Becoming like the Other

Wolff-Michael Roth
University of Victoria

People who spend time together begin to experience the world in similar ways, coming in fact to share the world. Just a few days ago, my wife and I walked through downtown Victoria to pick up a stereo amplifier from the repair shop when I noticed her head move slightly left to right. I turned my head in the direction of her gaze, and, before we began talking, I knew she was alerting me to the aboriginal people sitting against the wall asking for dimes, with faces ravaged by alcohol abuse. In fact, she was alerting me to the plight of the First Nations people in our country, their fight for self-government, and their battle against the alcohol. Seconds later, we talked about just that. That is, without having talked, a simple movement of her eyes while gazing in a particular direction had communicated to me what she was presently attuned to. As I thought about what had happened while walking on, I remembered many such incidences that had occurred between my younger brother and I during a period when we had spent a lot of time together. A little movement of the hand towards the forehead by of one of us allowed the other to see a person with a particular, funny haircut or hat; a slight turn of the eyes upward toward the ceiling made salient to the other of some voice that we began to overhear together.

Coming to experience the world in similar ways, or rather, coming to experience a similar world is not unique to members of the same family. A decade of research showed that people who coteach come to perceive their settings in similar ways, and they tend to act like one another. Initially, our observations were incidental: while analyzing videotapes of coteaching in the early 1990s, participating teachers, researchers, and research assistants noticed that a hand

• Paper presented as part of the Symposium "Preparing science teachers for the 21st century through coteaching: an international perspective" at the annual conference of the National Association for Research in Science Teaching, Vancouver, BC, April 1, 2004.

gesture by one teacher was seemingly taken up by the other; a particular stance toward the children while a teacher interacted with a small group was noticeable in the behavior of the other. However, ways of asking questions became the first phenomenon that allowed us to provide more than hunches. Extracting the questions two coteachers in one study asked over the course of nearly three months of coteaching showed that in the beginning of the engineering unit, their ways of questioning children were rather different. Brigitte, who had a developed the curriculum asked productive questions that allowed children to articulate and develop their engineering discourse. Her partner Christine, on the other hand, who had little science and engineering background knowledge initially asked questions that the children answered with yes, no, or other one-word responses. The analyses showed that over the three-month period, Christine came to ask questions like Brigitte.

Over a period of years of conducting research on coteaching at City High School in Philadelphia, a school serving an almost exclusively African American clientele, Ken Tobin and I noticed other ways in which coteachers became like the other. An initially plain and somewhat lethargic new teacher increasingly began to bounce about in the way that his coteacher did; intonations of one teacher came to be more like those of the other. However, although we had this strong sense, it was difficult to communicate it to others, particularly in the written medium of scholarly publications. Mere description was unsatisfactory evidence, both to myself and to reviewers of articles submitted for publication—that is, until recently when new digital recording technology made it possible to convert video images into high-quality offprints and new software allowed to render voice qualities such as pitch, loudness, and aspects of timbre in visual form.

In this paper, I draw on such technological advances to depict aspects of coteaching that are not normally accessible to consciousness of the participants, and that are insufficiently rendered by qualitative descriptions. Detailed analyses of alignments that occur at an unconscious level allow me to contribute to the building of a theory that explains why and how coteaching makes us become like the other, at least in those cases where the participants are inclined to work together and do not experience "conflicts of personality."

Production and reproduction of practice

In this paper, I take a theoretical perspective grounded in an agency|structure dialectic (Sewell, 1992), which implies that neither agency nor structure can be thought without the other: they are two sides of the same coin. Without action,

neither the surrounding world nor our patterned ways of perceiving could exist; but a structured world and structured perception are required to act in patterned ways. In fact, a structured world and a structured perception coemerge with active engagement in the initially unstructured material world (Giddens, 1984). That is, structure itself is dialectical, existing both in the form of the sociomaterial world and in the schema (mental structures) that allow us to perceive them in structured ways. Again, active engagement with the material world is required for both types of structures to emerge. To clearly distinguish the two forms of structures, schema, associated with the acting subject, are distinguished from the sociomaterial resources, associated with the setting.

This approach leads us to a dynamic model of practice, whereby engaging in teaching science, for example, inherently is linked not only to the reproduction of the practice but to the production of new forms and therefore its very change. At the outset, the fact that each action simultaneously constitutes both cultural production and reproduction may surprise—and some scholars may state this as a mantra rather than articulating the reasons for the phenomenon. Take, however, the phenomenon of queuing up—in a bank, at a local supermarket, or at a movie box office. When you arrive, some people are already aligned in a way that you recognize as a queue. You act by joining it at its end, although the end of the queue may be very different from one situation to the next—if you do not go to the "end," you may be held accountable for it by others, or hear their comments about your rude behavior. In your act, however, you not only contribute to constituting the queue, a form of cultural production, but you also engage in the reproduction of queuing qua cultural phenomenon. The dialectical nature of cultural production and reproduction is a direct consequence of the fact that human beings not just act in and react to a stable social world, but that their own actions produce this world. Queues do not exist as such; they only exist in the practical realization of queues, which requires competence in the relevant ethnomethods (e.g., Garfinkel, 2002).

Inherent in the dialectic of the production and reproduction of social phenomena (structure) is the fact that each act not only reproduces the world but also produces new variants of it, at the levels of sociomaterial resources and schema. On the one hand, this explains the drift in sociomaterial (cultural) practices over time; on the other hand, this explains how in each action, a practitioner not only changes his or her setting (conditions) but also him or herself (Lave, 1993). Even though these changes may be unnoticeable from one moment to the next, they are cumulative so that changes in a practice can be observed over longer time spans. This allows us to understand how people become

experts even with respect to the most mundane practice, through apparently, but never truly repetitive actions.

Because of the complexity of classrooms, coming to the point of reliably reproducing coteaching will take participating teachers and students some time. In our experience, more or less smooth transitions between different teachers can be observed after two months of teaching together about an hour a day. At that point, the coparticipants seemed to have come to the point that their anticipations of their coteachers' next actions have become sufficiently accurate to make coteaching unfold in the smooth ways that our research has documented.

To understand a practice such as coteaching, one needs to take into account three mutually constitutive, that is, dialectically related levels of activity to which the acting subject is simultaneously oriented: activity, action, and operation (Leont'ev, 1978). Activity is oriented to collective (societal) motives; actions are driven by goals, which the subject (individual, group) sets as part of its own concrete realization (version) of the collective activity; and operations are spontaneous, unconscious responses to existing conditions. Activity and action are dialectically related, because series of actions constitute the activity but activity motivates actions and their sequencing. Similarly, a particular action motivates a particular sequence of operations, but the concrete operations concretely realize the action. These relations are important for understanding coteaching, because they link common orientation and motivation, which are phenomena at the level of activity, with the embodied, unconscious operations that constitute the actions of the practitioner.

Entrainment and complementarity

It had been suggested that the alignment of practices occurred by means of the homogenization of dispositions, which operates when different individuals are exposed to the same conditions (Bourdieu, 1997). This explanation, however, is unsatisfactory because it separates the acting subject from its setting—in a dialectical approach, the acting subject (individual or collective) is a constitutive part of the setting. This leads to the fact that practitioners not only find themselves in some conditions but also contribute actively to the constitution of the conditions. When the subject is a collective entity, such as coteachers and their students, each individual also constitutes part of the setting for all other individuals. The actions of any individual contribute not only toward producing the lesson, which therefore emerges as a product of the enacted curriculum, but also to the constitution of the setting.

In coteaching, individual teachers therefore contribute not only to the constitution of the setting as they experience it but also to the setting experienced by their fellow teacher(s). When they are have a common orientation and motivation, the actions of coteachers eventually become complementary. So that the actions of different coteaching individuals do not interfere with respect to achieving some common goal, temporal and spatial alignment of (simultaneous or sequential) actions is required. Sociologists and social psychologists use the concept of entrainment (borrowed from physics and biology) to describe the processes by means of which temporal alignments in the actions of coparticipants come about (Giddens, 1987). Entrainment describes a process whereby two rhythmic processes interact with each other in such a way that they adjust towards and eventually lock in to a common phase or periodicity. The temporal patterns of individuals who are in interaction become mutually entrained to one another, that is, that they get in synchrony of phase and period. The actions of the collective thereby become complementary. There is preliminary evidence, for example, that in certain situations the periodic rhythms of speech continue across boundaries of turns at talk—in other words, a speaker may conform to the speech rhythms of the preceding speaker (e.g. Auer, Couper-Kuhlen, & Müller, 1999).

It has been noted that African American youths share particular traits, including harmony between humans, rhythm, an emphasis on emotions, and social connectedness (Allan & Boykin, 1992). We might therefore hypothesize that successful teachers of African American students, that is, teachers who are "in tune" with the particular ways of being of these students, will (probably unconsciously) adjust different aspects of their prosody to be aligned with characteristic features of their students' prosody. Or rather, we might expect that harmony and social connectedness of teachers and students is expressed in and leads to entrainment at the level of speech, including prosody. When new teachers work with more experienced and successful teachers of African American students, particularly when they are from a different cultural background, becoming like the other would mean that they become entrained into the existing harmonic relations between cooperating teacher and students.

The current object of talk, group size (e.g., small group, whole-class), and spatial arrangements mediate the nature of classroom interactions (Roth, McGinn, Woszczyna, & Boutonné, 1999). Thus, in whole-class, teacher-led situations, there is a general spatial orientation, often to the chalkboard, and a topical orientation to the issues usually controlled by the teacher with characteristic effects on who talks, when, about what, who responds, who evaluates, and so forth. When two or more coteachers conduct a whole-class session, they can-

not all talk simultaneously and over stretches of time. Furthermore, because such whole-class teacher-led sessions are related to particular spatial configurations in which teachers take up particular positions with respect to chalkboard and class, we can therefore expect interactions between current teacher in the lead, his or her position, and the nature of the unfolding talk. In fact, we may hypothesize that there will be changes in the positions coteachers take up, even unconsciously, to allow their mutual participation in the interaction with the class. That is, entrainment would be produced and expressed in the complementary positions with respect to the physical and metaphorical spaces during interactions between teachers and the whole class.

In the remainder of this paper, I provide evidence for and discuss forms of entrainment in two aspects—the complementary use of space, which inherently involves temporal alignments, and the adjustments that occur at the prosodic level.

Context

The materials for the following analyses derive from research conducted in an urban school in the American northeast. City High School is attended mostly by African American students from families living in poverty or representing the working class. Two teachers who participated in our research for some time, and with whom we also published together, were Cristobal Carambo and Chris Dalland. Cristobal is a Cuban-African-American teacher who, after several years of teaching in Miami, had come to City High School. Although he initially experienced difficulties due to cultural differences between the students in the Miami and his current situation, he had become an effective and by students well-liked teachers. Chris, a new teacher of Italian-American origin, was currently enrolled in a teacher education program, consisting of a one-year practicum that ran concurrent with the university coursework.

Both teachers had viewed their coteaching experience very positively. Chris in particular felt very much accepted by Cristobal. In recollecting the one-year experience, Chris described himself as having been very timid about teaching and building report with the students at the outset and thought that he would not be able to learn to teach the students at City High School. But in the course of coteaching with Cristobal, he had developed self-confidence and a sense of competence with respect to general and subject matter specific pedagogy. Chris attributed a lot to the coteaching: “Cristobal would often be teaching and look to me to step in, and always give me an opening, whether or not I had something to say. There were times that I had nothing to add, but he would to look to pass it

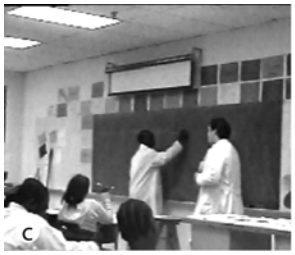
off to me and I would say, 'I don't have anything.' Having that opening several times a day allowed me to feel comfortable that when I did have something to say I could take it from him."

The data used in this paper derive from the beginning of one lesson, where Chris and Cristobal first reviewed some subject matter content related to experiments for which they then, thereby constituting the second part of the introduction to the lesson, provided specific instructions.

Spatial coordination of actions

Individuals who participated in coteaching for some time come to cover space in the classroom in similar ways, which they exhibit even when they subsequently teach alone. This, I want to suggest, is the product of a process of entrainment into complementary coverage of space during coteaching. In a previous study, we provided evidence for three scenarios of how successful coteaching covers space in complementary ways (Roth, Tobin, Carambo, & Dalland, 2004). (a) One person teaches alone, the other person in the wings, away from center stage where his or her actions could detract from those of the other. (b) The second person comes onto center stage, adding in talk or writing to the resources in a "helping" function without interfering with the actions of the other; he or she moves off center stage when the actions have been completed. (c) During transitions, one person moves off, the other onto center stage. If the stage is occupied but the end is not enacted, the second person moves off stage again. In the following, I focus on the micro-level events in the second case, in which the two teachers are present in the front of the classroom.

At the outset of this episode, Cristobal had stood to the front and side of the classroom, near the edge of the chalkboard. Chris was center stage, preparing students for the upcoming laboratory. One of the questions to be answered by students on the instruction sheet was, "Are chemicals elements or compounds?" Chris had previously told students that he and Cristobal wanted to practice note-taking skills in the laboratory, and, in preparation, wanted them to respond to the question. After several students had called out both "elements" and "compounds," Chris asked Ron to repeat what had been drowned in the general cacophony of responses. As the students talked, Cristobal had moved to the chalkboard and begun to record students' responses (offprint a). Chris continued to interact with the students, and Cristobal wrote a long note that covered the chalkboard to the right hand side (offprint b).[1]

01	Chris:	[a] Can you say this louder, Ron?	
02	Ron:	Compounds, there are two different substances chemically combined to form one.	
03		[b] (1.87)	
04	Chris:	Chemicals are compou[::nds.	
05	Joe:	[They don't need none of them.	
06		(1.48)	
07	Chris:	[c] Right.	
08		(1.29)	
09	Bill:	No, it's not=	
10	Chris:	=Well no no that's not true, that's not true. They combine to form other chemicals, other compounds.	
11		[d] (0.20)	
12		↑Right?	
13		(0.52)	
14		But you *ca::n't* ha:ve	
15		(0.36)	
16		you know	
17		(0.39)	
18		liquid copper.	
19		(0.81) ((Looks toward Cristobal, who is writing "Cu" on the chalkboard.))	
20		[e]↑Right?	
21		(0.18)	
22		It's a metal.	

23 (1.31)
24 Things like that right.
25 (0.52)
26 So you ha::v:e
27 (0.20)
28 *co:*pper [f]


g

29 (0.20)
30 with some othe:r elements
31 (0.96)
32 [g] for instance…

As he wrote, Cristobal increasingly moved in on Chris, whose physical space became limited, as he had backed off until he was touching the teacher's desk (offprint c). At this point, Chris began to cross to the other side of the classroom where, because Cristobal was moving to the opposite side, there was room for Chris to stand whereas Cristobal could continue to move to the right (offprint d). Cristobal eventually finished his note and began to back off again in the direction of the space that he usually took up (offprint e). But in backing off, he came closer and closer to Chris, who again experienced a lack of space, so that he, too, crossed over toward the position that he had initially occupied (offprint f). Cristobal stopped at the edge of the chalkboard, ready to contribute to the unfolding whole-class conversation or to note on the chalkboard when appropriate, while Chris continued talking to the students about the upcoming laboratory experiments (offprint g).

In this episode, the two coteachers moved in space. Their movements, however, were not independent. Rather, their movements were coordinated in space and time. As the supporting coteacher moved toward the central position in front of the classroom to produce additional semiotic resources by writing on the board, he exchanged preferred positions with the current lead teacher, who thereby made space for the actions of the other. Once the action of writing on the chalkboard was completed, the supporting teacher moved back to his preferred position, entraining the counter movement by the lead teacher. Or rather, his backing off can be seen as producing space in the central location to be taken up by the lead teacher. These transitions were usually seamless and required lit-

tle or no conscious attention, especially after the two had worked together for several months. At that time, the two seamlessly used the available space in the classroom in synchronized but complementary ways.

We can understand this situation as one of the micro-processes that both constitute and produce entrainment. Chris' movement to the other side of the front of the classroom was occasioned as Cristobal encroached on his physical space. His movement not only provided more space for himself but also produced space for the coteacher. At the same time, Cristobal not only moved toward Chris, encroaching on his space, but he actively took up the space that became available as Chris crossed over. By moving in a coordinated fashion, both coteachers produced the phenomenon of entrainment as much as entrainment produced the coordination of their actions.

While Chris was interacting with the students, Cristobal captured the essence of what was said in notes on the chalkboard (see offprints in transcript). These notes were not only for the benefit of the students, but also for the actions of both coteachers. More specifically regarding the enculturation of new teachers, these notes became resources for Chris that he could deploy in his subsequent actions. For example, in turns 14–18, Chris had said, "you can't have liquid copper." As soon as the first opportunity arose, immediately following the episode, Cristobal asked a question that led the class to discuss the possibility of liquids consisting entirely of an element. Students suggested that copper, for example, could be melted, a fact that Cristobal recorded on the chalkboard (Figure 1). Just as this discussion ended, Chris looked toward the notes (Figure 1a) and began to state, "What I said before is not exactly true," and continued to articulate a more appropriate statement about the relation between liquids and solids, on the one hand, and mixtures, elements, and compounds, on the other. While he summarized, he slightly turned to his right (Figure 1b), pointed toward the symbol of copper sulphate ($CuSO_4$), and uttered in reference to liquids, "most of one's we're dealing with are solutions."

In this situation, the question Cristobal had asked and the conversation that followed allowed Chris to realize that his earlier comment that there are no liquid elements was incorrect. Near what became the end of this part of the conversation, Chris looked toward the notes, which allowed him to perceive the record of what had preceded. He used this as an occasion for alerting students to the incorrectness of his earlier statement and in summarizing the result of the discussion. That is, by using these resources, originally produced by Cristobal, his actions also took on aspects that one would have attributed at the outset of the lesson to his partner only. Using the resources provided by his more experienced peer, Chris was actually entrained into using the resources at hand. Consistent

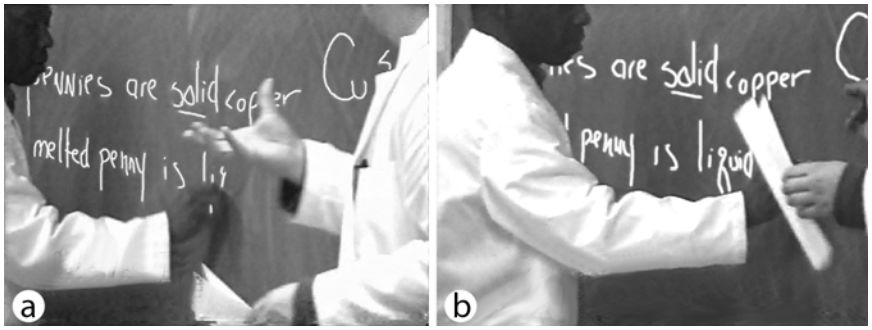


Figure 1. By drawing on the resources they mutually produce for one another, coteachers become also become entrained in their subject-matter-related practices (content, pedagogy).

with the dialectical approach taken here, the reverse is also the case. Cristobal would become entrained into acting in ways initially more characteristic of Chris or, for that matter, any other coteaching individual. That is, their mutual use of semiotic resources produced during teaching also produced entrainment into the ways of teaching and using particular resources.

In the above transcript, there are other features that we know from our database to have their origin in the coteaching experience. For example, Chris began to say "right" in particular circumstances in a way that Cristobal has done. Among other ways of using the word, the particular of interest here was always preceded and followed by pauses (turns 11–13, 19–21). Furthermore, there was a characteristic change in the pitch and even speech volume. In the past, we could only describe our sense. The recent availability of special software now allows us to represent characteristics of spoken language in a form that can be standardized across observers without having to go through face-to-face training and collaboration. In the next section, I focus on prosodic aspects that illustrate yet another level in which coteaching constituted a context for the entrainment of speech practices.

Prosodic coordination

Science educators have shown interest in classroom language since the publication of *Talking Science* (Lemke, 1990). However, their concerns have largely

been with meanings or concepts presupposed to lie behind the words. There has been little interest in exploring the way in which language is used to produce and reproduce alignments and differences along the lines of gender, social class, or culture. To produce such differences, we need to investigate how language and associated features—such as manual and vocal gestures—are used in situation and thereby achieve certain effects. Prosody, for example, is a vocal gesture that speakers use (unconsciously) to signal, among other things, emotions, emotional intensity, disagreement, and alignment (e.g., Goodwin, 2000). Given the central importance of emotion and social connectedness in the culture of African American students such as those who attend City High School, it should be of interest to science educators how prosody mediates talk in classroom interactions, on the one hand, and how new teachers, especially those working in cultural milieus different from their own, accommodate to existing patterns of interaction, on the other hand. Here, I focus on two aspects in which Chris was becoming like Cristobal. First, in the course of their coteaching experience, Chris developed certain features in his talk that were like those characteristic of Cristobal, including the production of "right" and "really, really" with a particular pitch contour and pausing. Second, in the course of working with Cristobal in the classroom, Chris became entrained to align the pitch of his talk with students and his fellow teacher.

Production and reproduction of ways of talking

Twice in the episode, Chris made an assertion, paused, apparently sought affirmation from the class saying "right" with a rising inflection, followed by another, usually shorter pause. Figure 2 depicts the waveform, sound intensity, and pitch for this pattern of speaking at another moment during this lesson. The waveform and intensity graphs show the significant separation of the word "right" from the previous and subsequent words "colder" and "heat," respectively. The intensity graph shows that at peak height, there utterance was more than 19 decibels stronger than the background, so that, together with the surrounding pauses, the word explosively imposed itself. Finally, the pitch rose by nearly 50 Hertz, first steeply then leveling off.

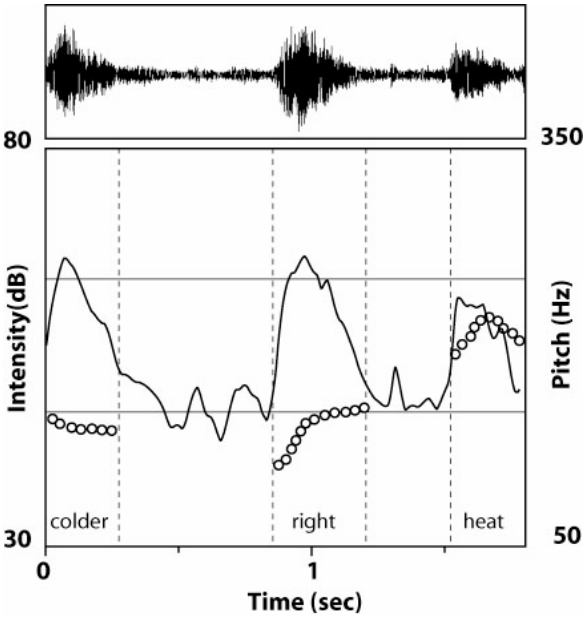


Figure 2. Waveform (top), intensity (—) and pitch (○○○) surrounding the articulation of "right," which Chris has developed while coteaching with Cristobal who had displayed this pattern prior to the collaboration.

All of these features created a characteristic pattern, which we had found in Cristobal's teaching for many years. For example, Figure 3 exhibits a comparison between the ways in which Cristobal (top) and Chris (bottom) uttered this form of right also during this lesson. In both instances—though a little less so for Chris—the pitch contour took the characteristic shape of increasing rapidly and to level off, distinct separation of the utterance from the surrounding utterances, and the volume against background noise. Throughout this study it was apparent that Chris had appropriated a similar way of teaching and exhorting students to think about what was asserted. In fact, students also adopted this style, evidence that it is not only coteachers who become like each other by coparticipating in the same situations. There are mediating circumstances that can change the particular form of an utterance, such as requirements for adjusting the pitch to previous speakers. I return to this phenomenon in the next subsection.

This form of "right" was different from its other uses. In turn 7, pauses preceded and succeeded the utterance. But these pauses were much longer than those surrounding the target utterance, there were no assertions on either end, and the pitch did not significantly change (184–188 Hz). (This was actually the pitch range at which the student had talked before. More about this phenomenon of pitch matching later.) The function of the utterance was to signal agreement with the preceding student statement (turn 5), an agreement that was revoked soon thereafter (1.29 s). (The pitch on "well no no" rose from 217–279 Hz, characteristic for statements of contradiction [Goodwin, 2000].) In turn 24, there was no change in pitch from "that" to "right" or within the utterance of the sound (108–110 Hz).

Another speaking pattern that Chris adopted from Cristobal in the course of their coteaching experience was the expression "really, really." This expression was used as a way of giving particular emphasis to some relevant feature in the situation. Thus, in the present discussion concerning the question "What happens if you heat a copper penny?" At one point, Chris said, "You have to heat it, I think it's like three thousand degrees or something really, really high." Less than two minutes later, Cristobal explained how to make the flame of a welding torch "really really hot." Figure 4 depicts speech intensity and pitch for both instances. In both cases, we observe the characteristically curved contour of "really really" followed by a sudden rise in pitch during the utterance of the modified predicate, hot and high, respectively. The figure also shows that the predicate was distinct from the surrounding volume either by being preceded (Cristobal) or by raising the intensity considerably above that of the preceding intensifier "really really" (Chris).

In both instances—"right" and "really really"—the matching feature was pitch contour. A pitch contour is a melodic movement of the pitch that can be heard as a coherent whole. In another study, pitch contour matching showed that it is the most frequent occurrence of prosodic matching (Szczepek, 2001). Such matching can, but does not have to signal agreement or mutual orientation. The present examples also show matching to occur at relative speech volume. Furthermore, in the present situation, the speaking turns were actually separate. In fact, similar prosody was observed even when Chris was teaching by himself. The question one might ask is, "How did Chris become entrained into these patterns of speaking?" Here, being a participant in talk in interaction, that is, being part of interaction sequences may provide some clues.

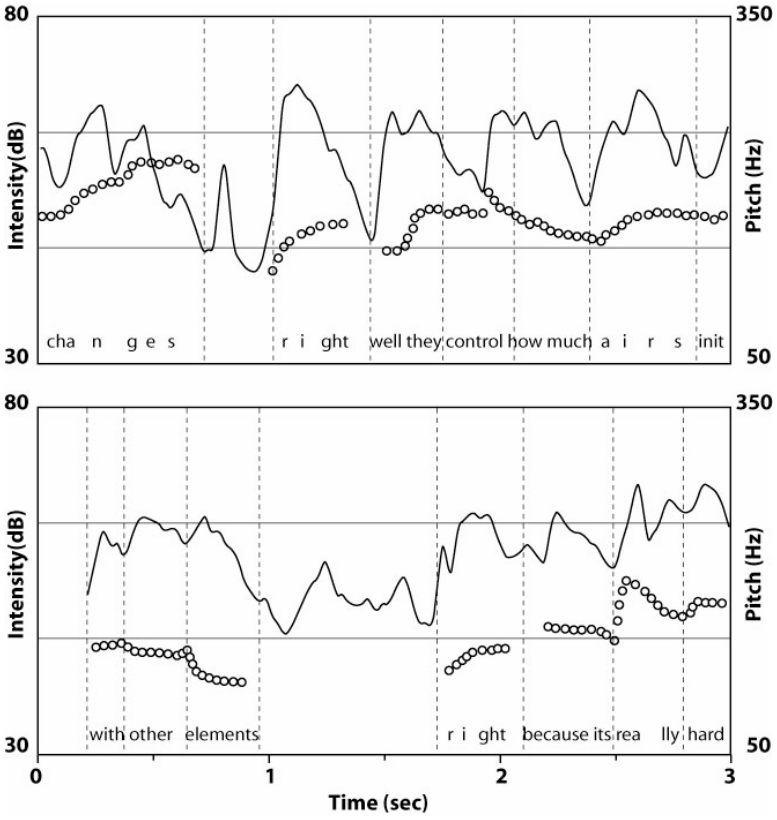


Figure 3. Intensity (—) and pitch (○○○) comparison of the use of "right" by Cristobal (top) and Chris (bottom), showing the similarity of the two contours.

Production and reproduction of pitch continuity

Pitch, pitch contours, and rhythm are periodic features, which are fundamental to the phenomenon of entrainment. Thus, when one speaker uses a certain pitch, pitch contour, or speech rhythm, theories of social entrainment predict the subsequent speaker to "chime in," at least in situations of agreement, and perhaps to differ in situations of disagreement (e.g., Goodwin, Goodwin, & Jaeger-Dror,

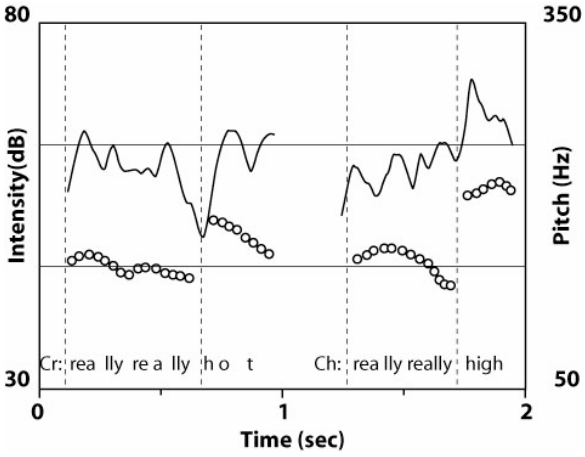


Figure 4. Intensity (—) and pitch (○○○) comparison of the use of "really, really" by Cristobal (left) and Chris (right), who had developed this way of talking while coteaching with the former. The similarity in the contours and subsequent step to the emphasized word is striking.

2002) or lack of (cultural) attunement. Prosodic orientation may create a bridge between two turns that could not be achieved by verbal means alone.

In his interactions with the students, both within and between lessons, Cristobal always seems to find the "right tone" with students whatever the situation. An analysis of pitch in consecutive turns shows that Cristobal matches prosodic features, including loudness and pitch to the preceding turn produced by a student. An example of such matching is provided in Figure 5, pertaining to the conversation about the relative hotness of candle and welding-torch flames. Following a student utterance, Cristobal queried to understand the student contribution, "when we did the candle?" (Readers will notice the characteristic rise in pitch at the end of the utterance, which is heard as a question.) Cristobal's pitch before the rise had been around 180 Hz. However, the student had answered at a much lower level, moving from 110 to 130 Hz. The plot shows that when he continued after the student, Cristobal (likely unconsciously) first matched his own pitch to that of the student before returning to his own preferred pitch level. Furthermore, the intensity levels show a similar pattern. The student had responded speaking with a much softer voice, which Cristobal matched before returning to a larger volume.

Figure 5 also provides an example of the interaction between Chris and a student during the interaction about heating a penny. The student suggested that holding the penny in the flame for a long time would lead to a different result. The pitch plot shows that Chris matched the student's pitch both during the overlapping word "right" (a continuer, that is, an indication by the listener that he or she is listening, while indicating that the speaker may continue) and in the subsequent response, where Chris suggested that the flame has a temperature and however long one holds the penny, it will not exceed the temperature of the flame. Pertaining to the intensity, he picked up at about the mean of intensity for the last four words.

Here, both teachers matched volume and pitch to the levels of the preceding student. This matching contrasted, for example, the earlier mentioned rapid rise in pitch when Chris changed from an initial agreement with a statement to a disagreement. That is, the sudden rise in pitch signals an opposition between two ideas. Cristobal and, following him, Chris showed a preference for pitch matching unless they expressed displeasure and opposition to the current situation. Thus, at the beginning of the lesson, Cristobal called the class to order, "Excuse me! (0.20) Hey!" In this utterance, the pitch rose from about 90 Hz on "ex" to from 290–315 Hz on "cuse," to drop descending contour from 105–95 Hz. The pitch then rose from 137 to 215 Hz on "me," which is heard as an exclamation. The subsequent "Hey!" rose from 275 to 348 Hz. In both situations, the high pitch compared to Cristobal's normal pitch level between 150 and 180 Hz signaled disapproval.

A final example for the fact that Chris was becoming like Cristobal can be seen from the fact that in turns involving both and some students, the pitches were matched such as to constitute a continuity. Thus, in the multi-speaker turn displayed in Figure 6, Cristobal initially matched the absolute pitch level of the previous student speaker. Chris, slightly overlapping with Cristobal, matched his pitch to that of his peer, who in turn matched his pitch to that of Chris. Although speakers are seldom aware of the absolute or relative pitch levels of their talk—because of resonance phenomena, we do not hear our own pitch in the same way we hear that of other speakers—matching pitches is a way to signal and produce emotional alignment.

In this situation, we observe prosodic complementation as a form producing and achieving alignment in collaborative action. A first speaker (Cristobal) has produced a contour that in itself is complete, but we might expect it to be followed by a particular contour from the next speaker. Both contributions constitute complete turns (Figure 6). However, although the first participant's turn signaled turn completion prosodically syntactically and pragmati-

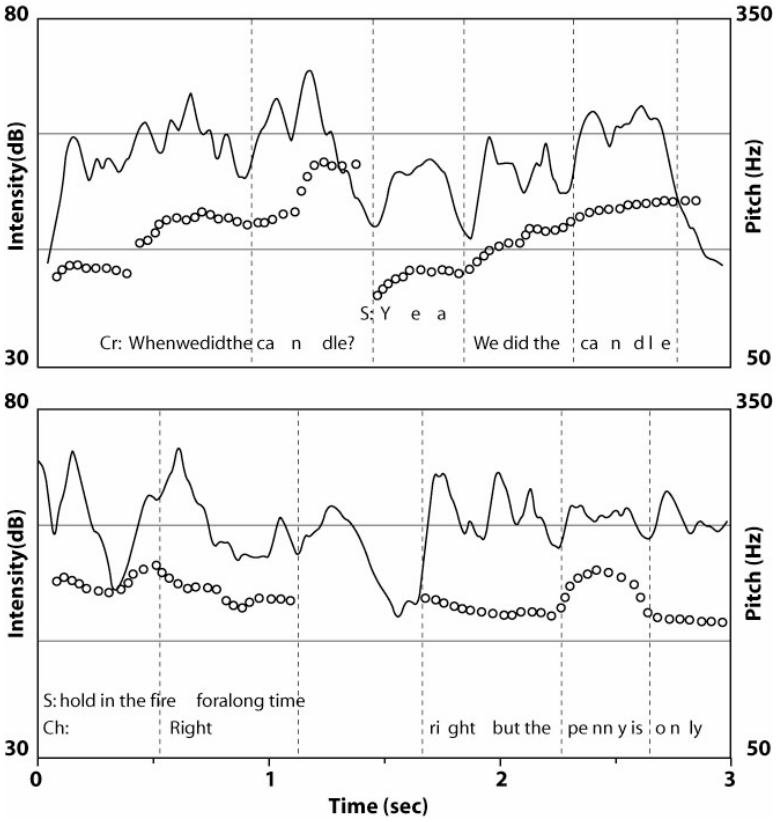


Figure 5. Chris (bottom) came to mach students' pitch levels in overlapping and subsequent turns similar to Cristobal (top).

cally—Cristobal has agreed with the student, ending on a descending pitch—the second contour complemented the first both in content (semantically) and prosodically, so that the two together formed a prosodic pair. Furthermore, when Cristobal chimed in again, he confirmed the content of Chris' utterance by repeating it, and signaled and produced alignment and agreement by continuing the pitch contour. Discord and difference, on the other hand, would have been indicated and produced by producing significant pitch differences with the previous speaker (e.g., Goodwin, Goodwin, & Yaeger-Dror, 2002).

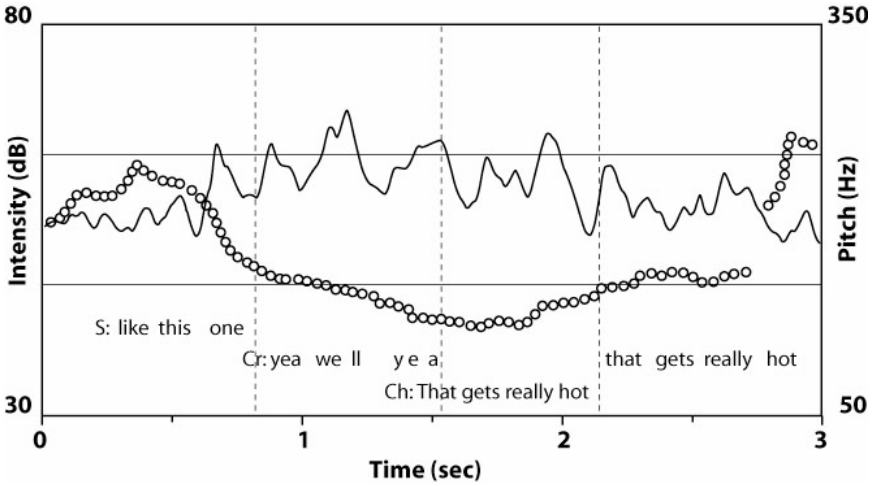


Figure 6. Pitch matching in turn sequences across multiple sometimes overlapping speaking turns involving the two teachers and one student.

Mimesis and entrainment

In this paper, I am concerned with the question how coteachers, in the course of weeks and months of working together, come to resemble one another. At the outset one might assume that practices are acquired by means of a process of imitation, which, since antiquity, has been discussed under the label of mimesis. Here, I first suggest that mimesis may not be the main (or only) process that explains why and how coteachers become like the other and then propose the concept of entrainment as a viable and productive alternative.

Mimesis

The assumption that teachers learn to teach by a process of mimesis appears to be inherent in teacher education programs that require university students, as part of their practicum, to sit in the lessons of (more) experienced teachers and observe before actually planning some lessons and teaching courses themselves. In this way, beginning teachers are to learn about the enacted practices and, by imitating them, to get a head start in their own development as teachers. Mimesis alone, however, does not constitute a good, sufficient, or satisfactory expla-

nation for the phenomenon of becoming like the other. If mimesis was the explanation, then new teachers could become like their mentors or cooperating teachers by sitting in the back of the classroom, watching what the more experienced colleague is doing. This, however, does not usually happen. New teachers do not develop practices by watching other teachers. In fact, our entire research program concerning coteaching at City High School, which included the requirement that supervisors, methods teachers, and researchers coteach, was in part driven by our understanding that watching others teach does not allow us to understand teaching from the perspective of the teacher. Thus, if mimesis indeed occurs, it seems to require the common orientation on the part of the coteachers toward the motive of activity and goal of current actions.

Concerned with the production and reproduction of practices, a mimetic relation between field and disposition has been proposed such that mimesis produces congruence between dispositions and field (Bourdieu, 1980). In the present study, Cristobal, the students, and the school would constitute the field to which Chris adapts so that his dispositions come to be like Cristobal's. Mimesis here would occur when a set of dispositions (Chris') copy those that are embodied in the field. This perspective is problematic, however, because the field is taken as stable and the dispositions (Chris') as malleable. The notion of disposition implies disposition for perception, so that the field itself undergo continuous change from the perspective of the newcomer. The concept and process of entrainment helps us out of this situation.

Entrainment

At the outset, I suggested that entrainment might be at the heart of the phenomenon of becoming like the other that we have described at a meso-level in previous research on coteaching (e.g., Roth & Tobin, 2002). The concept of entrainment is due to the Dutch physicist Christian Huygens, who observed, while working on the design of the pendulum clock, that two pendulums hung near one another on the same wall eventually ended up swinging at the same rate though they may initially have swung at different rates. This entrainment is due to their mutual influence on one another. Such a perspective of mutual influence and entrainment is more consistent with our observation that not only teachers new to a situation adapt to a classroom, becoming like the other teacher, but also that teachers with many years of experience become entrained in the practices of novice teachers. Furthermore, we observed that the practices of the classroom as a whole, teachers and students included, tended to change with the arrivals of other teachers. For any actor, other individuals constitute part of the field; thus, entrainment constitutes, in contrast to the previously elaborated perspective, not

merely a mimetic adjustment of a newcomer to the field, but in fact entails the mutual adjustment of field and person. In this way, enculturation entails changes not only in the newcomer, who becomes like other practitioners by adapting, as they did, to the field but also changes to the culture itself. Such a dynamic view of mutually constitutive changes also explains the production of novel forms of cultural practices that accompanies the cultural reproduction through enculturation of new members. This, however, does not yet provide an answer how coteachers become like the other through entrainment. That is, we still need to answer the question, "How does entrainment operate?"

To answer this question, we need to understand that coteaching is both a practice, produced in my actions, and a context, produced by the actions of my partner. It is a phenomenon that arises from participants' actions that constitute it such that it can be recognized as a phenomenon. Because there is the possibility of acting in ways that interfere with the smooth unfolding of coteaching, it is, like all social phenomena, fragile. It is fragile in the sense that if one of my actions is not in the spirit of coteaching, it does not produce and reproduce coteaching, and the situation goes awry, as it has been reported in one recent study of coteaching (Tobin, Zurbano, Ford, & Carambo, 2003).

In the present paper, I provide evidence for the production and reproduction of complementary actions on the parts of both coteachers. Thus, as Cristobal moved into the physical space that Chris currently occupied, the latter moved to the opposite side of the classroom. As Cristobal relinquished the space by backing off, he both moved into Chris' current space and released his partner's preferred space. Simultaneously, Chris released and moved into the available physical spaces. Here, the actions of the two coteachers were aligned in space and time, as the smoothly adjusted to the requirements of the other and made available resources. Further evidence for mutuality was observed at the prosodic level. First, I showed how Chris not only had come to use particular phrases ("Right?", "really, really") but also had come to employ the same pitch contours. Both Cristobal and Chris normally also aligned their absolute pitch with that of the preceding speaker (student or the respective other), so that there was a continuation and completion in pitch lines.

Both the mutual production and taking of space and the alignment of pitch to produce continuation and completion of pitch contours and lines shows that the individual coteacher was not and could not act completely independent of the other or the students. That is, when a coteacher produces and signals harmony, shared emotions, and social connectedness, he does not act out of his own volition. Rather, actions arise from the dialectical relation of the individual and the setting, that is, the dialectical relation between schema and sociomaterial re-

sources. The alignment and dialectical relation does not occur within independent movements, but involves itself a level of "fore-sight." In other words, a coteacher has to recognize intentional projections into the future such that his own actions are consistent with and harmonically linked to those that are currently in progress but have not yet ended.

Foresight is characteristic of praxis—such as when (a) jazz musicians get together for a jam session and, though they improvise, play in harmony, (b) athletes join and immediately play for a new team, or (c) researchers smoothly participate in coteaching in a school where they had not taught before. Foresight is based in practical understanding, which may but does not have to exist in a form that can be articulated in so many words (Heidegger, 1977). This practical understanding and therefore the capacity of foresight is produced and reproduced at the very same moment that a coteacher contributes to the ongoing events. Our actions do not leave us unchanged, but, while making a change in the setting, that is, in the sociomaterial resources available for subsequent actions, existing schema are changed, however slightly this might be. If this was not the case, we would not be able to explain how apparently repetitive actions, such as hammering a nail, could lead to the hammering expertise observable in carpenters or masons. In a similar way, teachers change their practices by teaching such that being in the classroom also means becoming in the classroom (Roth, 2002). Thus, we learn to teach by teaching even if we do not coteach. But in coteaching, the presence and actions of the other teacher constitute constraints that lead, by means of entrainment, to a more rapid adjustment to successful practices.

I assume that entrainment—a micro-level process—occurs when and because there is a common or compatible orientation toward existing motives of activity (historically grounded, and therefore macro-level) and goals (meso-level). This is so because any moment of praxis constitutes a unit in which activity, action, and operation stand in a dialectical relationship. Contradictions on the inside of this unit constitute forces that move it ahead. When coteachers do not experience "personality conflicts" at a conscious level, that is, when their motives and goals are aligned, any differences arising from unaligned or misaligned operations will eventually disappear as new actions, emerging from the dialectic of schema and external sociomaterial resources, not only reproduce themselves but also produce increasing adjustments. On the other hand, when coteachers experience "personally conflicts," their goals are not aligned and they realize different motives. In this context, their practices will not align at the unconscious level, for, to extent the pendulum metaphor, they do not share the wall or are mounted to far apart on the same wall to allow and produce entrainment.

Coda

My research on coteaching had begun with the chance observation that teachers come to resemble one another in their actions when they work together in the same classroom pursuing the same goals and concretely realizing the same collective motives. Initially, the explanation that working under the same conditions, that is, finding oneself in the same field, would allow novice practitioners to become like another through processes that I introduced here as mimesis and adaptation. However, in the course of my research, it became clear to me that mimesis and adaptation could not be the main processes. Although they explain well how cultures are reproduced and how new practitioners are enculturated, they do not explain cultural renewal and change. The dialectical concept of (mutual) entrainment, however, does explain both reproduction and production of culture, and therefore provides a dynamic explanation of practices such as teaching in general but coteaching in particular. It has provided me with a way of explaining a phenomenon, which I have known on a descriptive level for more than a decade.

The phenomenon of entrainment fundamentally involves time. Not only is speech constituted by period phenomena and unfolds in time, it also has to be coordinated with the speech of others, inherently requiring a synchronization of actions, even in the case when interacting persons disagree or find themselves in discord. Persons, who speak at the same pitch level, produce the same pitch contours, or use the same rhythm, have coordinated their own actions with those of others. In addition, spatial coordination, as shown, also requires temporal coordination in making and taking up the space for the other. This is true not only for coteachers but also for the relation between students and teachers. It is therefore not surprising to find coteachers to adopt other rhythmic features, such as in their gates or use of gestures, themselves aligned with other aspect of behavior (speech). Future research might be designed to focus on other temporal aspects involved in teaching and in the alignment of teaching practices.

Notes

1. The following transcription conventions have been used: (0.41) : time in seconds; [d] : letter in square brackets marks the moment corresponding to a particular offprint; = : equal sign shows latching, that is, two utterances are not separated by the normal pause; .,?! : punctuation is used to indicate speech features, such as rising intonation heard as a question, or falling intonation to indicate the end of an idea unit (sentence); – : the n-dash indicates stop in utterance without voice inflection indicating end of idea unit; ↑ : up ar-

row marks rising pitch; *can't* – italicized phonemes are emphasized; ((Looks)) – double parentheses enclose transcriber's comments, such as actions.

References

Allen, B. A. & Boykin, A. W. (1992). African American children and the educational process: Alleviating cultural discontinuity through prescriptive pedagogy. *School Psychology Review, 21*, 586–596.

Auer, P., Couper-Kuhlen, E., & Müller, F. (1999). *Language in time: The rhythm and tempo of spoken interaction*. New York: Oxford University Press.

Bourdieu, P. (1980). *Le sens pratique*. Paris: Les Éditions de Minuit.

Bourdieu, P. (1997). *Méditations pascaliennes*. Paris: Seuil.

Garfinkel, H. (2002). *Ethnomethodology's program: Working out Durkheim's aphorism.* Lanham, MD: Rowman & Littlefield.

Giddens, A. (1984). *The constitution of society: Outline of a theory of structuration.* Cambridge: Polity.

Giddens, A. (1987). *Social theory and modern sociology.* Stanford, CA: Stanford University Press.

Goodwin, C. (2000). Action and embodiment within situated human interaction. *Journal of Pragmatics, 32*, 1489–1522.

Goodwin, C., Goodwin, M. H., & Yaeger-Dror M. (2002). Multi-modality in girls' game disputes. *Journal of Pragmatics, 34*, 1621–1649.

Heidegger, M. (1977). *Sein und Zeit*. Tübingen, Germany: Max Niemeyer.

Lave, J. (1993). The practice of learning. In S. Chaiklin & J. Lave (Eds.), *Understanding practice: Perspectives on activity and context* (pp. 3–32). Cambridge: Cambridge University Press.

Lemke, J. L. (1990). *Talking science: Language, learning and values*. Norwood, NJ: Ablex.

Leont'ev, A. N. (1978). *Activity, consciousness and personality*. Englewood Cliffs, NJ: Prentice Hall.

Roth, W.-M. (2002). *Being and becoming in the classroom*. Westport, CT: Ablex.

Roth, W.-M., McGinn, M. K., Woszczyna, C., & Boutonné, S. (1999). Differential participation during science conversations: The interaction of focal artifacts, social configuration, and physical arrangements. *Journal of the Learning Sciences, 8*, 293–347.

Roth, W.-M., & Tobin, K. (2002). *At the elbow of another: Learning to teach by coteaching*. New York: Peter Lang.

Roth, W.-M., Tobin, K., Carambo, C., & Dalland, C. (2004). Producing alignment in coteaching. *Submitted.*

Sewell, W. H. (1992). A theory of structure: duality, agency and transformation. *American Journal of Sociology, 98*, 1–29.

Szczepek, B. (2001). Prosodic orientation in spoken interaction. *Interaction and Linguistic Structures, 27*. http://www.uni-potsdam.de/u/inlist/issues/27/index.htm. Accessed February 20, 2004.

Tobin, K., Zurbano, R., Ford, A., & Carambo, C. (2003). Learning to teach through coteaching and cogenerative dialogue. *Cybernetics & Human Knowing, 10* (2), 51–73.