

THE LEXICON OF THE CONDUCTOR'S FACE

Isabella Poggi
University Roma Tre
Roma – Italy
e-mail: poggi@uniroma3.it

1. Introduction

In the last decade, the multimodal aspects of communication have become an emerging field of research. Much work has been done on single systems of communication different from the verbal one - gestures, facial expression, gaze, body movements (see for example Kendon, 1993; Ekman and Friesen, 1978; Argyle and Cook, 1976; Birdwhistell, 1970) - and on the relationship among acoustic and visual modalities (Rimé and Schiaratura, 1991; Mc Neill, 1992). These studies provide information about how different modalities interact in accomplishing a common communicative task.

An interesting topic in this field is how communication in one modality can provide information as to what is to be done in another modality. A case of this is the orchestra Conductor's communication (Rudolf, 1993). A Conductor has to communicate to players information about rhythm, timbre, loudness, expression in their playing, and does by gesture, facial expression, gaze, body movement: here the visual modalities are used to provide information on how to perform in the acoustic modality. The Conductor's communicative behavior has mainly been studied on its gestural side. Boyes Braem and Braem (1999) provided a very interesting analysis of the Conductor's handshapes and their meanings. In this work I will analyze the communicative functions of the Conductor's gaze, head movements and facial expression, trying to show that these expressive signals are not at all idiosyncratic but very consistent and systematic, to the extent that it is possible to write down a lexicon of them, a list of expressive items where each gaze or facial signal corresponds to a precise meaning.

To build such a lexicon two different approaches can be taken: if you adopt a bottom-up approach, you can record and analyze observational data, while trying to see whether, for instance, the same gaze or head signal always has the same meaning. With a top-down approach, on the other side, you wonder what are in principle the types of information that a Conductor may need to communicate to players in his conducting, and for each of them you figure out, on the basis of your communicative competence, and/or find out in observational data, what gaze, head and face signals the Conductor does or might perform to communicate that meaning. In this paper I start from both points of view: in Section 2. I try to figure out what are the meanings a Conductor may have to communicate, and what gaze, face and head signals are generally devoted to communicate them. In Sections 3. and 4. I present a procedure for the transcription and analysis of multimodal communication that is called "the musical score" of the vocal, gestural, facial, bodily communication; I adapt it (Sect. 5.) to the analysis of some fragments of Conductors' communicative behavior, to test whether the signals hypothesized in the first part are in fact used in real conducting; finally (Sect. 6) I outline a lexicon of the Conductor's face. I conclude (Sect.7) by discussing some general problems in the theory of communication regarding the mechanisms of polysemy and diachronic evolution of signals.

2. Signals and meanings in the Conductor's face

In this section I adopt the top-down approach described above. I do not start empirically from data but deductively from a general typology of possible meanings that can be conveyed in communication. By applying this deductive reasoning to the Conductor's communication, I wonder: what are the meanings a conductor needs to communicate to players during conducting? Can these meanings be conveyed only by gaze, head and face, without necessarily resorting, say, to gesture? By which face, head and gaze actions are they usually conveyed? And, are there meanings that cannot be conveyed by facial communication?

A Conductor has both to suggest players how they should play and to provide feed back about how they are playing in fact. The former thing is sometimes done in advance, before starting: by gesture and face, s/he may rehearse for the players a particular passage they will have to play, with some information on how to perform it; but more frequently this is done on-line while the players are playing, by communicating what they should do immediately next. The latter thing, too, providing feed back about how they are performing is done on-line, but its ultimate goal is, again, providing information about how to play on.

Within the first meaning, how players should play, the Conductor communicates **who** is to play, say, by *gazing at players*, and **when** to play or sing (information about openings) by *raising eyebrows* immediately before the start, then with a *head nod* at the very moment of starting. Then s/he may communicate **what sound** s/he wants from players: what melody, rhythm, speed, loudness and expression: s/he may ask for a "piano" by *raising eyebrows*, for a "forte" by a *frown*. Again, s/he may suggest **how** to produce the sound from a technical point of view, and finally provide a feed-back on current performance, say, approving sound with a *head nod* or disproving with a *head shake*.

To each of the meanings listed, a specific signal corresponds, just like in a lexicon, i.e., a list of signal-meaning pairs, of the Conductor's facial repertoire.

Let us now adopt the bottom-up approach. I will present a procedure for the transcription and analysis of multimodal communication that is called "the musical score" of the vocal, gestural, facial, bodily communication. Adapting the score to the conductor's facial behavior will allow us to test whether the signals we hypothesized are in fact used in real conducting.

3. The "musical" score of communication

In audio-visual interaction we use multimodal communication: we communicate not merely through words but also through prosody, intonation, gesture, gaze, facial expression and body movement, and these different signals interact with each other in complex ways, with the overall meaning conveyed by the globality of them. But how are meanings distributed across modalities? Answering this question implies the use of some procedure that allows one to analyze all the meanings conveyed in multimodal communication and to distinguish the meaning individually borne by each communicative signal in each modality. Multimodal communication may be seen as a concert of many instruments playing together: following this musical metaphor, a procedure was elaborated to transcribe, analyze and classify chunks of multimodal communication, one similar to a musical score (Poggi & Magno Caldognetto, 1997).

The "score" of multimodal communication is a procedure where signals in two or more modalities are transcribed, analyzed and classified. In a classical score, signals delivered in five different modalities are reported on parallel lines: verbal (the words and sentences uttered), prosodic (speech rhythm, pauses, intensity, stress, intonation), gestural (hand and arm movements), facial (head and eye movements, gaze, smile and other facial expressions), bodily (trunk and leg movements, use of space, proxemics and so on). Each communicative item may be described in a discursive way or through some notation system, and possibly classified according to some typology (say, a deictic gaze, an iconic gesture...); afterwards, its meaning can be expressed verbally, on the basis of the postulate that any communicative signal, qua communicative, by definition conveys some meaning, and any meaning can be glossed in a verbal language. Finally, it is assessed what the relationship is between that communicative signal and a parallel signal in another modality: whether it repeats the same meaning, adds information, provides information that is not provided in the other modality, contrasts the meaning conveyed in the other modality, or whether it bears no relation to the other concomitant signal.

4. Direct and indirect meaning: a two layers score

The score presented so far takes into account only the literal meanings of the signals in all modalities; which looks quite unsatisfactory, given the relevance of indirect meaning in communication. According to a model of communication in terms of goals and beliefs (Poggi & Magno Caldognetto, 1997), a sentence is a Communicative Act, and its literal meaning can be reconstructed by processing the lexical meanings of its words and its syntactic form. The sentence literal goal is made up of a performative and a propositional content. The performative is the communicative intention with which the Sender performs one's Communicative Act, and it includes information on the kind of Action the Sender S requests from the Addressee A (whether to provide some information, like in the act of asking; to do some action, like in requesting; to believe some belief, like in informing) and on the relationship between S and A (a relation of power, like in an order, of benevolence, as in advice...). The propositional content is the content of the Act requested, of the information provided or asked.

Beyond its literal goal, though, any sentence may have one or more supergoals. A supergoal is a goal that is hierarchically superordinate to a goal, in that the goal is but a means to the supergoal. But while the goal of a sentence is to be understood merely through linguistic processing (lexical and syntactic rules), the sentence supergoal, even as it is a communicative supergoal, i.e., one that the Sender wants to be caught, is by definition not stated explicitly, it is a goal that the Sender wants the Addressee to catch by inference. Supergoals may be either idiomatic or creative. An idiomatic supergoal is a goal where the inferential path from literal to indirect meaning is crystallized (i.e., the same in any context) and condensed. A case of an idiomatic supergoal is the classical *Can you pass the salt?*, where the literal meaning ("I ask you if you are able to pass the salt") is bypassed, not even felt anymore, since the supergoal meaning ("I request you that you pass the salt") almost has a lexical status. To understand a creative supergoal, the Addressee may have to catch different goals in different contexts, through inferences generated on the basis of contextual knowledge. A case of a creative supergoal is when I ask a colleague of mine: *Are you going home?* If he knows my car is broken, he may infer the supergoal of asking for a lift. But if we work on the same computer, he will infer that my supergoal is to ask if I may use the computer. Now, not only a sentence, but also a gesture, a gaze, a posture can be Communicative Acts, hence they may have goals and idiomatic and creative supergoals. The gesture *hands up* has an idiomatic supergoal. Its literal meaning is: "I show you my hands empty, hiding no weapon", but in fact idiomatically it means: "I resign, I do not oppose you". Again, see a creative supergoal of a facial signal: by *directing gaze* to an interlocutor we ask for attention, but from this first meaning the interlocutor may infer different supergoals, depending on the context: I may ask your attention because I want to blame you, ask for complicity, or simply refer to something somehow linked to you.

Thus, since not only verbal but also nonverbal communication may undergo a second layer of interpretation (may have supergoals to infer), a two-layers score should be used to account for the second-layer interpretation of multimodal communication. In fact, a further development of the score procedure was put forth, where each signal in each modality goes through two layers of semantic analysis: both literal and indirect meaning are written down and classified as to their meaning and function. This new version of the score was applied to Totò, a famous Italian comic actor, and to political discourse (Poggi and Magno Caldognetto, 1997).

5. The score of conducting a score

An adapted version of the two-layers score was applied to the analysis of the conductor's head, gaze and facial behavior. Two different conductors (Bruno Aprea and Massimo Freccia) were videorecorded, both conducting Beethoven's 9th Symphony, during a public concert and during a rehearsal. Some fragments of these videorecordings were analyzed through the score procedure.¹ For each item of gaze, mouth or head movement its literal and indirect meaning was assessed. The score of two fragments from Aprea's rehearsal is shown in Tables 1, 2 and 3.

Head movements and gaze are represented on parallel lines. On each line three aspects of the signal are described: direction, movement and, possibly, combination. More specifically, we write in what direction head and eyes look (up, down, right, left, forward, right-down, beyond the orchestra to the choir...); the type of movement performed (still, head tilt, head nod, frown...); and, sometimes, if the signal analyzed is combined with others, whether represented in the score or not (a specific gaze may combine with some head movement or with a gesture).

Each aspect of each signal is described and classified through three columns: in the first we write a description of the signal; in the second and third columns, respectively, we write a verbal formulation of the literal and of the indirect meaning of that aspect of the signal, and we classify the Communicative Act performed as an Information, Question or Request. On the fourth and last column to the right we write down what seems to be the overall meaning of the combination of signals analyzed.

Table 1.

		SIGNAL	LITERAL MEANING	INDIRECT MEANING	COMPLETE COMMUNICATIVE ACT
HEAD	Direction	<i>Head upward</i>	I am in an alert position (I)	I ask you to be ready (R)	Choir, be ready to start (R)
	Movement	<i>Still</i>	I stand still before starting (I)	I'll start in a moment (I)	
GAZE	Direction	<i>In front of himself, beyond the orchestra</i>	I am addressing you there (I)	I am addressing the choir (I)	
	Movement	<i>Eyes around</i>	I am addressing each one of you (I)		

In the specific example of Table 1., head is upward and still: its first level meaning is: "I am in an alert position" (an Information), which means in its turn: "I ask you to be ready" (a Request). At the same time, gaze is directed forward, beyond the orchestra (then to the choir) and eyes look around like in gazing at each singer one by one. The meaning is then: "I am addressing the choir, and each of you singularly". The overall meaning conveyed by head and gaze is a complex Communicative Act made up by a vocative ("You choir") plus a Request ("Prepare to start").

Table 2.

		SIGNAL	LITERAL MEANING	INDIRECT MEANING	COMPLETE COMMUNICATIVE ACT
HEAD	Direction	<i>Head forward</i>	I address you in front of me (I)	I address you wind instruments (I)	You wind instruments play soft and gently (R)
	Movement	<i>Moving slowly right and left</i>	No, don't do that (R)	Play soft (R)	
GAZE	Direction				
	Movement	<i>Eyes shut</i>	I am concentrating (I)	Play gently (R)	

In Table 2, head forward (= "You wind instruments") slowly moves right and left, meaning "No" ("Don't do that"), which in this case is a Request to play softly. At the same time, eyes shut, meaning "I am concentrating", which in this context may be interpreted as "Play gently". The overall meaning is a vocative plus a double Request: "You, wind instruments, play soft and gently".

Table 3.

		SIGNAL	LITERAL MEANING	INDIRECT MEANING	COMPLETE COMMUNICATIVE ACT
HEAD	Direction	<i>Head forward</i>	I address you in front of me (I)	I address you strings (I)	I ask you stressed and clearcut chords (R)
	Movement	<i>Scanning time</i>	I am scanning time (I)	I ask you chords strong and scanned (R)	
	Combination	<i>Head + Hands + Body</i>	I show it with all my body (I)	It is important for you to do this (I) I strongly ask you this (R)	

In Table 3., as it is represented by the line "combination", the movement of the head combines with the simultaneous movements of the hands and the whole body. The very fact that they all combine is not simply redundant: doing the same thing at the same time with different instruments is a metacommunication that means: "that I am scanning time (line 2, col.3), is something that I show with all my body (line 3, col. 3)", which indirectly conveys the Information "this is a particularly important message" and hence the Request "I strongly ask you to do this".

6. A lexicon of the Conductor's face

Table 4. represents a sample of the Conductor's facial lexicon, that is, a list of correspondences between facial signals and meanings, as they result from the combination of our top-down approach (Sect. 2.) with the score analysis (Sect. 5.).

In columns 1 and 2 we write the classes and subclasses of meanings the conductor has to convey; in col.3 a specific facial signal, in cols. 4 and 5 respectively the "apparent" and the "real" meaning (where the "real" meaning is generally the indirect one, except when only the literal meaning holds).

In suggesting players how to play, the information about **who** is to play is usually communicated by a deictic use of head or gaze direction; when Aprea looks in front of himself beyond the orchestra, he is referring to the choir in a deictic way, that is through pointing at it. As for **when** to play (or sing), the conductor can provide information about openings before opening by *raising his eyebrows*, which means "I am in an alert position", so "be in alert position", then "be ready to open"; at the moment of opening, he *strongly nods*: "Open now!". He can also signal when it is not yet time to open, by *looking down* or by *closing his eyes*.

Another important information concerns **what sound** to produce: specifically, what **melody, rhythm, speed, loudness**. *Raising face up* or *dropping it down* may mean "I want a high tune" or "I want a low tune"; the kind and speed of *head movements* can inform analogically about the due rhythm and tempo. Different signals are devoted to inform about loudness. A *frown* or a *grimace*, by expressing determination, generally mean "Play aloud"; among the facial signals that ask of playing softly, the most frequent and idiomatized ones are to *move head left and right* as in saying "No", and to *raise eyebrows* like in saying "I'm alarmed". An alternative more idiosyncratic way (one seen in nonrecorded observation) is to show a disgusted or horrified face (performed by *shutting eyes, frowning* and *opening the mouth*), that produces the inferences "What a distressing sound" and then asks for a softer one. In all of these cases, the meaning "Play more softly" is an indirect, generally idiomatized meaning.

One more information typically provided by head, face and gaze is about **expression**. Here of course facial expression is the most apt way to exhibit the emotions that the Conductor feels or pretends to feel, and that he is calling for in players, so they can display them in their music. The Conductor, for instance, by *raising the inner parts of his eyebrows* shows sad, then meaning "play a sad sound".

This concerns the sound quality that is to be the output of the players' playing. But sometimes the Conductor also informs about **how** this output should be produced, by suggesting the techniques to use for producing the sound required. A choir conductor, for instance, can *open his mouth wide* to ask singers to open it wide. He can also *round his mouth* to mean "Sing with rounded mouth", with the indirect meaning "produce a softer and more delicate sound".

Let us come to the feed-back signals. A conductor may approve or disprove of the players' playing. As he *slowly nods* or *closes his eyes*, he is communicating "This is ok, go on like this". The same meaning may be indirectly conveyed when he *keeps his*

head oblique, which is a relaxed position, thus meaning "I feel ok like this"; "You are playing well". A blame instead is communicated in the case above, when the conductor closes his eyes but at the same time frowns and opens his mouth, as in an expression of disgust. The indirect meaning conveyed by this negative feedback is often "Do not play this way".

Table 4.

THE CONDUCTOR'S LEXICON

TYPE OF MEANING		SIGNAL	LITERAL MEANING	INDIRECT MEANING
SUGGEST HOW TO PLAY	Who is to play	<i>Look at the choir</i>		you choir
	When to play	<i>Raised eyebrows</i>	I am alerted (emotion)	prepare to start
		<i>Look down</i>	I am concentrating (mental state)	You concentrate, prepare to start
		<i>Fast head nod</i>		start now
		<i>Look down</i>	I am not alerted	do not start yet
	What sound to produce			
	Melody	<i>Face up</i>		high tune
	Rhythm	<i>Staccato head movements</i>		Staccato
	Speed	<i>Fast head movements</i>		Svelto
	Loudness	<i>Frown</i>	I am determined (mental state)	play aloud
		<i>Raised eyebrows</i>	I am startled (emotion)	it is too loud, play more softly
		<i>Left-right head movements</i>	No! (not that loud)	Play more softly
	Expression	<i>Inner eyebrows raised</i>	I am sad	Play a sad sound
	How to produce the sound	<i>Wide open mouth</i>		Open your mouth wide
<i>Rounded mouth</i>			Round your mouth	
PROVIDE FEED BACK	Praise	<i>Head nod</i>	Ok	go on like this
		<i>Closed eyes</i>	I'm relaxed (emotion)	Good, go on like this
		<i>Oblique head</i>	I'm relaxed (emotion)	Good, go on like this
	Blame	<i>Closed eyes + Frown + Open mouth</i>	I'm disgusted (emotion)	Not like this

7. Indirect meaning and the creativity of facial language

An aspect of the Conductor's communication that pops out thanks to the score is the issue of literal and indirect meaning. Often the conductor's head and gaze signals have a literal meaning but they mean something else in fact: they have an indirect meaning. For instance, by opening eyes wide when music is too loud, the Conductor means "I feel alarmed" as a literal meaning, but "Please, play softer" as an indirect meaning. The literal meanings are linked to the indirect meanings through inference chains of this kind:

- I am stressing rhythm ≈ stress rhythm
- I am pointing at you ≈ I am addressing you ≈ prepare to start
- I am alerted ≈ be alerted ≈ prepare to start
- I am alarmed ≈ this sound is too loud ≈ play softer
- I am sad ≈ feel sad ≈ play a sad sound

Also in this case, as well as in verbal direct and indirect communicative acts, some of the indirect meanings are of the idiomatized type, in that the literal meaning can be interpreted only in one way, while other indirect meanings can change across contexts. We have an idiomatized indirect meaning when the conductor nods to the orchestra, which almost always means "I like how you are playing, go on like this". A scared or horrified face, meaning "I am afraid" or "I am horrified (by this loud sound)", at the indirect level idiomatically means "Play softly". But take the signal of eyes shut, which generally means: "I am concentrating": this might mean "Prepare to start", when music has not started yet; but it might also mean "Play lower" or "Play in a mystic or mysterious way": different inferences, hence different indirect meanings, are triggered in different contexts.

Analyzing the Conductor's face communication through the two-layers score is also of help to solve some theoretical problems. First, the ambiguity of signals. A problem with the list in Sect.2. was that some signals seemed to have more than one meaning: a head nod may mean "Start now" but also "Go on like this". Now, thanks to a score analysis that carefully distinguishes the components of gaze from head and face, and within each component different possible directions and movements, we can tell that signals seemingly identical are not in fact exactly the same: for example, the opening *head nod* (Tab.4, line 3) is faster than the *head nod* that means "go on like this" (line 16). Thus, the presence of ambiguity is challenged already by the score analysis at its first level. But the discovery of an indirect level of meaning may account for both ambiguity and synonymy of facial signals: the same signal may have the same meaning at the literal level but two or more different meanings (mediated by different inferences) at the indirect level. This is the case for *eyes shut* which mean "I am in concentration" at the first level, and may mean either "prepare to start" or "play soft" at the second level. And also, two different signals may be synonyms at the indirect level: both *eyes shut*, that means "I am in concentration" and *wide open eyes*, that means "I am alerted" have as an indirect meaning "prepare to start". The existence of ambiguity and synonymy in the conductor's face communication, and the possibility to account for them, shows that this can be considered a lexicon in its own right, since the link between signals and meanings is as precise and systematic as in word and gesture lexicons.

One more reason why it is important to take indirect meanings into account is that they widen the range of meanings that can be conveyed in this communication system. In fact, how many meanings can the Conductor's face mean? There are, maybe, some kinds of meanings that a Conductor should communicate but that cannot be expressed by face, while they can, say, by gesture (Boyes Braem and Braem, 1999). For instance, by combining gesture and face a Conductor may ask some players to play soft because the music theme is held by other instruments. Now, I think this could not be done by face only. Nonetheless, indirect meanings do widen the range of meanings that can potentially be conveyed by face only.

The creation of new signals in a communicative system is constrained by two things: the Agent's communicative needs (the meanings it needs to convey) and its resources (the perceivable objects, forms, movements it can produce). Now, a Conductor's communicative needs are to convey the meanings of Tab.4, while the resources he is endowed with are his face, head and gaze, who can only do three kinds of communicative actions: a. point at some places by head or gaze; b. perform rhythmic movements by head; c. express states of mind (states of thought, like "I am concentrating", or emotions, like "I am sad"). By these mere resources, the only meanings a Conductor's face could convey literally would be: referring to players or instruments; showing rhythmic movements of his own; expressing his own mental states of emotions. But if we add a bunch of inference rules to these meanings that the Conductor can convey literally in a natural way, a fair amount of other meanings can be conveyed indirectly, whether idiomatized or not. Two of the inference rules that may account for the development of new meanings from the basic ones above are: (1) *pointing* (by pointing at players or singers, the Conductor often addresses them, and may even perform a request, like "Prepare to start"); and (2) *mirror* (by moving his head he may imitate the movements the players should perform on their instruments, and then ask them to perform those movements); where a *mirror* inference can also be applied recursively (by expressing an emotion he can ask them to feel the same emotion and to play in such a way to induce that emotion in other people).

These inference rules give rise to semiotic devices that are at work not only in the language of the Conductor's face, but in many, if not all, communication systems. Also in everyday interaction, pointing is a way to make reference to things or people, and then possibly to address them. But the device of mirroring looks particularly interesting in the evolution of signals, since a mirroring device is often used to induce in other people the same behavior as ours: a mother, while feeding her child, instinctively opens her mouth to have him open his mouth; smiling to a person is the best way to elicit her smile; as we want to emphasize the content of our sentence, we raise our eyebrows, a signal of surprise which has the function of inducing the same surprise and consequent attention in our interlocutor (Poggi and Pelachaud, 2000).² In this sense the face of the Conductor is a microworld where the same semiotic devices hold as in other communication systems.

The primary function of Language is to influence other people, that is, to cause them to do what we want; and this function is so compelling that language finds its way in fulfilling it not only in a straightforward manner, but also through indirect devices. Just because of the distance between what the Conductor has the goal of communicating and what our head and face naturally allow us to communicate, in the diachronic evolution of a shared code between a Conductor and an orchestra or a choir, some inferential links have been built and then idiomatized; these links allow people to understand, from a movement of the Conductor's face, a movement requested of the players, and from an emotion of the Conductor, a request for a particular sound, or an opening, or a particular expressive rendering.

Notes

- (1) I am indebted to Mara Mastropasqua who collected and carefully analyzed the videotaped fragments of orchestra conduction, while working on her thesis in Theory of Communication, at the Faculty of Education, University Roma Tre.
- (2) Might this have to do with Rizzolatti et al. (1997) *mirror neurons*, the monkeys' neurons that fire both while the monkey is producing a gesture and while it is seeing it?

References

- Argyle, M., & M. Cook (1976). *Gaze and Mutual Gaze*. Cambridge: Cambridge University Press.
- Birdwhistell, R. (1970). *Kinesics and Context: Essays on Body Motion Communication*. Philadelphia: University of Pennsylvania Press.
- Boyes Braem, P., & Th. Braem (1999). A pilot study of the expressive gestures used by classical orchestra conductors. In K. Emmorey & H. Lane *The Signs of Language Revisited: An Anthology in Honor of Ursula Bellugi and Edward Klima*. Mahwah: Lawrence Erlbaum Associates.
- Ekman, P., & W. V. Friesen (1978). *Facial Action Coding System*. Palo Alto: Consulting Psychologists Press.
- Kendon, A. (1993). Human Gesture. In T. Ingold & K. Gibson (Eds.), *Tools, Language and Intelligence*. Cambridge: Cambridge University Press.
- McNeill, D. (1992). *Hand and Mind*. Chicago: University of Chicago Press.
- Poggi, I., & E. Magno Caldognetto (1997). *Mani che parlano. Gestì e psicologia della comunicazione*. Padova: Unipress.
- Poggi, I., & C. Pelachaud (2000). Emotional Meaning and Expression in Performative faces. In A. Paiva (Ed.), *Affective Interactions. Towards a New Generation of Computer Interfaces*. Berlin: Springer.
- Rimé, B., & L. Schiaratura (1991). Gesture and Speech. In R. Feldman & B. Rimé (Eds.), *Fundamentals of Nonverbal Behavior*. New York: Cambridge University Press.
- Rizzolatti, G., Fadiga, L., Fogassi, L., & Gallese, V. (1997) The space around us. *Science* 277 (11 July 1997), 190-191.
- Rudolf, M. (1993). *The grammar of Conducting*. New York: Schirmer.