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When up is down and down is up: Body orientation, proximity, and gestures as resources

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ABSTRACT

This article is concerned with understanding situations in which speakers talk in the presence of scientific inscriptions (lectures in science classes, public presentations). Drawing on extensive video materials accumulated in middle and high school science classrooms and university lectures, we develop a framework for the resources speakers make available to their audience for understanding what the talk is about. We distinguish three situations according to the nature of reference to the phenomenon talked about: (i) talk is about phenomenon but mediated by reference to a two-dimensional (2-D) inscription; (ii) talk is about phenomenon but mediated by reference to a three-dimensional (3-D) inscription; and (iii) talk is directly about phenomenon. Associated with these three situations are different body orientations, distances from inscriptions, and types of gestures. When speakers laminate talk characteristic of two different types of situations, the orientation "up" can become "down" and "down" can become "up," potentially leading to confusing statements. (Gesture, orientation, spatial arrangements, body movement.)

> *Language, gesture, cognitive style, and many aspects of spatial behavior, come to form a coherent and distinctive complex. (Levinson 1997: 125)*

Anyone who has taught a lecture course and subsequently tested students on what they have learned has probably encountered unsuccessful students who explained that "it all made sense during the lecture," but that they failed to understand when they "studied from their notes." There are many possible explanations for the students' failure. One might ask, however, whether the actual lectures provided resources for understanding that the students did not find in their notes, which usually consist of copies of blackboard contents and transcriptions of the lec-

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turer's utterances. This question is prompted by the observation that speakers use body orientation and gesture as informational and utterance-framing resources (e.g. Haviland 1993). In this article, we present a detailed description of the local resources incorporated by lecturers while they are talking over and about different types of images (photographs, graphs, diagrams, maps, etc.) drawn on a blackboard or projected onto a screen. We describe how the integration of these local resources involves an intricate LAMINATION OF FRAMES. The key resources discussed in this article are body orientation, gesture, and spatial position of a speaker with respect to inscription and audience. In addition, we develop existing research on the relation between gesture and language (e.g., C. Goodwin 1986, McNeill 1992, Kendon 1997) by situating talk within a larger framework that includes space as a critical resource for understanding the topic of talk (e.g., Goffman 1974, Heath 1986, Kendon 1990).

INTRODUCTION

We begin with the fundamental assumption that language, in the sense of Saussurian *parole* as distinct from *langue*, is only one aspect of a broader phenomenon of human communication (Clark 1996). Close analysis of everyday talk in formal (e.g., Roth 1996) and informal settings (e.g., Levinson 1983) shows that the meanings of utterances by themselves are underdetermined. Everyday talk (*parole*) is full of "mumbles, stumbles, malapropisms, tics, seizures, psychotic symptoms, egregious stupidity, strokes of genius, and the like" (Rorty 1989:14) that listeners need to adjust to in order to make sense of what it is that the speaker is talking about. In communicative encounters, however, speakers (as listeners) make available to each other many other resources that provide contexts for constraining the meanings of utterances. These resources are fundamentally grounded in the fact that human speakers have bodies: various kinds of movements with different parts of the body provide cues on how to understand just what is being said by limiting the range of possible interpretations. The body is so important to making sense in speech situations that there is a greater likelihood of communicative breakdown and need for conversational repair if visual access is barred or mediated by some technology (Heath & Luff 1993, Goodwin 1995, Egbert 1996).[1] In this study, we are concerned with lecture-type situations where speakers use a variety of inscriptions and are in view of their audiences so that their gestures, body orientation, and physical placement become important resources for the audience to use in making sense of what they hear.

Lectures are a pervasive mode of discourse in science courses at all levels of schooling (Roth & Tobin 1996), but they remain a little-understood phenomenon, despite the traditional view that they "transmit" information. In light of recent empirical and theoretical studies of knowing and learning that suggest that individual beings are closed with respect to information (i.e., signs that have meaning) and have to construct systems of meanings internally (von Glasersfeld 1989),

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it comes as little surprise that students of science often find it difficult to make sense of lectures (Roth & Bowen 1999a, 1999b). For example, our previous research shows that many students have difficulty understanding scientific inscriptions (Roth, McGinn & Bowen 1998). In our attempt to understand these difficulties, we began to investigate different contexts in which graphs were used, including textbooks and lectures (Roth, Bowen & McGinn 1999, Roth & Bowen 1999a, Roth, Tobin & Shaw 1997). It was here that we came to understand the important role of gestures in the presentation of graphical materials. At the same time, we also noted that the relationship between gesture and talk alone could not account for the phenomenon of understanding inscriptions in lectures. This is the starting point for the present study, which takes an integrated approach to the phenomenon of communication – including talk, gestures, other body movements, and physical placement.

The research reported here adds to understanding communicative processes in lectures in that attention to body movements (gesture) and orientations extends the existing literature concerned with these dimensions. Furthermore, our present analysis concerns talk in the presence of inscriptions with referents in the community: utterances may refer to the inscription or, transparently, to the world it stands for.

To set the stage for several detailed analyses of the interaction of speech, gesture, and other body movements, we provide a brief survey of the literature on talk related to body movements and spatial arrangements, gestures, and inscriptions. We then describe the databases that we analyzed and present and elaborate our model for lecture talk in the presence of inscriptions.

BODY MOVEMENT, SPATIAL ARRANGEMENT, AND TALK

There is strong neuroscientific evidence of the interrelation of cognitive processes and bodily movement (Rizzolatti, Fadiga, Fogassi & Gallese 1997). It is, therefore, not surprising that studies of interaction show speech and body movements as coordinated phenomena (Kendon 1990). That is, whenever people are co-present in the sense that they can perceive one another, they are inevitably sources of information for one another (Kendon 1988b). Yet this information does not come only in the form of utterances: rather, as Goffman 1974 illustrates, a multiplicity of cues serves to regulate, bound, articulate, and qualify a story line or an appropriate "directional track." Moreover, not only do speakers provide such cues to the listener; listeners also provide information to speakers. Thus, Kendon 1990 provides evidence that listeners' body movements and gestures are coordinated with those of speakers. In one detailed example, the interaction between two speakers, B and T, is described in the following way:

> [W]hen B is moving, his movements are coordinated with T's movements and speech and … in their form these movements amount in part to a 'mirror image' of T's movements: as T leans back in his chair, B leans back and lifts his head then B moves his right arm to the right, just as T moves his left arm to the

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> left, and he follows this with a headcock to the right, just as T cocks his head to the left. (Kendon 1990:100)

Speakers and listeners make available to each other resources (body movements, gestures) that allow coordination of speech in particular, and of the entire interaction more generally. Consequently, body movements and gestures allow interacting individuals to coordinate their expectations, and thereby to develop and maintain the smooth running of the encounter (Bavelas, Chovil, Coates & Roe 1995).

Artifacts that are both present in a situation and topic of talk provide enhanced opportunities for communication compared to similar communication situations where such artifacts are absent (Luff & Heath 1993, Hutchins 1995). The presence of artifacts mediates among individuals with differing interests, tasks, expertise, and goals. The spatial placement of the speaker (as either lector, audience member, or participant within a group) with respect to the inscription is a critical variable in the way speakers are oriented, and therefore in the types of resources they can make available to listeners for making sense of their utterances (Roth 1996, Roth, McGinn, Woszczyna, and Boutonné 1999).

In the present study, we are concerned with understanding communication in classrooms. With a traditional arrangement that divides teacher/presenter from student/audience, classrooms have a spatial organization that requires participants to engage actively in it and to maintain it in order to count as participants. However, the mainline story is not dealt with in the same way as in, for example, a dinner conversation or a service encounter (M. Goodwin 1996). In a traditional classroom, individuals separately attend to an unchanging focus, whereas in dinner conversation, they jointly create and develop the topic. As part of the ecology of conversational interaction, participants must be oriented appropriately. How the interacting participants enter into and maintain spatial and orientational arrangements has been the topic of studies of FORMATION SYSTEMS (Kendon 1990). Here we are concerned with a formation system characterized by a speaker who faces an audience, and by limited verbal interactions.

GESTURES AND TALK

Gestures constitute a subset of body movements that has become a topic of research in its own right, largely because gestures have been recognized as a central feature in human communication (Bavelas 1994) and across cultures (Kendon 1997). Furthermore, anthropological studies suggest that gestures are not merely aspects of communicative acts, but that they are also deep features of cognition (Haviland 1993, Widlok 1997). Microgenetic studies in school science laboratories confirm that some gestures emerge from the manipulation of objects – movements that later reappear as iconic gestures when students are asked to describe and explain what they have done and observed (Roth & Wetzel 2001).

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There are different types of gestures, ranging from involuntary gesticulations that accompany speech to grammatically structured sign languages (Kendon 1988a). Here, we are concerned with two particular forms of gesticulations: iconic and deictic gestures. ICONIC GESTURES draw their communicative strength from their perceived similarity to a phenomenon simultaneously encoded in speech. For example, McNeill 1992 reports on subjects who quickly move their index and middle fingers while they narrate an incident from a story in which a cartoon character is running. DEICTIC GESTURES are used to point out features in the environment, to indicate directions, or to establish and maintain narrative geographies that become taken as shared, so that speakers can make subsequent use of them without employing words (Haviland 1993).

INSCRIPTIONS AND TALK

A considerable number of studies have focused on gestures in situations in which people talk about experiences or retell stories (see review in Kendon 1997). In contrast, there have been far fewer studies on gestures in situations in which the speaker talks in the presence of a relevant artifact. Among the artifacts that are central to conversations in science, inscriptions are of particular importance (Latour 1987). Inscriptions such as photographs, maps, charts, diagrams, and graphs are of particular importance to the smooth functioning of collective activity among scientists or engineers (Amann & Knorr-Cetina 1990, Henderson 1991), and they constitute a pervasive means of scientific communication. For example, a survey of six high-school science textbooks (c. 4,500 pages sampled) and five research journals in ecology (c. 2,500 pages sampled) showed that there were about 1.4 inscriptions per page, and no statistically detectable difference between the two types of publications (Roth, Bowen & McGinn 1999). Furthermore, inscriptions are frequently used in scientific laboratory talk and during lectures. The existing research includes studies of physicists talking about diagrams on the chalkboard (Ochs, Gonzales & Jacoby 1996), of a professor giving lectures in an undergraduate ecology course (Roth & Bowen 1999a), and of students talking in the presence of diagrams representing scientific phenomena (Roth 2000). One of the important features of these studies provides important clues about how gestures evolve as communicative resources. Deictic (pointing) gestures aid in making particular objects or features salient. Iconic gestures also make features salient, and they are perhaps more efficient at it than deictic gestures because the added motion enhances audience comprehension of topological features.

Another important finding, described by Ochs, Jacoby and Gonzales 1994, is that scientists can be understood as journeying through the representations over and about which they are talking. The presence of the inscription provides a ground against which scientists "create an intertextual space in which the identities of scientist-as-subject and constructed-scientific-world-as-object are de-

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constructed and reconstructed as a single blended entity" (Ochs et al. 1994:152). That is, physicists can be said to talk and travel through a graphic space.

STUDY CONTEXT

We will now explore cases in which speakers talk about scientific topics in the presence of inscriptions as they occur in various science-related contexts. We focus on "lecturers," situations in which one speaker talking about a scientific issue addresses a larger, mostly listening audience. Our data sources derive from studies originally designed to investigate the learning of science in three distinct populations: grade 7 students studying water and its ecology; undergraduate students enrolled in an introductory ecology course; and future elementary teachers enrolled in a physics course.[2] In all three contexts, speakers drew on a large number of inscriptions as part of their teaching; for example, there was a mean of 25 inscriptions per lecture in the ecology course. In each case, we had videotapes of all lessons pertaining to the course or unit (3 hours per week over a period of 3 or 4 months).

In each study, the videotapes were transcribed, within hours to a few days after recording, on a word-by-word basis but without indication of pause length or overlaps. The transcriptions of episodes that had apparent theoretical appeal were then enhanced to include those features common to Conversation Analysis – extent of pauses, overlaps, stresses, and so forth. In addition, representations of the focal situations (artifacts, drawings, etc.) over and about which conversations took place were included in the transcripts. In this article, these representations are based on video stills of the actual presentation. Because the videotapes were recorded at a rate of 30 frames per second, the timing of gestures and speech and coordination between the two channels is accurate to within one frame, or 33 milliseconds.

We randomly selected two videotapes from each of the three data sets. Using a classification scheme developed for the detailed analysis of scientific inscriptions in high school and university textbooks and scientific journals in ecology (Roth, Bowen & McGinn 1999), we counted the total number of inscriptions. Table 1 shows the frequency of inscriptions in each set of videotapes. The relatively high number of inscriptions with depth information (three-dimensional spaces depicted in two dimensions) in the middle school (grade 7) class is due to the frequent use of photographs and naturalistic drawings. This finding is consistent with the distribution of photographs in pre-college textbooks and in college textbooks and scientific literature (Roth, Bowen & McGinn 1999). Although there are many situations in which physicists use diagrams to draw and plot phenomena in three dimensions, the introductory course in physics for elementary teachers had relatively few.

Making sense of talk and inscriptions in scientific contexts requires an understanding of the scientific domain. Our research shows that scientists – though

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TABLE 1. *Frequency and type of inscription in three contexts.*

Context	Type of Inscription in selected lessons		Total Inscriptions
	2-D	3-D	
PRE-COLLEGE			
Grade 7 ecology	19	17	36
COLLEGE			
Sophomore ecology	50	5	55
Physics for elementary teachers	30	0	30

often regarded as experts when they are characterized in psychological literature – experience difficulties in making sense of inscriptions, even from an introductory textbook in their field (Roth and Bowen 2001). We therefore chose all our examples from presentations by environmental activists in a grade 7 curriculum on water and its ecology. Our analyses pertain to repeated presentations given by environmental activists to students; the same features showed up in our videotapes of presentations to other audiences.

SCIENTIFIC LECTURES WITH INSCRIPTIONS

Inscriptions

Past theoretical and empirical work on inscriptions in scientific practice (Latour 1999, Roth & Bowen 1999c) have shown that one can characterize inscriptions in terms of their level of abstraction, or distance from lived experience. At one end of the scale is the lived experience of the world as inhabited space; toward the other end, inscriptions become increasingly abstract as situational details are dropped (Fig. 1). Although scientific research begins with quite tangible manipulation of worldly objects, it is designed to produce increasingly context-independent inscriptions. In the process, "gratuitous detail," which provides an illusion of continuity with lived experience (Myers 1990), is dropped in favor of increasing generalizability.

It turns out that this continuum does not simply reflect the unfolding of scientific research; it is in fact central to human cognition and communicative interactions. On one hand, inscriptions with high levels of realism (photos, naturalistic drawings) include much detail that makes it easier for people to see connections with the lived world than when they must interpret highly abstract graphs (Roth & Bowen 1999a). On the other hand, the very detail of realistic inscription increases not only the resources for making sense but also viewers'

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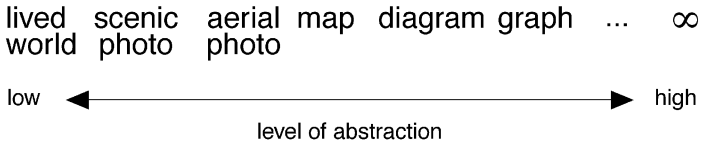

FIGURE 1: Classification of gesture referents in terms of the level of abstraction, i.e., distance of representations from lived experience. Because speakers always inhabit a lived world, talk about and reference to an inscription can coincide with talk about the world – potentially leading to logically incoherent construction which, depending on the situation, may be resolved in a pragmatic manner.

interpretive flexibility and uncertainty about just what is that they are being asked to attend (Bastide 1990).

As we analyzed the videotaped lectures, we began to realize that the different types of inscriptions were associated with different types of gestures and body orientations. Scenic and aerial photos and maps provide much more detail, so that speakers often have to provide additional resources to assist the audience in locating relevant features; in contrast, only minimal assistance is noticed in situations where the inscription is constituted by a relatively small number of features, as in Cartesian line graphs and other statistical graphing techniques. Scenic photographs and other diagrams characterized by illusionary third dimensions (perspective views) provide a new context for the use of gestures. In the following subsection, we analyze space and associated gestures as these arose from our analysis of the data. We then provide several detailed analyses of videotape excerpts to show the relationships among talk, gesture, and orientation during science lectures.

A model of talk, gesture, and body orientations

Any present situation requires that a speaker be situated in a space that is both immediate and local. Within this locally anchored immediate space, speakers have available various ways to refer to entities, including naming entities or their properties (*the red one*), using verbal deixis (e.g., *this*, *that*, *here*, *there*), or enacting gestural deixis (pointing, gestural sign) (Haviland 1993, C. Goodwin 1996). In addition to occurring in locally anchored immediate space, speech events establish interactional spaces defined by the configuration and orientation of coparticipants. Although the intersection of the action and attention hemispheres of speaker and listener constitutes the interactional space, the speaker's (frontal) hemisphere is of particular importance to the interaction (Haviland 2000). In certain instances, however, locally anchored space may be used to anchor a narrated space – that is, a space associated with a different locale that is evoked in the narrative.

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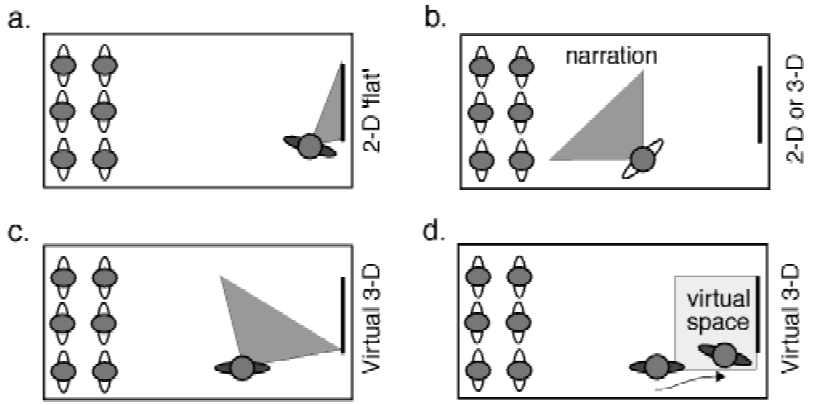

FIGURE 2: Orientation and gestural space as a function of the type of inscription. (a) The inscription is "truly" two-dimensional (map, aerial photograph). (b) The speaker talks about some place or phenomenon without direct reference to the inscription. (c) The inscription provides the illusion of three dimensions (scenic photograph). (d) In addition to situation (c), speaker movement creates a virtual extension of the three-dimensional inscription into local space.

In the course of our analyses, we realized that the physical arrangement of audience, speaker, and inscription is associated with a preference for the speaker's orientation and positioning with respect to the specific referents of utterances (Fig. 2). The gestures associated with various positions and orientations are different in nature and have different functions. We distinguish three cases: (i) speaker talks about phenomena mediated by inscriptions in which two dimensions are salient (2-D flat); (ii) speaker talks directly about phenomena without reference to inscription (2-D or 3-D); and (iii) speaker talks about phenomena mediated by inscriptions in which perspective is introduced (virtual 3-D). (In addition, Fig. 2d shows how additional perspective is created by the speaker's movement creating the illusion of walking "into" the 3-D image.)

Inscriptions with two salient dimensions. First, when the talk is about the inscription per se, speakers are oriented to the right-hand quarter defined by the audience–speaker–inscription axis (Fig. 2a). Gestures are predominantly of a pointing (deictic) nature and, with few exceptions, are enacted with the right hand. (The geometry is inverted when the speaker faces in the opposite direction.) Speakers point to or circle specific features (with the expectation that the audience will pick out the relevant entity), or they follow some feature along a more or less recognizable boundary (e.g., road, forested area, or gravel pit). In

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TABLE 2. *Examples of verb- and noun-related gestures.*

Word	Gesture
VERB-GESTURE COORDINATION	
Tumbling:	*Fingers of both hands oriented towards each other, circular movement around axis defined by finger direction.*
Meandering:	*Palms of both hands touching each other, meandering movement of hands away from body.*
Absorbing [water into ground]:	*Both hands form cups, open to ceiling; hands move downward toward the floor.*
NOUN-GESTURE COORDINATION	
Pavement:	*Hand with palm toward floor, moving from body center line outward to the side of the body, at level of solar plexus.*
Underground:	*Similar to "pavement" but at level of pelvis.*
Watershed:	*Both arms form near circular shape at shoulder level.*

this case, there is a reflexive relation between the gesture and the inscription, in the sense that the speaker's gesture is motivated by some feature of the inscription while, at the same time, the gesture motivates the observer's gaze to search for the feature.

In this situation, the speaker is oriented to the inscription, which itself is anchored in local space. That is, the inscription is tied to local space so that speakers can orient the audience by using relative coordinate terms such as *up*, *down*, *left*, and *right*, which have the same meanings and orientations as if they referred to actual physical objects in the room. Also tied to this orientation are compass points, so that north and south correspond to *up* and *down*, respectively. Thus, there are instances in which a speaker refers to a town lying beyond the reach of the map as "further up there" (*pointing to about 1 o'clock, toward ceiling*) or "further down, to the south of there" (*pointing to 6 o'clock, to floor*).

Narration. When the talk is about the thing re-presented in the inscription but absent from the local space, there is a preference for orientations to the left quarter of the audience–speaker–inscription axis (Fig. 2b). Speakers physically move away from the inscriptions, thereby providing potential resources for their audiences to understand that the talk is about something other than the inscriptions. (Whether the audience actually uses such movements as resources to make sense of talk needs to be tested experimentally.) Iconic gestures, most often involving both hands, are associated with this orientation. As the examples in Table 2 show, iconic gestures are associated with and embody both verb and noun meanings. In this situation, orientation terms and gestures are relative to the hemisphere of the speaker. For example, one speaker standing sideways to the audience

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says *the farm lies over there to the right,* accompanied by a sweeping gesture to her "right," although from the audience perspective, the gesture is forward rather than to their right. Thus, during narration, the space is anchored to and defined by the speaker's body.

The two orientation–gesture configurations shown in Figs. 3a and 3b are employed when the speaker identifies *the heights of land* as the top of a mountain (Fig. 3a); the speaker subsequently talks about a potential oil spill in this location, even though it is not perceptually available (Fig. 3b). The depictions are associated with the following transcript.[3]

(1)

1 So * say, say something happened up in the heights of land,
Continuously points to the 'heights' as in fig. 3a but turns
2 the head waters of this area *, like
head toward audience. She turns her body.
3 * a, like an * oil spill.
Spilling gesture in fig. 3b.

In the first part of this episode (lines 1–2), the speaker is clearly oriented toward the photograph behind her. She turns her head in the direction of the audience toward the end of line 2, and then, with the first occurrence of *like*, she shifts her entire body into a position in narrative space (depicted in Fig. 3b) to produce the utterance about the oil spill (line 3). The gesture in narrative space is iconic, depicting the spilling of a liquid over the rim of a container. (The other hand enacts a mirror image of the gesture.) The gesture is already completed before the speaker verbally refers to the oil spill, a pattern that has led some researchers on gestures to advance the hypothesis that gesture facilitates speech production (Butterworth & Hadar 1989).

In our database, there is only one instance in which the same iconic two-hand gesture is used to make salient an aspect of the inscription and to refer to the entity it stands for (Fig. 3c). In that instance, the speaker used two arms to highlight the confluence of two tributaries into the main stem of the creek. The spoken context for the gesture toward the inscription behind her is depicted on the left in Fig. 3c and occurred in the following context:

(2)

4 It has at that point ∗ two parts that are draining into what's
Gesture of two tributaries, Fig. 3c on left
5 called the main stem . . . And this is basically ∗ the area
Points to main stem *Gesture of two tributaries, Fig. 3c on left*
6 where the creeks ∗ are coming . . . Graham is coming this
Gesture of two tributaries, Fig. 3c on left
7 way and Hagan is coming down that way . . .
Follows each tributary with finger in extended pointing gesture

This episode is part of a presentation in which the speaker wants to communicate what a watershed is. She does this by pointing to all the creeks that empty into the

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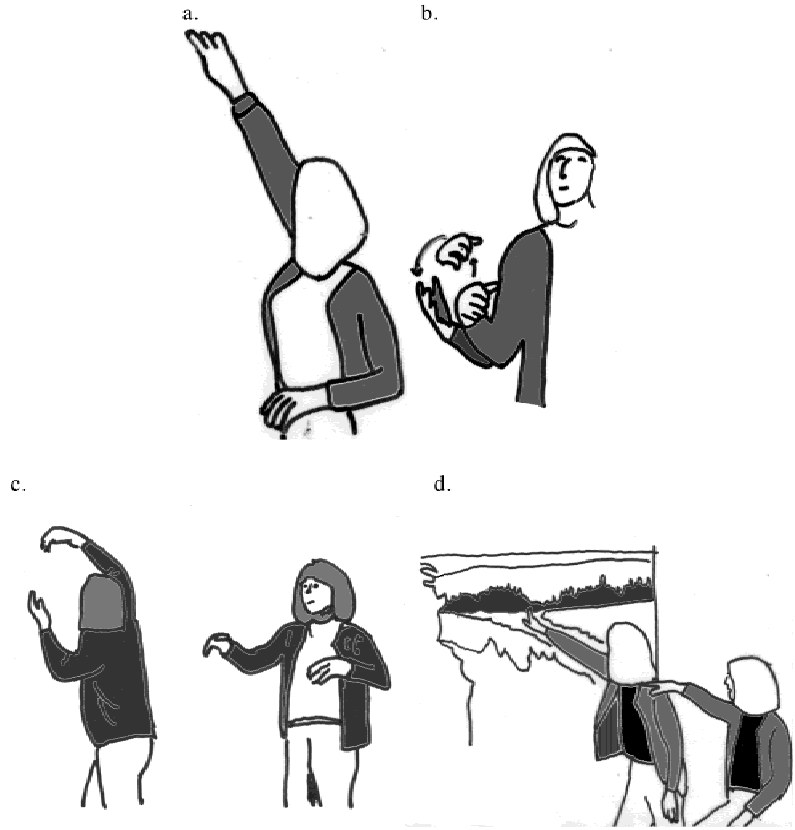

FIGURE 3: Gestures are related to the nature of talk, nature of inscription, and speaker orientation. (a) In graphic space, there is a preference for deictic gestures, one-hand (arm) involvement, and head orientation toward inscription; the talk is ABOUT the inscription. (b) In narration space, there is a preference for iconic gestures (here "oil spill"), often involving both hands, and a body orientation toward the audience. (c) There is only one instance where the same iconic two-arm gesture is used in both spaces ("confluence of two creeks"). (d) When the inscription simulates a third dimension as in scenic photographs, gestures typical for narration space overlap those typical for graphic space; here, "movement into the valley" corresponds to a movement of the gesture in three dimensions, including in the audience-inscription direction, thereby producing additional resources for interpreting depth.

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same main stem. She uses the same gesture three times to show the coming together of the two tributary creeks (lines 4, 5, 6), separated by deictic gestures to other features. The gesture is oriented to the graphic, and the hands make salient the creeks on the map behind the speaker.

After pointing to and outlining the tributary creeks, their confluence, and the main stem on the map, the speaker visibly rotates her body to face the audience. Now she is in narrative space, and she produces a gesture that again articulates two tributaries that eventually join (shown in the joining of her two hands) and continue as one creek (two hands, moving away from her):

(3)

8 * So this is basically a drainage area that is collecting all
Body and arm position as in Fig. 3c on left, but slight 'pumping'
9 water that is coming down * and it is all funneling down
motion of both arms *hands are approaching and touching*
10 through the streams and ultimately into Saanich Inlet.
Hands joined move forward and away from speaker's body.

The gesture accompanying line 8 (Fig. 3c) helps to establish that a watershed is a drainage area. The speaker then brings her two hands together in a downward and forward motion, as if showing two creeks that flow downward, approach each other, and eventually join to continue together (lines 9–10). Thus, the speaker sets up a narrative space where the heights forming a watershed transform into the two arms of a creek, which eventually they combine into one. The three-dimensionality of narrative space allows her to articulate the topology of "coming down" and "funneling," which cannot be expressed as well in words. In this case, there is also elevation information as the arms slowly descend and continue to do so until they indicate the mouth of the creek. That is, iconic gestures in narrative space essentially exploit three dimensions, whereas gestures in graphic space normally limit themselves to the two dimensions spanned by the inscription.

Inscriptions with depth information. Scenic photographs are inscriptions that provide the viewer with depth information, despite their 2-D surface. Fig. 2c shows that, in this situation, the previously preferred separation of narration and graphic spaces changes to overlap. Now, the apparent third dimension can be exploited by speakers in that gestures can be seen as occurring in and pertaining to the virtual space in front of and behind the surface on which the inscription appears (Fig. 2d). For example, as the speaker refers to the creek in the foreground of a scenic photograph (Fig. 3d), she not only moves her hand horizontally and vertically – she also moves it closer to the screen. Her gesture enacts a creek that is flowing from her current position to the distant background, where the creek disappears into the forest. These two gestures appeared in the context of the following talk:

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(4)

11 And this is, again if you are driving just north of Brentwood,
Oriented toward the image
12 you'll see * Hagan Creek * running down through the
Points to creek [Fig. 3d, right] close, then orients back to audience
13 valley * this is the main stem and just into Saanich
Points again and begins movement 'into' the image
14 Inlet which is * right here.
to end where the creek disappears [Fig. 3d, left]

At the beginning of this episode (line 11) the speaker is oriented toward the image and speaks hesitatingly, as if thinking about how to describe the location where the photograph was taken. After identifying how to get there (*driving just north of Brentwood*), she announces the creek by name (line 12) while pointing to a location in the foreground of the image, thereby helping the audience interpret a potentially confusing image. As she points again to the creek (line 13), she draws on the three-dimensionality of local space as a resource by moving her hand along the creek and simultaneously bringing her hand closer to the screen (Fig. 3d, left). That is, she situates herself with respect to the virtual third dimension of the image and moves (walking, gesturing) in a way that enhances the illusion of this added dimension. (In a subsequent example, we provide an overhead perspective that gives the depth information.) The speaker thereby orients herself so that the narrative space virtually extends the inscription into local space. The associated gestures are also a blended version of the types discussed earlier.

Laminations. So far, we have seen that the nature of gestures is linked to the orientation and topic of the talk. If the talk and gesture are about an inscription, the orientation is also toward the inscription. If talk and gesture are about entities not directly available in the inscription, the preferred orientation is toward the audience (in the narrative space). However, because maps and aerial photographs refer to tangible things available to experience (creeks, buildings, roads, mountains, parks), there exists the potential for a LAMINATION of talk and gesture about a feature in the two-dimensional inscription and talk about the actual entities to which the inscription refers. As the episode in Fig. 4 shows, this may lead to strange situations where *up* is actually *down* and *down* is *up*, or where a gesture and inscription make salient a horizontal feature associated with talk about *down* (cf. Fig. 6 and associated discussion).

In this episode, the speaker has projected an aerial photograph onto the screen. Her body and gaze are oriented to the aerial photograph. Having identified for the audience the locations of familiar landmarks, she first locates and then traces a creek (*Graham*). As her finger traces the creek downward on the image (i.e., upstream), she describes the creek as *flowing all through here and down*; but she completes the sentence by saying *up to the headwaters*. In the same way, in ex. (4) she traced the creek and described it as *going up* but completed the phrase by saying *down the valley*. Here, then, *down* is *up* and *up* is *down*. Oriented toward

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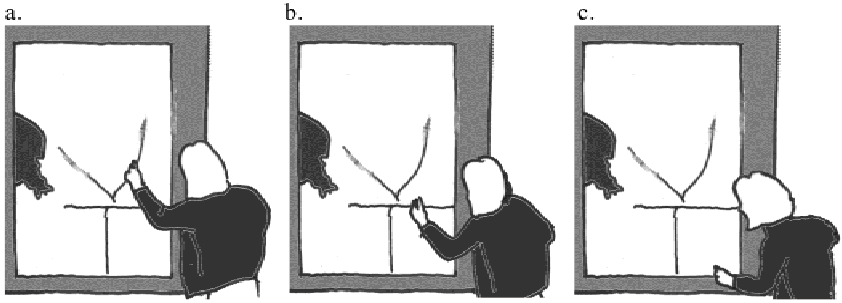

FIGURE 4: When is down up? Two discourses get intermingled as the speaker shows where the creek is located on an aerial map (downward) on the map but upward in the landscape (lived experience).

the inscription – which is orientationally aligned with local space – the speaker's references pertain to the aerial photograph: the gesture is downward, coinciding at some point with its verbal analog *down*. However, in the narrative space pertaining to the lived experience (and, to some extent, the linguistic field of the term itself), driving to the headwaters from the nearby village means going perceptibly uphill. *Down* pertaining to the inscription anchored in local space is *up* in narrative space. That is, in those (few) situations in which speakers do not provide the audience with body orientation as a resource for understanding the referents of *up* and *down*, they end up making potentially confusing statements when graphic and narrative space become laminated.

Gestural, references to maps and aerial photographs are aligned with particular features in the two dimensions spanned by the inscription, a pattern that does not permit a simultaneous gesturing of differences in elevation. In the left panel of Fig. 3c, the left arm gestures up, which corresponds to down (downhill) in terms of elevation. In the right panel of Fig. 3c, however, the gesture shows the same confluence of the two creeks, now featuring differences from higher to lower elevation. At the same time, being in narrative space, the gestures no longer preserve cardinal directions; rather, the gestures provide an image of the relative changes in the direction of the creek and its tributaries, before and after the point of confluence.

GESTURE, ORIENTATION, AND TALK IN LECTURES WITH INSCRIPTIONS

In this section, we take a closer look at several episodes to illustrate how speakers coordinate their actions within and across different spaces.

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Inscriptions without depth information

This sequence is part of an episode in which the speaker attempts to orient the audience toward the creek that is the topic of the presentation. The creek is within the local area in which the audience (grade 7 students) lives. Prior to the episode, the speaker has already pointed to several points on the map and has associated them with particular landmarks known by the students (e.g., Mount Newton, Centennial Park, and gravel pit). The presentation moves on to situate the creek with respect to the already identified landmarks. Coincidentally, a bridge crosses the creek near its mouth: as becomes clear afterward, the speaker traces the creek from the mouth to its headwaters.

The sequence begins when the speaker points to the road that leads out of the village; her finger follows the road (on the aerial photo) while she talks about *driving along West Saanich Road* (Fig. 5a–b). At this point, the speaker's talk becomes halting. In a smooth motion, she turns her body away from the map so that her left side is profiled to the audience and her right side is profiled to the map. With her head turned slightly down and toward the audience, she brings her arms and gaze into a position parallel to the inscription until her hands are in front of her face; she bends her knees and straightens them, thereby providing a hint of a traveling body going through a dip in the road. From there, she moves her hands on a trajectory downward and away, then leveling off (Fig. 5c–e) while uttering *through* and filling the subsequent pause with *hm*. The gesture repeats as the speaker names a location, *Tsartlip Band Reserve* (Fig. 5f–g). As she utters *you start to head downhill*, she sets up the same gesture again, but she completes it with her right hand only (Fig. 5k). The speaker now orients both head and hand back to the inscription pointing at the line that denotes the creek (Fig. 5k). Following the represented episode, she talks about a farm next to the road just described. Here too, the speaker orients herself as in the middle section, so that she is seen in profile by the audience (Fig. 5c); she moves her outstretched right arm outward from the line defined by her body center, covering about 90°. This gesture is continuous with the earlier narrative of driving downhill, in which the audience would find the farm and its land lying along the creek to the driver's right-hand side.

Hand, arm, and head are oriented toward the inscription in the first part of the episode (Fig. 5a–b). Only the right hand is engaged in gesturing. However, the speaker does not just point out a particular feature, she does so in terms of describing an experience: *driving along West Saanich Road*. That is, her gestures make salient the topological quality of the graphic space that is central to the ongoing narration. By shifting orientation from graphic space to local space, the speaker is able strategically to laminate the topological possibilities of gestural with graphic information in order to overcome the limitations of each and to enliven her narrative.

In the middle section of the episode, the speaker moves into and remains at the limit of the narrative space (Fig. 5c–h). Despite the common preference of speak-

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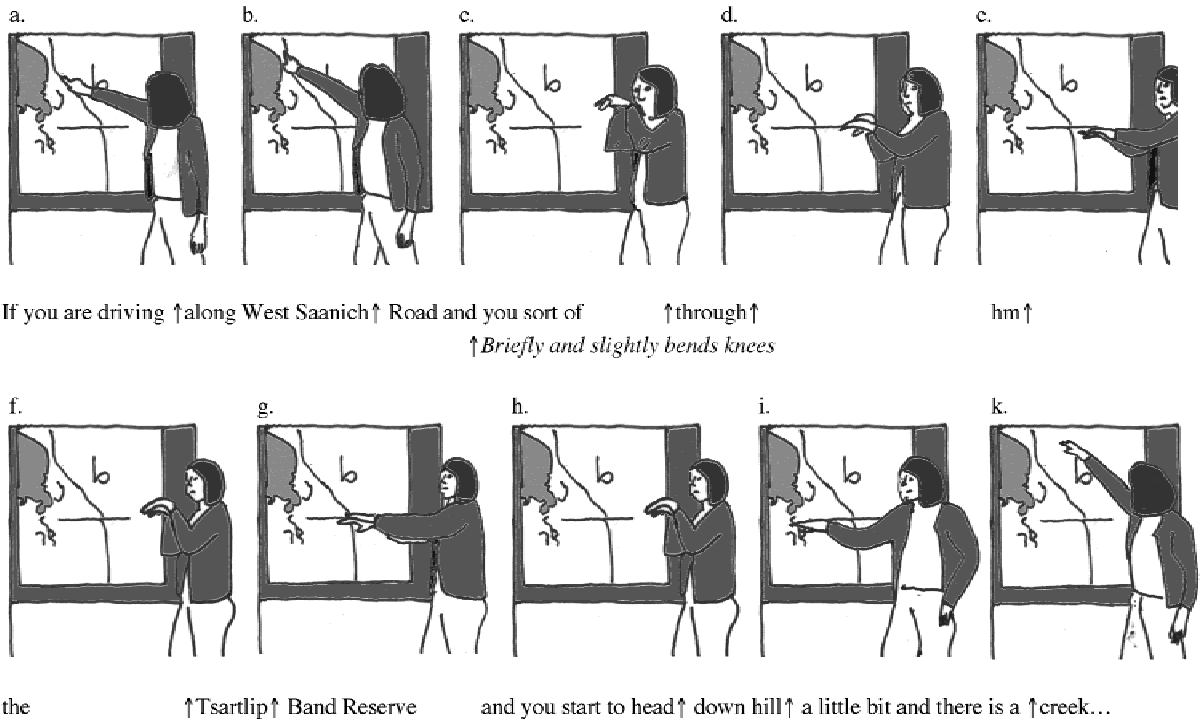

FIGURE 5: The speaker moves in and out of the two spaces, graphic and lived space. When she is in graphic space, her gestures are clearly oriented to the inscription, here the aerial map. When she moves to narrative space, her body orientation is toward the audience. The gestures have the horizontal and vertical orientations of the lived world – up/down, left/right. Graphic space is oriented parallel to the vertical orientation of the inscription.

ers in narrative space to orient further toward the audience, the particular concept being gestured is more easily visible when presented in the side view shown here. Using both hands, the speaker renders the experience of driving through the reserve where the road descends to the bottom of a valley carved by the creek. There is a threefold gestural rendering of driving downhill before the speaker describes the phenomenon verbally. Such delays between gestural and verbal renderings are not normally observed among competent speakers (McNeill 1985), but they may occur when a speaker is searching for words (i.e., during "lexical search"; see Butterworth & Hadar 1989), or when a narrative is being constructed for the first time (Beattie & Coughlan 1998).

We can understand the middle part (Fig. 5c–i) as an elaboration of locating the creek, which the speaker begins by identifying West Saanich Road (Fig. 5a–b) and completes by pointing to the creek (Fig. 5k). The elaboration occurs in terms of driving along West Saanich Road, which passes through the reservation. When we actually take the drive, we find the road descending through the entire reserve until we reach the creek, whence the road goes noticeably uphill again. The situation depicted in Fig. 5i can be seen as a transitional stage between the two spaces. The speaker's shoulder is back in the same position where it was before she entered narrated space, and her gesture is restricted to her right hand.

The speaker's move from an orientation toward the graphic into a narrative mode and an associated shift in orientation to and distance from the inscription has the potential to allow the audience to find the referent of the road, as represented on the map, in terms of their own experience of driving along West Saanich Road and through the Tsartlip Band Reserve. If the audience members recall such a drive, they will naturally arrive, in their imagination, at the bottom of the hill where the creek is situated.

Inscriptions with depth information

Transitions. Despite their flatness, scenic photographs provide cues for understanding in terms of our normal experience of viewing a landscape. When we liken a photograph to a window onto the world, it is easy to understand how speakers can create additional resources that make use of a third dimension. In the present episode (Fig. 6), the speaker intends to provide her audience with a better understanding of the landscape around the creek by projecting a scenic photograph. She begins by placing herself with respect to the depicted landscape: her utterance *we are standing on the southern, on the southeastern one* [part of valley] *here* is accompanied by a gesture in which both arms form a circular shape (Fig. 6a). The underarms are parallel to the ground, suggesting the spot from which she took the photograph. This spot is imagined as being in front of the screen, and this cue opens up a space that can be seen as continuing from the local space into the photo. This spatial interpretation of the situation becomes even more salient in the moments that follow (Fig. 6b–e).

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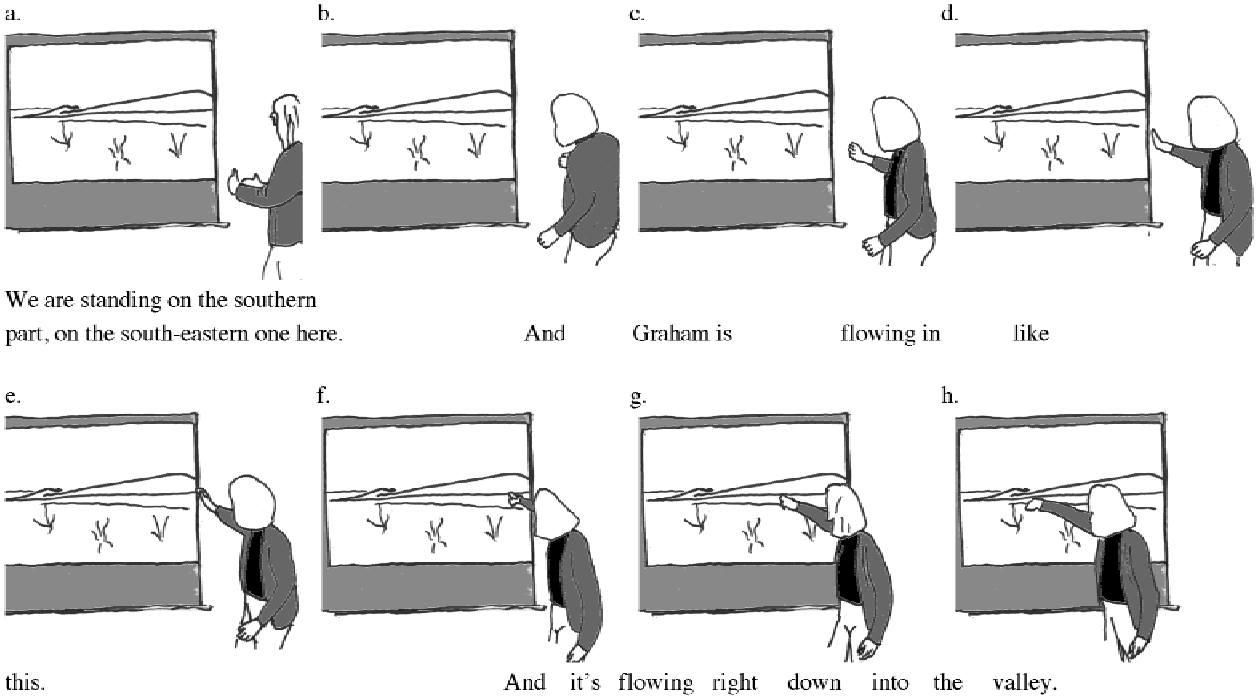

FIGURE 6: (a) Meagan turns to situate herself spatially with respect to the landscape depicted. (b–e) The speaker uses an iconic gesture to show how Graham Creek flows in the virtual space opened up. (f–h) The gesture moves horizontally in graphic space but down in narrated space. There is continuity between narrative space and graphic space, including here the virtual space opened by the scenic photograph.

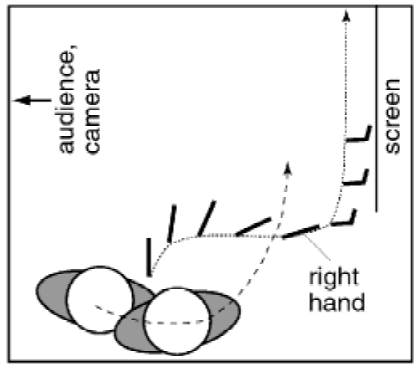

FIGURE 7: Overhead view of the situation in Fig. 6b–h. The right hand moves through an S-shaped trajectory (dotted line) as the body slightly rotates and then moves closer to screen (broken line). The hand bends and then follows a horizontal landscape feature in the image projected onto the screen.

Having opened a narrative space anchored by her current position and by the depth cues provided by the photograph, the speaker now makes the creek come alive, with a gesture that evokes an S-shaped meander (Fig. 6b–d). As her hand reaches the screen (Fig. 6e), it turns and moves parallel to the image at a constant height and follows a ridge (Fig. 6f–h), while her utterance evokes a creek flowing downward (*and it's flowing down into the valley*). Fig. 7 makes even more apparent these movements into the depth of local space. In the beginning, and corresponding to Fig. 6b, the speaker's shoulders are oriented toward the screen, and her right hand is partially concealed. This hand then moves away from her body as her arm extends and turns to become almost parallel to the overall trajectory (the dotted-line arrow in Fig. 7), and it begins to bend as it almost touches the screen (corresponding to Fig. 6f). In the meantime, her shoulders have rotated to become oriented more toward the audience; they stay in this position as the speaker walks parallel to the image (trajectory indicated by broken-line arrow in Fig. 7). Throughout this section, the speaker is oriented toward the inscription, but her first gesture (Fig. 6b–e) is typical of orientation during narrative, whereas her second gesture (Fig. 6e–h) is typical of orientation that goes with two-dimensional descriptions.

Here, in the narrative space opened up by the speaker's positioning and the scenic photograph, the gesture evokes a creek as a three-dimensional feature of the land. Narrative space overlaps with the space normally associated with talk over and about inscriptions. In contrast to conversations analyzed in other research, where CARDINAL directions are preserved in narrative space (e.g., Haviland 1993), our speaker preserves RELATIVE positions and directions.

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The gesture that articulates the flowing creek bears a visual similarity to the shape of the creek on a map: the gesture is iconic. There is, however, a contrast between the verbal information and the gestural information made available in the last part of the episode. While the speaker's finger tracks a visibly horizontal feature (Fig. 6f–h), her utterance evokes a creek that is *flowing down in the valley*. The gesture is no longer iconic in regard to the content of the utterance (*flowing down*). Here, as in Fig. 4, seemingly contradictory claims are made as two spaces are laminated. The speaker's gesture, anchored to the inscriptions, follows and makes salient (from the audience's perspective) a feature that is seemingly contradicted by the utterance; however, we can now see that the utterance pertains to the narrative space, where the creek is in fact flowing down.

Shifting spaces. Shifting can also occur in the case of inscriptions with perceived depth information: in fact, it appears to be necessary whenever the speaker talks about something that is not directly available from the inscription (the photograph) itself. In the following example, the speaker asks the audience (grade 7 students) whether they know what a "watershed" is. Because there is no response, she asks for the next slide, a scenic photograph featuring mountain ranges around a lake. Here, too, the speaker travels between the two spaces, but with notable differences from her approach to the other inscriptions.

The scenic photo provides the view of a valley that extends from somewhere below the speaker into the background. With eyes and left arm and hand oriented toward the photo, she communicates where the water flows in the depicted watershed (Fig. 8a–b). Here, her hand, palm facing the floor, moves downward against the mountain, beginning at the top and moving down to the lake. It is not merely a gesture following a vertical feature in the photograph; the flat palm provides an image of water that flows down over an extended area.

Because the inscription is anchored in local, lived space, the utterance *one watershed* [is] *flowing this way* and the downward gesture communicate water flowing downhill on the mountainside against which the gesture is seen. However, the gesture that works to show that the waters from the visible mountain ranges flow into the lake and therefore form *one watershed* does not work to depict another watershed that is not perceptually available. At first, the speaker brings up her right hand to the mountaintop, similar to the gesture in Fig. 8a. Then there is a small gesture in which she very quickly waves her hand down and to the right as she utters *what's the other watershed* (Fig. 8c). She finally shows *flowing on the other side* by means of a gesture typical of narration space (Fig. 8d–e). Associated with this change is the use of both hands, and an orientation (gaze and right hand) away from and parallel to the screen.

Here, the speaker defines two watersheds in terms of how the water flows. The two parts of the sentence are structurally equivalent: *what's one watershed* and *what's the other watershed*; however, there is a difference between the gestures. In the first instance, the gesture can be seen in a space continuous with the photo-

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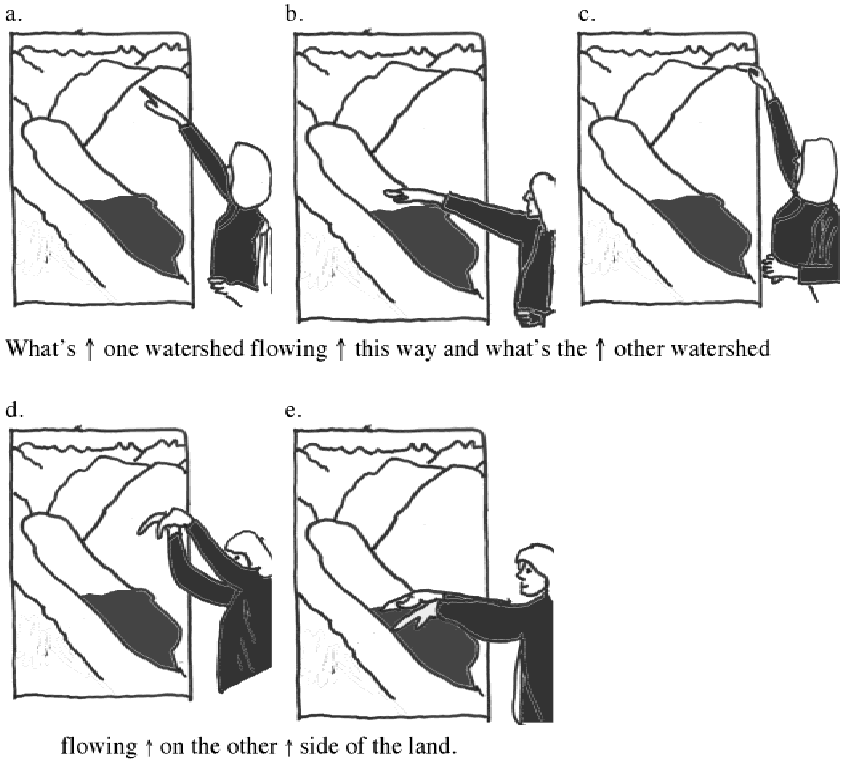

FIGURE 8: In this episode, the speaker attempts to explain the notion of watershed to grade 7 students. (a–b) She moves in a combined space where her gestures have referents both in the lived world and the photo. (c) She turns to show where the water flows down on the other side. (d–e) She turns away from the inscription space and produces a gesture (with both hands and arms) that shows the flow of water down an incline.

graph: the right hand moves from the top of the mountain range down to the lake, with the palm facing the ground throughout the gesture. The utterance *this way* and the downward gesture in the context of the photo are continuous. In contrast, there is no parallel with respect to *what's the other side* in the second definition. Rather, *what's the other side* is gesturally identified by a gesture that utilizes the three-dimensionality of local space. To show this, we resolve the episode around Fig. 8c to allow the microanalysis of the gesture, depicted in Fig. 9. The first line of Fig. 9 shows how the hand rises to the mountaintop and then begins to bend so

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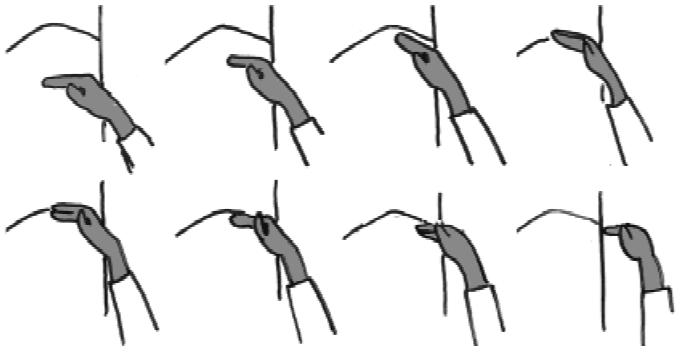

FIGURE 9: Microanalysis of the situation around Fig. 8c. The hand movement depicts information ("what's the other watershed") not available from the image itself. In the first line, the hand rises to the crest of the range in the photograph, and bends so that the fingers are horizontal to the ground. In the second line, the hand moves to the right and down and rotates 90° into the direction of the screen, thereby creating the impression of a slope of the mountain away from the audience and into the picture.

that the fingers are parallel, similar to their position just prior to Fig. 8a. Then, rather than moving down as it did before (Fig. 8b), the hand moves to the right (as seen from the audience) and down, and it rotates 90° into the direction of the screen. Viewed in real time, the gesture creates the impression of a mountain slope directed away from the audience and into the picture. The speaker then orients herself away from the screen, raises her other hand, and brings both hands down to indicate, or perform, the flow of water as the audience would see it on a side-view image of the hill (Fig. 8d–e). That is, *flowing down the other side* cannot be gestured against the photo in the way the speaker did to show the watershed visible in the photo.

The moment depicted in Fig. 8c and Fig. 9 constitutes the changeover between two orientations; more specifically, the change occurs at the beginning of the second line in Fig. 9, when the arm and hand make use of space to indicate *what's the other side*. The change in orientation is clearly noticeable in the speaker's change to bring her line of sight and arms parallel to the screen, and her introduction of her left arm into the gesticulation process. Furthermore, it changes the origin from which the speaker speaks. In the first two frames, the perspective is that of an observer looking from an elevated point over the lake and to the mountains behind it. In the last two frames, the gesture is no longer to be seen as acting against the photo, but rather as from the perspective of a person moving downhill (or the perspective of water flowing downhill). Notice that the gesture is similar

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to the one the speaker used to describe what it means to drive through the Tsartlip Band Reserve (Fig. 5).

DISCUSSION

To understand interactions requires a study of the setting and the resources that it makes available to discourse participants for making sense of each other's utterances and gestures (C. Goodwin 1996). There is a need to move beyond the study of speech and gestures in communication and to include environmental structures and body movements. In this study, we provide an expanded framework of communication to include an aspect of the environment – visually available inscriptions – and the relative position of speakers with respect to audience and inscriptions. Although we suggest that the framework allows us to understand communicative situations, we do not claim that speakers CONSCIOUSLY attend to producing information such as differential orientation in space. Rather, such orientations that co-vary with and distinguish different referents are likely to be in the nature of involuntary information – that is, information GIVEN OFF (Kendon 1988b).

A speaker is always located in the local space of the present situation. Furthermore, we know that, in focused encounters, speaker and listener orient themselves toward each other (Heath 1986). However, the presence of an inscription about which the speaker talks establishes constraints. Here, in situations where the speaker is positioned between audience and inscription, the speaker's orientation can be parsed into two domains. First, there is an orientation to the inscription. Talk and gesture are relative to the inscription, which may have dimensions that are not continuous with lived experience (abstract concepts). Second, there is an orientation to the referent of the inscription. In the present case, maps and photographs denote a valley near the village where the presentation takes place. It is therefore likely that the audience recognizes features of the landscape from the description and projects them onto their own experience of the valley. For example, the utterances *down the slopes of Mount Newton* or *down through the Tsartlip Band Reserve* and their associated gestures may allow the audience to associate the present talk with their own lived experience in the valley. In our database, such a relatively clean separation does not exist in the speech component, and this leads, in the case of maps and aerial photographs, to a blending of narrative space (Haviland 2000) and the space associated with an orientation to the inscription. In these situations, going down (left, right) on the map (graphic space) may coincide with going up in narrated space; similarly, going up on the map (graphic space) may coincide with going down in narrative space. This observation also throws light on a study of Japanese rock climbers (Kataoka 1998) that has questioned the absolute value assigned to vertical space as being an overestimation rooted in European conceptualizations of space. Our study questions and relativizes the absolute nature of what is up and what is down.

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When it is oriented to the inscription, the gesture calls attention to a particular feature: In fact, gesture and feature mutually motivate each other. The primary expressive means is not the gesture, but the representation to which the gesture refers. The inscription then refers to the world not immediately available to the participants. In narrated space, it is the gesture itself that has a primary role in representing that aspect in the world.

When the illusion of depth is provided by the inscription, as by the scenic photographs studied here, we observe a shift in that the orientations toward inscription and narrative space begin to overlap and blend. It has been noted that physicists who talk over and about inscriptions inhabit a LIMINAL world, situated between the world of perceptually available inscription and the constructed world it indexes (Ochs et al. 1994). In this liminal world, distinctions between subject and object are no longer sharp. In our present analysis, the liminal world is achieved largely by the lamination of narrated space and inscription space. For example, physicists talk about being in "domain state," which is a clearly identified shaded area on a graph; getting out of domain state and its graphical representation is associated with the trajectory of a gesture that begins within and moves out of this area. This domain state is available only in and as the inscription. In contrast to the findings of Ochs et al. 1994, 1996, the world referenced by the inscriptions in the present study is the everyday lived environment of speaker and audience. It is a shared world that blends with the local space of the classroom. In the physicists' case, the constructed world is of a conceptual (symbolic) nature and is therefore discontinuous with the local space of the laboratory where the conversations take place.

Speakers' gestures, when they refer to an inscription, are iconic in the sense that there is a similarity relation that is easily picked out by the onlooker. The gestures in narration space also portray things and events in terms of a similarity relation, but the directional orientations are not maintained. For example, the speaker repeatedly accompanies her talk about the confluence of Hagan Creek and Graham Creek with gestures involving both arms and hands to depict something of the type of "two things coming together" (Fig. 3c). When she talks in the direction of the inscription, the arms and hands move in a plane more or less parallel to the map (or aerial photograph): the gesture reproduces the topological relation between the two creeks, their confluence, and the joint water flow after it. In narrative space, by contrast, the two creeks, their confluence, and the subsequent joint movement of waters occur in a plane parallel to the floor (i.e., at a 90° azimuth angle and a rotation of approximately 90° counterclockwise). The orientation of narrative space provides a constraint such that speakers do not preserve the cardinal direction.

Our findings with respect to the spatial orientation of speakers are consistent with other recent research on orientation (Levinson 1997). Thus, whereas aboriginal speakers of Guugu Yimithirr and Mayan (Zinacantec) make reference to cardinal directions in absolute terms (Haviland 2000), western European (Dutch)

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subjects show a preference for relative orientation (Levinson 1997). In our case, iconic gestures associated with narratives are defined by their location in narrative space and relative to speakers' dominant axes, rather than by the actual cardinal directions of the landscape features that they talked about. Furthermore, in the case of scenic photographs, direction indications are anchored to the image, and therefore relative to the line of sight, rather than being anchored to the cardinal directions of local space.

Our research provides evidence that language is not an independent phenomenon but is closely tied to social situations and to physical aspects and arrangements of the speech situation. Furthermore, speech is integrated with body orientation and movements, and to gestures. These dimensions are nearly unexplored in research on interactions in educational settings where there is an emphasis on language. However, this and other research conducted by our team in education settings shows that gestures and other body movements, orientation, and physical arrangement of speaker, listener, and artifacts have considerable influence on the nature and form of the language used. Situations, such as lectures, where there are few overt interactions between speaker and audience may be the easiest contexts to analyze. There is little, if anything, known about the interrelation in more complex classroom situations involving a teacher and one or more students.

NOTES

[1]The importance of the body in making sense of speech situations is by no means a universal phenomenon. Rather, it seems to reflect an actor-orientation characteristic of Indo-European languages which is distinct from Austronesian languages that are characteristically non-actor-oriented (Senft 1997).

[2] Readers will find more information about the original intents for each study and the findings with respect to cognition and learning in the following publications: grade 7 (Roth, Masciotra & Boyd 1999), introductory ecology (Roth & Bowen 1999), and physics for elementary teachers (Roth, Tobin & Shaw 1997).

[3] We use the following conventions. A single asterisk '*' marks the moment when the associated and depicted gesture occurred. Two asterisks and underlining of the intermediate text '* say, say . . . *' denote the overlap of talk and an extended gesture. Italics are used to provide a verbal description of the depicted gesture.

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