Gestures: Helping Students to Understand Photographs in Lectures

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ABSTRACT: Photographs are the most frequent visual representation in high school biology textbooks. However, little is known about how students make sense of and learn from photographs when they come across them; even less is known about the different semiotic resources available for making meaning when photographs appear in lectures. In this study, events during which individuals used photographs in lectures and lecture-type situations were culled from a database established during three ethnographic studies and analyzed with respect to the meaning-making (semiotic) resources that speakers standing next to the projected photographs provided for understanding and learning from them. Our analysis, methodologically informed by interaction analysis, identified eight types of gesture/body orientations as semiotic resources that decreased the ambiguity inherent in photographs. We describe these eight types in detail and show in which respect they enhance the understanding of photographs and the scientific concepts embodied in them. Differences are noted with events where photographs are projected so that the speaker did not stand next to the projected photograph (e.g., overhead projectors, darkened lecture halls). We surmise that teachers can help their students learn to read and interpret photographs from lectures when they project reproductions against a screen in such a way that it allows the use of gestures and body orientations as additional meaning-making resources.

KEYWORDS: Photographs, scientific representation, semiotics, gesture, body orientation

We live in a visual world: (visual) representations pervade our lives. This is especially true in the sciences, where scientists rely heavily on the use of visual representations when they talk shop in scientific research laboratories and when they write research articles (Knorr-Cetina & Amann, 1990; Latour, 1993). Following the usage in the social studies of science, visual representations in any medium (paper, computer monitor, projected image) are now generally referred to as “inscriptions” in the educational literature, too (Roth & McGinn, 1998);
they include photographs, maps, charts, diagrams, graphs, formulas, and so forth (Latour, 1987). Inscriptions are of particular importance to the construction of scientific objects and to the construction of scientific knowledge both at the level of the individual laboratory and at the level of the scientific community (Henderson, 1991); they constitute a pervasive means of scientific communication.

It should not come as a surprise that scientists and science teachers at all levels of schooling also draw heavily on representations when they communicate the current state of the art to the next generation of scientifically trained individuals both in textbooks (Roth, Bowen, & McGinn, 1999) and in lectures (Roth & Bowen, 1999). What may perhaps come as a surprise is the fact that the frequencies of particular inscriptions differ between high school textbooks and scientific journals. Thus, despite nearly the same number of inscriptions per page, there is a prevalence of graphs, statistics, and mathematical formulae in scientific journal articles whereas high school biology textbooks contain a large number of photographs and naturalistic drawings (Roth et al., 1999).

In a previous study that was Part One of the first author’s master’s thesis, a number of structural features of photographs in Brazilian high-school biology textbooks were shown to pose potential problems for making sense from the photographs (Pozzer & Roth, in press). Because of the abundance of contextual detail, photographs lend themselves to being perceptually structured and therefore interpreted in different ways so that what exactly is important to the scientific phenomenon to be taught is often not easily discernible by the reader. The previous study showed that neither caption nor main text were able to constrain this tendency of photographs to proliferate meanings rather than to constrain the number of ways readers can make meaning when they read a particular scientific text (Bastide, 1990).

When presenters or teachers use photographs during a lecture, we may expect them to deploy meaning-making resources not available to the reader of a text. For example, under certain circumstances, we expect lecturers to use gestures, pointing sticks, or lasers to point to a particular spot in the photograph; linguistically, this pointing constitutes a deictic gesture (McNeill, 1992). Furthermore, lecturers can also use iconic gestures, which get their name from the perceptual resemblance of gestures with the phenomena they depict—following the shores of a lake on an aerial photograph or using two hands to illustrate the confluence of two creeks constitute iconic gestures. That is, learning from photographs in the context of lectures can be expected to be a very different kind of work than learning from photographs in textbooks.
Photographs in Lectures

The purpose of the present study was to investigate the semiotic (meaning-making) resources that lecturers make available to their audiences; such resources can assist in better understanding just what photographs are intended to express. We studied cases in which speakers talk about scientific topics in the presence of photographs. We focus on “lectures,” that is, situations in which one speaker talks about scientific issues while addressing a larger, mostly listening audience. We analyze talk, gestures and relative position of speakers with respect to audience and to photographs, with a particular interest in how a speaker’s words, gestures, and body orientations assist in making salient photographic detail pertaining to the scientific issues at hand.

Background

When scientists interact with others, and also when they teach and make use of inscriptions, they do not just use words, but they also gesture, point, and move in real and imaginary spaces (Goodwin, 1995; Ochs, Gonzales & Jacoby, 1996). In these situations, visual representations, such as photographs, and (verbal or written) text are normally co-deployed such that meaning is, at the same time, multiplied (Lemke, 1998) and limited to allow only a limited range of meanings (Bastide, 1990). This study is situated at the intersection of two domains of scholarly work in the context of scientific communication: semiotics of photographs and associated text and gesture studies as these disciplines pertain to science and science education.

Semiotics of Photographs

High school biology textbooks heavily draw on photographs; one might think that this means a lot of information is made available by visual means. However, photographs alone contain too much undifferentiated information and therefore mean little; they are full of “gratuitous” detail that allows many different ways of looking at and interpreting it (Myers, 1990). On the one hand, this photographic detail provides a space that is continuous with the lived world, allowing readers to establish a link with the everyday world that surrounds them. On the other hand, this detail provides few cultural codes that could delimit the photograph’s sense and meaning as intended by the author. To control the range of possible meanings that a photograph can give rise to, authors use captions and embed the photograph/caption combination in still further text (main text) that together constrain the meaning a reader can make (Bastide, 1990). That is, the text constitutes a specification of order of coherence from which the rational visibility of the object (beating, scientific object) emerges. Therefore, when
there are only photographs and texts, such as in science textbooks or scientific journals, the work of reading, in part, consists of uncovering how caption, main text, and photographs are linked. Reading is required to construct and reconstruct the orderly sense of the scientific findings and concepts presented. The text presents particular constraints in terms of how it orders the reader’s way of looking at the photograph and therefore constitutes a particular pedagogic arrangement.

The situation is different, however, when we consider photographs in the presence of a verbal instead of a written text. Consider for instance the photograph in Figure 1 and the text uttered by the person talking about it. If this photograph and the text associated with it were part of a textbook, the reader would certainly have some difficulties to interpret this figure. For instance, which mountains are “these mountains”? Where, in the photograph, is the “other side” referred to in the text? What exactly does the utterance “up here” refer to in the photograph? From the use of terms such as “here” and “this,” which are always context sensitive, one can infer that the text associated with the photograph in Figure 1 is not part of a textbook. If one considers the text and the photograph in Figure 1 as part of a discourse situation such as a lecture, for example, one can interpret it in a different way. In this example, the audience had to rely on pe-

“What is happening here is that if rain is falling on the land it would fall onto these mountains and it would drain either down one side or down the other side. So little creeks would form up here and they drain into a bigger creek, and into a bigger creek, and drain all the way down into this larger area.”

Figure 1. Example of a photograph and a lecturer’s utterances that explained what the audience is to see in it.
Peripheral clues for interpretation. It had to take into account not only the established text but also the clues provided by the context to make sense (Brown & Duguid, 1992). However, even realizing that the text accompanying the photograph in Figure 1 is not a written but a verbal text, the problem of identifying the “right” objects in the photograph is still present. Further resources are necessary to enable audiences to make sense of this photograph and text. In a speech situation these resources consist, for example, in the gestures and body orientations that speakers use during their talk. It is, therefore, as if the two classes of organizational materials, text and photograph, are linked through and coordinated by the gestures and body orientations. This paper is centrally concerned with speakers’ gestures and body orientations as resources produced as meaning-making (semiotic) resources for the audiences.

**Talk, Gesture and Photographs**

In a speech situation, such as a lecture, 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. There is evidence that listeners actively interpret even highly idiosyncratic gestures and use them as resources to make sense that parallels speech (Kelly, Barr, Church & Lynch, 1999); in fact, when speech and gesture express different concepts, gestures are usually more reliable and conceptually advanced (Church & Goldin-Meadow, 1986). Given the importance of gestures in teaching and learning settings, particularly mathematics and science environments, it is surprising that the role of gestures in scientific and mathematical discourse remains largely unexplored in educational research (Lemke, 1998).

Gestures have been classified into different types including beats (or batons) and gestures of deictic (pointing), iconic, and metaphorical nature (McNeill, 1992). *Beats* are gestures that are void of propositional or topical content, and yet lend a temporal or emphatic structure to communication. Beats function as interactive gestures, which serve to regulate the coordination of speaking turns, to seek or request a response, or to acknowledge understanding (Bavelas et al., 1995). *Deictic* gestures are used in concrete or abstract pointing. They “point” out some aspect of the content, making it salient figure against everything else, which becomes rather diffuse ground. The accompanying utterance about this aspect is therefore “grounded” by means of a relation to the referent that is made salient by the deictic gesture. These gestures, thus, are context dependent. Deictic gestures, coupled with deictic utterances, play an important role during interaction because they establish a *distinction* between figure (topic) and ground (Hanks, 1992). They are used to point out features in the environ-
ment, 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).

Gestures are called *iconic* when their shape is isomorphic with the content they convey (Lemke, 1999), that is, iconic gestures are hand/arm movements that bear a perceptual relation with concrete entities and events (McNeill, 1985). This perceptual similarity constitutes their communicative strength. Iconic gestures are also said to have a transparent relationship to the idea they convey, particularly within a narrative event in which they depict concrete objects and events (McNeill, 1992). The hands next to the temples with fingers configured such as to suggest horns while talking about a charging bull constitute an iconic gesture. *Metaphorical* gestures are like iconic gestures but provide a visual expression of abstract rather than concrete objects. A mathematician, whose left palm approaches the steady right palm in the context of talk about mathematical limits (e.g., in calculus), produces a metaphorical gesture.

In communicative encounters, speakers as listeners make available to each other many resources that provide contexts for constraining the meaning of utterances. 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 figures to be isolated in a photograph. 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 (Goodwin, 1995; Egbert, 1996). During lectures that include inscriptions, gestures are important resources for the presenter to organize the alignment of talk and visual representations, such as photographs, transparencies, and film or video (Goodwin, 1994). Gestures are important for sense-making processes, for when there are misalignments between features of the inscription, gesture, and speech, comprehension on the part of the audience is made more difficult (Roth & Bowen, 1999).

**Study Design**

To gain a better understanding of the relation between gestures and talk over and about photographs, we analyzed videotapes from a four-month seventh-grade ecology course, an entire second-year university ecology course (36 fifty-minute lectures), and a variety of lectures given by environmentalists about the watershed that they attempt to protect. In several instances a biologist-environmentalist assisted two seventh-grade teachers in teaching about the ecology of watersheds. In all these situations, the speakers made use of photographs
that were visually available to the audience. There were contextual differences that allowed us to tease out the role of gestures. Thus, when the same biologist-ecologist gave a lecture to the seventh-grade students, she used a variety of gestures; giving a similar lecture with the same set of photographs to the scientists at a federal research institute, she presented in a darkened auditorium where she could not come near the projection screen, used a laser pointer, and could hardly be seen herself. Finally, the professor in the second-year university course used an overhead projector to project transparencies against a screen. Here, his gestures were directed toward the transparency, yielding a different geometry between his arms, hands, and the projected photographs.

We began our analysis by jointly viewing the videotapes to conduct Interaction Analysis (Jordan & Henderson, 1995), an interdisciplinary, collective method to investigate the interaction of human beings with each other and with the objects in their environment. The meetings, which included the authors and others attending the open analysis meetings, were video-recorded allowing us to establish key elements for the quality of interpretive inquiry, “progressive subjectivity” concerning the categories that we developed and at the same time an “audit trail” (Guba & Lincoln, 1989). During the group meetings, videotape replay was stopped whenever someone thought a significant event had occurred; the event was reviewed as often as necessary so that each tentative assertion could be fully explored by all participants. In the absence of a substantial body of prior research, we began our analyses without predetermined analytic categories, developing them together as our group analysis evolved. As our comments and assertions evolved, so did our analytic approach. First, we noticed a need for a classification of the different gestures used to refer to the photographs during the lectures, as we identified the gestures as the most important semiotic resource available to the audience to interpret the photographs in the context of a lecture.

To facilitate further analysis of the use of photographs in lecture situation, we therefore proceeded to a categorization of the gestures and body orientations that the speakers used in the different settings. This classification emerged through the attentive observation and further development of categories that had emerged during group analysis. Before we arrived at the categorization presented here, we went through a process of refining each category, by discussing all the examples of gestures provided in the videotapes, and by developing criteria to distinguish each one of the categories. We changed our classification until we had identified a set of exhaustive, non-overlapping functions of gesture/body orientations as meaning-making resources in talk over and about photographs. Our classification system covers the domain of gestures in our entire database.
Episodes were extracted from the videotapes for the constitution of vignettes that exemplify our categories; these episodes were imported into iMovie (a program supplied with Macintosh computers), which allowed us to play the clips at slower rates, to conduct frame-by-frame analyses, and to save individual frames for the production of still images. Still images were extracted to produce the visual representation of the gestures that would accompany each vignette. The videotape was played through the computer monitor, and each significant frame pertaining to a specific gesture was isolated and then printed out. Subsequently, using a transparency, we produced drawings of the selected frames, highlighting only the relevant features for the representation of each category of gestures and body orientations. The drawings were scanned and inserted in our written analyses.

**Gestures and Body Orientations:**

**Constraining and Multiplying the Meaning of Photographs**

The study of gestures and body orientations as meaning-making (semiotic) resources for understanding and learning from photographs is new to science education. We therefore provide some principles of analysis that we developed as part of this work before moving to the description of the different functions that gestures/body orientations have as semiotic resources that constrain and multiply the meaning of photographs used during lectures.

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*Principles of Analysis*

Communication can be analyzed in terms of the dialectic relationship between imagery and language (McNeill, 2002). In the present situation, there are two modes of imagery—photographs and gestures—that constitute the counterpart to speech; together, imagery and language form a unit. Any unit that embodies simultaneously different but inseparable elements is a dialectic unit. This means that there are inherent tensions between the text (written or verbal) and the imagery embodied in photographs and gestures. Lemke (1999) contrasted these two means of communication in terms of the difference between the typological nature of language and the topological nature of images and gestures. However, there is more to the imagery-language dialectic, for the speech and gesture are produced in the course of talk but photographs constitute something like a stable ground. Talk and gesture are therefore also in a dialectical relation with the photograph—co-produced, they inform listeners about what might be found in the photograph. At the same time, the photograph may be treated as evidence for the existence of the phenomenon elaborated by the lecturer. The gestures co-
occur with the text and are directed toward the photograph, providing anchors that integrate text, photograph, and gestures into a total performance.

The types and shape of gestures produced by a speaker also depends on body orientation (Haviland, 1993; Roth & Lawless, 2002). Body orientations, in fact, constitute interpretive frames for gestures limiting their interpretive flexibility and thereby enhancing and even multiplying the meaning of photographs. We therefore analyze all events in terms of gestures and body orientations.

A wide range of different interpretations can emerge by looking at the photographs. When making reference to a photograph, the author/lecturer makes use of different strategies to constrain the emergence of diverse interpretations that, though legitimate, are not suitable for the topic at issue. In a textbook or article, these strategies include the written text, the indexical reference to the photograph, the caption and, in exceptional cases, the use of arrows, highlighting etc. on the photograph itself. These strategies limit but do not completely avoid the emergence of different interpretations of the photograph (Bastide, 1990). When a photograph is used in a lecture situation, however, the strategies used by the lecturer to constrain the occurrence of misinterpretations are different. Although the text still plays an important role in directing the audience towards the “right details” in the photograph, the ambiguity of the text implies the use of more explicit associations between text and photograph. In this context, the gestures/body orientations function not only as the reference to the photograph, but also as the means by which text and photograph are explicitly associated with each other. Through gestures, lecturers narrow the range of ways for looking at photographs. Thus, although most journalists and television audiences saw the Los Angeles police officers beat up Rodney King, Goodwin (1994) showed how an expert taught the judge and jury to view the video recordings as evidence for the contention that Rodney King was not beat up but intelligently kept under control. In our database, each specific instance of the talk was directly associated with a correspondent gesture/body orientation, which, in turn, guided the viewer through the photograph. That is, the lecturers guided their audiences through photographs not only by means of text but also by their deployment of gestures and body orientations.

What utterances lack in sophistication or specificity is provided by the gestures/body orientations directly associated with them, that is, the text which by itself could generate many doubts because of its ambiguous nature, is enhanced by the gestures, which complement the text. Both text and gestures together form a structure that becomes the lens through which the photograph is viewed. Although different interpretations may still arise, a photograph in a speech
situation can have its interpretive horizon narrowed such that the opportunities for new and diverse interpretations are mostly reduced.

The body orientation is part of the periphery of the gestures that contextualizes the entity to be made salient in the photograph. Such changes in periphery can be perceived as a clue that allows the audience to move its attention away from the currently project photograph and to focus on the relation between words and gestures alone. When a speaker stands between the audience and the screen onto which photographs are projected within reach of the speaker, we distinguish two orientations. In the first, the speaker’s head and frequently shoulders and upper body are oriented toward the photograph. This orientation signals that gestures and talk pertain to something visible in the photograph. In the second, the speaker is clearly oriented toward the audience. This body orientation signals that the topic was about something not available in the photograph (Roth & Lawless, 2002).

When a photograph is used in a lecture situation where photograph and lecturer are visible to the audience, the body orientation therefore becomes a resource upon which the audience can rely when interpreting the photograph in the context provided by the text, in this case, a discourse. The lecturer’s body orientation helps to distinguish different types of gestures and provide resources for connecting verbal text and photograph, insofar as it provides cues to the audience about where to focus their attention, either on the photograph or on the lecturer. Each position or orientation the lecturer assumes represents a different phase of the speech, and the audience is able to grasp that, just by looking at the position of the speaker. When the lecturer is turned towards the photograph, her body orientation accounts for the same as if she had said, “now look at the photograph”; however, when she turns sideways or fully to the audience, turning back to the photograph, this is the same as saying, “now pay attention on me and my gestures but not the photograph.” The lecturer does not have to say this in words, but indicates the attitude expressed in simply turning and continued talking.

Functions of Gesture and Body Positions

The gestures appeared as the most important semiotic resource that the audience could rely upon to interpret the photographs in the context presented by the discourse during a lecture. Our classification of the gestures therefore helped us to investigate the pedagogical functions a photograph can achieve when it is used in a lecture situation as opposed to a textbook or journal situation. Describing each category of gestures allowed us to analyze the interactions between photograph, text and gestures that are associated to the work of interpreting and using
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photographs during lectures. We emphasize the function of each gesture in the working of interpreting the photographs and connecting them to the topic of the discourse, that is, the subject matter to be taught. To limit the amount of explanations required in explaining the concepts of the lectures, we took all the following examples from one 15-minute lecture of an environmentalist who repeatedly assisted two seventh-grade teachers in the process of implementing a four-month environmental unit. (We provide frequency data for this particular lecture.) In the particular lecture chosen, the environmentalist attempted to teach the concept of “watershed” drawing on photographs, aerial photographs, and maps mounted as slides and projected against a screen covering the chalkboard. Throughout the presentation concerning the concept of watershed, the environmentalist/lecturer stood next to and in front of the projection screen. She used many of the same photographs in other lectures, including another recorded lecture that she gave to the scientists in a nearby federal research institute.

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In the particular lecture chosen, the biologist-environmentalist attempted to teach the concept of “watershed” drawing on photographs, aerial photographs, and maps mounted as slides and projected against a screen covering the chalkboard. Throughout the presentation concerning the concept of watershed, the biologist-environmentalist stood next to and in front of the projection screen. She used many of the same photographs in other recorded lectures, including one that she gave to the scientists in a nearby federal research institute.

During our analysis, we classified the different functions that gestures/body orientations had in relation to the photographs when used by the different lecturers in our database. Our classification includes eight different functions of gestures/body orientations produced as semiotic resources for making sense of
Representing The gestures classified in this category were those speakers used to represent objects or phenomena not directly available in the photograph and yet associated with some feature of it. Although utterances were related to the photograph, the gestures were about something not directly visible in the photograph such as a.

<table>
<thead>
<tr>
<th>Function</th>
<th>Gestured phenomena available in photo?</th>
<th>Deictic/iconic</th>
<th>Specific/generic</th>
<th>Body position (toward?)</th>
<th>N</th>
</tr>
</thead>
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<tr>
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<td>No</td>
<td>Iconic</td>
<td>Generic</td>
<td>Audience</td>
<td>30</td>
</tr>
<tr>
<td>Emphasizing</td>
<td>Yes</td>
<td>Iconic/deictic</td>
<td>Generic</td>
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<tr>
<td>Highlighting</td>
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<td>Deictic</td>
<td>Generic</td>
<td>Photograph</td>
<td>12</td>
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<tr>
<td>Pointing</td>
<td>Yes</td>
<td>Deictic</td>
<td>Specific</td>
<td>Photograph</td>
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<td>Outlining</td>
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<td>Deictic/iconic</td>
<td>Specific</td>
<td>Photograph</td>
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<tr>
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</table>

photographs: (1) Representing, (2) emphasizing, (3) highlighting, (4) pointing, (5) outlining, (6) adding, (7) extending, and (8) positioning (Table 1). In this classification, we take into account the position of speakers when they gesture, the relation of the gesture with the photograph (e.g., if the photograph is used as a background for the gesture or not), the visual availability of the object/phenomenon in the photograph, and the primary function of the gesture in relation to speech and photograph. We distinguish the production of gestures along the following lines: gestures are deictic, iconic, or both; they can be distinguished as specific or generic; they present a phenomenon that is or is not available in the photograph; and body orientation (Table 1). The total number of gestures in the 15-minute lecture was $N = 92$; in Table 1, we provide frequency data for this particular lecture.

Representing
“And you go sort of through the Tsartlip Band Reserve, and you start to head down the hill a little bit...”

Figure 2. Example of representing category of gestures. The photograph does not contain the feature represented in the gesture. The speaker turns the head toward the audience, but remains sideways so that the downward motion of hand/arms remains visible. The gesture is iconic and generic.

gesture enacting the downward slope of a road seen on the projected aerial photograph (Figure 2). These gestures were iconic, resembling the shape or the movement of something real, familiar to the audience. They were also generic because they referred to slope in general rather than portraying the specific slope of the road in question. When using such gestures, the speaker was always (100%) oriented such that the speaker’s regard fell somewhere between paralleling the projection screen to facing the audience (making 25% of all possible body orientations). This type of gesture/body orientation was the most frequent in the watershed lesson analyzed. In the entire presentation, 30 representing gestures were recorded.

In this sequence, the speaker represented the downward slope in the road previously pointed out by another type of gesture. Her body was turned halfway to the audience, shifting position as she started talking about a sloping hill that was not represented in the aerial photograph. The speaker looked at the audience as she uttered and gestured, providing a noticeable frame directing attention away from the photograph and to the gestural resources.

These gestures, therefore, not only provided resources to focus attention, shifting from photograph/speaker to speaker alone at the moment that the audience is expected to do so, but they also help to understand the topic of the dis-
course, insofar as they represent something not visually available or available in another way. That is, in the present situation, the audience could see in the photograph a bird’s eye view of road winding its way from the village along the coast and toward the creek that defined the watershed. The speaker’s gestures provided a means for students to connect to their experience of driving along this road; that is, the gestures constitute an iconic, concretely embodied representation of driving along the road that was perceptually available to the audience only by means of the aerial photograph. The gestures opened up a third dimension in the photograph and connect it to the discourse and the real world the photograph partially represents.

The topic of the lesson from which we extracted the examples of the different categories of gestures, was the watersheds. In this context, the lecturer’s representational gestures helped the students to define a watershed. The road followed a downhill slope towards the creek that gathered all water in the area; in fact, the road crossed creek the only two hundred meters from where the latter shed into the inlet. The gestures were used to provide a visual image of the downhill slope, which the photograph by its nature could not depict. Similarly, when the lecturer bent her arms, forming a circle parallel to the floor, at the
same time referring to a watershed, the audience is able to associate visual and verbal resources to define a watershed as a delimited area (Figure 3). In another situation, she used the same gesture but then moved both arms downward until they met and then meandered to suggest the creek flowing into the ocean inlet.

Emphasizing

In this category, we counted iconic gestures that emphasize an entity directly available in the photograph, by generically following the shape/movement/direction of the object/phenomenon referred to in speech; the gesture therefore also had deictic function. When speakers gestured in such cases, they were positioned towards the photograph (shoulders somewhere between parallel to the audience’s line of sight and parallel to projected image) and the gestured phenomenon was available in the photograph. Here, too, the speaker’s orientation therefore functioned as a frame orienting the audience to look at the relation between gesture and corresponding features in the photograph. There were 20 emphasizing gestures produced during the presentation on the watershed concept.

In Figure 4, for example, the gestures emphasized the confluence of two creeks (Graham, Hagan), and how they come together at some point. The background for this gesture is an aerial photograph, and, although the speaker was not specifically tracing the creeks in the photograph, she approximately repre-
sented the direction of those creeks as they were perceptually available in the photograph. The gesture is iconic, for there were two creeks that came together at about the area she gestured; the gesture was generic in that neither right nor left hand arms paralleled the creeks; and the gesture was deictic, for it allowed the students to look in a particular direction for finding the referent of the gesture. A similar two-armed gesture (e.g., Figure 3) produced in the context of an orientation towards the audience signified the “heights of land that define and delimit the watershed.” These heights of land, in contrast to the creek, were not visible in the projected image, a fact clearly signaled in the corresponding body orientation. This second instance, therefore, despite its perceptual similarity to the gesture in Figure 4, was a representing gesture.

Central to understanding the concept of a watershed is the idea that all water falling within its confines is carried away through a river system that sheds at one location into the ocean. A watershed is a drainage basin common to a particular area, defined by “the heights of land.” Figure 4 clearly shows that the gesture do work in emphasizing the common direction that two different creeks in the system are taking. After pointing out the two creeks sequentially, the double-arm gesture simultaneously represents the two creeks and their confluence, which emphasizes the aspect of a watershed as a drainage basin. When she turned away from the photograph and rotated the double-armed gesture into the horizontal direction, the same gesture represented the “heights of the land” from where the water flowed and represented the two creeks that meandered (meandering motion of hands joined at palms) downwards to the ocean. This downward flow of water in a watershed was not visually available in the photograph, thus the rotation away from it. They become perceptually available, however, through the representational gestures. The gestures here add the ideas of downward flow and the idea of motion, and therefore link the static photograph to a dynamic phenomenon.

Highlighting

Highlighting gestures are deictic but have a generic shape; they usually are circular or elliptical in shape without having clearly determined boundaries. These gestures are used to focus attention to the approximate area where something was to be found; the orientation is therefore toward the photograph. For example, while introducing students to an aerial photograph of the watershed that also included their school and village, the speaker used these gestures to direct attention to different but not well-defined areas that she wanted students to identify, such as the mountain that dominates the valley. Because there are no determined boundaries, it is harder to identify the object completely; the circular gesture
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(e.g., Figure 5) simply directs the viewer’s attention to some area in the photograph, but there are no details available that would assist the audience in identifying the specific feature to be attended to. It is therefore not surprising that it took several increasingly concrete prompts before the students provided the name of the entity (mountain, quarry) that the speaker wanted them to identify. We counted 12 highlighting gestures during the mini-lesson on watersheds (Table 1).

We consider these gestures as a special type of deictic gestures, insofar as they point out something in the photograph, but in a very general way, without clearly identifying boundaries as outlining gestures (see below) do. In this sense, they are deictic gestures that highlight something in generic fashion instead of specifically pointing to something in the photograph.

Photographs are inherently full of details many of which are not relevant to the main features; this increases the difficulty in selecting just what is to be seen in the photograph as can be seen in the present case when students named features other than the mountain that the speaker wanted to make salient. There are almost endless possibilities of interpretation of the same photograph. The text narrows these possibilities and gives the audience guidance towards the “right details” in the photograph. In a textbook, caption and body present the relevant text. In a lecture, the text is provided by verbal utterances; gestures and body orientation of the lecturer constitute additional semiotic resources available to

“And so up here, any idea [what this is]?”

Figure 5. Example of highlighting. The gesture is iconic, pointing to something, but generic because the outline of the thing is not specifically identified. The orientation is toward the photograph.
the audience that in fact will help them to distinguish background and foreground in the photograph and choose the right details as the relevant ones in any given context. When highlighting the mountain in the photograph, the speaker directs the attention of the audience to an essential object in the photograph, one that is crucial to understanding of the concept of watershed. A watershed is delimited by the heights of the land, and in this particular watershed, the mountain in the photograph is part of the boundary that defines the watershed within which the students’ village and school lies. Therefore, identifying this object in the photograph, even if only in generic fashion, is an important part of the lesson and highlighting gestures assisted, though could not entirely disambiguate, the nature of the watershed boundary.

Pointing

Pointing gestures belong to the class of deictic gestures. During the lectures analyzed, speakers pointed to specific objects in the photograph, or, in some instances, to the entire photograph. Pointing is very specific, towards an object in the photograph that is clearly defined (at least to the speaker). It is also frequently accompanied by deictic terms such as “this,” “that,” or “here.” The objects in this situation are always visually available, that is, the action of pointing requires the availability of the object in order for the audience to understand. This characteristic of the object—its visual availability—is the most important one in order to distinguish between what is considered a pointing and what is considered an extending, according to our classification. In the lesson about watersheds, there were eleven pointing gestures.

In Figure 6, for example, when the speaker pointed to the photograph and said, “right here,” she did more than just pointing. That is, the students had available not only an index for finding their school in the photograph, but also an indication of the boundaries of this object, its extension—it is small in comparison to the entire photograph or extended objects such as the mountain in Figure 5. When the extensions of the entity are small, students can easily identify what is being pointed out. The gesture brings the exact location of the school in the aerial photograph to the foreground, leaving everything else in the background.

These gestures are distinguished from the previous category (highlighting) because of their specificity; that is, pointing implies a very specific object or phenomenon in the photograph, while highlighting is a more general gesture, pointing out something not entirely delimited in the photograph. In this situation the possibilities of different interpretations of the photograph are narrowed such that only one interpretation is possible, namely that intended by the speaker. As
long as the audience is able to see what the lecturer is pointing to in the photograph, the connection of text and photograph is immediate. However, when the entity to be referred extends in space, a simple pointing gesture is insufficient as it could refer both to the entity and one of its parts (which a novice could in fact interpret to be the entity). In this situation, outlining gestures provide meaning-making resources to the students.

Outlining

Outlining gestures are very specific deictic gestures often used to follow the shape of some entity in the photograph; because over time the gesture traces out a shape (nearly) identical to the object, it is also iconic. In outlining gestures, the speaker always makes use of the photograph, which the audience, assisted by the gesture, is expected to divide into figure and ground. The shape of this gesture depends on the visual availability of the object in the photograph insofar as that what is outlined is something in the photograph, visually available to the speaker and to be identified by the audience. In the talk about the watershed concept, there were eight gestures that outlined an entity in a photograph.

Figure 7 exemplifies the outlining of a specific area in the photograph. As expected, the speaker is directed towards the photograph, carefully following the shape of the coastline, thereby defining the boundary of the inlet into which the watershed empties. Both her gestures and the referent object (Saanich Inlet) are visible from the audience’s perspective. Because of the close spatial relation...
between the moving pointer (finger), the possibilities of mistaking the coastline and with it “Saanich Inlet” for something else are greatly narrowed and the identification of the relevant details in the photograph is immediate. In following the coastline and thereby in outlining the inlet in the aerial photograph, the lecturer provides a resource for students to guide their attempts of connecting the photograph with their lived and experienced world, their neighborhood. In doing so, the speaker provided a concrete part of the complete system that defines a watershed. The gestures constituted important resources in isolating the concrete case of a whole watershed or its parts from the interpretively under-specified photograph.

Adding

Adding gestures were also used to outline entities, but, in this case, the object/phenomenon was not visually available in the photograph but that could have been there. The gestures provided another layer of specific perceptual objects that were created in iconic form in front of the photograph but were to be understood as an addition. Gestures that added something to a photograph occurred six times in the watershed lesson.

Consider for instance Figure 8. In this example, the speaker modeled a phenomenon, “an oil spill in the heights of the land,” as it would unfold in the area represented in the photograph. As she talked about a potential oil spill, she traced what would be the results of this hypothetical phenomenon in the photo-
“Say something happened up in the heights of the land, the headwater of that area, like an oil spill. You would ultimately be able to trace the impact of an oil spill up in the top, all the way through the creeks, and its impact right down in to this lake here.”

*Figure 8. Example of gestures that add something in the photograph. The gesture is specific/generic and iconic/deictic, associated with a body orientation toward the inscription.*

graph, that is, the oil flowing down into the creeks and subsequently into the lake. Although neither the creek nor the phenomenon of an oil spill can be seen in the photograph, the speaker “drew” another, virtual image of oil flowing down into the creeks and into the lake. The situation is hypothetical—but the gestures rendered this event concrete. The speaker added something, literally layered it onto the photograph, in a way that only her gestures could make it perceptually available to the audience. This is a completely new meaning-making resource for understanding photographs not achievable in a textbook. The gestures can be understood as a form of concrete, public, and witnessable thinking.

In this example, the presenter emphasized a particular feature of a watershed, that is, the idea of a watershed being a drainage area that is delimited by the heights of the land and providing the topology defining water flow. By adding a new event using the photograph as a background, a direct association was established between the photograph and the idea of a watershed, as well as the consequences of pollution to a watershed; this pollution would not just remain where it occurred but by moving in the way the gestures showed, would have an effect on the entire system. The lecturer here was able not only to associate
photograph and speech for defining a watershed, but also she amplified the photograph as if it was showing an event.

Extending

These gestures are specific deictic gestures used to add something to the photograph that does not fall within its boundaries. That is, the entity referred to is located outside the limits of the photograph, so that, if the photograph was taken from a greater distance, the entity would have been included; consequently, the body orientation was toward the photograph. In this sense, the chalkboard, the wall, and anything that surrounds the photograph becomes an extension of it, insofar as the speaker pointed out something in these areas, outside the photograph. Because the gesture is intended to add something beyond the boundaries of the photograph, the speaker orientation is, consistently, toward the representation (Figure 9). In the watershed presentation, these gestures were observed three times.

As with the adding gestures, the audience is invited to imagine something not visually available in the photograph. The gestures connect the photograph, as a representation of something real, to the actual real world, extending the boundaries of the photograph to include other aspects. Talk and gestures are again a means by which the lecturer can transform the photograph as to show to the audience something that is actually not visually available just by looking at
it. It is almost as if the photograph was a different photograph; the lecturer points to objects that are outside of the photograph just beyond of its boundaries and yet as if represented on the (extended) screen. The audience is invited to follow her through her gestures and speech to envision the aerial photograph as covering a little more area. The relevant function of this gesture to the effort of defining a watershed is the fact that the lecturer can introduce additional elements that assist the audience in understanding the concept or the location of the photograph with respect to the larger setting known to the audience.

Positioning

This type of gesture, specific/generic and iconic is strongly related to body orientation, constitutes another type of extension, but this time into three dimensional space. Speakers positioned themselves against the photograph as if they were actually taking the shot at that exact moment, standing in the landscape depicted. Speakers therefore allow the audience, through their body orientation, to understand the photograph as if it was extended into the lived space to produce a three-dimensional image. There were two examples of positioning in the lesson analyzed, both in the context of landscape photographs.

Figure 10 provides an example of positioning. The resulting representation goes one step further than any photograph—through its association and placement relative to the speaker it makes the photograph an extension of the watershed into the classroom allowing the speaker’s actual movement to become movements in the watershed. The speaker in fact takes up a position in a hybrid world that instantiates the watershed in the classroom. Positioning works as an explanation, an introduction to the photograph itself and the topic related to it. The lecturer introduced the photograph to the audience as a depiction of the real world, making a direct connection between photograph and real world in showing how and from what angle the photograph was taken. By doing this, she also made explicit the role of the photographer in the production of the photograph, exposing the human interference in this process that could otherwise be regarded as an essentially objective representation of the world.

The introduction of the photograph to the audience provides resources for looking at the photograph in a particular way, and it is very important for the work of interpretation of the photograph that will eventually follow. In this particular case (Figure 10) the lecturer was trying to identify the boundaries of another watershed, where the heights of the land that define the area are more difficult to be identified in the photograph. Therefore, she positioned herself as to simulate where and how the photograph was taken so the audience would be able to recognize the photograph as a depiction of an area they are familiar with.
She subsequently showed how the creek flows, first in a direction perpendicular to and approaches the areas seen in the photograph, then turning and flowing parallel to the screen toward the ocean on the left (from the audience). It is immediately evident that there were no examples of positioning when speakers talked about similar photographs but did not stand near the projected image (e.g., the biology professor using transparencies or the environmentalist using laser pointer in a darkened lecture hall).

Discussion

School science relies heavily on inscriptions photographs as pedagogical elements in teaching facts and concepts; they are the most frequent inscriptions in secondary-level biology textbooks. Whereas previous a previous study showed the limited number of meaning-making (semiotic) resources available to high school students when facing photographs in Brazilian textbooks, the present study shows how hand gestures and body orientations provide additional semiotic resources that teachers/lecturers can make available to assist students in making sense of photographs and the new concepts that they pictorially render. These gestures and body orientations play an important role in understanding just what students are to attend to in a photograph, whose meanings are inherently under-specified. Understanding the relationships between talk, gestures, and photographs in science lectures therefore should be an important considera-
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For the situation where teachers/lecturers stood next to the photographs projected onto a screen in a room where they and the gestures were clearly visible, we identified eight categories of gestures. These are distinguished by the function they have in relation to the photograph and exemplified these categories in the context of part of a talk concerning the concept of “watershed” presented by a biologist-environmentalist to an audience of seventh-grade students and their teachers. These categories include representing, emphasizing, highlighting, pointing, outlining, adding, extending, and positioning. All eight types constitute important resources that are deployed in addition to verbal discourse for understanding photographs, their contents, and their relevance to the theoretical concepts to be learned. They do multiple duties by limiting, amplifying, and multiplying meaning.

These eight types of gesture/body orientation combination constitute a range of semiotic resources not normally made available in textbooks. It is possible that written texts could provide suitable textual information to do what gesture and body orientation do. But identifying a specific object in a photograph by means of a written text would require a very descriptive and detailed text to generate a similar explicitness of the relation between text and photograph. The written text would become much more complex, and, yet, would not be able to guarantee that the relation between text and photograph will be appropriately established by the reader. Our previous research had shown that there are many features that make it difficult to understand photographs in the way they are deployed in textbooks. With present technology—photocopying, scanning—teachers could actually project textbook images and, deploying relevant gestures/body positions, could assist students in picking out relevant detail to assist them in meaning-making processes. This would make the highly text-oriented way of teaching science to include other modes of representing facts and concepts, including photographs and gestures. Future research should be designed to study whether students’ competencies in interpreting and learning from photographs increase when they are exposed to whole-class presentations and readings of photographs where the teacher uses gestures and body orientation explicitly as additional resources for making salient or adding features.

As additional semiotic resources, gestures/body positions take advantage of the fact that they are of a different kind than text. If a textbook were to use the words “here” and “there,” these would be far more difficult to understand than if
a speaker who used gestures. These indexical words imply a specificity that cannot be achieved by the text, at least not in the same way in which I is implemented by gestures in the speech situation. Not only the photograph itself would have to have additional signs that would delimit the object of interest but also the text would have to be more detailed and descriptive to identify this object in the photograph. Gestures and body orientation are of a different kind than written and pictorial resources and, by their very nature, can be “layered” onto the photographs without nevertheless encumbering the auditory information channel. That is, because gesture and body orientation are of a different kind they can be apprehended without requiring additional attention resources.

In a speech situation, the “periphery” (Brown & Duguid, 1992) of the text is enlarged by gestures and body orientations, allowing the use of fewer words in a less structured way, and still being able to transmit the same message; the different semiotic resources multiply meaning because, in some sense, they include a certain level of redundancy in and synergy of the different modalities (Lemke, 1998). Classrooms where the gestural modality become available to teachers (and students) in addition to photographs and texts therefore implement some of the recommendations educational psychologists have made with respect to the need to use multiple representations of the same concept (Snow, 1997); gestures and body positions are a means that make classroom teaching inherently adaptive to the representational needs of students.

Much of the simplicity of the verbal text is due to the presence of the gestures that accompany the discourse. The gestures also function as part of the text (discourse), as a resource that simultaneously simplifies and amplifies the text, and consequently, enhances the explicitness of the connection between text and image. The gestures and body orientations that accompany speech and are directly related to the photographs allow the verbal text to be simpler and yet more specific and constrained in meaning than the written text. That is why, in some instances, we expect students with difficulties understanding concepts in the book to more easily understand the same concept when the teacher (or someone else) provides them with a very similar explanation.

Role of Spatial Configuration

There is evidence that classroom discourse changes in fundamental ways when gesture and body orientation become available as resources to teachers and students alike because the spatial configuration allows speakers to stand next to the artifacts and inscriptions (Roth, McGinn, Woszczyra, & Boutonné, 1999). When speakers do not stand next to the artifact or inscription, the communicated content becomes more limited and the audience understands less. Thus, spatial
configurations that do not allow the deployment of gestures and body positions to complementing speech decrease the number of meaning-making resources to decrease and become similar to those available for understanding photographs in textbooks. For instance, consider the differences in two situations when an ecologist talks about watersheds first in a classroom where her gestures and body orientation were visually available to the audience and then in a dark auditorium, where the audience could only listen to her and look at the photographs projected in the wall. In these two different lecture situations, the role of the photographs and the discourse itself changed drastically. When the gestures were visually available to the audience, the text was simpler and more specifically directed towards the photographs; the photograph became the topic of the discourse, and its pedagogical function in helping to understand the scientific concept presented was enhanced. However, when the gestures were not visually available to the audience, the lecturer (in biology course, environmentalist speaking in darkened lecture hall) only made references to the photographs while they spoke using pointers but the gestures were not available to make sense of what the text was about. Details pertaining to the photographs but which were not visible could not be made available in the same way that the environmentalist had done in the examples provided here.

When lecturers use transparencies, the gestures are made toward the transparency, and, although they function to highlight some aspects of what can be seen in the photograph on the transparency, the lecturer’s body orientation, as well as all the other types of gestures that do not use the photograph as a background, are absent from the audience’s view. Therefore, the audience members have to attend to what is being projected on the wall without other semiotic resources being available in the case of talk next to the projected image. The fact that the room must be dark and the fact that the lecturer gestures on the transparency instead of on the projected image on the wall, further contributes to the distancing of the audience from the lecturer and separating him or her from the photograph. In this case, the gestures that make use of the photographs as a background and that are in other circumstances important resources to facilitate the interpretation of the photograph are not available. The same types of gestures are not used, or if used, are not visually available to the audience, limiting what could be learned from photographs had the additional semiotic resources been available as a pedagogical means. That is, the importance of a photograph as a pedagogical resource in a lecture situation is greatly increased when the audience is able to see both photograph and lecturer at the same time, and when the lecturer gestures over and about the photographs, thus exploring the photograph in its full potential. In the potential chaos arising from the proliferation of
new ways of talking that students may experience in lectures, in which the same words are often used to denote different objects, gestures and body orientations are crucial resources to establishing a coherence that allows audience to appropriately connect photograph and text, being able to understand what is being talked about. Gestures, therefore, play an important role in science discourses, and should be more carefully investigated.

References


