

measure the relationship between physical space and conceptual space. Therefore, we propose that eye tracking is congruent with system discourse in not only a possible tool to answer questions about how and when mental models of spatiality are used, but should be considered as the most appropriate and potent method of study.

3

The Development of Semantic Space for Pointing and Verbal Communication

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3.1 Introduction

We present an analysis of the development of the semantic space of a child from gesture to verbal communication. As a driving example, we will analyse the different forms of pointing. Our aim is to show that the meaning processes involved in communication by pointing are essentially the same as those in spoken communication, and that the development of linguistic communication ability can be seen as a transition from pointing in physical space to pointing in mental spaces. The natural semantic space does not only contain a representation of the physical space (where an object is), but we also include category space that contains differential information properties (what an object is), *action* space (representing the value of an object), and *goal* space (representing the intention of the communication).

Our starting point is that the relevant semantic structures can be modelled with the aid of conceptual spaces with topological and geometric structure (Gärdenfors 2000). Using combinations of physical (visual) space with various mental spaces, we show that there is a semantic continuum in development, and that purely verbal communication may arise from a bootstrapping process grounded in gestural communication.

In Warglien and Gärdenfors (to appear), we propose a semantic framework based on a 'mapping of minds' that will form the background for our analysis.

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According to this framework, the meanings of expressions do not reside in the world or solely in the mental schemes of individual users, but develop via communicative interactions (cf. Brinck 2006, 2008). The fundamental role of human communication is indeed to affect the states of mind of others. A meeting of minds occurs in pointing when the interactants perceive that they align their attention in physical space and in verbal communication when the interactional partner that they align their attention in mental spaces (Pickering and Garrod 2004).

The goal of this chapter is to develop this semantic framework to show that there is a continuity between gestural and verbal communication. Pointing is a special gesture that serves as an interface between the physical environment and the semantic spaces of the communicators (Brinck 2004b, 2008). It is often used in conjunction with words, and plays an important role in the acquisition of verbal language in children (McNeill 1991; Golán-Meadow 2007). Not only do different types of pointing activities serve different purposes, but they also differ in terms of their cognitive representation, which we will model in terms of spatial structures. A key idea of the chapter is that growing cognitive complexity is achieved by expanding the structure of the semantic space. The basic operation that is used to compose multiple domains can be modelled as a product of spaces.¹ The expansion by composition of spaces generates a minimum of communication situations. In this way, the spatial approach provides an underpinning for the developmental sequences of gestural and verbal communication.

We will use a classification of different kinds of pointing basically borrowed from Bates et al. (1978), but with some further refinements from Brinck (1994), Tomasello et al. (2007), and Golán-Meadow (2007). We call the individual doing the pointing the pointer and the enlooker the attendant. We will not be concerned with the exact timing of the different forms of pointing in child development. Our objective is rather to reconstruct the semantic developmental continuum. However, we will draw extensively from the existing empirical evidence.

The nature of the mental spaces that are introduced also affects the type of intersubjectivity that is involved. In this context, intersubjectivity means the sharing and representing of others' mentality. The term 'mentality' is taken here to involve not only beliefs, but all sorts of forms of mental states, including emotions, desires, attentional foci, and intentions (Gärdemans 2007).

3.1 Imperative Pointing

During their first months children learn to coordinate their sensory input—*vision, hearing, and touch*—with motor activities (Thelen and Smith



FIG. 3.1. Imperative pointing. P—pointer; A—attendant; O—object. The thick line is the direction of pointing. The thin lines are related to the attendant's gaze. The dashed line from the pointer to the object is the closure of the triangulation performed by the attendant.

1994). This generates a narrow egocentric space that basically maps the visual field of the child.² The space is manifested, for example, by the fact that from six months the child can follow the gaze of their mother, if she looks at an object within the visual field of the child by turning her head (D'Entremont 2000). From twelve months the child can follow the gaze if she just turns her eyes towards the object (Butterworth and Jarrett 1991). As we shall argue, the egocentric space forms the foundation for the development of semantic space.

Since Bates et al. (1978) made the distinction between imperative and declarative pointing, the imperative form has been recognized as the most elementary. It is performed in order to make the attendant do something for the pointer (for example, bring the toy they are pointing at). In this type of pointing the pointer treats the attendant as a causal agent that one can influence by pointing (Bates 1997; Brinck 2004a). In principle, imperative pointing is therefore not necessarily an act of communication—it could be like pushing a button triggering a chain of causal events. As a pointer, you can learn to point without considering other agents, for example as a mere result of reinforcement learning. However, in practice, imperative pointing in general has communicative intent. Infants who point imperatively often monitor the attention of their social partners.

² There is a potential ambiguity when we talk about visual field or physical space: we may refer both to the actual physical space and to its representation in the mind of the child. In general, the context should resolve the ambiguity, but whenever necessary we will be explicit.

¹ This can be seen as a special form of compositionality as it is treated in Wargny and Galambos (in press).

Cognitively, the only thing that needs to matter to the pointer is their own egocentric space in which the focal object is located. Thus from the pointer's view no intersubjectivity is necessarily involved. This conclusion is supported by Tomasello's (1999) observation that in this stage of development, children can master pointing without understanding the pointing of others. However, the attendant must understand the desire of the pointer. Not does the attendant need to go beyond their egocentric space (Brinck 2004a). However, the attendant must identify the location of the object with the aid of the direction of the pointing and stopping at the first salient object in that direction (see Figure 3.1). What is salient is determined by the context of the situation. If no other clue is given, the first object found is chosen.

3.3 Emotive Declarative Pointing

Declarative pointing involves directing the attention of the attendant towards a focal object (Bates et al. 1975; Brinck 2004a; Tomasello et al. 2007). In contrast to imperative pointing, declarative pointing always involves intentional communication since the pointer wants to affect the state of the mind of the attendant. The crucial difference with respect to imperative pointing is that the child need not desire to obtain the object pointed at, but rather to achieve joint attention to the object with the attendant. The pointer thus takes the mental state of the attendant into account (Brinck 2004b).

Declarative pointing consists of one individual pointing to an object or spatial location and at the same time checking that the attendant focuses their attention on the same object or place (Bates 1976; Brinck 2004). The attendant in turn must check that the pointer notices that the attendant attends to the right entity. This attending to each other's attention is called 'joint attention' (Tomasello 1999; Tomasello et al. 2007) and it is a good, but fallible, mechanism for checking that the minds of the interactors meet in focusing on the same entity.

One should, however, distinguish two basic types of declarative pointing: emotive and goal-directed. (This corresponds to what Tomasello et al. (2007) call the expressive and the informative subtypes.) In emotive declarative pointing, the pointer wants the attendant to share emotions concerning the object. In contrast, in goal-directed declarative pointing, the joint attention to the object is instrumental to the attainment of a goal.

Some authors claim that the emotive form is the more fundamental (Brinck 2005). The evaluation of a shared object is mainly achieved by an exchange of emotive information about it. For example, the child points to an object that they find scary in order to obtain a reaction of fear or reassurance from the attendant. The main benefit for the child of this kind of exchange is that they can learn about objects vicariously. This primary function presupposes that the child can understand the emotions and the attention of the addressee, but it does not require the



FIG. 3.1. Emotive declarative pointing. P=pointer; A=attendant; O=object. The thick lines refer to the pointer, the thin lines to the attendant. The dashed lines are the contours of the triangulation performed by both the pointer and the attendant.

understanding of intentions or beliefs (Brinck 2008). It is well known that emotive intersubjectivity is practised in mother-infant attachment interactions (Stern 1985).

In addition to the visual space involved in imperative pointing, emotive declarative pointing builds on an emotion space. There have been many attempts to define such a space, but for our purpose it is enough to assume some generic (multi)dimensional space. A classical example would be a space with valence (positive-negative) and arousal dimensions (Osgood et al. 1957).

Minimally, emotive declarative pointing thus takes place in the product space that is the composition of visual and emotion spaces.¹ Emotive declarative pointing requires both spaces to be available for the participants. Adding the emotion in a pointing situation enriches the context. In turn, the visual space involved in pointing may enable the alignment of the emotions of the participants.

In emotive declarative pointing, both participants must check the attention of the other as well as the emotional state of the other (see Figure 3.2). If successful, it entails convergence of the participants in two domains: the egocentric space (point converge on the same object) and the emotion space (both express compatible emotions).

In an experiment by Liszkowski et al. (2007) an adult correctly identified what the child was pointing at, but, in different conditions, either expressed interest or

¹ This is in analogy with how Gärdenfors enters takes place in the product of view and space.

disinterest in the object. In the disinterest case, which is a mismatch in emotion space, the child rapidly decreased pointing activities (as compared with the interest condition). The child seems to have learned that the object was not worth attention.

In emotive pointing, there is no need to have a separate representation of the spaces of the other. Just as an agent may assume that there is only one visual space (their egocentric space), it is sufficient that each participant assumes that there is only one emotion space and that the emotions of the other mirror their own. This makes the level of intersubjectivity minimal. However, children tend if the attendant does not show an expected emotional response.

3.4 Goal-directed Declarative Pointing

Goal-directed declarative pointing can be introduced by an example from Liszkowski et al. (2008). A child observes an adult searching for an object that has been misplaced and shows him the object by pointing. More generally, this kind of pointing supports the fulfilment of the attendant's goal. The pointer understands the goal from the actions of the attendant and perceives the mismatch between the current state and the goal, and points in order to help the attendant achieve the goal. In this way the pointer gives the attendant sufficient information to solve the coordination. In the example, another solution would be that the child brings the object to the adult. It is important to note that the intersubjectivity of the pointer only requires understanding the goals of the attendant, not their beliefs (Brück 2008, 2009a). In line with this, Goren (2008: 792) proposes that 'behaviors are directly perceived as intentional. [...] without necessarily representing that they are driven by unoberrable mental states'.

Recognising the actions of somebody else seems to be a fundamental cognitive process. Going from understanding actions to understanding the goals behind them is not automatic. However, it develops during the first year in human children (Tommasello 1999). In other words, the intersubjectivity of goals is present when children begin to point in a goal-directed manner.

A natural representation of goals can be supplied by a goal space. In the case of pointing to an object, the problem is processed by a mismatch between the attendant location and the object location together with the attendant's lack of awareness concerning the location of the object. Pointing is triggered by the difference between the attendant's desired state and the current state. In this case, the goal space is derived from physical space: to reach a goal is to reach a location. The goal space is determined by the locations of entities in physical space. The perceived goal is that agent and object are at the same point. The difference is that in the goal space it is not the locations of the individual and objects that matter, but the distance between them.

Since the location of the attendant and the object are both points in physical space, the desired states can be represented as points in the goal space where the agent and the object have the same location.⁴ Pointing solves the problem by helping the attendant to move to the object. Of course, an alternative (but more costly for the pointer) fulfilment of the goal is to bring the object to the attendant.

More generally, goal spaces can be more abstract than the physical space. In economics and AI, goal spaces are represented by abstract spaces.⁵ However, we suggest that these spaces may be generated by metaphorical extensions from the original physical space. This is witnessed by the pervasiveness of spatial metaphors in relation to goals: 'reach a goal', 'an attainable goal', 'the target was too high', etc.

In emotive declarative pointing, the physical (visual) space is composed with emotion space to help determine the meaning of the pointing gestures. In goal-directed declarative pointing, it is the composition of physical with goal space that determines the meaning of the pointing. More elaborate forms of declarative pointing can be derived from combinations of these primitive forms. In particular, pointing can be a form of inquiry to get evaluative information about objects related to the goals of the pointer (Brück 2008, 2009a). In appropriate contexts, pointing can express questions such as 'is this food good?' or 'is that animal dangerous?'

3.5 How Joint Attention is Achieved

In declarative pointing (of both kinds), joint attention is necessary. To achieve this, the agents must ensure that they attend to the same thing, and that they both know that they are doing so. In imperative pointing, joint attention may not be achieved because the pointer may not check that the attendant attends to the desired thing.

Achieving joint attention in a scene where there is a pointer, an attendant, and a set of object involves the following steps (see Figure 3.1):

1. The pointer indicates the direction of the focal object (this can be done by pointing or by gaze directing).
2. The attendant looks at the angle of the pointer's indicated direction.
3. The attendant follows the direction until their own gaze locates the first salient object.
4. The pointer looks at the angle of the attendant's indicated direction.
5. The pointer follows this direction until their own gaze locates the first salient object and checks that it is the same object as they have indicated.

⁴ Alternatively, these points have the diagonal of the product of the location spaces.

⁵ The classical example is the General Problem Solver of Newell and Simon (1958).

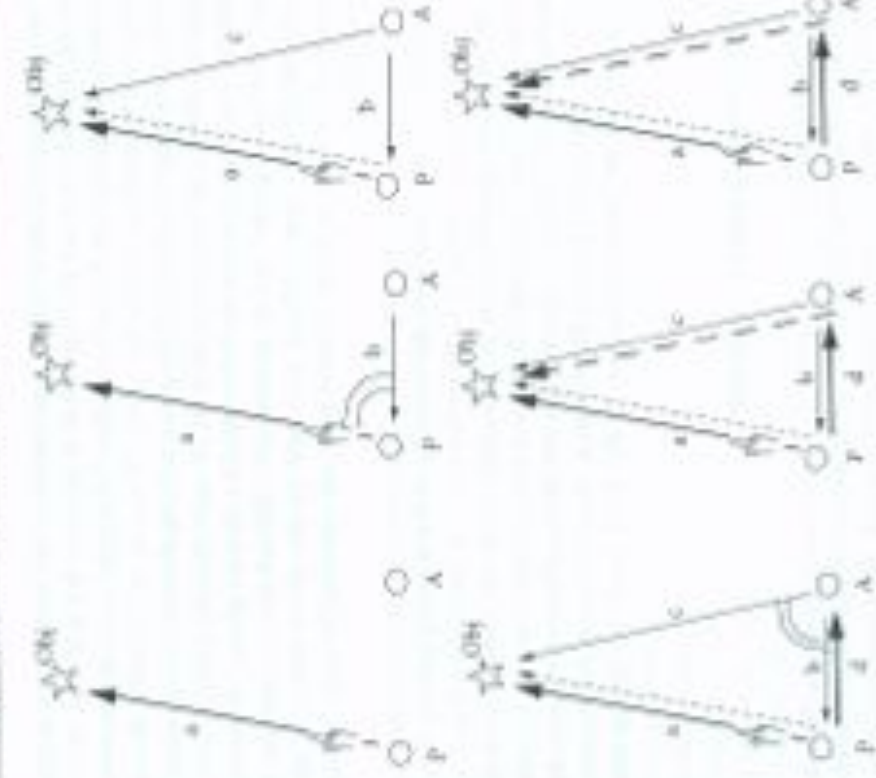


FIG. 3.3. Steps in achieving joint attention to an object.

However, this is not enough for joint attention, but only guarantees shared attention, that is, that pointer and attendant look at the same object. To achieve joint attention, one more step is necessary:

The pointer signals in some way that he or she has located the same object (or signals a mismatch).

Figure 3.3 suggests a natural formal interpretation: each participant represents a visual space with location of participants and objects. When joint attention is achieved, each participant represents two overlapping triangles, cbp and adb . Each triangle has in common in the sense that the composition of a and b is

equal to c and the composition of d and c is equal to a . This is a very concrete way to visually solve a system of equations.⁸

Normally, joint attention is achieved via a mutual gaze together with an emotive or evaluative expression. In the case of emotive declarative pointing-convergence in visual space has to be accompanied with convergence in emotive space (cf. the example from Liszkowski et al. (2007) above). In the case of goal-directed declarative pointing, convergence in visual space has to be matched with convergence in goal space. For example, if the pointer indicates an object that does not fulfil the attendant's goals, the attendant should signal disappointment (there is no 'handshake').

Convergence in declarative pointing is both meeting of eyes and meeting of minds. In the emotive case, participants have to find resonating emotional states. Formally, this can be described as convergence in the product of the visual space and the emotion space. We have already seen that meeting of eyes, but misalignment of emotions is disappointing for the pointer. Conversely, an experiment by Liszkowski et al. (2004) with infant pointers shows that if the attendant responds with the correct emotion but simply does not look at the focal object, the infant expresses disappointment.

Similarly, in the goal-directed case, successful pointing implies convergence in the goal space. Pointing indicates attaining the goal by having the attendant move to the point where the object is. Again, if the pointer indicated an object that does not satisfy the attendant's goal, then a mismatch occurs (this time making the attendant disappointed).

Whether a pointing gesture is emotive or goal-directed may by itself be indeterminate—what type it is must be decided by context (Brock 2004). In our case, the context is provided by gaze, emotive expressions, or other cues. What kind of 'common ground' (Clark 1996; Pickering and Garrod 2004) is available to the pointer and attendant will depend on which product space is triggered.⁹

In step 3 above, the attendant was required to locate the first salient object along the pointed direction. A problem is that there may be several objects along that line, one of which must be chosen. In the absence of other contextual criteria, the most obvious is the first one encountered. But of course knowledge of the context may suggest the selection of another object. In an emotive context, for example when the pointer shows surprise, the selected object should be new to the pointer. In this case the pointing is emotive declarative. Its goal-directed structures, the actions of the attendant generate a context including a goal that

⁸ An analogous case is finding a fix-point (see Wierzbica and Gärdenfors, to appear).

⁹ Just as in conversation, verbal cues allow speakers to quickly align the salient domains in discourse (Pickering and Garrod 2004). In pointing, the alignment of product spaces is described by visual and gestural cues.

determines which object is focal. This argument shows why it is necessary to multiply visual space with other spaces in order to resolve ambiguities.

In order to verify that the visual images constructed by the pointer and the addressee are the same, it must be assumed that the participants share the same visual space (Brück 2006). However, the representation of the participants need not be identical but just similar enough. For example, if the participants are in front of each other, they might perceive an opposite orientation of the space, but this will not disturb the possibility to triangulate with a third point in the space. In contrast, if direction were to matter, for example in the use of the words 'left' and 'right', they might easily miscoordinate. In general, checking that coordination is achieved may require a kind of visual 'handshake' between participants. This means that the addressee must expect a match-mismatch reaction from the pointer and vice versa.

Even if the participants correctly represent the perceptions of each other's visual space, the shape of the space itself may obstruct or create mismatches in the triangulation procedure. For example, obstacles can create non-coincidences in the visual space: the salient object may be blocked from the view of the addressee. If all points between the participants and the focal object are visible to both participants, the problem can always be solved. This indicates the attractive importance of the convexity of the visual fields (Gärdenfors and Wargham and Gärdenfors, *op. cit.*).

The fact that a child can already from an early age follow the gaze of others, even if they look at points outside its immediate visual field, requires that the representational visual space is not just the current visual field but covers the entire physical space. This implies that the child can then understand pointing outside its visual field.

A much deeper transformation of the representational physical space comes from the ability to represent an allocentric space. This means being able to orientate of the space as seen from the point of view of another (Paquet 1961). The important fact to note is that this involves a shift of perspective. In general, this can be modelled via a coordinate transformation together with the unlimited extension of the space. What is involved is a combination of an allocentric representation of space with the egocentric one provided by the visual system. (This combination is indicated by the fact that we have double codes for referring to positions: egocentric 'left' and 'right' and allocentric 'west' and 'east'.) A concrete example of the use of allocentric space is the ability to redirect somebody whose vision is blocked by an obstacle.

3.6 Declarative Pointing Composed with Words

As we have seen, when pointing does not select focal objects uniquely, composing visual space with further spaces (emotion space and goal space) is helpful. In addition to this, verbal language dramatically expands the possibilities of multiplying spaces.

As Goldis-Meadow (2007) and others have demonstrated, children combine pointing gestures with words long before they can rely on words alone.¹⁸ In addition to the emotive and goal spaces, words trigger richer mental spaces. Objects are not only points in physical space, but are also represented in a 'category' space (Gärdenfors 2000) that has its own quality dimensions. (Physical space represents 'where' an object is and category space 'what' it is.) In Gärdenfors (2000) it is proposed that a noun corresponds to a multidimensional region in a category space. By using a noun in conjunction with pointing, the physical space is composed with such a category space. Mathematically, this is expressed by considering the product space of the physical and category spaces. Pointing and noun maintain each other: pointing indicates a linear region of physical space (where), while the noun indicates a region in category space (what) that determines a subset of the objects available on the scene. This makes it easier to identify the focal object. As an example from our personal experience, a child was pointing at two neighbouring objects, a toy and a saxophone, saying 'guitar', which was his noun for all music instruments. Actually a true guitar was located a few steps away, but pointing was discriminating between the two instruments, while the word was selecting between the two neighbouring objects.

However, sometimes a noun is not sufficient to select a unique focal object along the line of pointing, since there may be several objects of the same kind located in that direction. In these cases an adjective may do the job. According to Gärdenfors (2000), an adjective refers to a region of a sub-space in a conceptual space. For example, 'red' denotes a (convex) region of colour space. Saying 'the red one' while pointing to similar objects close in space may define a unique solution that a combination of pointing and a noun could not solve.

Since the physical world is crowded with objects, pointing may often be indeterminate. We have now seen several examples that have a common pattern: by composing the physical space with different types of mental space (emotion space, goal space, category space), pointing becomes a multidimensional activity that facilitates the selection of a unique object. We do not only point in physical space, but learn to simultaneously point in our mental spaces. Facial expressions

¹⁸ An even is shown if the one-year-olds in the study do point to horses or also to the arm.
¹⁹ Gärdenfors (2000) provides several examples of languages that use 'cardinal' direction to the extent that they do not refer to the allocentric space using 'north', 'south', etc. In those languages, nevertheless, unambiguously word pointing patterns as the 'correct' category direction' (*op. cit.*).

²⁰ Lorenz and Rappaport (1990) note that humans obtain 90% of their visual while pointing data from the eyes. A similar human studies the same percentage of gestures accompanied by vocalizations (linguistic or non-linguistic) is 40 per cent, while it is only 33 per cent for chimpanzees.

point into emotion space, actions point into goal space, and words point into category space.

3.7 Language without Pointing

When interactants are communicating about the external world, pointing is sufficient to make minds meet on a referent. However, when the interactants need to share referents in their mental spaces, a different tool is required. This is where language proves its muscle (Brück and Gärdenfors 2003, Gärdenfors 2004, Gärdenfors and Överhag 2001). In a sense, language is a tool for reaching joint attention: by 'pointing' to places in our inner worlds as shown above. This mechanism is bootstrapped by pointing, other forms of gestures and creative expressions. As a matter of fact, Góddin-Meadow (2007: 74) goes beyond our metaphorical assertion and writes that in children, 'pointing gestures form the platform on which linguistic communication rests and thus lay the groundwork for later language learning'. For example, prelinguistic children about twelve months old can sometimes refer monomorphically in an absent person by pointing to a place where that person has recently been or is normally located (Tomasevic et al. 2007).

Góddin-Meadow (2007: 74) notes that 'mothers often "translate" their children's gestures into words thus providing timely models for how one- and two-word ideas can be expressed in English'. Learning a word enables the child to make a projection (a dimensional reduction) from the product of physical space and category space to the category space alone. This projection reduces the redundancy created by mothers' translation of gestures into words. This suggests that mothers scaffold the developmental sequence in which children start communicating about physical space, then learn to use category spaces in combination with physical space to make more effective communication, and finally, by this dimensional reduction, make it possible to detach themselves from the physical space by projecting it onto category spaces. In the manner recommended by Wittgenstein, the child throws away the physical ladder when it is not needed anymore.

In this way, language becomes detached from the current environment (Hockett 1960). Language then opens up for new fields of communication: future cooperative plans, absent people (gossip), imaginary entities and situations (play language and storytelling). Once this level of representation is reached, the roles and functions of communication change drastically. Words (rather than fingers) are mainly used to point to one's inner world, hoping that attendants can view a similar point in their inner world, from their perspective. Communication becomes a matter of 'meeting of minds' (Warglien and Gärdenfors, to appear). However, we view the processes of creating joint referents (and other meanings) as being essentially the same in pointing and in speaking (cf. Brück 2005, 2004b, 2006). We do see traces of this mental pointing in the metaphorical way ordinarily

use to speak about communication: for example, 'Do you see what I mean?' and 'Do you follow me?'

While reference in category space can lose connections to the physical space, as in narrative, it still resorts to pointing as the basic mechanism for achieving meeting of minds. In fact, pointing gestures are frequently reintroduced in storytelling and other detached uses of language. Their function now is to give a visual complement to what the words point to in mental space (Harvilland 2000, McNeill 2005: 40). Bühler (1982) calls this 'deixis as phantasms'. Haviland (2000) provides several interesting examples of this phenomenon. One concerns a Zinacantan Tzeltal speaker who tells a story about returning to a place where he had left a dying horse. When he says 'it was getting late', he looks up at the place in the sky where the sun would have been at that time. This is a deictic gesture that metaphorically describes the time of the event in the story. Deixis at phantasms reinforces the claim that verbal language and pointing gestures are embedded in a unique semantic structure.

3.8 Summary

The evolution from simple imperative pointing to the sophisticated process of directing others' attention in inner conceptual spaces can be seen as a process that builds and combines physical space with mental spaces of growing complexity and dimensionality, penetrating multiple levels of mutual understanding. The mental spaces we have considered in this chapter are emotion space, goal space, and category space.

To sum up our analysis, the developmental sequence of pointing can be described as an expanding set of product spaces:

1. Imperative pointing. Only the mapping of physical space is implied. The pointer need not have any communicative intention (but in general has).
2. Emotive declarative pointing. The physical space is combined with emotion space. Communicative intent is present.
3. Goal-directed deictive pointing. The physical space is combined with goal space. The communicative intent here also implies a representation of the attendant's goals.
4. Pointing together with words. The physical space is combined with category space. In this case, the products of spaces have to be coordinated with a combination of communication modalities (visual plus auditory).
5. Detached language. In this case, communication is based on category space without combining it with physical space. Communication aims at pointing into the other's inner world.

We have shown how products of physical and mental spaces provide a basic framework to understand how these lie on a semantic continuum, and how

purely verbal communication may arise from a bootstrapping process grounded on gestural communication. The theory represents in a single semantic frame-
work's gestural as well as verbal communication.

While our analysis has essentially aimed at establishing the semantic continuity of pointing gestures and verbal communication, we can also outline a pragmatic account. The numbering 1-5 below refers to the five stages above. However, from a pragmatic perspective it is natural to start with grasping (cf. Benick 2004b):

1. Grasping. This is a direct action resulting in control of an object. The primary goal is to use the object (for sucking, for instance). Then this action can develop into a secondary goal of evaluating or learning about the object.
2. Imperative pointing. Instead of direct grasping, the pointing act, if successful, leads to somebody else performing the action and bringing the object to the pointer with the same result as for grasping.
3. Declarative pointing. This does not result in any grasping of the object, but if joint attention is achieved, the pointer can achieve vicarious evaluation or learning about the object via the emotional, postural, or linguistic reactions of the attendant. This form of declarative pointing still involves an imperative element on the part of the pointer: Help me evaluate the object!
4. Goal-directed declarative pointing. This form reverses the roles of the pointer and the attendant: here it is the attendant who wants to grasp (or interact with) the object (for using or for evaluating). The pointing helps the attendant to achieve this goal (which can also be achieved by bringing the object to the attendant). Of course the attendant may interact with the object at a distance (look at it, shoot at it), so grasping is not necessary. This form has no imperative component, but is purely communicative.
- 4-5. Transitive or verbal language. The use of words allows detachment of reference. Not only can one point to elements of the other's inner world, but to non-present or even non-existent entities. This provides ground for activities like counterfactual and strategic reasoning, prospective planning (Gärdenfors and Östvall 2000), play language, and narratives.

Drawing Motion That Isn't There: Psycholinguistic Evidence on the Spatial Basis of Metaphorical Motion Verbs

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4.1 Introduction

Motion verbs are pervasive in language and are commonly used to express both physical and metaphorical motion, such as in (1) and (2), and (1a) and (2a), respectively:

- (1) a. John ran through the neighborhood.
b. John ran through the presentation.
- (2) a. John tackled the quarterback.
b. John tackled the problem.

In interpreting (1a), for instance, one might imagine John physically running through his neighborhood or some similar scenario. But sentence (1b) does not express actual physical motion, because 'ran' here metaphorically expresses forward progress through John's presentation. Notice that the physical or metaphorical interpretation of 'ran' is not clear until the final noun is mentioned.

How do people understand the contextually appropriate meanings of metaphorical motion verbs? There are several traditional answers to this question. One approach assumes that people understand the metaphorical meaning of 'ran' in sentence (1b), for example, by first analyzing the literal meaning of the word, finding it inappropriate in context, and then drawing an inference, such as a conversational implicature, to get an contextually appropriate, metaphorical interpretation (Grice 1975; Scaife 1979). This 'standard pragmatic view' does not predict anything about the exact meaning people infer when seeing 'ran' used metaphorically, such as whether people create a highly abstract or more detailed interpretation of this verb, perhaps based on their spatial, physical understanding of 'ran'. At the same time, this view would predict that metaphorical motion verbs