient to just point to their existence and, if applicable, to their specific spatial arrangement. In fact, the gestures here take care of the 'where' of the entities, which also entails their position with respect to one another (e.g. the placement pronouns in phrasal word constructions, Figure 8, or the insertion of an infix, Figure 17). This bimodal strategy is highly economic and makes verbal paraphrases (i.e., prepositional phrases) unnecessary. While some of these observations indicate the kind of asymmetry suggested by Talmy (1983), more research is needed to correlate the geometry of objects and their relations in the gesture modality with cognitive and discourse-pragmatic factors such as, for instance, attention, perceptual saliency, information flow, pragmatic inferencing, and the exact cross-modal encoding of spatial information.

5 Concluding remarks

Gesture assigns meaning to space. It employs hand shapes, movement, and space to describe not only physical objects and their spatial relationships, but also spatial models underlying abstract knowledge domains and other concepts that are difficult to represent such as time, values or emotions. The gestures discussed in the present paper have, as I hope to have shown, the capacity to unite phenomena that at first might appear contrasting in one way or another, including the interrelation between form and motion, spontaneity and systematicity, and the abstract and the concrete.

First, in the gesture modality form may become motion and motion may become form (*FORM IS MOTION*, cf. Lakoff and Turner 1989). Hands may dynamically represent the form of an object by drawing its contours in the air (such as the wave-like movements representing the notion 'intonation contour', see Figure 21); or the virtual trace left by a manual motion may evoke a form (such as a virtual container in which items can be subsequently placed, see Figure 10). A gestural sign may depict the formal essence of an entity and/or its characteristic movement, both of which can be used independently of the perception or presence of the object. In addition, gestures can portray the process character of mental operations of which we often only see the final product, for example an assembled word or sentence (e.g., infixation, see Figure 17).

Second, despite their spontaneous and unreflective dimensions, gestural representations have been shown to exhibit a considerable degree of systematicity regarding both the form they take and the space they exploit. There is more and more converging evidence that the factors motivating the structure of gestures of the abstract include embodied image and motor schemas, conceptual metaphor and metonymy (Bouvet 2001; Cienki 1998, 2005; Cienki and Müller 2008; McNeill 1992, 2005; Mittelberg 2006; Müller 1998, 2004b; Núñez 2004; Núñez and Sweetser 2006; Sweetser 1998, 2007; Taub 2001), as well as routine object-oriented actions and practices of social interaction (Calbris 2003; Clark 2003; LeBaron and Streeck 2000; Kendon 2004; Müller 1998, 2004; Streeck 2002; *inter alia*).

Third, metaphoric gestures mediate between the abstract and the concrete: while being abstracted from physical objects and actions, they make abstract phenomena tangible. By isolating the essential properties of the objects and actions they represent, they provide insights into the abstractive capacities and embodied structures of the human mind, and incarnate the principles of conceptual metaphor and abstract inferencing (Johnson 2005). In the meta-grammatical discourse analyzed here, linguistic form and structure seem to propel manifestations of a set of image-schematic and geometric patterns in the gesture modality. Embodied 'common-sense geometry' (Deane 2005:245) thus manifests itself in these gestures to a certain degree, and it would be interesting to see whether such tendencies appear in gestures accompanying discourses about other abstract subject matters (cf. Cienki 2005; Núñez 2004; Smith 2003; Sweetser 2007). Such work could further attest to the embodied nature of basic image and motor schemas in general and spatial-relations concepts in particular (Lakoff and Johnson 1999:34ff.; Hampe 2005; Talmy 1988). Another promising avenue for further research would be to explore the pragmatics of the 'flexible schematizing of objects' and the relative geometry of figure and ground objects in co-speech gesture (Talmy 1983; Emmorey 1995; Landau 1996; Landau and Jackendoff 1993).

Theoretical, academic discourse might have the reputation of being dry, technical, and objective; however, the multimodal classroom discourse examined here is strikingly dynamic, immediate, and engaging. The professors' gestures convey not only visuo-spatial illustrations of grammatical concepts and theories, but also intuitive, felt qualities of thought and meaning-making processes which no doubt deserve further (cross-disciplinary) attention.

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Notes

- 1 The approach to multimodal discourse developed in Mittelberg (2006) combines Peircean semiotics (Peirce 1955), Jakobson's theory of metaphor and metonymy (Jakobson 1956), and contemporary cognitivist approaches to metaphor and metonymy (see also Mittelberg and Waugh 2009).
- 2 Gesture researchers have suggested various schemes for how to graphically capture not only the close temporal relationship between speech and co-speech gesture, but also the kinetic features of gestures (cf. Calbris 1990; Duranti 1997:144–154; Kendon 2004; McNeill 1992, 2005; Müller 1998:175–199, 284ff.; Parrill and Sweetser 2004; *inter alia*). This study has particularly been inspired by the methods of transcription, coding, and analysis developed by members of the McNeill Lab (McNeill 1992), Müller (1998, 2004a) and Webb (1996).
- 3 Another possibility would have been to adopt the form inventory of a signed language such as American Sign Language (c.f. McNeill 1992:86–88; Webb 1996).
- 4 I thank Allegra Giovine and Daniel Sternberg for their invaluable collaboration on this part of the analysis.
- 5 Here a link can be made to abstraction in the visual arts. Georges Braque and Pablo Picasso developed their Cubist transformations of people and everyday objects through extracting their most essential characteristics (see Mittelberg 2006 and in prep.).

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