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## How gesture use enables intersubjectivity in the classroom

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In communication it is essential for speaker and listener to establish intersubjectivity, or “common ground.” This is especially true in instructional settings where learning depends on successful communication. One way teachers enable intersubjectivity is through the use of gestures. We consider two circumstances in which gestures establish intersubjectivity: (a) making conversational repair and (b) explicitly relating the novel (target) representation to a familiar (source) representation. We also identify two main ways gesture is used in establishing intersubjectivity. *Linking gestures* are sets of attention-guiding gestures (often deictic gestures) that delineate correspondences between familiar and new representations. *Catchments* use recurrent hand shapes or movements to convey similarity and highlight conceptual connections across seemingly different entities.

Communication is an effort to ground meaning in both the cognitive and social realms (Clark 1996). To enable common ground, or *intersubjectivity*, among agents in a social setting, one needs to delineate the common referents for all listeners. One situation in which establishing intersubjectivity is particularly important, though also challenging, is classroom instruction. In this social setting, there are frequent references made to complex ideas, new representations and abstract systems of notation. In such circumstances, intersubjectivity serves both the student and the teacher. For the student, common ground is necessary in order to comprehend the teacher’s actions and statements. For the teacher, common ground is necessary in order to connect to students’ prior knowledge and experiences, as well as to interpret and assess students’ actions and comments, and to appropriately respond to students’ questions.

We propose that one way that teachers enable intersubjectivity is through the use of gestures. We consider two different circumstances in which gestures serve this role. In one, the teacher identifies or anticipates misunderstandings and uses gestures to institute conversational repair. In the second, the teacher presents a novel representation.

To imbue the new representation with meaning, the teacher uses gesture to connect the novel (target) representation to a familiar (source) representation.

In addition to identifying these two circumstances, we identify two main ways in which gesture is used for establishing intersubjectivity. First, *linking gestures* are sets of attention-guiding gestures (often deictic gestures) that delineate referential correspondences between the familiar and new representations (Alibali & Nathan 2005, 2007; Nathan 2008). Second, gestural *catchments* (McNeill & Duncan 2000) use repeated features, such as recurrent hand shapes or hand movements, to convey similarity and to highlight conceptual connections across seemingly different entities. The findings presented here suggest a new view of instruction as communication and underscore the central role of gesture for enabling intersubjectivity during instructional communication as a way to foster meaning making and learning.

### Intersubjectivity in the classroom

Common ground provides a shared frame of reference within which any interaction unfolds. Its centrality to many theories in the social sciences cannot be overstated. Vygotsky (1986) considered intersubjectivity to be at the heart of learning and of consciousness itself. Schegloff (1992) elevates intersubjectivity, stating that it is “theoretically anterior” to all other considerations in social science because without intersubjectivity, social science stands without reference to the world it purports to identify and describe. Rather than a force that acts on the discourse, intersubjectivity can be regarded as a precondition for discourse itself to occur (Nystrand 1997). When established, intersubjectivity affects listeners’ comprehension and subsequent uptake (Wells & Arauz 2006). Even when speakers exhibit divergent – possibly opposing – perspectives, there can be intersubjectivity, as people draw upon commonly held concepts and representations when they articulate their ideas and critique the ideas of others (Nathan, Eilam & Kim 2007).

Classroom learning depends on successful communication between teacher and student and among students. Intersubjectivity is particularly important and challenging when teachers communicate about new representations or concepts. To enable intersubjectivity, one needs to (a) delineate common referents and (b) establish the relations between them. In this chapter, we present two examples to illustrate gesture’s role in each of these activities. In the first example, we show how gesture is used in anticipation of a trouble spot during instructional communication. In this case, the teacher utilizes a gestural catchment to provide conversational repair so that all those involved are likely to come away with a common understanding of the referents involved. In the second case, we examine a teacher’s use of a novel abstract representation – a matrix – to record, compare and ultimately algebraically model patterns of growth. In this example, the teacher uses a series of attention-guiding deictic gestures, which we call *linking gestures*, to establish the correspondence between values in the matrix and the physical objects to which they refer.

### Gestural catchment to provide conversational repair

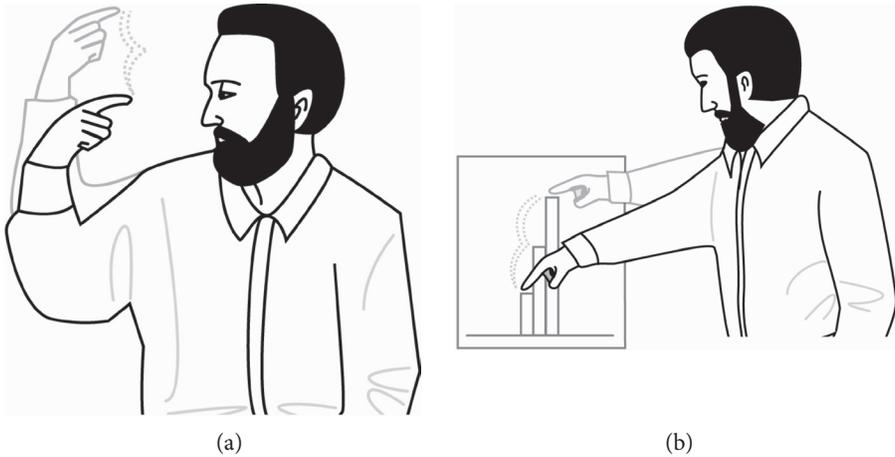
In this example, a 7th grade math teacher starts out sitting on the desktop, speaking and gesturing without any physical referent to his beginning algebra class. He describes the verbal rule the class generated the previous day to describe the growth patterns of a set of tiles – “add the next odd number” – and relates it to the specific values that follow from the rule. Brackets indicate the speech that co-occurs with the gesture in each line. Gesture descriptions are then provided in boldfaced text.

#### *Example 1: The Bar Graph*

- 1 ((Facing the class)) You can notice that [you can add ... the next odd number]  
**Sequence of hopping gestures**
- 2 so ... ((T turns and walks to the board))
- 3 we added [three]  
**Point to graph**
- 4 [we added five to get the next one]  
**Point to graph**
- 5 [we added seven to get the next one]  
**Point to graph**

In Line 1 the teacher describes a general rule that was used to obtain a series of values and uses a hopping gesture (Figure 1a) as if to depict the pattern exhibited by the corresponding bar graph in thin air. He seems to realize that this may be difficult for the students to understand; he pauses in the midst of line 1, and says, “So ...” in Line 2, stands up and moves to the board, where there is a bar graph the class had prepared the day before. In Lines 3–5 he repeats the hopping gesture (Figure 1b), indicating the tops of the bars, this time using specific referents in speech as well (“we added three”, “we added five”). Thus, in this episode, the teacher linked (1) a verbal description of an abstract rule (“you can add ... the next odd number”), (2) a set of concrete values that implement that rule (“3, 5”), and (3) two variations of a graphical representation of the series of bars that result from execution of the rule: a figurative graph in the air and a graph drawn on the board.

For our current purpose, the move at Line 2 from facing the class to referring to the drawing of the graph on the board is of particular interest. It is here that the teacher acts out a kind of replication of his previous action. The first act (Line 1; see Figure 1a) can be interpreted as a sign (an iconic one) in the Peircean sense, following LeBaron and Streeck (2000). The hand in motion is acting out an idea without a perceptually salient context or referent. Of course, it is meaningful to the speaker. We can also infer that it is intentional as well, since he means for these particular gestures to be understood by the listeners.



**Figure 1.** (a) Teacher describes a general rule the class used to obtain a series of values (add the next odd number) using a hopping gesture (a series of points that hop from one location to the next) in space in front of him. (b) He repeats the hopping gesture, this time indicating points at the tops of the bars in a bar graph and using specific referents in speech (“we added three”, “we added five”). See text for additional details.

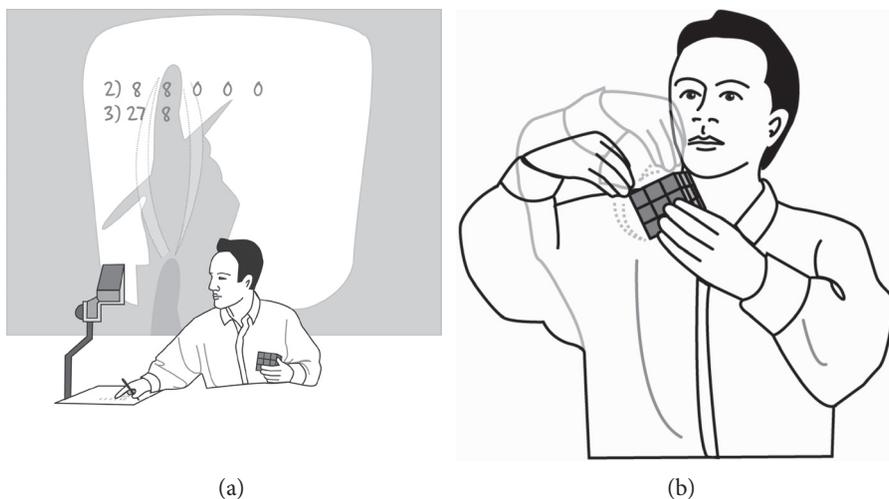
However, these are not sufficient conditions for effective instructional communication. Specifically, the teacher’s actions are not likely to be understood by the students because the teacher has not satisfied the two conditions for intersubjectivity: (a) He has identified no common referent for the students (i.e., students do not know he is invoking the bar graph), and (b) there is no relation established between such a referent (if there is one) and his sign (i.e., students do not know that each finger position in the sequence is locating the tops of each bar in the graph of the mathematical function). Line 2, then, serves as a self-initiated repair (Schegloff, Jefferson & Sacks 1977) to the instructional conversation. Repairs can take many forms, but they are commonly enacted by repeating or re-voicing the offending material. After recognizing a trouble source (Line 1), the teacher re-voices and employs a salient representation of the graph in the process. He has thereby provided one of the conditions for intersubjectivity – a common referent. The second condition – establishing the relation between sign and referent – is met through the gestural catchment. In a *catchment* (McNeill & Duncan 2000), distinct features of a gesture such as hand shape, location, orientation, trajectory of motion, and so on, are reenacted in order to reinstate the referent of the original gesture. The teacher not only indexes the graph, he also replays the same hopping motion that he used before, and in this way re-invokes his earlier idea from Line 1.

In this short instance, we see how a teacher made a pedagogical move using gesture to address a potential communication failure. The original communicative act

was rich with gesture, but the specific form was not one with shared meaning for the speaker and listeners. The teacher's gestures serve to establish intersubjectivity, both by indexing a common and appropriate referent and by establishing the link between the original sign and the intended referent.

### Use of linking gestures to enable intersubjectivity for a novel representation

In the next example, an 8th grade mathematics teacher introduces a novel representation to students and shows its usefulness for recording, comparing and modeling the pattern of growth exhibited by cubes of varying side lengths. One aim of the activity is to show students how the growth of the different constituent parts of the cube (the corners, edges, faces, and the total number of blocks) as a function of the side length, follows different mathematical functions (constant, linear, quadratic and cubic functions, respectively). Standing next to an overhead transparency projector while holding a Rubik's Cube in his left hand and pointing to the transparency with his right hand (Figures 2a and 2b), the teacher refers to the values of the number of blocks of each type for each cube in the sequence. When this episode commences, the class has already reviewed the entries for cubes of side length 2 (and volume of 8) and 3 (and volume of 27). His immediate point is to show how the matrix reveals patterns in the data; in this case, the relevant pattern is that no matter the size (above 2), there will always be eight corner blocks.



**Figure 2.** (a) While holding a Rubik's cube, the teacher points to the column in the matrix that displays the number of corner cubes as a function of side length (a constant function). (b) The teacher points to the corners of the Rubik's cube.

*Example 2: The Cube Problem*

- 1 T: ((Facing the class)) how many of them  
 2 T: [have three faces painted]?  
**Points to cube faces.**  
 3 S: Eight  
 4 T: ((enters '8' in the second row of the second column))  
 5 T: Eight, and as a matter of fact you should see a pattern right away  
 6 T: [How about this column]?  
**Point traces matrix column with 2 entries of '8'.**  
 7 S: eight ... eight  
 8 T: [((Holding cube))] it's always the [corners, right]?  
**Beat in silence while holding cube.**  
**Points to corners of cube.**  
 9 T: ((Sets down 3x3x3 Rubik's cube and picks up the 5x5x5 cube))  
 10 T: and no matter how big the cube gets,  
 11 T: [there's still always eight corners], right?  
**Points to corners of cube.**  
 12 T: ((creates table rows 3, 4, 5, and 6))  
 13 T: ((enters '8' in second column of each row))

In this episode, the teacher is constructing a matrix representation that summarizes for various sizes of cubes, the number of small blocks of each type (one face showing, two faces showing, etc.). The teacher wishes to highlight the fact that, regardless of side length, there is a constant number of "corner" cubes (those that have three faces showing). To make this point, in Line 6 he highlights the column in the matrix that will be filled with 8's when it is completed (Figure 2a). In Line 8, he then points to corners on a small sample Rubik's cube (Figure 2b). To elaborate his point about the universality of this property, he holds up an even larger Rubik's cube in Line 9. He then goes on to mark out additional entries in the matrix (Lines 12–13), which, following his words (Lines 10–11), are expected to all contain the same value in the second column.

The central actions in this episode, for our purposes, occur at Lines 6 and 8–11. Here the teacher uses gesture to link the entries in the matrix and the specific, physical referents on the cube. He establishes the link through a coordinated series of gestures (in this case, pointing actions to the column in the matrix and to the corner cubes). The matrix entries are, of course, the novel representational form. They are highly abstract, not only because of the numerals used to denote the number of blocks, but also because *position* in the matrix denotes the physical referent: The row header is always the side length; the first column always the total number of blocks (volume); and the next column is always the number of corners.

The matrix is a powerful, versatile, but potentially opaque representation. Because of this, intersubjectivity cannot be assumed. Links must be established to connect to students' knowledge and to denote the references of each of the representations. To

enable intersubjectivity, both referent and relationship must be established. The teacher accomplishes this using a series of inter-connected pointing gestures between the entries in the matrix and the corresponding components of the example cube he is holding (Figures 2a & 2b). Speech also helps to establish the relationship between the linked referents in this example (Lines 10–11). Thus, during this short episode, the teacher linked (1) a symbolic representation, specifically, the (as yet incomplete) column within the matrix that will represent the constant function, (2) two different physical instantiations of the constant function on two different Rubik's cubes, one small and one large, and (3) a verbal description of the constant function (“no matter how big the cube gets, there's still always eight corners”).

## Discussion

The two examples presented here highlight the role that gestures play in fostering intersubjectivity during mathematics instruction – laying out and then employing a taken-as-shared set of ideas and representations. In the first example, a teacher uses a gestural catchment to fix an impending communication failure. Gestures help to establish intersubjectivity by indexing a common referent and by establishing the link between the original sign and intended referent. In the second example, the teacher establishes intersubjectivity through a series of inter-connected pointing gestures between entries in the matrix and features of a physical cube. These examples contribute to our understanding of the conditions that exist during socially mediated learning.

Studies of communicative gesture, as with language more generally, unveil a rich and complex set of processes that appear to reflect *both social and individual* aspects of human behavior. There is a lively debate within the literature about the primary role that gesture serves. Some argue that gestures that co-occur with speech serve primarily a self-oriented role, either in facilitating lexical access (e.g., Krauss 1998) or in facilitating the packaging of information in verbalizable form (e.g., Kita 2000). Others (e.g., Kendon 1994, Roth 2003) argue that gesture primarily serves the audience, contributing to the likelihood that ideas will be understood.

A perspective that draws on the role of gestures for intersubjective meaning making suggests a third position (Nathan 2008). According to this view, establishing common ground is paramount to communication, and gestures simultaneously enable individual and communicative (social) functions (Ishino 2007). In serving social functions, gestures guide listener attention, convey substantive information, manage social interactions, and express emphasis (Alibali, Nathan & Fujimori, 2011). Gestures can be used to ground abstract ideas by invoking concrete referents (either physically or as enacted simulations; e.g., Alibali & Nathan 2007, Hostetter & Alibali 2008). They are more frequent when listeners pose questions and exhibit lack of comprehension, or when instructional ideas and representations are novel and more abstract (Alibali & Nathan 2007). At the same time, gestures also serve individual functions. Constructing

and maintaining intersubjectivity – especially in educational settings where the goal often is to convey new ideas – makes considerable demands on the processes that mediate speech production. Accessing lexical items and packaging information into syntactic units are integral to formulating fluent speech, and fluency contributes to communicative effectiveness. Thus, by supporting speech production, the self-oriented functions of gesture also contribute to promoting intersubjectivity.

This dual nature of gesture in the personal and social realms is perhaps most striking in example 1, where the teacher uses gestures as a means of conversational repair. Initially (Example 1, Lines 1–2) he expresses a sequence of hops along a line that has no clear referent to the students. He is speaking as he gestures, but the utterance is not coherent and not very descriptive. It is as if he has no immediate words for the ideas he wants to express, though they are readily available to him as simulated actions moving through space (cf. Hostetter & Alibali 2008). His replay of those motions directly on the referent (in this case a drawing of a linearly growing series of entries on a bar graph) provides cohesion (Halliday & Hasan 1976) between the earlier utterance and action and the missing referent and it also helps trigger a more descriptive verbal account of the mathematical idea. In this way gesture appears to have contributed to both the social and individual aims.

In sum, we have argued that teachers use gestures as a tool for enabling intersubjectivity in classroom instruction. We have illustrated that teachers use gestures in service of intersubjectivity when making conversational repairs and when making novel representations meaningful by linking them to other, more familiar representations. We identified two general mechanisms by which gestures are uniquely suited to establish and maintain common ground. In one, gestural catchments (McNeill & Duncan 2000) use repeated features (hand shapes, movements, location) to reinstate conceptual connections across seemingly different entities. In the second, linking gestures guide attention and delineate correspondences between the familiar and new representations (Alibali & Nathan 2007).

In terms of theory, we specified two conditions that we propose need to be met for gestures to enable intersubjectivity. First, the speaker needs to delineate the referents held in common by both speaker and audience, in order to identify taken-as-shared ideas, objects and representations. Second, the speaker must explicitly establish the specific relations that hold between the familiar, common referent and the novel, target representation. Our framework further suggests that, if we wish to understand when and why instructional communication is effective, our analyses must account for teachers' gestures.

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