Rethinking gesture phases: Articulatory features of gestural movement?*

JANA BRESSEM and SILVA H. LADEWIG

Abstract

This paper presents a proposal for the description of gesture phases derived from articulatory characteristics observable in their execution. Based on the results of an explorative study examining the execution of gesture phases of ten German speakers, the paper presents two sets of articulatory features, i.e., distinctive and additional features by which gesture phases are characterized from a context-independent and context-sensitive point of view. It will be shown that gesture phases show a particular distribution of the features, thus distinguishing one phase from another. Furthermore, changes in the execution of phases in linear successions can be described by means of features. Contrary to other accounts, whose focus on gesture phases is primarily in relation to speech and|or adjacent phases, this proposal concentrates on the visible physical characteristics of gesture phases.

Keywords: *gesture phases; articulatory features; form-based analysis; context-independent and context-sensitive description; linguistic perspective*

> I think it would be worthwhile to pursue a program of research on the perception of action to try to identify what appear to be the movement features that people rely upon to separate "gesture" (actions perceived as produced to "say something," etc.) from other kinds of actions.
> —Kendon (1996: 8)

When watching people talk, it can be observed that speakers quite frequently move their hands. Speakers might do this because they want to describe what a particular object looks like. They might depict its form, size or shape. At

Semiotica 184–1/4 (2011), 53–91
DOI 10.1515/semi.2011.022
0037–1998/11/0184–0053

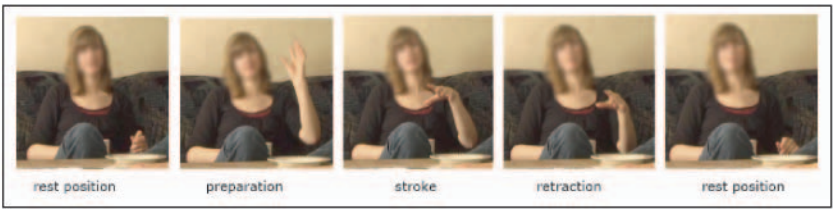

Figure 1. *Succession of gesture phases*

other times, speakers use their hands to point at things in their surroundings, such as objects in the real world or the person they are talking to. Also, speakers frequently use their hands to convey their attitude to what is being talked about. They might mark the utterance as a question, a negation, a doubt or to belittle another person.

When doing so, speakers are engaging in the act of gesturing, i.e., they perform "communicative movements of the hands and arms, which, similar to language are used to express the thoughts, feelings, and intentions of a speaker . . ." (Müller 1998: 13, our translation). When people gesture, they move their hands and arms in a particular succession. Starting from a relaxed position, such as on their lap or on a table, they move them to a place in front of their body, where they may perform further movements, and then back to a relaxed position again (see Figure 1). These successions, first defined by Kendon (1980), are referred to as "gesture phases" and describe the different movement phases observable in the execution of gestures.

The meaningful part of the gesture[1] — the part people rely on in their interpretation of a gesture — is the *stroke* (Kendon 1980). In order to perform a stroke, the hands need to prepare for its execution during the phase referred to as *preparation* (Kendon 1980). The stroke may be followed by a *retraction*, a phase in which the hands relax and move back into a *rest position*. These gesture phases build higher-level units, namely: 1) the *gesticular phrase|gesture phrase*, which is composed of a preparation and stroke and 2) the *gesture unit*, which is "demarcated as extending from the moment p begins the excursion of the limb to the moment when the limb is in rest again" (Kendon 1980: 212) and may include one more gesture phrases.[2]

Kendon's pioneering work on the description of gesture phases, along with the work of others that have followed, has been essential to the study of co-verbal gestures. It has shown that gestural movement sequences can be broken down into a succession of different phases, which correspond to units at speech level (Kendon 1972a). Furthermore it has shown that gestures form larger units, which match higher-level units at the verbal level (Kendon 1972a). More importantly however, it has provided a technique for detailed accounts of ges-

tures and their relation to speech, and has proven the fact that "speech and movement appear together as manifestations of the same process of utterance" (Kendon 1980: 208).

It has been more than thirty years since Kendon's first account of the structure of gesture phases was published. Since then, only minor changes have been made (see Section 2). To this day, the relation of gesture to speech is mainly of interest to prove the close relationship between speech and gesture (see for example Bohle 2007; Kita, van Gijn, and van der Hulst 1998; Kendon 2004). Questions on the characteristics and features of different gesture phases, or questions on the status of gesture phases in the coding and in the analytical process are rarely addressed. Furthermore, questions on the role of gesture phases for the structure and composition of the medium of "gesture" itself, as, for instance, in the building of higher-level units (Kendon 1972a, 1980, 2004) or their recursive embeddings within these units (Fricke 2008) — properties that have so far been ascribed to speech only — have been paid attention to only selectively.

This paper therefore concentrates on the phases themselves and tries to inspire a linguistic perspective on the description of gesture phases. We will introduce them as minimal units of analysis, which can be described on their own and in relation to each other. In doing so, we approach gesture phases from the perspective of gesture analysts. We try to explicate features that an analyst perceives when coding gesture phases and relies on when describing their forms and functions. Thus, the questions we want to answer in the paper are: What do researchers perceive and attend to when segmenting and coding gesture phases? Are there features that aid not only the segmentation and coding process, but can also be used for a form-based characterization of the various gestures phases?

The aim of this paper is therefore to spell out the articulatory features attended to, systematize them, and classify gesture phases according to them. The proposal is not meant to be a guide for gesture phase coding. We challenge trained gesture analyst's perspectives on the object of investigation and their implicit use of these features in the whole coding process. We do this in order to provide a step in the direction of gesture phase coding only on the basis of articulatory features.

For the approach to be presented, we therefore conceive gesture phases as potentially separable units of analysis. Each gesture phase can be investigated and described on its own, independent of its integration in the flow of movement of a gesture unit (Kendon 2004). This analytical separation is assumed for all gesture phases and is a starting point for our articulatory description.

So far, investigations in gesture studies only implicitly conceive gesture phases as separable units of analysis and, moreover, mostly with respect to the stroke. Thus, particularities in the execution of gesture phases and possible

characteristic features have mostly been related to the stroke. Kendon for example writes, "the stroke is the phase of the excursion in which the movement dynamics of "effort" and "shape" are manifested with greatest clarity" (2004: 112). Similarly, Sowa points out that "it is assumed that the overall effort during a stroke is comparably high, while the other dynamic phase types are marked by a more or less constant increase or decrease from or to a low effort value" (2006: 195). Due to its special characteristics, the stroke has been an object of investigation from very early on in gesture research. Several studies have concentrated on the synchronization of the stroke with respect to the co-occurring speech and in particular to the correlation of the stroke and accents in speech (Efron 1972 [1941]; Kendon 1972a; Condon and Ogston 1967; McClave 1991; Nobe 2000; Loehr 2006; Queck et al. 2002; Yassinek et al. 2004). Other analyses have shown that a gesture waits for the speech in that the stroke for example might be "suspended" (Seyfeddinipur 2006) in order to be synchronized with the verbal component and to a create a "gesture-speech ensemble" (Kendon 2004: 127; see also Kita, van Gijn, and van der Hulst 1998 with respect to *pre-stroke* and *post-stroke holds* and their relation to the speech production process).

Apart from the stroke or hold, particular analyses have also detached other gesture phases from the flow of movement and investigated their relation to co-occurring speech. Seyfeddinipur (2006), for instance, was able to show that gestures can be interrupted in their execution. "Specifically, in disfluent utterances, gesture suspension tended to occur within a preparation or a stroke or right after a preparation" (Seyfeddinipur 2006: 143) thus leading to changes in the temporal organization of the gesture phrase (Kendon 2004).

Examples referring to particular gesture phases independent from their connection to the remaining gesture phases can also be found in specific types of gestures phases as "interrupted preparation/stroke" (Seyfeddinipur 2006: 109) and "partial retraction" (Kendon 1980; Seyfeddinipur 2006), for instance.

The status of gesture phases as units of description and the assumption that gesture phases can be treated on their own, apart from their integration in a gesture unit, have only rarely been addressed in gesture research. Explicit reference to single phases and their relation to the utterance process yet show that certain gesture phases are also conceived as single units of investigations. Furthermore, it indicates that phases possess particular features that allow for their recognition within the flow of movement and reflect the functions they fulfill for adjacent phases and for speech.

Some attempts at describing possible features of gesture phases have been made, especially in the field of research on automated gesture segmentation, (cf. Chafai, Pelauchad, and Pelé 2006; Harling and Edwards 1997; Latoschik 2000; Kahol, Tripathi, and Panchanathan 2004; Martell and Kroll 2007; Wilson, Bobick, and Cassell 1997). Yet none of these approaches has pursued a

linguistic, feature-based perspective that relates the different phases and their articulatory features to each other, on the level of single gesture phases as well as in successions of gesture phases.

Accordingly, our attempt in this paper is to describe gesture phases as part of a system of movement phases, in which each gesture phase exhibits particular features that differentiate it from the other gesture phases. We thus examine the different gesture phases in isolation as well as in reference to each other. In doing so, we aim at a set of *distinctive features* based on articulatory characteristics apparent in the execution of gesture phases, to identify and characterize the particular phases and to differentiate them from each other. The focus of this paper is solely on the articulatory characteristics of gesture phases, which they exhibit independent of speech. With the help of the distinctive features, the different gesture phases will be explored on two levels of description: one that is *context-independent* and one that is *context-sensitive*.

Gesture phases are often embedded within a series of further gesture phases. Ideally, this series constitutes a gesture unit (Kendon 1980, 2004, see Figure 1), i.e., a succession from a rest position to a rest position containing only one stroke. This sequence of gesture phases is understood as the *context* of a gesture phase. In a context-independent description, each gesture phase is depicted on its own by means of the distinctive features. Gesture phases are isolated from their adjacent gesture phases. As each gesture phase shows a particular realization of the set of distinctive features, each phase can be conceived as a unit of description. In a context-sensitive description, the influence adjacent phases may have on a phase is taken into account. For this level of description, the format of writing phonological rules (Chomsky and Halle 1968) is adapted to provide for the systematic variations in the set of distinctive features characteristic for a type of gesture phase. The context-independent characterization is necessary to perform the context-sensitive characterization as, first of all, the units of description need to be determined in order to write rules that make use of these units.

In a nutshell, it will be shown that 1) gesture phases are describable based on a limited set of articulatory features, and it is suggested that 2) changes in the execution of gesture phases due to their sequential embedding can be accounted for based on the set of these distinctive features. The paper therefore provides a first step for objectifying the nature of gesture phases as it explicates their characteristics.

With the following proposal, we wish to reconsider the categories of the various gesture phases from present-day gesture studies and arrive at an understanding and description of gesture phases that take into account their particular characteristics and structures that are independent of speech.

The first section of the paper provides a short description of how gesture phases have been determined and characterized, by tracing major descriptions

from its beginning stage to its most recent developments. In the next section, we comment on the study we conducted in order to show what articulatory characteristics are used for the depiction of the phases. We will then present a set of distinctive features of gesture phases and characterize the phases based on them. This context-independent description of gesture phases will be complemented by a context-sensitive description in the third section of the paper. Here, we exemplify two cases in which the sequential embedding of the phases in specific linear successions seems to result in a replacement of features in the particular phases. The last section will discuss advantages of the procedure presented, point out problematic aspects and give an outlook on possible extensions.

1. Description and classification of gesture phases in gesture studies

The first scholar of gesture to make the observation that bodily behavior consists of different movement phases or states was Kendon (1972a) in his paper "Some relationship between body motion and speech." In this pioneering article, Kendon examined various types of bodily movements, and showed that "the pattern of movement that co-occurs with the speech has a hierarchic organization which appears to match that of the speech units" (Kendon 1972a: 190). This aspect was further developed in his 1980 article, which particularly addressed the close relationship of gesture and speech as "the same process of utterance" (Kendon 1980: 208). While the focus in 1972 was on different levels of body movements, such as shifting the trunk, legs and head, and hands and arms, the 1980 paper focused solely on the description of "gesticulation," i.e., movements of the hands and arms, and aimed at a characterization of the structure of gesticulation. The paper addresses the phrasal structure of gestures alone, and provides a classification of the various movement phases that can be observed in gesturing and accounts for the organization of gestural movements with respect to building higher-level units.

Regarding the phrasal structure of gestures, Kendon identifies six different phases observable in the execution of gestural movements, i.e., rest position, preparation, stroke, hold, retraction/*recovery*, and *partial recovery* (see Table 2 for more detail). In addition to the gesture phases, Kendon introduces the concepts of the gesticular phrase and the gesticular unit (Kendon 1980: 212).

In his papers, Kendon shows that gesticulation has a structure of its own, meaning that separate phases of its execution are observable and describable. Moreover, he provides the terms needed for a closer description and analysis of gestural movement patterns. His work marks the beginning of the coding of gesture phases in gesture research, and sets the stage for further accounts of

gestural movement patterns. Following distinctions refer implicitly or explicitly to Kendon's differentiations.

Later contributions on gesture phases focus in particular on specific types of gesture phases. In this manner, Kita, van Gijn, and van der Hulst (1998)[3] classify holds further and point out that a stroke can a) be preceded by a hold, a so called pre-stroke hold or b) be followed by a hold, a so called post-stroke hold. This differentiation is grounded in the functions of these two types of holds with respect to speech. Whereas a pre-stroke hold "is a period in which the gesture waits for speech to establish cohesion, so that the stroke co-occurs with the co-expressive portion of speech" (Kita, van Gijn and van der Hulst 1998: 26), a post-stroke hold is "a way to temporally extend a single movement stroke so that the stroke and post-stroke-hold together will synchronize with the co-expressive portion of speech" (Kita, van Gijn and van der Hulst 1998: 26). Furthermore, Kita, van Gijn & van der Hulst distinguish between "*independent* holds," i.e., holds that can stand by themselves and be a "gestural expression" on their own and "*dependent* holds," which flank a stroke and are "parasitic to the stroke" because "they arise from the semiotic coordination or modification of the expression in the stroke" (Kita, van Gijn and van der Hulst 1998: 28). This functional specification of holds is currently almost omnipresent in analyses focusing on coverbal gestures (see for example Queck et al. 2002; Gullberg and Holmquist 2006; Kendon 2004; Kettebekov and Sharma 2001; McNeill 2005, in press; Parrill 2001; Sowa 2006) and has been a major contribution to the discussion of gesture phases (see also Duncan n.d. for further investigations on the hold).

A new turn in the identification of gesture phases is initiated with the segmentation method of the "frame-by-frame marking procedure" introduced by Seyfeddinipur (2006: 105). Former accounts of gesture phases have usually focused on the definition of gestures phases and their function in relation to speech (cf. Kita 1990; Duncan n.d.). Questions on how to segment sequences of gestural movements or questions on how to identify the particular phases were usually put aside. Although Kita, van Gijn, and van der Hulst (1998) addressed the segmentation of movement phases, an actual procedure of how to determine "onsets and offsets of gesture phases" (Seyfeddinipur 2006: 105) has long been missing.

Seyfeddinipur's "frame-by-frame marking procedure" aims exactly at these questions of the identification and coding of gesture phases. It introduces a methodological approach to the identification of movement phases and establishes "unambiguous coding criteria for obtaining consistent and frame-accurate times of gesture phases" (Seyfeddinipur 2006: 105). For this purpose, Seyfeddinipur takes advantage of an artifact of videos, namely, the sharpness of a video image in which the execution of movement becomes apparent in blurry and clear images. Using this artifact, Seyfeddinipur tells apart three

Table 1. *Selective overview of existing differentiations of gesture phases*

	Kendon (1980: 212)	Kita, van Gijn and van der Hulst (1998: 26, 29)	Duncan (n.d.)	McNeill (2005: 31)	Seyfeddinipur (2006)
rest position	"moment when the limb is in rest"	"part of the body or the furniture where the hands can be supported" "position where the self-adapting body movements take place"			"static position, e.g., on the lap, arm rests, arms are folded in front of the chest"
preparation	"a phase in which the limb moves away from its rest position to a position at which the stroke begins"	"non-stroke phase that departs form the resting position" (includes location preparation, hand internal preparation, liberating movement)		"the limb moves away from the rest position into the gesture space where it can begin the stroke"	
interrupted preparation/ stroke					"a dynamic phases abruptly ended and the abruptness was not part of the depiction"
pre-stroke hold		"a period in which the gesture waits for speech to establish cohesion so that the stroke co-occurs with the co-expressive portion of speech"		"a temporary cessation of movement before the stroke"	

stroke	"excursionary movement in which the limb shows a distinct peaking of effort"	"phase in which more force is excerted than in neighboring phases"	"interval of apparent gestural effort"	"gesture phase with meaning; it is also the phase with effort"	"phase which appeared to display the meaning of a gesture"
post-stroke hold		"a way to temporally extend a single movement stroke so that the stroke and post stroke hold together will synchronize with the co-expressive portion of speech"		"hand freezes in midair before starting a retraction, thereby maintaining the stroke's final position and posture"	
stroke hold				"such movements are strokes in the sense of meaning and effort but occur with motionless hands"	
hold	"the hand is held still in the position it reached at the end of the stroke"	"phase in which the hand is held still" (includes pre- and post-stroke hold)	"full hold," "virtual hold"		"when the hand/s were held in a static position other than the rest position"
full hold			"no detectable movement		
virtual hold			"some movement but maintenance of hand shape and/or general location in gesture space"		

Table 1. (*Continued*)

	Kendon (1980: 212)	Kita, van Gijn and van der Hulst (1998: 26, 29)	Duncan (n.d.)	McNeill (2005: 31)	Seyfeddinipur (2006)
partial retraction	"phase in which the hand does not return all the way to the position it was in"	"interrupted retraction"		"the hands return to rest"	"hands move towards a potential rest position (e.g., the lap), but came to a hold before the rest position was reached, thus resting in an intermediate position"
retraction	"phase in which the limb is either moved back to its rest position or is readied for another stroke"	"a non-stroke phase that arrives at rest position"			

types of transitions in the execution of gestural movement sequences: 1) "transition from a dynamic to a static phase," 2) "transition from a static to a dynamic phase," and 3) the "transition from a dynamic to a dynamic phase" (Seyfeddinipur 2006: 105). These types of transitions are characterized by particular transition points that mark the move from one type of gestural movement phase, i.e., dynamic or static, to another. Specific successions of clear and blurry images thus represent particular sequences of gesture phases. These types of transitions therefore provide the basis for the assignment of gestural movement phases to a specific type of gesture phase.

The segmentation procedure developed by Seyfeddinipur (2006) marks a new milestone in the identification and coding of gestures. It addresses the question of how to mark boundaries of movement phases and provides a method, which allows for the differentiation and the marking of gesture phases. By using characteristics of video images, Seyfeddinipur was able to establish the basis for a detailed, more exact, and inter-individual segmentation procedure of gestural movement phases. This therefore contributes fundamentally to the practice of how to code gesture phases.

The preceding section has presented a short overview of the description and coding of gesture phases and has shown that the categories introduced by Kendon in 1980 are still valid today. Although changes in the set up of these categories have been carried out for years (cf. for instance, Kita, van Gijn, and van der Hulst 1998), the basic differentiation and characterization of gesture phases remains the same. Major modifications have predominantly been made with respect to technical aspects involved in the coding of gesture phases (cf. Seyfeddinipur 2006).

Existing work on the approach to gesture phases has so far mainly been focused on the proof that a) gestures dispose of a structure of their own, i.e., that gestural movements are characterized by the progression of specific phases, b) gesture phases are hierarchically organized and c) they coordinate with units at the speech level.

All in all, however, gestures are for the most part considered and defined by their interconnection with other gesture phases, whether preceding or following. Likewise, Kendon, for instance, defines the preparation as the "phase in which the limb moves away from its rest position to a position at which the stroke begins" (1980: 212). Furthermore, researchers only selectively focus on the phases themselves and only seldom pursue questions on their nature and possible characteristics. In a lot of cases, gesture phases are defined respectively in relation to speech:

> The approach to gesture phraseology and phaseology is *in its essence* meaning-driven. Locating the beginnings and ends of gesture phrases, or locating the gesture stroke among a movement's several phases of execution is a matter of how the phases

(movement or hold phases) coordinate, in terms of meaning, with units of the co-occurring speech, and/or with larger-scale discourse meanings currently in play. (Duncan n.d.: 7)

What we would like to contribute to existing accounts on gesture phases with this paper is a form-based perspective that detaches gestures phases from their relation to speech, their interconnection to each other and concentrates solely on possible articulatory features of gesture phases. We therefore ask the following questions: Do the phases show particular articulatory characteristics? Can one perceive articulatory characteristics in the execution of the phases that differentiate them from each other? Is it possible to identify and characterize gesture phases on the basis of such characteristics?

We therefore suggest a focus on articulatory characteristics that are visible in the execution of gesture phases and aim at their characterization on the basis of these characteristics. By taking this perspective, the approach tries to account for a characterization of gesture phases independent of the verbal modality, as well as a context-independent definition of gesture phases, i.e., without reference to adjacent phases. The paper tries to separate these varying perspectives by pursuing a form-based approach and by investigating the features and characteristics of gestures phases from a foremost context-independent perspective. More importantly, however, it turns the reader's attention to the nature of the phases themselves.

2. Describing gesture phases

In this paragraph, we introduce a context-independent description and characterization of gesture phases. In particular, the approach aims at two aspects: a) to present articulatory characteristics apparent in the execution of gestures phases and b) to characterize and define the gesture phases based on these characteristics.

By pursuing a context-independent perspective on the various gesture phases, we examine the phases detached from their position within the movement sequence, i.e., isolate each gesture phase from their adjacency to preceding or following gesture phases. This context-independent description aims at figuring out articulatory characteristics visible in the execution of the phases that can be used to define each type of gesture phase, and distinguish the different types of phases from each other.

2.1. *Study*

In order to determine the specific characteristics of the various gesture phases, a comparative analysis has been undertaken. For this, we examined ten occur-

rences of each gesture phase of ten different speakers. As our focus was on a form-based characterization of the single gesture phases, as units of description, we excluded any relation to adjacent gesture phases as well as to speech. Accordingly we arrived at the following gesture phases that were perceivable based solely on their articulatory characteristics: rest position, preparation, stroke, hold, and retraction.

The data we used for the analysis are taken from video-recorded conversations (dyadic, triadic, as well as smaller group constellations) of a parlor game, and conversations, which were not confined to a certain topic (see also Ladewig 2007, 2010, forthcoming). Furthermore, we used recordings of the German TV show *Genial Daneben* in which five comedians try to answer peculiar questions sent in by viewers. From these recordings, we chose an equal share of women and men whose gestures we examined with respect to the gesture phases. The gestures that would build the basis for the analysis were chosen randomly.

For the first step, we segmented the gestures based on the "frame-by-frame marking procedure" (Seyfeddinipur 2006, see also Section 2) into single movement phases. Using this procedure, we defined different onsets and offsets of movement phases within the flow of gestural movements (cf. Seyfeddinipur 2006: 105). Following Seyfeddinipur's segmentation procedure, we partitioned the gestural flow by marking changes in the execution of movement. Using the annotation software ELAN[4] we were able to identify static and dynamic phases from the flow of gestural movement. We then assigned the segments, which we obtained based on the "frame-by-frame marking procedure," to the different gesture phase categories.

In order to determine the distinguishing features of the gesture phases, we then analyzed the ten occurrences of each gesture phase in three separate steps. First, we looked at the instances of each gesture phase and watched them repeatedly in order to get a feeling of what kinds of observable articulatory attributes the gesture phases exhibit.

> The re-viewings permit a search for the natural usages and regularities within that process [the flow of human interaction]. The discovery of patterns leads, in time, to the clarification of unit identities within that process. The system itself, instead of an informant, provides the contrast which permits decisions. Analysis proceeds over time and is cumulative, with each bit of new evidence supporting previous findings and providing clues about further patterns. (Condon and Ogston 1967: 223)

Using this discovery procedure, we noted down striking articulatory characteristics in the appearance of the different phases, which we observed while watching them. In this first step of the analysis, we did not exclude any articulatory characteristic in the phases' appearance but wrote them down without making a choice.

While watching the instances repeatedly we noticed for example that, in most cases, the hands would move upwards in a straight movement pattern during a preparation and usually straight downwards in a retraction. Only seldom did we observe a different direction (e.g., preparation downwards and retraction upwards). In these cases, the hands of the speakers were above head level. Accordingly, regarding possible articulatory features of a preparation or retraction, in this first step of the analysis, we noted straight upwards and downwards movements.

In a second step, we compared the articulatory characteristics of the gesture phases with each other and picked out similarities and differences. The goal was to find out which characteristics occurred in all of the different phases and which ones were only observable in particular phases, and to sort the characteristics into groups of possible articulatory characteristics. Coming back to the example of the preparation and retraction given above, the particularity of the straight movement upwards or downwards was sorted as a feature occurring preferably in selective phases (see Section 2.2.2. on *additional features*).

In a third step, we then classified the observed qualities into a) distinctive features and b) additional features (see below).

2.2. *Articulatory characteristics of gesture phases: A context-independent description*

Based on the study presented above, we arrived at two types of articulatory features characterizing gesture phases. In particular, we defined two sets of features: a) distinctive features and b) additional features. The set of distinctive features comprises the categories "movement" and "tension." The set of additional features consists of the categories "possible types of movement" and "flow of movement."

Although both the distinctive and additional features are based on articulatory characteristics, which are observable in the execution of the phases, the two sets of features show different distributions. The set of distinctive features compromises attributes visible in all gesture phases. Accordingly, each gesture phase realizes features from this set. However, each gesture phase shows a particular implementation of these features.

The distinctive features make up a paradigmatic set of properties. The features included in one category, as, for instance, in the category "movement," are mutually exclusive of one another and stand in opposition to each other. If a gesture phase carries one particular distinctive feature, it cannot carry another feature from the same category. This is because the existence of one of the features results in the exclusion of the other ones from the same category. Hence, the distinctive features identify the phases as specific and differentiate

the phases from each other. Each gesture phase shows a distribution of the distinctive features that is particular for only this type of phase.

Apart from the distinctive features, we were able to identify further traits of gesture phases. Contrary to the distinctive features presented above, these additional features cannot be observed in all gesture phases. They only apply to phases that exhibit the distinctive feature "presence of movement." As these features only apply to specific phases and are not discernable in every instance of a phase that shows the feature "presence of movement," they can only be used to identify gesture phases selectively. They will be used for a further description in order to enhance the formal account of the gesture phases to be presented. Both types of articulatory features will be introduced in the following section.

2.2.1. *Distinctive features of gesture phases.* Based on the study presented above, we were able to identify two categories of distinctive features that characterize the execution of gestural movement sequences. These features are:

– *movement*
– *tension of the hand*

Movement. Probably the most prominent characteristic observable in the execution of gesture phases is the movement of the hands and arms. Gesture phases can thus be distinguished according to the presence or absence of movement. Accordingly, the category movement consists of the features:
a) *presence of movement*, [+movement], and
b) *absence of movement*, [−movement].

Tension. The category *tension* captures the tenseness of the hands during the execution of a gesture phase and aims at changes between phases of relaxation and exertion. During the execution of the different gesture phases, the hands are characterized by a variation in the occurrence and strength of tension. It is possible to observe phases in which the tension increases or decreases. At other times, the tension remains stable throughout the execution of a phase.[5]

Changes in tension of the hand can be observed from three kinds of muscular activities in different parts of the body: the volar and dorsal flexion of the fingers, the hand as well as the rotation of the arm. The volar flexion refers to the bending of the fingers towards the palm, the dorsal flexion to their extension. The hand configuration in these states of tension differs from that assumed in the default condition, which is characterized by residual muscle tension (tonus, Figure 2). In this (basic) condition, the muscles contract continuously and help maintain the body's posture. Thus, minimal tension is produced at all times.

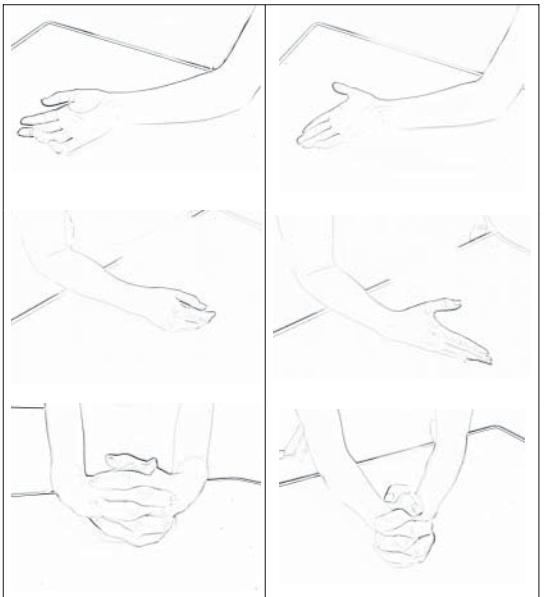

Figure 2. *Tension visible in the hand's configuration*

As tension can, among others, be observed in the flexion of the single fingers, it is self-evident that different qualities in tension are reflected in the configuration of the hand. More specifically, in the different stages of formation and deformation as well as in the stage of being fully formed.

The category "tension" shows two features:
a) *presence of tension*, [+tension], and
b) *absence of tension*, [−tension].

The feature [+tension] applies when the fingers either stretch (dorsal flexion) or bend towards the palm (volar flexion). The feature [−tension] applies when the hands are relaxed in a default condition (see above and Figure 2).

Phases showing the feature [+tension] can be sub-classified and marked by the features [+constant] and [−constant]. These features reflect transitions in tenseness, which become visible in transitions of the hand's configuration, i.e., formation, deformation or a stable hand configuration.

a) *Constant* [+constant]: In movement phases characterized by the feature [+constant] the beginning and the end of a phase does not show a difference in

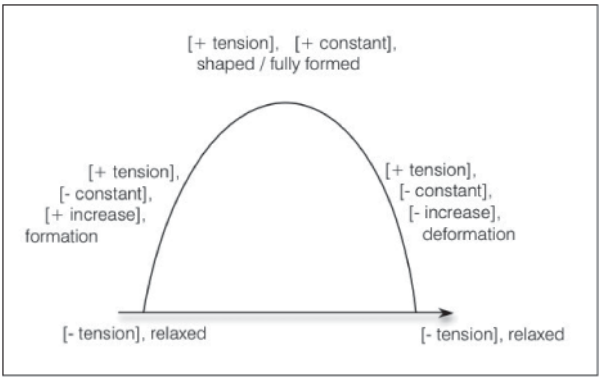

Figure 3. *Category "tension"*

tenseness. In these phases a specific hand configuration, which differs from the ones that can be taken in the default condition is maintained.

b) *Not constant* [−constant]: In movement phases characterized by the feature [−constant], the tenseness of the hand either increases or decreases. In terms of visible characteristics, the starting point of such a phase differs from the endpoint, in that the former marks the beginning of the flexion of the fingers whereas the latter marks the reaching of the full form. Accordingly, an increase is reflected in the formation of the hand's configuration. In phases identified by decreasing tension, the opposite is the case. The beginning of the phase is characterized by the hand's tenseness, whereas the endpoint exhibits a decline of tenseness. The decrease in hand tension corresponds with a deformation of the hand's configuration approximating the default condition (see also Harling and Edwards 1997; Martell 2005).

Thus phases characterized by the feature [−constant] can be further subclassified. Thus increasing tenseness, visible in the formation of a configuration, and decreasing tenseness, visible in the deformation of a configuration, are both captured by the feature pair [+-increase]. Accordingly the former is marked by [+increase], the latter by [−increase] (see Figure 3).

As has been pointed out, the features of the category "tension" become visible in the configuration of the hand, which differs from configurations that could be taken in the default condition (see Figure 2). Two different kinds of muscular activities contribute to this difference — the volar and dorsal flexion of the fingers. Accordingly, the configuration of the fingers is consulted in order to account for changes in tension.

However, in some cases it is possible to apply the feature [+tension] for which no flexion of the fingers can be observed. In these cases, tension is

reflected in the movement of the hand, i.e., the movement is anchored at the wrist, and/or arm:

a) The hand can be bended towards the pulse (volar flexion).
b) The hand can be raised towards its back (dorsal flexion).
c) The arm and thereby the hand can be rotated. Supination refers to the rotation upward, pronation to the rotation downwards.[6]

Although these cases can be observed, most of the time the flexion of the fingers goes along with a flexion and/or rotation of the hand.

With the help of these distinctive features the different movement phases identified in the "frame-by-frame marking procedure" (Seyfeddinipur 2006) can be defined as gesture phases by relying on articulatory characteristics alone. The additional features that characterize the different gesture phases more closely can enhance this formal account. These features will be elaborated in the following section.

2.2.2. *Additional features.* Dynamic gestures phases, i.e., phases characterized by the feature [+movement], show additional articulatory qualities that can be used to buttress the identification of dynamic gesture phases, and to further differentiate this class of gesture phases from each other. Accordingly, with respect to additional features of dynamic gestures phases, i.e., gesture phases carrying the feature [+movement], we distinguish two additional categories. Here, we introduce the category "type of movement" with its features [+-restricted] and the category "flow of movement" with the feature [+-variable]. Features from these two sets are used to buttress the identification of the gesture phases and provide additional articulatory attributes of dynamic gesture phases. The features subsumed in these two sets however partially differ from the distinctive features introduced in the section above. The distinctive features apply to all gesture phases and thus generally distinguish segments from each other because a segment cannot be marked as a [+movement] and a [−movement] at the same time. The additional features are only applicable to dynamic gesture phases. Accordingly, these features are not common to gesture phases in general, but rather to a subset of phases.

However, regarding the differentiation of the dynamic gesture phases, the additional features carry comparable weight as the distinctive features. For the dynamic phases themselves, they have a distinctive function as they clearly show a particular distribution across the dynamic phases and differentiate the phases from each other. The same is true for the distinctive features. The features from the two categories of the additional features are exclusive of each other, meaning that for example one phase cannot carry the features [+variable] and [−variable].

2.2.2.1. *Possible types of movement.* In the data, we found that the gesture phases vary according to the types of movement that can apply. These differences are captured by the category "types of movement" (cf. Bressem 2008). With respect to the phases characterized by the execution of movement, two features are distinguishable:

a) *Restricted* [+restricted]: Gesture phases that are restricted in their range of types of movement show either "straight" or "curved" movements. When the movement is anchored solely at the wrist, bending and raising of the hand as well as rotation can be observed.
b) *Not restricted* [−restricted]: Gesture phases that are not restrained in their range of movement can show the following: 1) "straight," 2) "curved," 3) "circle," 4) "spiral," 5) "zigzag," and 6) "s-line." Furthermore, movements of the wrist, such as "bending," "raising," and "rotation" may be performed.

2.2.2.2. *Flow of movement.* Gesture phases characterized by the execution of movement can show a variation in the quality of movement. The motion may be executed with varying force and/or a change of velocity. The category "flow of movement" captures these differences.[8] Two features are distinguished:

a) *Variable* [+variable]: The flow of movement can be described as variable if it shows some degree of variation within one movement phase: It may be accentuated, accelerated or decelerated (Bressem 2008).
b) *Not variable* [−variable]: If the flow of movement does not show any variation the feature [−variable] is applied.

The following table gives an overview of the distinctive and additional features described in this section.

Table 2. *Overview of distinctive and additional features*

distinctive features				additional features	
				possible types of movement	*flow of movement*
movement	+movement			+restricted	+variable
				−restricted	−variable
	−movement				
tension	+tension	+constant			
		−constant	+increase		
			−increase		
	−tension				

In this section, articulatory characteristics were described that were arrived at in a context-independent description. They can be used to identify and define movement phases in terms of gesture phases. A set of distinctive and a set of additional features have been determined based on the evaluated data. The set of distinctive features consisting of the categories "movement" and "tension" can be observed in all gesture phases. They are therefore used for identifying the five gesture phases rest position, preparation, stroke, hold, and retraction. The set of additional features can only be applied to such gesture phases that are characterized by the execution of movement ([+movement]). The features distinguished in the categories "types of movement" and "flow of movement" can be used to buttress the identification of gesture phases by the distinctive features.

Below the five gesture phases identified in the data are defined by using the sets of distinctive and additional features. Again the description of these phases relies only on articulatory characteristics and not on functional properties.

2.3. *Description of gesture phases*

As already mentioned in the section above, we are distinguishing five basic gesture phases, which can be identified and described based on observable articulatory characteristics. These are: 1) rest position, 2) preparation, 3) stroke, 4) hold, and 5) retraction.

Based on the category "movement," these phases can be divided into two groups: a) phases that involve the execution of movement, i.e., dynamic gesture phases and b) phases that do not show movement, i.e., static gesture phases. The following section will first describe dynamic gesture phases and then proceed to describing static gesture phases.

2.3.1. *Preparation.* The gesture phase preparation is characterized by the execution of movement. During the performance of a preparation, the tenseness of the hand increases, which is reflected in the formation of the hand's configuration. This means that the hand assumes a configuration that differs from the one that can be assumed in a default condition. Accordingly, this gesture phase is marked by the features [+movement], [−constant], and [+increasing]. The variation of the possible types of movement is restricted, meaning that only "straight" and "curved" (Bressem 2008) movements come into question, whereby the former is performed most often. If the movement is anchored merely at the wrist of the hand, the variation of movement is restricted in these cases as well: The hand can only be raised (dorsal flexion) and/or rotated (supination). Accordingly, the preparation carries the feature [+restricted]. The

Table 3. *Contrast of preparation and retraction*

Feature	Movement	possible types of movement	flow of movement	Tension	
Phase					
Preparation	[+movement]	[+restricted]	[−variable]	[−constant]	[+increase]
Retraction	[+movement]	[+restricted]	[−variable]	[−constant]	[−increase]

flow of movement does not show any variation, i.e., the feature [−variable] is applied.

2.3.2. *Retraction.* The gesture phase retraction is also characterized by the execution of movement. During the performance of a retraction the tenseness of the hand decreases and the hand's configuration is modified, insofar as its formation is resolved and approximates a default condition. Accordingly, this gesture phase is marked by the features [+movement], [−constant], and [−increasing]. The variation of the possible types of movement is restricted: only "straight" and "curved" (Bressem 2008) types of movement apply whereby the former is performed most often. If the movement is anchored solely at the wrist, the hand can only be rotated (pronation) or bent to pulse (volar flexion). The retraction thus carries the feature [+restricted]. With respect to the flow of movement, the feature [−variable] is applied.

In order to facilitate the distinction of the gesture phases preparation and retraction, the *distinctive* as well as additional features are contrasted in Table 3.

As can be seen in the table, both phases differ from each other only with respect to the category "tension." Whereas the tenseness of the hand increases during the performance of the preparation, it decreases in the implementation of a retraction, which is reflected in different formations of the hand.

2.3.3. *Stroke.* A gesture's stroke is characterized by the execution of movement. The tenseness of the hand remains stable. Accordingly, in most cases the configuration of the hand does not change. In some cases, the shape of the hand may be transformed during the performance of a stroke, e.g., a finger is raised during the execution of a circle. But as these changes occur within one movement phase and since the tension may undergo changes only in parts of the hand, the tension of the whole hand cannot be considered as resolved. Accordingly, even in these instances the tension can be regarded as constant.

The stroke is marked by the features [+movement] and [+constant]. Unlike the gesture phases characterized above, the types of movements are not

Table 4. *Contrast of preparation, stroke, and retraction*

Feature	Movement	possible types of movement	flow of movement	Tension	
Phase					
Preparation	[+movement]	[+restricted]	[−variable]	[−constant]	[+increase]
Stroke	[+movement]	[−restricted]	[+variable]	[+constant]	
Retraction	[+movement]	[+restricted]	[−variable]	[−constant]	[−increase]

Table 5. *Contrast of stroke and hold*

Feature	Movement	possible types of movement	flow of movement	Tension
Phase				
Stroke	[+movement]	[−restricted]	[+variable]	[+constant]
Hold	[−movement]			[+constant]

restricted at all. The gesture phase stroke is the only phase characterized by movement, which is not restrained in the implementation of motion patterns (see also Seyfeddinipur 2006: 106). In particular, the following six basic types of movement may be realized: 1) "straight," 2) "curved," 3) "circle," 4) "spiral," 5) "zigzag," and 6) "s-line" (Bressem 2008). Furthermore, movements anchored at the wrist, such as "bending," "raising," and "rotation" (Bressem 2008) may be performed. In addition, the movements executed during a stroke may be accentuated and/or performed with changing velocity. Thus, the stroke can be further marked as [−restricted] and in some cases as [+variable]. These features do not apply to any of the further gesture phases.[7]

As Table 4 shows, the stroke is the gesture phase among those characterized by movement in which the hand is tensed throughout the phase. Furthermore, this phase may exhibit an invariable flow of movement.

2.3.4. *Hold.* The hold is one of the gesture phases that is marked by the lack of movement and thus clearly differs from the phases characterized above. Accordingly, the feature [−movement] is applied. The hand is tensed throughout the execution of a hold, meaning that the hand's configuration is maintained. The configuration thus differs from the ones that can be assumed in the default condition, thus showing the features [+tension] and [+constant]. Sometimes a hold can show some movement, i.e., a slight drifting observable in its execution (see Duncan n.d.: 4; for a further differentiation of holds, see Tag in preparation).

Stroke and hold share one distinctive feature that is not realized in one of the remaining phases and which is essential for their identification — [+tension] that is further sub-classified by the feature [+constant].

2.3.5. *Rest position.* A rest position is also characterized by an absence of movement. The hands usually do not show any tension. This gesture phase is marked by the features [−movement, −tension]. If the hands are moved, then they either touch a part of the speaker's own body or an external object, such as a table or cup. These movements have been described as self-adaptors, object-adaptors, and fidgeting (see, e.g., Ekman and Friesen 1969, 1974, 1977; Freedman 1972; Müller 1994, 1998). Any movements that belong to the category of "self-touch" or object manipulation were not included into the description and are considered as non-gestural. Self-touching movements are movements such as scratching, hair stroking, nose rubbing, etc. Object manipulation includes holding a cup, fidgeting with a necklace or a pen, etc. In cases in which the body or object functions as reference object, we speak of "body-focused movements" (Freedman 1977) or "object-focused movements"[8] (Freedman 1977). We are aware of the fact that further research is needed to provide articulatory characteristics in order to distinguish such movements from body-focused movements or object-focused movements. However, as has been shown recently, people are able to distinguish fidgeting from gestural movements: "[S]igns, as cases of gesture, can be discriminated from other movements, in our study fidgeting, by their appearance." (Arendsen, Doorn, and Ridder 2007: 330; see also Kendon 2004).

The section above has presented the characterization of the five gesture phases rest position, preparation, stroke, hold, and retraction on the basis of distinctive as well as additional features, which are based on articulatory features observable in the execution of these phases. We have provided definitions for each phase based on these features. We discussed the distribution of the features in each gesture phase as well as across phases, presented characteristic sets of features for each type of gesture phase, and set up a feature matrix.

This characterization however constitutes an ideal depiction of the various gesture phases, meaning that we have described the phases with respect to the features they usually exhibit. These characteristics can undergo changes in particular linear sequences of gesture phases. The following section will thus present two types of sequential embeddings of the phases in specific linear successions, which result in changes of the articulatory characteristics of particular phases.

3. Articulatory characteristics of gesture phases in linear successions — a context-sensitive description

When watching people gesture, one observes that gestures and therefore gesture phases follow each other immediately. We can speak of an ideal succession of gesture phases if the speaker's hands progress from a rest position to a

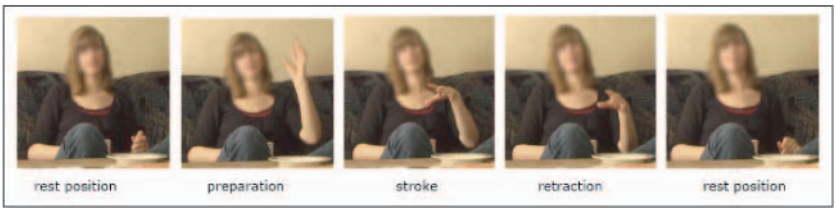

Figure 4. *Ideal succession of gesture phases*

preparation, then execute a stroke and afterwards progress via a retraction to a rest position again (see Figure 4).

However, this ideal succession of gesture phases constitutes just one possibility of how gesture phases can follow each other in order to constitute larger gestural units, such as gesture phrases or gesture units. In many cases, for example, rest positions are missing, meaning that the hand after executing a stroke or a retraction does not return to its rest position, but rather sets off in order to perform a new preparation or even a stroke. Also, preparation*s* are quite frequently missing, so that strokes follow each other immediately without exhibiting preparational phases in between.

In a lot of these instances in which the execution of gestures "deviate" from the ideal succession of gesture phases, changes in the articulatory characteristics of the phases can be observed. Due to their sequential embedding in a specific linear progression, the phases' characteristics might undergo changes. In a preparation, for example, usually characterized by the features [+movement, +tension, +increase], it is possible to observe instances in which the feature [+increase] is replaced. In other instances, differences in types of rest positions, such as hands resting in the lap or on the body of the speaker, result in changes of the foregoing retraction phase and the replacing of the feature [+decrease]. With gesture phases, in particular linear successions, it is therefore possible to observe changes in their articulatory features.

These changes resemble coarticulation phenomena in spoken language, namely, instances in which neighboring sounds influence each other in their articulation (see for example Menzerath and Lacerda 1933; Trubetzkoy 1958). Considering the similarities in the articulation process of speech and gesture, the existence of coarticulation phenomena in coverbal gestures is not surprising (cf. Fricke 2008). The same is true for speech. The articulation of coverbal gestures is a continuing process in which the separation of the individual gesture phases is not unproblematic, as the different phases seem to merge into each other.

In producing speech, the vocal organs "perform gliding fluent fading movements in which the positions for particular sounds are not realized in a downright fixed manner, but are rather aimed a relative manner" (Ternes 1999: 37,

our translation). This gliding into each other of the articulation movements brings about the influencing of sounds on one another. In the case of the German words *Kies* (gravel) and *Kuss* (kiss), for example, the pronunciation of the sound [k] differs. In the case of *Kies*, the articulation of the [k] is fronted because of the anticipation of the vowel [i:]. In the case of *Kuss*, however, the [k] is pronounced more in the back because it precedes a back vowel. However, for the treatment and especially the identification and coding of gesture phases such coarticulation phenomena pose a major problem. The difficult identifiable boundaries of the particular phases or segments are thus even catchier to perceive and manage.

By taking two particular cases in which the execution of the phases change, we would like to show that based on the articulatory characteristics introduced in this paper a context-sensitive description of phases in linear succession is possible, which shows that these changes do not show up randomly, but are rather limited to particular sequential contexts.

In order to describe changes in the features sets of the gesture phases, we will use the format of phonological rules as examined by Chomsky and Halle (1968). Phonological rules describe phonological changes in words and make general statements about the relations between sounds or types of sounds. They summarize the behavior of sounds in particular phonetic and grammatical surroundings. Chomsky and Halle (1968) distinguish between three different types of phonological rules: rules describing the insertion or deletion of a phonological segment, and rules describing changes in the value of segments. (The latter will be of interest for the context-sensitive description of gesture phases.) What is important to point out is that phonological rules do not substitute whole segments, but only individual features and are thus especially capable of capturing coarticulation phenomena.

An example for the use of phonological rules in linguistic analyses is the description of final devoicing in German. In German, the opposition between voiceless and voiced obstruents is neutralized in the final sounds of words, such as *Rad* (wheel) are pronounced in the same way as *Rat* (board or council), i.e., as /ra:t/. Written in terms of a phonological rule, final devoicing in German can be noted as follows:

$$/b\ d\ g\ v\ z\ ʒ/ \rightarrow [\ p\ t\ k\ f\ s\ ʃ]/\ \underline{\quad\quad}\#.$$

Figure 5 shows the general scheme for the notation of phonological rules. The rule of final devoicing in German reads as follows: The phonemes /b d g v z ʒ/ make up the input of the rule and [p t k f s ʃ] the output of the rule. The arrow denotes “is realized as.” The / stands for “in the context of.” The underline specifies the place where the changes takes places and the # stands for the end of a word. In sum, the rule describes the fact that the phonemes /b d g v z ʒ/ are realized as [p t k f s ʃ] at the end of a word in German.

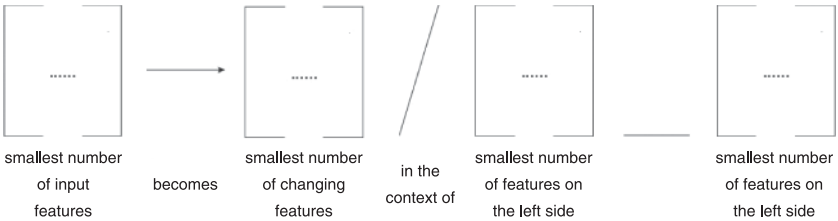

Figure 5. *General schema for the notation of phonological rules*

However, before focusing on the description of the gesture phase examples, we would like to clarify that the formulae are used solely as a tool to capture changes in the features of gesture phases, in particular linear environments. We use the formulae to describe observable phenomena in the execution of gesture phases, and do not adopt any of the implications of the theory of language associated with the use of phonological rules in generative grammar (cf. Chomsky 1993). Furthermore, we do not imply that the changes in the features are based on an underlying gesture phase feature structure. We use this notation as it is widely accepted in phonology and best captures the phenomena under investigation.

In our comparative study, we observed linear successions of gesture phases with a diverse range of modifications, meaning that the types and number of segments in which features are replaced differed. In general, we were able to distinguish linear sequences that cause replacement of features in a) one gesture phase or b) in two or more gesture phases (see Bressem in preparation). Whereas in the former, only one gesture phase shows replacement of some of its features, the latter causes replacement in the features of two or more adjacent gesture phases. In the following section, we will not discuss the second type but rather concentrate on two examples in which features of one gesture phase are replaced due to the sequential context.

3.1. *No execution of preparation*

As was mentioned in the beginning of this section, in an ideal linear succession of gesture phases (see Figure 3 above), a stroke is preceded by a preparation. Speaking in terms of the features presented, a stroke is thus usually preceded by a segment with the features [+movement, +tension, −constant, +increase, +restricted, −variable].

However, instances in which the preparation is dropped are quite common (see Kendon 1980, 2004; Kita, van Gijn, and van der Hulst 1998; McNeill 1992; Seyfeddinipur 2006). In the course of the comparative study as well as previous research on gesture phases, we particularly noted this type of

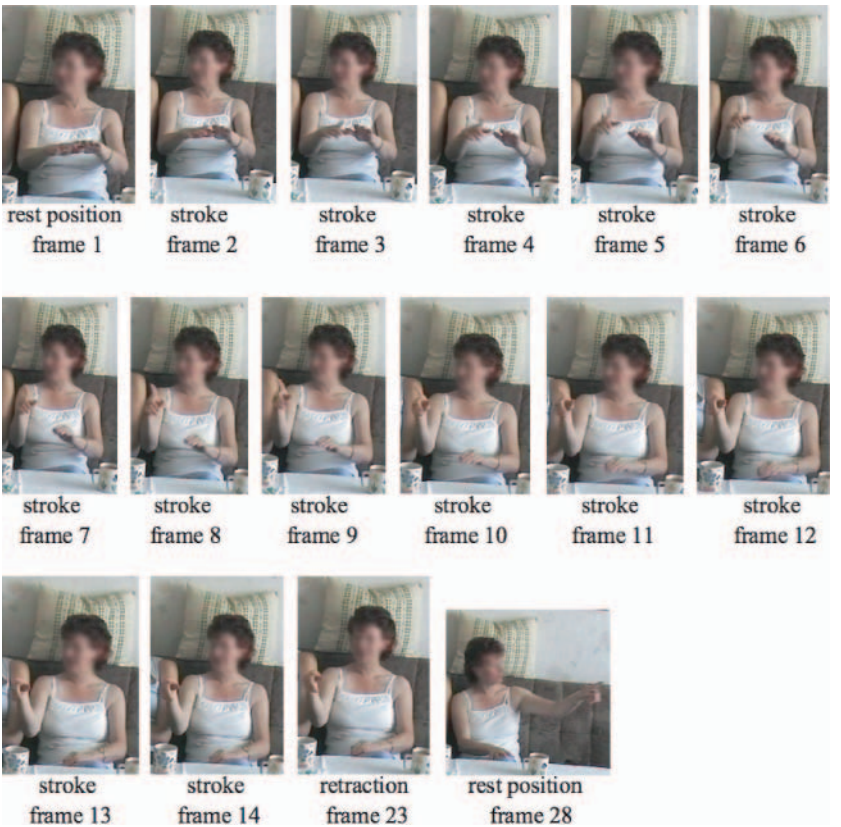

Figure 6. *Example of no preparation in the succession of gesture phases*

phenomenon for specific occurrences of deictic gestures (see Figure 6 for an example).

What is striking about these instances with respect to distinctive features of gestures phases as presented in the foregoing section, is the fact that, due to the omission of the preparation, the stroke undergoes changes in some of its distinctive features. A stroke is usually characterized by the features [+movement, +tension, +constant, −restricted, +variable] (see Table 5). A stroke in a linear succession missing a preparation may change in the category "tension" as well as in one of the additional form features.

In sequences in which no preparation is performed, as in the case of (specific) deictic gestures, the stroke must now be characterized in the following way [+movement, +tension, −constant, +increase, +restricted, +variable]. Contrary to the context-independent characterization, the stroke in successions

without a preparation is now marked [−constant] and is further specified for the feature [+increase] as well as [+restricted]. Contrary to the usual stroke, a stroke in these successions shows an increase of tension instead of the tension being constant. Also, it is restricted in the types of movements that are executable, such that mostly straight and curved movements occurred. All in all, the stroke thus now carries features that are distinctive for a different gesture phase, namely, a preparation (see Section 2.3).

The omission of the preparation thus has an impact on the following gesture phase, namely, the stroke, and leads to the replacement of particular distinctive features of that movement segment. These types of replacements have so far been observed only in successions in which the stroke is either preceded by a rest position or a retraction. So, the context in which the features of a stroke can be replaced seems to be limited.

However, although the stroke shows no distinctive features characteristic for a preparation, the stroke is still clearly identifiable as such as it is marked for the feature [+varying], a feature it does not share with any other gesture phase. So, in the instances investigated, the flow of movement executed in the stroke phase could vary. In quite a few instances, the end of the movement was accentuated (see Bressem in preparation),[9] a characteristic of movement phases that can only be found in strokes.

In order to describe the replacement of features visible in these particular instances of strokes, we will apply the format of phonological rules (cf. Hall 2000). By doing so, we are able to account for the replacement of individual features in the particular contexts that we observed. It allows us to relate the context-independent description presented in the previous section with the context-sensitive description, and lets us account for the change of gesture phase characteristics in linear successions.

The replacement of features in the stroke observed in the particular cases of missing a preparation can thus be formulated as shown in Figure 7.

What we would like the reader to bear in mind is that this description along with the rules we presented, is not meant to be universally valid in all instances of missing preparations. Rather, what we presented is the first description of one particular phenomenon visible in the execution of gesture phases of specific deictic gestures. Whether similar effects can be described for other instances in which preparational phases are omitted remains to be answered (Bressem in preparation).

3.2. *Transition from a retraction to a rest position on the speakers' body or to an action*

Another interesting example of changes in the distinctive features caused by the linear succession, in which the gesture phases are embedded, is the transi-

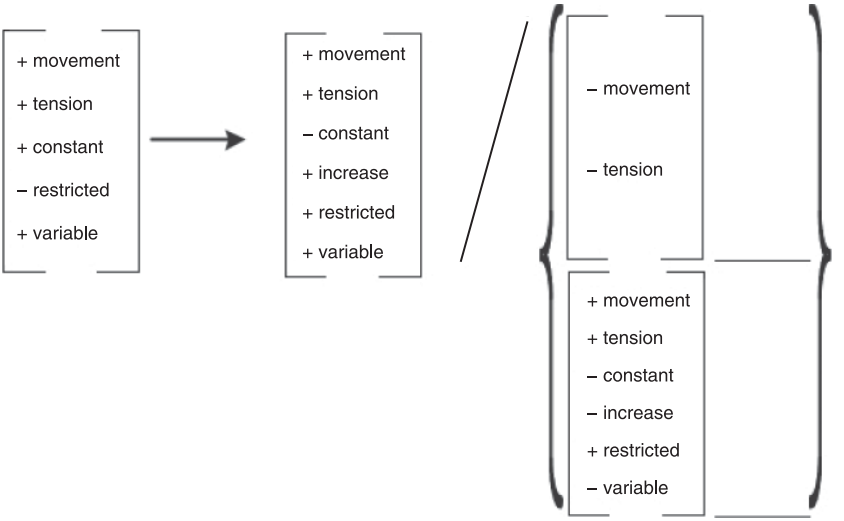

Figure 7. *Rule expressing the changes of distinctive features in the gesture phase stroke in instances of no preparation*

Figure 8. *Possible rest positions on the speaker's body*[10]

tion from a retraction to a rest position on the speaker's body or to an action. In these cases, the speaker does not bring his or her hands into a typical rest position (e.g., lap, table, see Figure 8) but rather, after executing a retraction, moves his hands into a rest position on his or her body or starts to perform actions. Examples of rest positions on the speaker's body can be seen in Figure 8. Actions that can be performed after a retraction are self-stimulating movements or taking hold of objects (see Section 2.3).

Before making further descriptions of the cases in mind, we would like to point out that the types of instances we are referring to do not include cases in which the speaker indexes to him/herself. Cases such as a deictic gesture with a stretched index finger on the chest of the speaker for example do not fall under the phenomenon presented here (see Section 2.3 for body-focused movements). We only include instances in which the retraction of the hand leads to a rest position or the performance of an action.

In these instances again, particular distinctive features of the gesture phase retraction seem to be replaced by other features. Similar to the example in which the preparation is omitted, thus causing a replacement in features of the stroke, the retraction also shows the replacement of some of its distinctive features. Usually a retraction is characterized by a decrease in tension along with a deformation of the hand's configuration and has been defined in section 2 on the basis of the distinctive features as follows: [+movement, +tension, −constant, −increase, +restricted, −variable]. However, in cases in which the hand transitions into rest positions on the body or into actions after the execution of a stroke, the feature [−constant] is replaced. The tension no longer decreases, but rather stays constant. The constant tension furthermore goes along either with the maintenance or the change of a hand's configuration. In these cases, the retraction can no longer be characterized as [+movement, +tension, −constant, −increase, +restricted, −variable] but has to be accounted for with the features [+movement, +tension, +constant, +restricted, −variable]. Accordingly, retractions in these linear successions now carry a distinctive feature that is an actual characteristic for strokes and holds, i.e., [+constant]. However, due to the marking of the feature [−variable], the movement segment cannot be mistaken as either one of the two phases and thus must be identified as a gesture phase usually characterized by changes in tension.

By means of the format of phonological rules (see Figure 9), we are once again able to capture the changes in the particular distinctive feature of retractions. Similar to the cases of a missing preparation, this format allows us to describe the observable changes in the retraction in such transitions, based on the distinctive features introduced in the foregoing sections.

In this section, we presented two cases in which the sequential embedding of the phases in specific linear successions may result in replacements of particular distinctive features. An examination of two instances has shown that the replacement of distinctive features only affects individual features and seems to depend on particular contexts.

Both cases presented thus appear to reflect the fact that the articulation of gestures, similarly to the verbal utterance, is a continuing process in which the different phases glide into each other are mutually affecting their articulation. As a result, coarticulation phenomena, such as the ones presented in this section, can be observed on the level of gesture phases. However, the kinds of

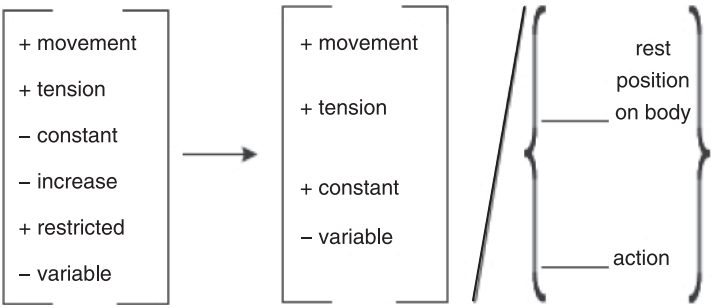

Figure 9. *Rule expressing the changes in formal features of a retraction in transitions to rest positions on the body of the speaker as well as transitions to actions*

coarticulation phenomena that come into play here cannot be answered yet and go beyond the scope of this paper. For answering questions on the direction and range of change, such as whether the cases presented here could be conceived of as examples for progressive or regressive assimilation (cf. Trubetzkoy 1958) needs further investigation. The aim of this paper was to provide a first contribution to this question, and to show that based on distinctive features defined on articulatory characteristics of gesture phases, such phenomena can be described.

4. Summary

In this paper the definition of gesture phases applied in current gesture studies has been reconsidered. A context-independent depiction of the phases preparation, stroke, hold, retraction, and rest position based on their articulatory characteristic alone, leaving functional aspects aside, was proposed.

Based on a comparative analysis of the different gesture phases, we provided two sets of features, which are based on articulatory characteristics observable in the execution of these phases, namely, distinctive features and additional features. Besides providing definitions for each of the five gestures phases based on these features, we discussed the distribution of the features in each gesture phase as well as across phases. According to this, characteristic sets of features for each type of gesture phase were presented and a feature matrix was set up. With respect to the distinctive features, two categories were proposed — "movement" and "tension." Features from these categories apply to all gesture phases but their distribution varies, i.e., each gesture phase shows a distribution of these features that is particular for only this type of gesture phase. Phases characterized by the feature marked [+tension] can be sub-

classified according to transitions in the tenseness of the hand, which become visible in transitions in the hand's configuration (feature pairs [+-constant] and [+-increasing]). Additional features only apply to dynamic gesture phases, i.e., phases characterized by the feature [+movement]. The categories that make up the set of additional features are "types of movement" and "flow of movement." The category "types of movement" shows whether the gestures phase would execute any type of motion, as for instance circle, spiral, zigzag, or straight, or whether only restricted set of movement types could be realized by a particular gesture phase (feature pair [+-restricted]). "Flow of movement" describes whether the movement could show accentuation or variation in its velocity (feature pair [+-variable]).

The features of the categories just described are mutually exclusive, meaning that if a phase, for instance, carries the feature [+movement] it cannot carry the feature [−movement]. According to these two feature sets a preparation is marked [+movement, +tension, −constant, +increasing, −variable, +restricted], a hold is marked [−movement, +tension, +constant] (see Table 4 and 5).

In the second part of the paper, it has been shown how the sequential embedding of the phases in specific linear successions results in changes of the formal characteristics of particular phases. Accordingly, it is possible to distinguish linear sequences, which systematically cause replacements of features in one gesture phase as in the cases of "no execution of a preparation" or the "transition from a retraction to a rest position on the speakers body or to an action." In order to account for these phenomena, the format of writing phonological rules (Chomsky and Halle 1968) was adapted. As the examination of these examples has revealed, it is necessary to distinguish between the description and analysis of gesture phases, i.e., a context-independent and a context-sensitive description. In the former each gesture phase is depicted on its own by means of the distinctive features and additional features. In the latter, the influence adjacent gesture phases may have on a phase is taken into account. It has been pointed out that first the units of the analysis need to be determined in the context-independent description in order to account for variations in their behavior, due to the replacement of features in a context-sensitive description.

5. Discussion

The articulatory description of gesture phases presented in this paper contributes to the ongoing research in gesture studies in several respects. It supplements existing definitions of gesture phases focusing either primarily on their relation to speech or their adjacency to preceding and following phases. By offering an articulatory description divided into a context-independent and context-sensitive section, it offers a clearer differentiation of the various levels

of analysis possible with regard to gesture phases. Considered as the first analytical step in investigating gestures' movement phases, it provides the foundation for a further characterization. It spells out the articulatory characteristics visible in the execution of gesture phases to which gesture analysts and coders may attend when segmenting and coding the phases. The present proposal therefore points out features of gesture phases that, if possibly supplemented and enhanced by further characteristics and proposals, could be used for the identification and coding of gesture phases. Accordingly, the paper contributes to the ongoing discussion of how to code gesture phases and to the comparability of gesture analyses. The application of a set of articulatory characteristics provides for a possible consistency in the coding of gesture phases as well as an agreement between different coders. Therefore, inter-rater reliability tests as well as studies on the perception of gesture phases would be possible.

By and large the approach also contributes to the discussion on questions regarding the (automatic) segmentation of gestures (e.g., Eisenstein and Randall 2004; Harling and Edwards 1997; Kettebekov and Sharma 2001; Sowa 2006) and their implementation in artificial agents.

Furthermore, by concentrating on articulatory characteristics of gesture phases, the current description may contribute to the discussion of "gesturalness" (Kendon 2004: 15), i.e., the features that gestures carry in order for them to be perceived as such. Asking with Kendon, "what are the features that an action must have for it to be treated as a gesture?" (Kendon 2004: 12), the paper may provide first answers to the question as it explicates the features that make gesture phases stand out against each other and possibly against other types of actions.

By doing so, we did not aim at stating that gesture phases are akin to speech phonemes. This might be read easily into our analysis as we exploit linguistic analyses on sound structures in mind when we conceive of gesture phases as possible bundles of distinctive features. Nonetheless, adopting a feature-based perspective for the description of gesture phases must not necessarily imply the assumption that the described gestural units resemble or are akin to units described in speech. Rather the goal was to describe gesture phases by a means of articulatory features. This was done to show that the phases can be characterized separately by particular features and bundles of features, and are perceivable and treatable as separate units of analysis. The phonological framework thus served as an apparatus for description and did not aim at an equation of the described units with linguistic units.

By providing a specification of the characteristics of gestures phases, the paper offers the possibility of perceiving and treating them as a subject of investigation, which provides the opportunity to describe patterns and structures on the level of the gesture phases themselves (see also Bressem in prep., Fricke 2008). Furthermore, it allows for a more fine-grained analysis of the interwoven

nature of linear and simultaneous aspects of speech and gestures, and for a better integration of these two modalities into a single framework.

We will now make some concluding remarks on the theoretical framework of the approach postulated in this paper. We approach the study of gestures from a linguistic-semiotic viewpoint and especially a multimodal view on grammar (Fricke 2007, 2008; Ladewig and Bressem under revision; Müller 1998, 2004; Müller, Fricke, Lausberg, Liebal in preparation). Accordingly, gesture and speech are two distinct sign systems that exhibit common and specific semiotic properties that unite and distinguish the two modalities. First studies conducted within a multimodal approach to grammar have shown apparent common structural principles for language and gesture as, for instance, proto-morphological structures in gestures (Müller 2004), the recursive embeddings of gesture phases within gesture units (Fricke 2008), and processes of grammaticalizations working in recurrent gestural forms and gestures (Ladewig and Bressem under revision). Furthermore, there seem to be points of structural integration of gestures into the syntax of speech, as gestures might function as attributes to nominal phrases (Fricke 2008) or are used in a noun or verb position within a sentence (Ladewig in preparation). Starting with the assumption that speech and gesture are two distinct systems while sharing common properties, linguistic analyses of gestures aim at discovering commonalities and overlapping characteristics as well as differences and specificities of the two modalities. The objective is not to prove linguistic structures and properties of verbal language in gestures. Rather, the use of theoretical and methodological concepts from linguistics aims at extracting similarities and differences of the two sign systems by exploring their overlapping sets. Limits of adaptability of linguistic concepts are therefore not conceived as obstacles in proving gestures to be like a language, but are rather understood as necessary limits in finding the characteristics of gestures and also of speech (see also Birdwhistell 1970).

> Suggesting a linguistic approach to the analysis of systems of communicative behavior other than languages does not mean supposing that these other systems are languages. It means, rather, adopting the *level of analysis* at which linguists operate when they approach speech and seeking for their *mode of expression.* Such an approach does assume, of course, that when people interact they make use of a repertoire of behavioral forms that they share with others and use in accordance with sets of shared rules. This does not presuppose the nature of these forms, however, nor does it presuppose the nature of their rules of patterning. These may be quite different from those that may be found in language. (Kendon 1972b: 443–444)

The linguistic approach thereby serves as a theoretical building block from which elements are selectively taken and carefully adopted in the analysis of gestures. This adaptation is always guided by the cautiousness of not imposing

linguistic structures onto gestures, which they themselves do not exhibit. Nevertheless, speaking with Pike (1967), "verbal and nonverbal activity is a unified whole, and theory and methodology should be organized to treat it as such" (Pike 1967: 26).

In doing so, a linguistic approach is a companion to present foci, such as psychological or interactional approaches, by expanding the fields of investigations and approaches in gesture studies and thereby contributing to a more thorough understanding of the medium "gesture" itself as well as the relation of speech and gesture. It allows for a different point of view on phenomena observable in gestures and a perspective of description so far missing in gestures studies.

Notes

* This paper was written within the project "Towards a grammar of gesture: Evolution, brain, and linguistic structures" which is funded by the Volkswagen foundation (see http://www.togog.org). First ideas of this gesture phase description were presented in a talk given in the research colloquium "Multimodality" at the European-University Viadrina, Frankfurt (Oder) on 18 May, 2007. The revised and final version, on which the paper is based, was presented at the MGA I on October 11th 2007. We thank Ellen Fricke for helpful comments on an earlier version of this paper and the members of the togog-group as well as the participants of the MGA I Workshop for their suggestions.

1. With the term "gesture," we refer to instances of strokes as well as strokes in concjunction with holds, i.e., gesture phrases in the sense of Kendon (1980, 2004).
2. Contrary to his proposal in 1980, Kendon excludes the phase retraction from the "gesture phrase" and defines it as being made up of the phases "preparation," "stroke," and "post-stroke hold" (Kendon, 2004: 112). Furthermore, Kendon incorporates the notion of the "post-stroke hold" and steps back from the notion of the "partial retraction" in his latest work.
3. First considerations on this topic go back to Kita (1990), where he puts forward the idea of functionally different types of holds.
4. ELAN (Eudico Linguistic Annotator) has been developed at the Max Plank Institute for Psycholinguistics in Nijmegen (see http://www.lat-mpi.eu/tools/elan/ for further information).
5. Unlike Fricke (2008), we do not include the parameter *gravitation* to describe the articulatory features of the gesture phases. According to Fricke, the amount of muscular tension "is measured by which and how many muscles of the hand and arm are executed antagonistically to gravitational force" (Fricke 2008: 158, our translation). Accordingly, the impact of gravitational force remains constant during the execution of a stroke. The antagonistic muscle movements produce constant tension and remain constantly articulated (Fricke 2008: 194). However, when using Fricke's proposed features, phenomena such as accentuated strokes (see Section 3) could not be described as gravitational force does not remain constant in these cases but changes. Concluding from this, one could reason that Fricke also uses movement and tension as the driving features to determine the gesture phases and not, as proposed, gravitational force.
6. The terms "pronation" and "supination" have been introduced into the description of sign language by Stokoe (1972) and into the study of gestures by Ott (1892), Efron (1972 [1941]), Kendon (2004), Sparhawk (1978), Sager (2005) or Weinrich (1992).

7. Attempts in gesture research at capturing the movement qualities of strokes usually refer to the "effort-shape" approach as put forward by Laban and Lawrence for the notation of dance. We are familiar with the notation and the effort and shape characteristics as well as approaches trying to characterize gestures based on them (cf. Martell 2005; Sowa 2006; Zhao 2001), but, nevertheless, refrain from using "effort-shape" terminology for the description of gesture phases. Speaking with Martell, we "do not yet accept their irreducibility. For present purposes, we see Effort and Shape as describing equivalence classes of movements. Our interest is in understanding the low-level physical aspects that make up these classes of movements" (Martell 2005: 30).
8. The terms "body-focused" and "object-focused" movements have been introduced by Freedman (1972, 1977). He defines object-focused movements as "representing behavior and body-focused movements as attention sustaining behavior" (Freedman 1977: 118). The former are executed in front of the body, depict the content of a message or the "form of what is being represented" (Freedman 1977: 121). The latter refer to movements of self-stimulation and fulfill regulating functions, as they appear to be effective adaptations "to stress, allowing for the sustained processing of thought" (Freedman 1977: 124).
9. By accentuation of movement, we understand that parts of the motion are stressed such that the movement is carried out with more force. This rise in force leads to an increase in the intensity of the movement execution. Similarly to the accent in the spoken language, in which the accent is used to stress particular segments of speech such as syllables, for instance (see for example Pompino-Marschall 1995), the accentuation of gestural movements is used to stress a particular gestural segment (see also Bressem in preparation for a more detailed discussion of accentuation patterns in gestural movement patterns).
10. We are grateful to Mathias Roloff for providing the drawings (http://www.mathiasroloff.de).

References

Arendson, Jeroen, Andrea J. van Doorn & Huib de Ridder. 2007. When and how well do people see the onset of gestures. *Gesture* 7(3). 305–342.

Birdwhistell, Ray L. 1970. *Kinesics and context*. Philadelphia: University of Pennsylvania Press.

Bohle, Ulrike. 2007. *Das Wort ergreifen — das Wort übergeben. Explorative Studie zur Rolle redebegleitender Gesten in der Organisation des Sprecherwechsels.* Berlin: Weidler Verlag.

Bressem, Jana. 2008. Characterizing gestural form features — Suggestions for a form based notational system of coverbal gestures. http://www.janabressem.de/Downloads/Bressem_notating%20gestures.pdf (accessed 1 December 2010)

Bressem, Jana (in preparation). Repetitions in gesture: Structures and cognitive aspects. Frankfurt: European-University Viadrina dissertation.

Chafai, Nicolas, Catherine Pelachaud & Pelé Danielle. 2006. Analysis of gesture expressivity modulations from cartoons animations. Paper presented at the LREC 2006 workshop on "multimodal corpora," Genova, May.

Chomsky, Noam. 1993. A minimalist program for linguistic theory. In K. Hale & S. J. Keyser (eds.), *The view from building 20*, 1–52. Cambridge: MIT Press.

Chomky, Noam & Morris Halle. 1968. *The sound pattern of English.* New York: Harper and Row.

Condon, William S. & William D. Ogston. 1967. A segmentation of behavior. *Journal of Psychiatric Research* 51. 221–235.

Duncan, S. D. n. d. Coding "manual." http://mcneilllab.uchicago.edu/pdfs/Coding_Manual.pdf (accessed 29 November 2010).

Efron, D. 1972 (1941). *Gesture, race, and culture*. Paris & The Hague: Mouton.

Eisenstein, Jacob & Davis Randall. 2004. Visual and linguistic information in gesture classification. In *Proceedings of the sixth international conference on multimodal interfaces*, 113–120. New York: ACM.

Ekman, Paul & Wallace Friesen. 1969. The repertoire of nonverbal behavior: Categories, origins, usage, and coding. *Semiotica* 1. 49–98.

Ekman, Paul & Wallace Friesen. 1974. Detecting deception from the body or face. *Journal of Personality and Social Psychology* 29. 288–298.

Ekman, Paul & Wallace Friesen. 1977. Hand movements. *Journal of Communication* 22. 353–374.

Freedman, Norbert. 1972. The analysis of movement behavior during the clinical interview. In Aron Wolfe Siegman & Benjamin Pope (eds.), *Studies in dyadic communication*, 153–175. New York: Pergamon.

Freedman, Norbert. 1977. Hands, words, and mind: On the structuralization of body movements during discourse and the capacity for verbal representation. In Norbert Freedman & Stanley Grand (eds.), *Communicative structures and psychic structures*, 109–132. New York: Plenum.

Fricke, Ellen. 2007. *Origo, Geste und Raum: Lokaldeixis im Deutschen*. Berlin & New York: Mouton de Gruyter.

Fricke, Ellen. 2008. Grundlagen einer multimodalen Grammatik des Deutschen: Syntaktische Strukturen und Funktionen. Unpublished Habilitationsschrift, Europa-Universität Viadrina Frankfurt (Oder).

Gullberg, Marianne & Kenneth Holmquist. 2006. What speakers do and what addresses look at: Visual attention to gestures in human interaction live and on video. *Pragmatics & Cognition* 14(1). 53–82.

Hall, Alan T. 2000. *Phonologie: Eine Einführung*. Berlin & New York: Walter de Gruyter.

Harling, Phillip & Alistair D. N. Edwards. 1997. Hand tension as a gesture segmentation cue. In *Progress in gestural interaction: Proceedings of gesture workshop 1996*, University of York, 19 March, 1996, 75–88. London: Springer Verlag.

Kahol, Kanav, Priyamvada Tripathi & Sethuraman Panchanathan. 2004. Automated gesture segmentation from dance sequences. In *Proceedings of the IEEE international conference on automatic face and gesture recognition*. http://www.public.asu.edu/~kkahol/publications/kanavfandgesture2004.pdf (accessed 29 November 2010).

Kendon, Adam. 1972a. Some relationship between body motion and speech. In Aaron Siegman & Benjamin Pope (eds.), *Studies in dyadic communication*, 177–216. Elmsford: Pergamon Press.

Kendon, Adam. 1972b. Review of kinesics and context. *American Journal of Psychology* 85. 441–456.

Kendon, Adam. 1980. Gesture and speech: Two aspects of the process of utterance. In Mary R. Key (ed.), *Nonverbal communication and language*, 207–227. The Hague: Mouton.

Kendon, Adam. 1996. An agenda for gesture studies. *Semiotic Review of Books* 7(3). 8–12.

Kendon, Adam. 2004. *Gesture: Visible action as utterance*. Cambridge: Cambridge University Press.

Kettebekov, Sanshzar & Rajeev Sharma. 2001. Toward natural gesture/speech control of a large display. In R. Little & Laurence Nigay (eds.), *Engineering for human-computer interaction*, 221–234. Heidelberg: Springer Verlag.

Kita, Sotaro. 1990. *The temporal relationship between gesture and speech: A study of Japanese-English bilinguals*. Chicago: University of Chicago master's thesis.

Kita, Sotaro, Ingeborg van Gijn & Harry van der Hulst. 1998. Movement phases in signs and co speech gestures and their transcription by human encoders. In Ipke Wachsmuth & Martin Fröhlich (eds.), *Gesture and sign language in human-computer interaction*, 23–35. Berlin: Springer.

Ladewig, Silva H. 2007. The cyclic gesture and its variants — a new gesture family? Unpublished manuscript.

Ladewig, Silva H. 2010. Beschreiben, auffordern und suchen — Varianten einer rekurrenten Geste. *Zeitschrift für Sprache und Literatur* 41(1). 89–111.

Ladewig, Silva H. in press. Putting a recurrent gesture on a cognitive basis. *CogniTextes*.

Ladewig, Silva H. in preparation. *Syntactic and semantic integration of gestures into speech: Structural, cognitive and conceptual aspects*. Frankfurt: European-University Viadrina dissertation.

Ladewig, Silva H. & Jana Bressem. under revision. Discovering structures in gestures based on the four parameters of sign language.

Latoschik, Marc Erich. 2000. *Multimodale Interaktion in virtueller Realität am Beispiel der virtuellen Konstruktion*. Bielefeld: Universität Bielefeld dissertation.

Loehr, Dan. 2006. *Gesture and intonation*. Washington: Georgetown University dissertation.

Martell, Craig. 2005. *FORM: An experiment in the annotation of the kinematics of gesture*. Philadelphia: University of Pennsylvania Dissertation.

Martell, Craig & Joshua Kroll. 2007. Corpus-based gesture analysis: An extension of the FORM dataset for the automatic detection of phases in gesture. *International Journal of Semantic Computing* 1(4). 521–536.

McClave, Evelyn. 1991. *Intonation and gesture*. Washington: Georgetown University dissertation.

McNeill, David. 1992. *Hand and mind*. Chicago: Chicago University Press.

McNeill, David. 2005. *Gesture and thought*. Chicago: Chicago University Press.

McNeill, David. in press. Gesture and thought. In C. Patrick Hogan (ed.), *Cambridge encyclopedia of the language sciences*.

Menzerath, Paul & Antonio de Lacerda. 1933. *Koartikulation, Steuerung und Lautabgrenzung*. Berlin & Bonn: Ferd. Dümmlers Verlag.

Müller, Cornelia. 1994. Cómo se llama . . . ? Kommunikative Funktionen des Gestikulierens in Wortsuchen. In Peter-Paul König & Helmut Wiegers (eds.), *Satz — Text — Dikurs*, 71–80. Tübingen: Niemeyer.

Müller, Cornelia. 1998. *Redebegleitende Gesten. Kulturgeschichte — Theorie — Sprachvergleich*. Berlin: Berlin Verlag.

Müller, Cornelia. 2004. Forms and uses of the palm up open hand: A case of a gesture family? In Cornelia Müller & Roland Posner (eds.), *Semantics and pragmatics of everyday gestures: Proceedings of the Berlin conference April 1998*, 233–256. Berlin: Berlin Verlag.

Müller, Cornelia, Lausberg Hedda, Liebal Katja & Ellen Fricke (in preparation). Gestural modes of representation or how hands turn into gestures: Semiotic structures, neurological foundations, and evolutionary implications.

Nobe, Shuichi. 2000. Where do *most* spontaneous representational gestures actually occur with respect to speech? In David McNeill (ed.), *Language and gesture*, 186–198. Cambridge: Cambridge University Press.

Ott, Edward Amherst. 1892. *How to gesture*. New York: Hinds & Noble.

Parill, Fey. 2001. Hand to mouth: Linking spontaneous gesture and aspect. Unpublished Berkeley: University of Berkeley dissertation.

Pike, K. 1967. *Language in relation to a unified theory of the structure of human behavior*. The Hague: Mouton.

Pompino-Marschall, Bernd. 1995. *Einführung in die Phonetik*. Berlin & New York: Walter de Gruyter.

Queck, Francis, David McNeill, Robert Bryll, Susan Duncan, Xing-Feng Ma, Cemil Kirbas, Karl E. McCullough & Rashid Ansari. 2002. Multimodal human discourse: Gesture and speech. *ACM Transactions on Computer-Human Interaction* 9(3). 171–193.

Sager, Sven F. 2005. Ein System zur Beschreibung von Gestik. *Osnabrücker Beiträge zur Sprachtheorie (OBST)* 70. 19–47.

Seyfeddinipur, Mandana. 2006. *Disfluency: Interrupting speech and gesture* (MPI Series in Psycholinguistics 39). Nimegen: University of Nijmegen.
Sowa, Timo. 2006. *Understanding coverbal iconic gestures in object shape descriptions*. Berlin: Akademische Verlagsgesellschaft Aka GmbH. Berlin.
Sparhawk, Carol. 1978. Contrastive-identificational features of Persian gesture. *Semiotica* 24(1/2). 49–86.
Stokoe, W. C. 1972. *Semiotics and human sign language*. The Hague & Paris: Mouton.
Tag, Susanne. in preparation. Retractions, holds and rest positions: Three gesture phases under examination.
Ternes, Elmar. 1999. *Einführung in die Phonologie.* Darmstadt: Wissenschaft-liche Buchgesellschaft.
Trubetzkoy, Nikolai. S. 1958. *Grundzüge der Phonologie*. Göttingen: Vandenhoeck & Ruprecht.
Webb, Rebecca. 1996. *Linguistic features of metaphoric gestures*. Rochester: University of Rochester dissertation.
Wilson, Andrew D., Aaron Bobick & Justine Cassell. 1997. Temporal classification of natural gesture and application to video coding. *IEEE computer society conference on computer vision and pattern recognition*, 17–19. 948–954.
Weinrich, Lotte. 1992. *Verbale und nonverbale Strategien in Fernsehgesprächen. Eine explorative Studie.* Tübingen: Niemeyer.
Yassinik, Yelena, Margret Renwick & Stefanie Shattuck-Hufnagel. 2004. The timing of speech accompanying gestures with respect to prosody. http://www.rle.mit.edu/soundtosense/conference/pdfs/fulltext/Friday%20Posters/FA-Yasinnik-STS-MAC.pdf (29 November 2010)
Zhao, Liwei. 2001. Synthesis and acquisition of Laban movement analysis qualitative parameters for communicative gestures. Philadelphia: University of Pennsylvania dissertation.

Jana Bressem (b. 1979) is a research assistant at European University Viadrina <research@janabressem.de>. Her research interests include descriptions and analyses of gestures from a linguistic-semiotic point of view both in human and non-human primates.

Silva H. Ladewig (b. 1978) is a research assistant at European University Viadrina <sladewig@cgest.de>. Her research interests include descriptions and analyses of gestures from a linguistic-semiotic as well as a cognitive-linguistic view point.