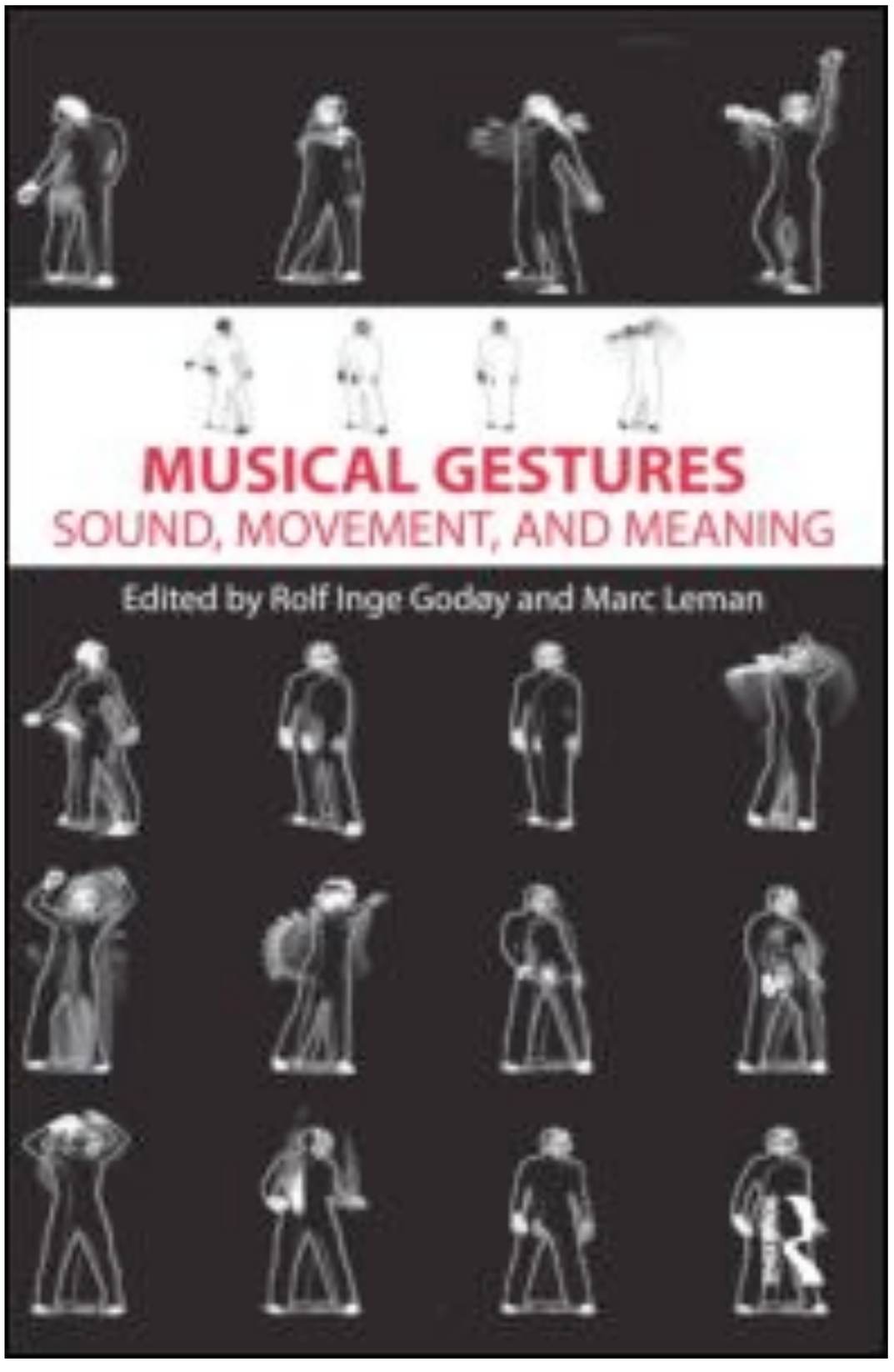

MUSICAL GESTURES
SOUND, MOVEMENT, AND MEANING
Edited by Rolf Inge Godøy and Marc Leman

Musical Gestures: Sound, Music, and Meaning

- En bok om kroppsbevegelser og musikk
- Grunntanken i boka: Musikk = lyd + kroppsbevegelse (både synlige og usynlige)
- På engelsk blir ‘gesture’ ofte brukt der vi på norsk ville brukt ‘bevegelse’, f.eks. ‘gesture control’ vil vi gjerne oversette med ‘bevegelsesstyring’
- ‘Gesture’ har også mange betydninger på engelsk (noe som drøftes inngående i boka), men på norsk kan vi stort sett greie oss med ‘bevegelse’, eller mer presist i vår sammenheng, ‘kroppsbevegelse’

Musical Gestures: Sound, Music, and Meaning

- Delresultat av EU-prosjektet *ConGAS*, *Gesture Controlled Audio Systems*, 2004-2007
- Men også delresultat av NFR-UiO prosjektet *Musical Gestures*, 2004-2007
- Og arbeidet fortsetter:
- Nytt EU-prosjekt, *SID*, *Sonic Interaction Design, 2008-2011*
- Nytt NFR-UiO-prosjekt *SMA*, *Sensing Music-Related Actions*, 2008-2012
- Også: NFR-UiO-prosjektet *Music, Motion, and Emotion*, 2009-2012

Musical Gestures: Sound, Music, and Meaning

- Målsetting: Kartlegge og beskrive forskjellige musikk-relaterte kroppsbevegelser
- Bedre vår forståelse av sammenhengene mellom lyd og kroppsbevegelse i musikkopplevelsen
- Belyse ulike funksjoner til kroppsbevegelser i musikk
- Belyse dette fra forskjellige fagfelt, og boka er utpreget tverrfaglig
- Vise både teoretiske og praktiske anvendelser av kunnskap om musikk og kroppsbevegelser

Mange slags kroppsbevegelser til musikk

- Frambringe lyder
- Endre på lyder
- Hjelpe til i lydframbringelsen
- Hjelpe til i utforming/tolking
- Kommunisere med medmusikanter
- Gjøre inntrykk på publikum (og på seg selv)
- Danse, gå, marsjere, arbeide, mime, leke
- Nyte, helbrede, lære
- Ofte flere ting på en gang:

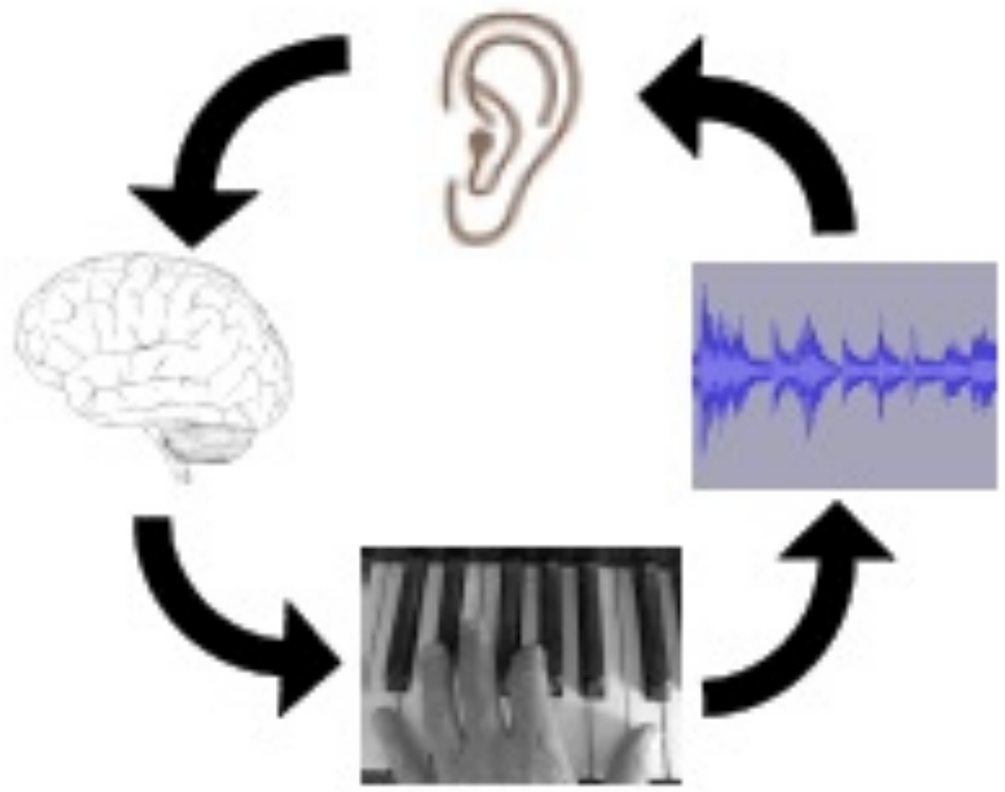
Utfordringer i arbeidet med boka

- Få en enighet om kategorier og terminologi innen feltet (håp om å unngå gjentatte misforståelser)
- Gi en oversikt over aktuell or tidligere forskning på musikk og bevegelse
- Gi en så vidt mulig god forståelse av sammenhenger mellom lyd, bevegelse og mening
- Vise mulige veier videre i denne forskningen

Utfordringer i arbeidet med boka

- Tverrfaglighet: Presentere innsikter fra mange forskjellige fagfelt
- Integrering: Vise sammenhenger mellom fagområdene og tilnærmingene
- Tilgjengelighet: Tekster med minst mulig fagterminologi/begreper, og gjøre boka tilgjengelig for mange lesere, dvs. musikere, dansere, koreografer, regissører, ingeniører, musikkforskere, psykologer, bevegelsesforskere, og andre interesserte

Sammendrag av boka:



Dette går igjen i de fleste kapitlene i boka:

Chapter 1

Why Study Musical Gestures?

Marc Leman and Rolf Inge Godøy

Chapter 1:

- People seem to be making gestures to music everywhere
- Musical gestures as an expression of a profound engagement with music, and as an expression of a fundamental connection that exists between music and movement
- We believe that musical experience is inseparable from the sensations of movement, and hence, that studying these gestures, what we call musical gestures, ought to be a high priority task in music research

Chapter 1:

- Studying musical gestures is not something new
- However, in contrast with these earlier and often more philosophical studies, we believe that it is now a favorable moment in time to make more systematic studies of musical gestures
  - First and foremost, we now have at our disposal technologies that allow us to study musical gestures with great detail and precision
  - Second, we now see the emergence of a conceptual apparatus that is more attuned to the primordial role of gestures and movement in human perception and cognition in general

Chapter 1:

- However: ‘Gesture’ is an often-used word, and it has quite diverse connotations
- ‘Gesture’ in contexts such as linguistics, psychology, anthropology, aesthetics, musicology, and human–computer interaction
- ‘Gesture’ also denotes semantic action or deeds such as in “making a gesture of goodwill” by doing someone a favor.
- Thus, the multiple uses of the word ‘gesture’ is both a problem and something valuable: it is a testimony to the importance of movement for the human mind

Chapter 1:

- Research on gesture:
- Many different approaches are legitimate and welcome
- Qualitative and quantitative: not necessarily conflict, rather complementarity
- Introspective approaches
- Qualitative observational approaches
- Quantitative observational approaches
- Experimental approaches
- Modeling and simulation approaches

Chapter 1:

- “A straightforward definition of gesture is that it is a movement of part of the body, for example a hand or the head, to express an idea or meaning.” p. 5
- Primary focus: on extension, namely the human body and its movement in space
- Secondary focus is on intention, namely that which is imagined or anticipated
- Gesture as body movement in music, e.g. producing sound, accompanying sound, etc.
- But gesture also as mental images, as that we can’t see
- Hence, ‘sonic gestures’ = perceived movement in the sound

Chapter 1:

- Gesture as a category of our perception–action system
- Body schema and body image
- But what is the difference between ‘gesture’ and other kinds of body movement? (for instance, between waving goodbye and waving away an insect?)
- Gestures must be understood in socio-cultural contexts
- The study of musical gestures should then ideally include the whole spectrum: the physics of movement, biomechanics, motor control, acoustics, perception, psychology, social sciences, music technology, computer science, in short, very many subjects

Chapter 2

Musical Gestures

Concepts and Methods in Research

Alexander Refsum Jensenius, Marcelo M. Wanderley, Rolf Inge Godøy, and Marc Leman

Chapter 2:

- Aim of chapter: to give an overview of different notions of gesture in various research and different research methods
- Notable change of paradigm in the cognitive sciences (psychology, computer science, social sciences) with so-called ecological psychology and embodied cognition. Basic ideas:
- *Our senses and minds adapted to the environment*
- *Perception and thinking related to the body and body movement*

Chapter 2:

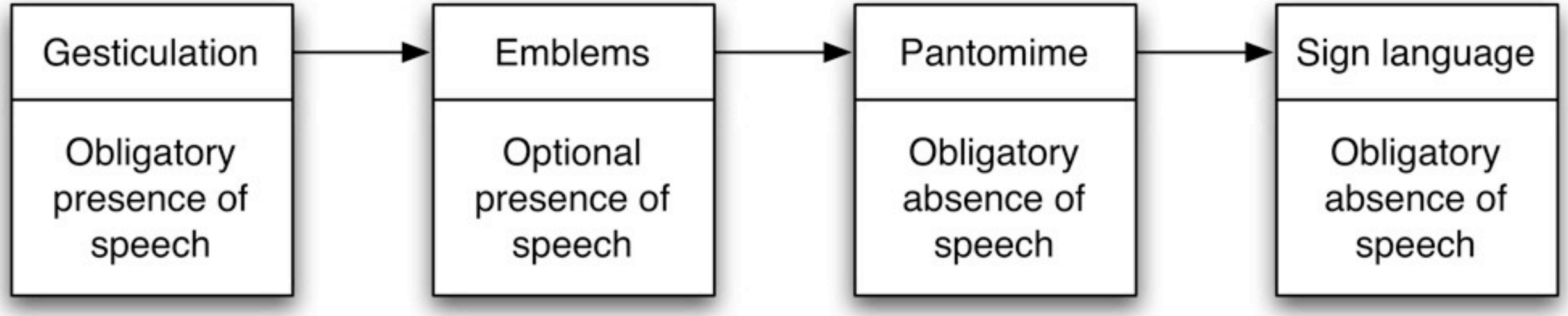
- Different types of gestures:
- *Sound-producing gestures*
- *Sound-accompanying gestures*
- Important to note: any gesture may have multiple functions
- ‘movement’, ‘action’, ‘gesture’: we have to consider the intention of what people do when we discuss these terms

Chapter 2:

- *Communication* is involved when gestures work as vehicles of meaning in social interaction
- *Control* is involved when gestures work as elements of a system, such as in the control of computational and interactive systems
- *Metaphor* is involved when gestures work as concepts that project physical movement, sound, or other types of perception to cultural topics
- The term ‘gesture’ is used in various fields, in particular linguistics and computer science

Chapter 2:

- Gesture as communication, following McNeill:
- *Iconics*: feature of an object
- *Metaphorics*: an abstract feature of an object
- *Beats*: stressing words
- *Deictics*: pointing in space
- *Emblems*: patterns with agreed meaning
- Spoken language and body gestures (primarily hand gestures) often inseparable and may be linked in evolution as well


Gesticulation
Obligatory presence of speech
Emblems
Optional presence of speech
Pantomime
Obligatory absence of speech
Sign language
Obligatory absence of speech

Chapter 2:

- Gesture for control
- In human computer interaction (HCI)
- In new musical instruments
- Gestures with some instrument contact
- Gestures without instrument contact, “empty handed gestures”
- Gestures with or without energy transfer
- Gestures with or without haptic feedback

Chapter 2:

- Gesture as metaphor
- Mental images of gestures that are not really there, projecting gestures onto music we hear
- But: well-founded motor schemas at work in music perception based on massive experiences of sound-action relationships
- But: do gestures have to be intentional in order to be perceived as meaningful?
- Probably, we perceive much more than that which is consciously intended by other people

Chapter 2:

- Terminological considerations:
- Considering the various uses of not only ‘gesture’ but also of ‘movement’ and ‘action’, the best solution seems to be to add qualifications, that is to say ‘gesture’ + some other term(s), thus:
- Sound-producing gestures
- Sound-accompanying gestures
- + further differentiations of these

Chapter 2:

- Concepts for Studying Musical Gestures
- "The subjective phenomenological level focuses on the descriptive aspects of gestures, such as describing a gesture in terms of its *cinematic* (e.g. the speed), *spatial* (the amount of space), and *temporal* dimensions (e.g. frequency range)." p. 19
- Performance spaces, or a personal space. Laban's term *kinesphere*
- In general: consider the geometry of the gesture space as well as the musical correlations of this

Performance scene
(a)

Home position
(b)

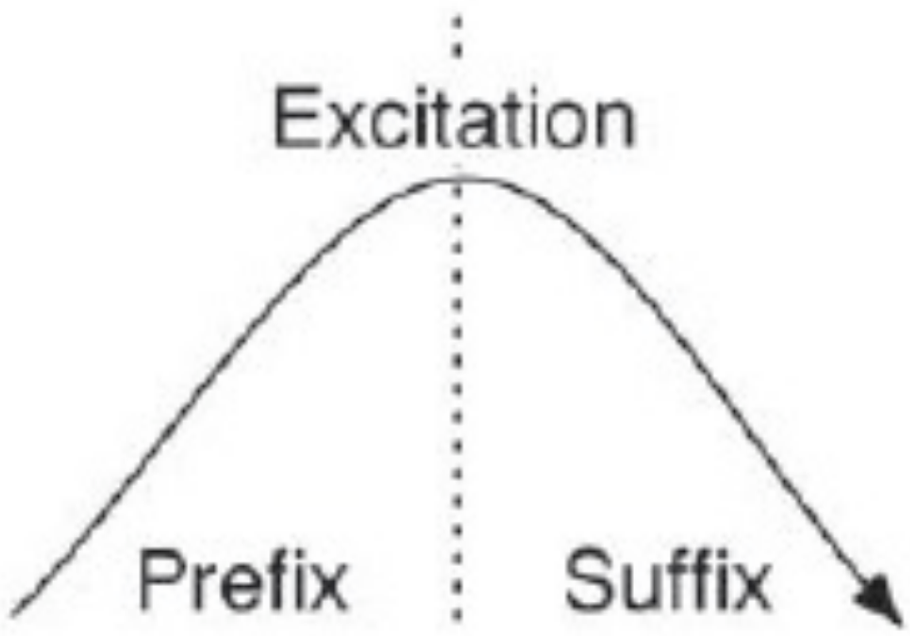
Start position
(c)

Performance position
(d)

Figure 2.2 The *performance scene* (a) is the imagined area in which performance can happen. The *home position* (b) is the position where the musician is sitting (or standing) at ease before starting to perform. The *start position* (c) is where the performance starts, and the *performance position* (d) is the position(s) of the musician during performance.

Chapter 2:

- Also consider the shape of gestures
- Very many different shapes possible, but one main phenomenon is that of starting at some equilibrium, moving outwards towards a goal, and then back again to an equilibrium:


Excitation
Prefix
Suffix

Chapter 2:

- Functional aspects of musical gestures:
- *Sound-producing* gestures: *excitatory* and *modulatory* + *selection*
- *Communicative* gestures: with fellow musicians and with the audience
- *Sound-facilitating* gestures: *support*, *phrasing*, and *entrained*
- *Sound-accompanying* gestures: dancing, moving, tracing, gesticulating

Chapter 2:

- Methods for Studying Musical Gestures
- Observation and/or introspection
- Qualitative and/or quantitative methods
- Motion capture
- Processing and representation
- Simulations and/or animations
- Annotation and interpretation
- Conclusion: gestures are multifunctional

Chapter 3

Gestures in Performance

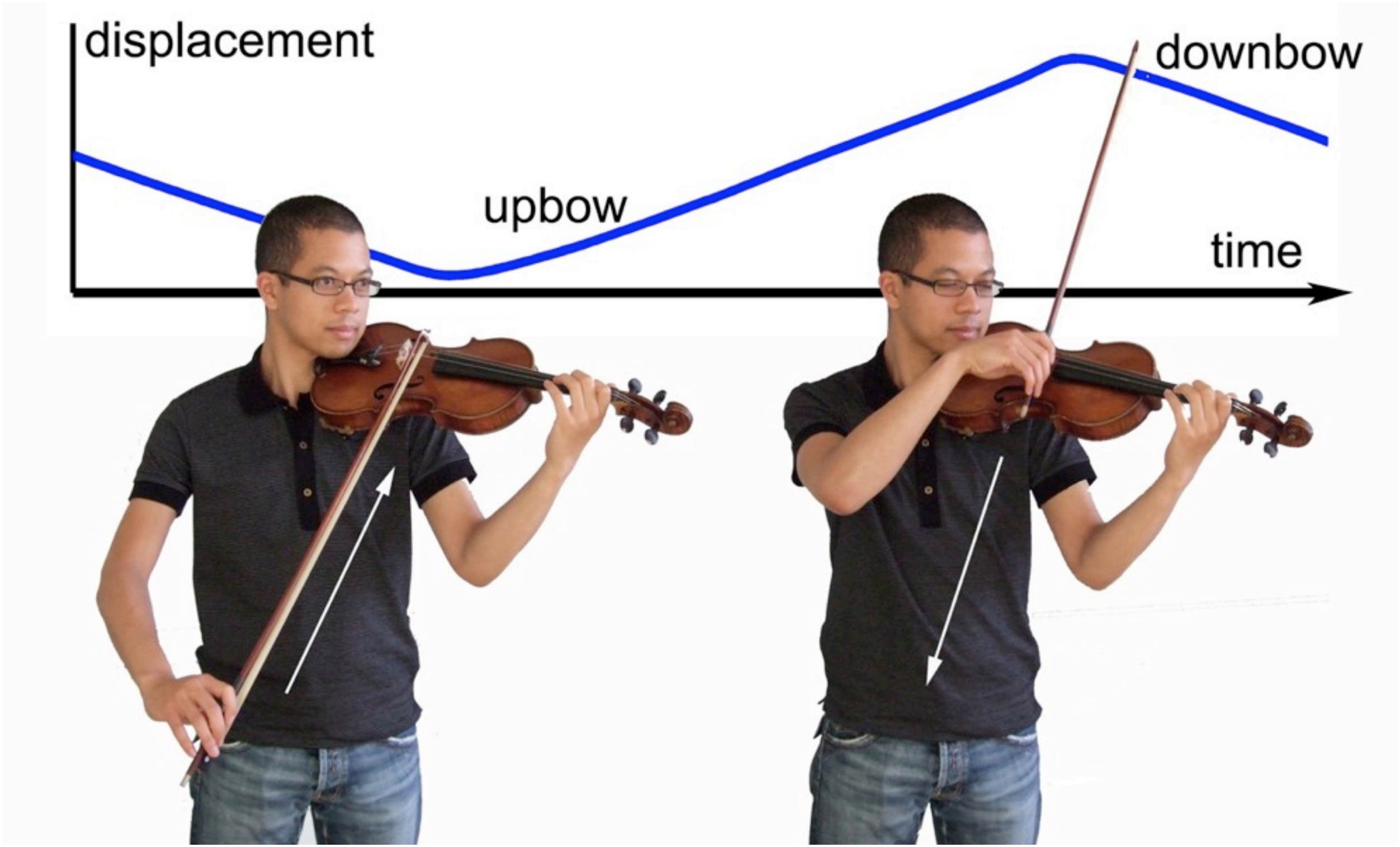
Sofia Dahl, Frédéric Bevilacqua, Roberto Bresin, Martin Clayton, Laura Leante, Isabella Poggi, and Nicolas Rasamimanana

Chapter 3:

- Aim of chapter is to present musical gestures in different performance contexts
- Repeating gesture types from chapter 2: *sound-producing*, *communicative*, *sound-facilitating*, *sound-accompanying* and emphasizing that any single gesture may have multiple functions

Chapter 3:

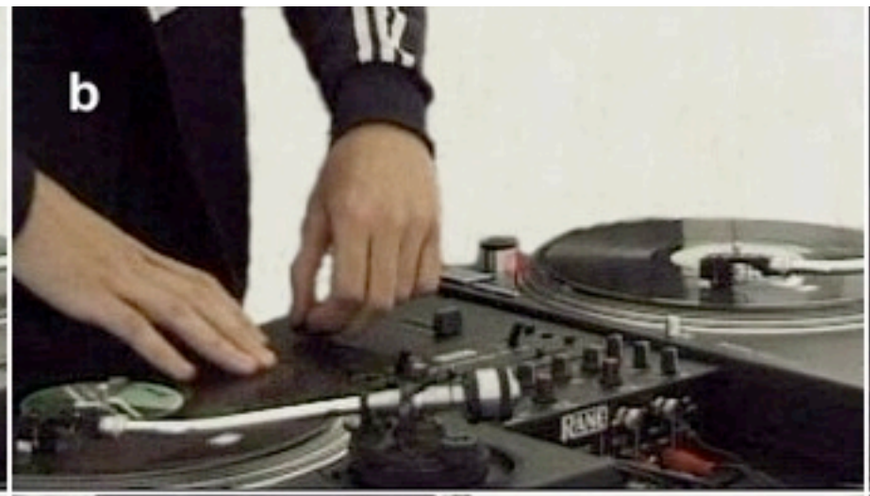
- Sound-producing gestures:
- Optimization in sound-producing gestures: least effort, greatest reliability, individual differences
- Playing techniques/styles on different instruments
  - Drumming
  - Piano playing
  - Bowing gestures


displacement
downbow
upbow
time

Chapter 3:

- Gestures in the control of electronic instruments
- DJ-scratching
- Mapping gestures to sound
- Different mapping schemes
  - With or without energy transfer
  - DJ-scratching interesting as having both some energy transfer and using playback of sounds


a


b


c


d


e


f

Chapter 3:

- Communicative gestures:
- Communicating with co-performers
- Communicating with the audience
- Interpretation and expressing emotional intention

- Davidson 1993: musicians' movements highly influential in audience's perception of the music
- Woodwind gestures: Wanderley's work show remarkable consistency of musicians' gestures
- Musicians clearly prefer to make gestures

Chapter 3:

- Entertaining an audience
- Entrainment: making someone move in synchrony with someone else or with some sound source
- Sound-facilitating gestures: gestures that help sound-production
- Co-expressiveness between movement and sound
- Often found in Western music
- Also common in Indian music:


A
B
C
D

Chapter 3:

- Sound-accompanying gestures:
- Entrainment: both in performance between musicians and between musicians and audience
- In conclusion: large differences in the amount of movement in music-related gestures
- Music-related gestures are very often multi-functional
- Various gestures in music performance clearly influence the perception of the music

Chapter 4

Music and Gestures

A Historical Introduction and Survey of Earlier Research

Albrecht Schneider

Chapter 4:

- Aim of chapter is to give a historical overview of music-related gestures
- Starts off with some general conceptual issues of music-related gestures
- Considers the relationship to language and to various modes of bodily expression
- Considers the relationship to emotion
- Presents an overview of some main elements in Western thought on music-related gestures

Chapter 4:

- The Aristotelian concept of *mimesis*: "...that of an artistic expression or representation through which observers and listeners perceive psychic processes and emotional states by means of music (based on melody, mode, rhythm) and gestures." - p. 77
- Types of music are related to temperaments and affects, something that is carried on in the late Renaissance and the Baroque area
- "The so-called *musikalische Figurenlehre*, which connects music to rhetorics, developed principally in humanistic, Protestant circles of Germany between, roughly, 1600 and 1730." p. 78

Chapter 4:

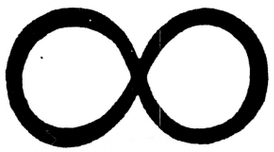
- Late Renaissance music and the development of monody ties music closely to language and speech, with gestural qualities mostly in the declamatory style of the music
- The *Affektenlehre* of the German Baroque clearly related to musical gestures
- The affect-related elements of later Western music can likewise be related to body movements
- This also includes more contemporary forms of music, such as various kinds of jazz

Chapter 4:

- This chapter also presents some elements of earlier research on music-related gestures
- In particular, the period between the two world wars seem to have been a productive period for various ideas on music-related gestures
  - The idea that different kinds of (Western) music would create different sensations of movement
  - Becking's concept of sympathetic movements (Mitbewegungen)

Historische Tabelle der Schlagfiguren.

(Die Kurven können nur andeutungsweise, die Anweisungen nur unvollständig gegeben werden.)

Typus	Der vorklassische Rhythmus in Deutschland					Der klassische Rhythmus in Deutschland						
	Barock (kursorisch)			Aufklärung		Klassik			Romantik			Wagner
	Generation von 1580	—	Generation von 1680	Rokoko	Rationalismus	Sturm und Drang	1. Klassiker	2. Klassiker	3. Klassiker	1. Generation	2. Generation	3. Generation	
I			 Arm! Die Abstriche barock aushöhlend **Händel**				 Herzhaft abwärts **Haydn**	 Selbstverständlich abwärts. Sorgfältig getönt **Mozart**			 Führen und Schwingen **Schubert**		
II	 Schulter! starr **Schütz**		 Arm! Gebunden schwingend **Telemann**	 Hand! Frei schaukelnd **Hasse**	 Ohne Schnörkel. Schlicht **Ph. E. Bach**				 Tief abwärts zwingen **Beethoven**	 Herziehen und Wegschieben **Hoffmann**	 Links und rechts ausschwingen **Weber**	 Herziehen und Wegschieben **Schumann**		
III	 Schulter! starr **M. Franck**		 Arm! Die Abstriche barock aushöhlend **J. Seb. Bach**		 Nicht aushöhlend. Spröde **Gluck**	 Explosionen **Stamitz**						 Überfein **Mendelssohn**	 Flackriger Druck **Wagner**

Chapter 4:

- Manfred Clynes: essentic forms and sentics
- Sentics: each composer has a distinct motor pulse
- Essentic forms: “Clynes, an essentic sound form is one that “appears to act directly to communicate its quality,” that is, one where no symbolic transformation is needed to understand its meaning. In some respect, essentic forms might be regarded as gestures in that they are dynamic wholes that express a certain emotional (or “sentic”) state.” - p. 90

Chapter 4:

- “Manfred Clynes (Clynes 1978) suggests that each emotion has its specific temporal form (sentic form). In order to measure these shapes he developed the sentograph. People had to push a button to express the temporal form and spatialization of the emotions.” - p. 164
- Truslit on Bodily Motion and Musical Motion
- “The sound pattern that results is said to have a Dynamo–Agogik (temporal–dynamic organization) identical to that of the muscles used for sound production.” - p. 94
- Music-movement discussed since antiquity, scientifically studied more recently

Chapter 5

Gestural Affordances of Musical Sound

Rolf Inge Godøy

Chapter 5:

- Aim of chapter is to show gestural affordances of musical sound
- Affordance = the use and/or possible movements we spontaneously perceive in objects or events of our environment, e.g. we usually perceive a pencil as something to write with, a bicycle as something to ride on
- Affordances dependent on previous learning and state of mind at any moment
- Gestural affordances of musical sound = the gestures that music suggest we make or imagine

Chapter 5:

- Obviously, there may be very many different kinds of gestures made to the one and same music
- Yet people may also make very similar kinds of gestures to the same music
- Are there any more general principles involved in peoples' spontaneous gestures to music?
- Consider the Chaplin Barber Scene:

Chapter 5:

- Some factors in listening:
- The perception-action cycle
- Embodiment
- Multimodality
- Ecological knowledge
- Knowledge of source (materials, objects)
- Knowledge of sound-producing actions
- Spontaneous motor imagery when listening to music, both for experts and non-experts

Chapter 5:

- Some basic motor schemas:
- General motor programs
- Main categories:
- Sustained
- Impulsive
- Iterative
- Distinct effort sensations and sonic results
- Projecting motor schemas onto new or ‘unheard’ sounds as well as onto sounds that do not have any clear temporal structure

Chapter 5:

- Embodied cognition:
- Phenomenological background
- Classical motor theory
- Support from recent neurophysiological research: imitative behavior and so-called mirror neurons
- Related ideas of body image schemas in cognitive linguistics
- Motor equivalence as the basis for generalizations
- Hands seem to have a privileged status in reasoning
- Conclusion: sonic events embedded in actions

Chapter 5:

- Sound-related gestures:
- Sound-producing (with sub-categories)
- Sound-accompanying (with sub-categories)
- Gestures are very often multi-functional
- Basic gestures:
- Sustained
- Impulsive
- Iterative
- Combined into more complex musical textures

Chapter 5:

- Combined into more complex musical textures
- Mozart
- Mantovani
- Lutoslawski
- Etc.
- Phase-transitions between categories
- Coarticulation
- Fusion-fission
- Energy schemas applicable to all kinds of music

Chapter 5:

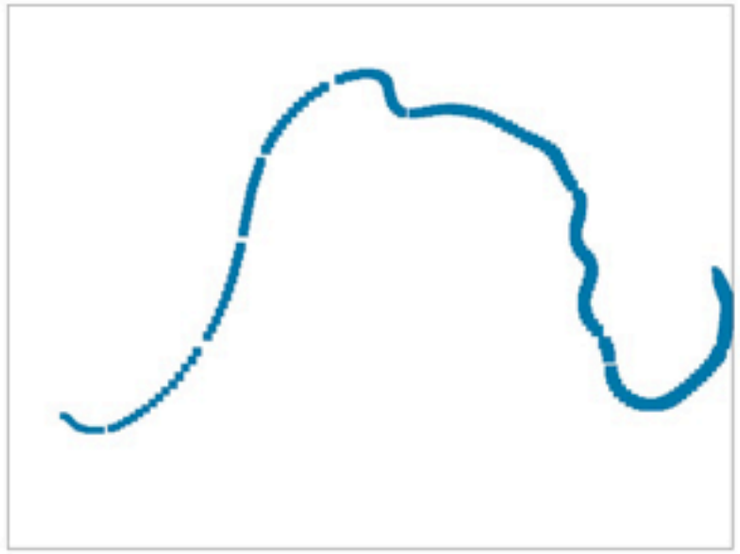
- Sound features
- Holistic perception of chunks
- Metaphor of trajectory shapes in time and space
- Feature dimensions

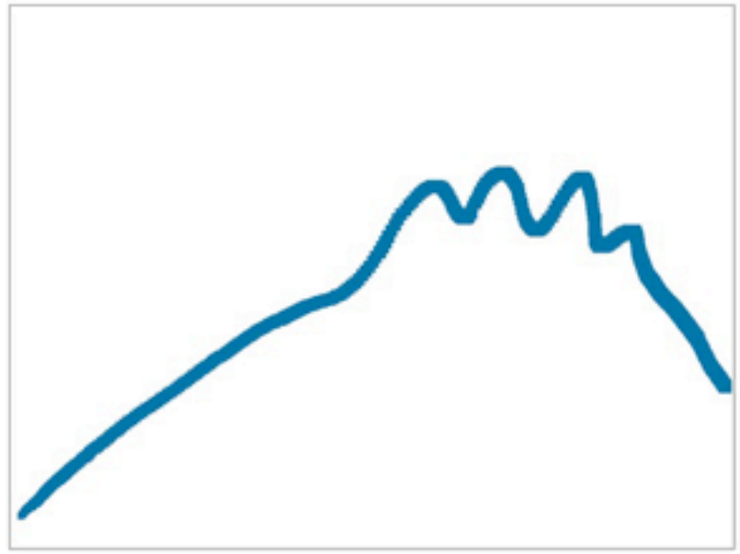
Chapter 5:

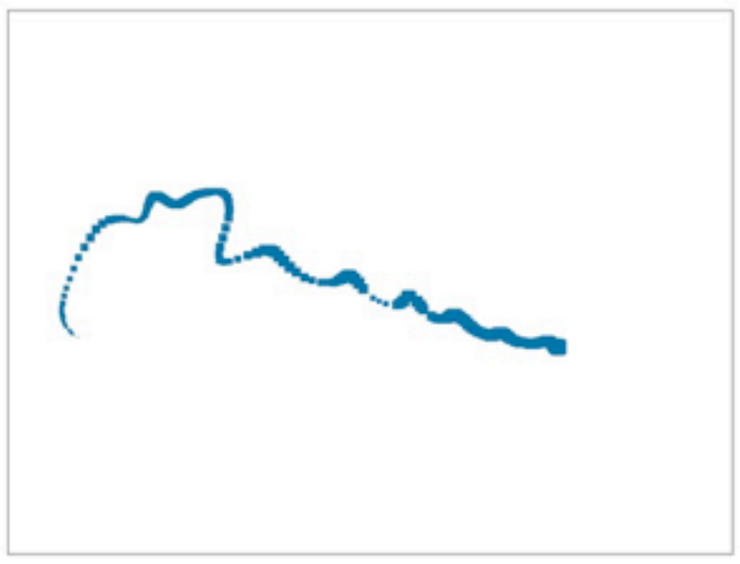
- Onsets
- Pulses
- Cyclical patterns
- Accents and articulations
- Dynamic contours
- Pitch contours
- Tessitura contours
- Modulations/fluctuations in the sound
- Ornaments and textural patterns

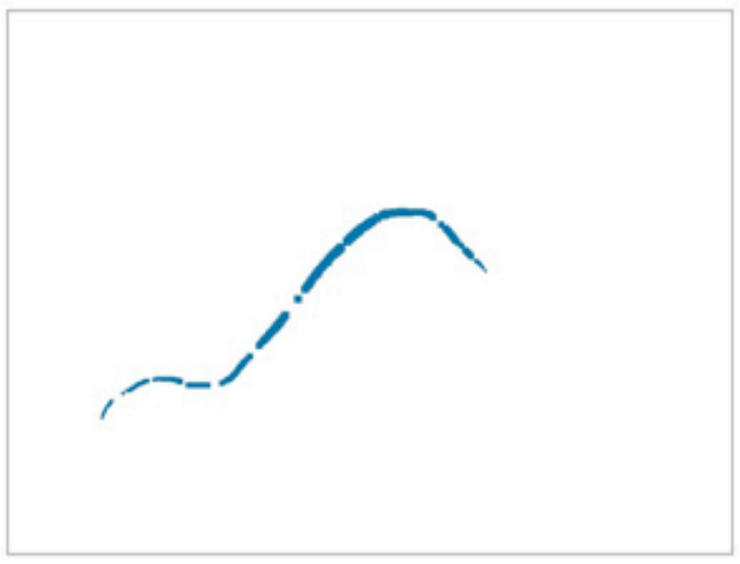
Chapter 5:

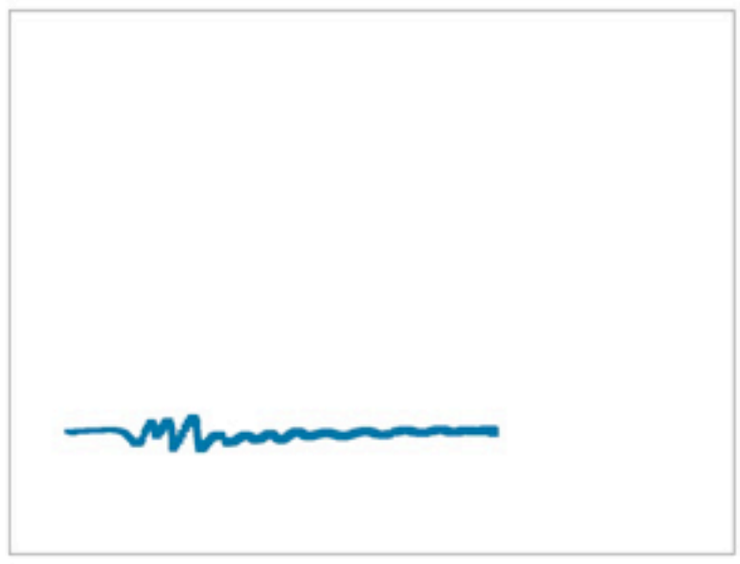
- Gestural rendering of musical sound
- Air instruments: air guitar, air piano, etc.
- Free movement
- Evaluation of correspondences
- Sound-tracing:

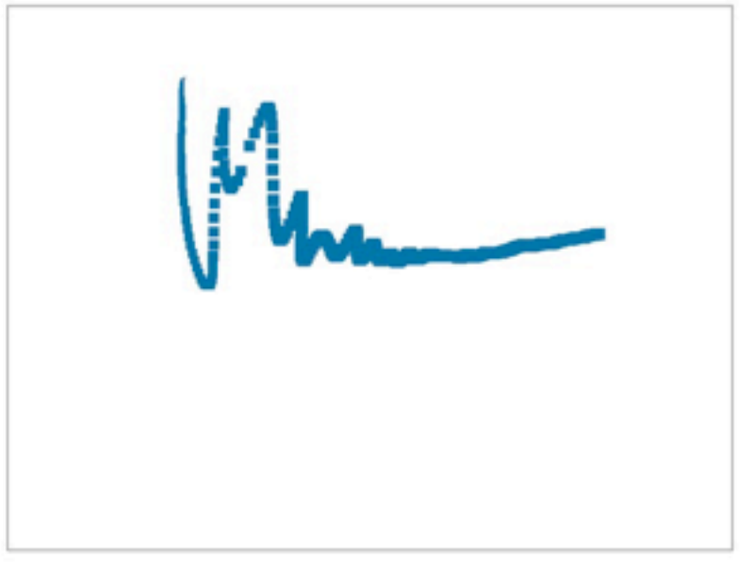


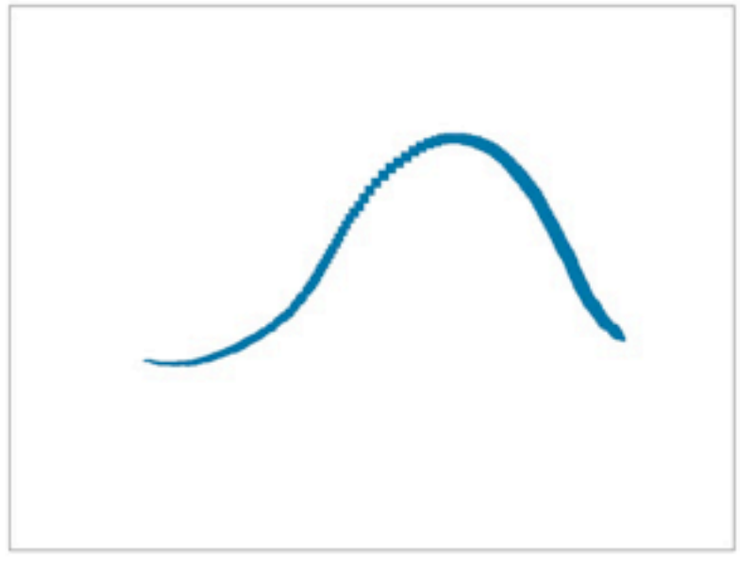












Chapter 5:

- The perception-action cycle and music-related gestures
- Exploring what we perceive through body movement
- Privileged role of the hands
- Element of discontinuity in the perception-action cycle: chunking
- Theories of chunking in cognitive science
- Phenomenology
- Conclusion: music as sound-gesture interaction

Chapter 6

Music, Gesture, and the Formation of Embodied Meaning

Marc Leman

Chapter 6:

- Aim of chapter: explore the basis for meaning formation by music-related gestures
- Music as carrier of multiple meanings, e.g. Mozart's *Don Giovanni* ranging from personality to politics
- Lower levels of meaning formation: corporeal articulations (i.e. body movement reflecting musical features)
- Marc Leman's book *Embodied Music Cognition and Mediation Technology* gives a broad basis for embodied cognition in music

Chapter 6:

- The human body seen as the mediator between mind and environment, without need for words
- Three different perspectives: *a third-person perspective*, which is based on the measurement of body parts and sonic forms, *a first-person perspective*, which is based on self-observation and interpretation of experiences and, finally, *a second-person perspective*, which is based on how gestures function as social cues.
- This last perspective could show how musical gestures are used for social interaction and bonding

Chapter 6:

- “The formation of musical meaning can initially start from sensations and perceptions of qualia, and then evolve into phenomenal representations, conscious awareness and finally, hermeneutic interpretations and linguistic descriptions.” pp. 127-128
- Transition from sonic features to body sensations
- Cenaesthetic transformation: starts from the synaesthetic and kineasthetic levels and link these with more conceptual levels, i.e. goes from sensory to more abstract images

Chapter 6:

- “It suffices here to say that the cenesthetic transformation can be seen as a precondition for a fully symbolized type of meaning formation, which Broeckx calls the analogical process, but which other authors have called the semiotic (Tarasti 2003; Monelle 2000) or the hermeneutic process (Hatten 2003). It is the level at which felt properties or descriptions thereof are linked with cultural symbols and topics. It is the level at which we say that a menuet by Mozart expresses the aristocratic class, or at which we say that the pounding rhythms in Stravinsky’s Rite of Spring expresses the anxiousness of mankind to accommodate to nature.” pp. 128-129

Chapter 6:

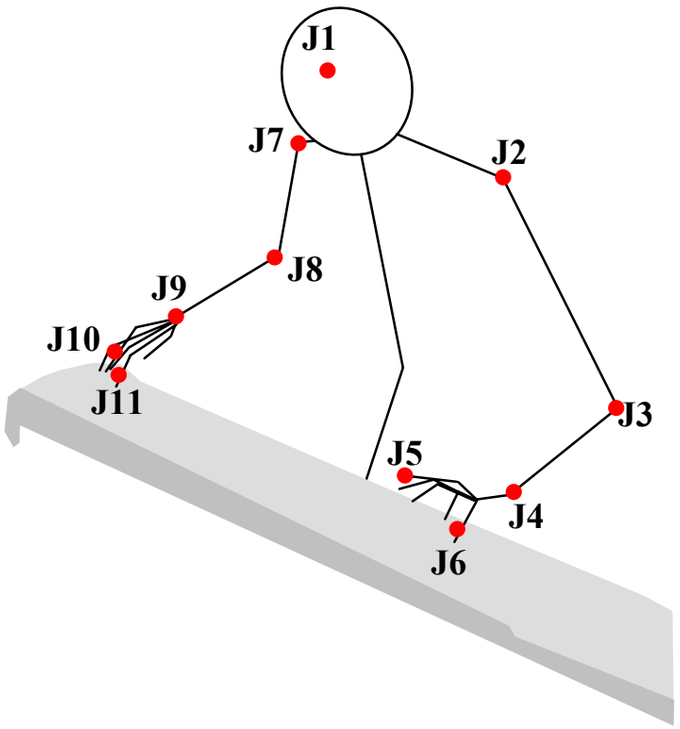
- Possible to proceed empirically in at least parts of this by observing, measuring, processing, etc. sound and movement
- Considering gestures as fully embodied: gestures as close to body movement and meaning
- Studying performer-listener relationship

Chapter 6:

- “...the observer looks at three forms of activity: (1) physical activity, related to the generation and transmission of energy along different communication channels (audio, haptic, visual ...), which allows objective measurement of gestures; (2) bodily activity, related to the mediation between the mental and physical levels at which gesture occur; and (3) mental activity, related to the way in which music is experienced as gesture.” p. 131
- The interplay of mental and physical aspects with the body as the mediator

Chapter 6:

- Third person perspective on gesture:
- “The so-called third-person perspective on gesture focuses on the objective, and in principle repeatable, measurement of moving objects. The observation can be done by any person, even a machine, or a combination of human and machine, provided that it follows a pre-established procedure in a proper way.” p. 131
- Example: *guqin* performance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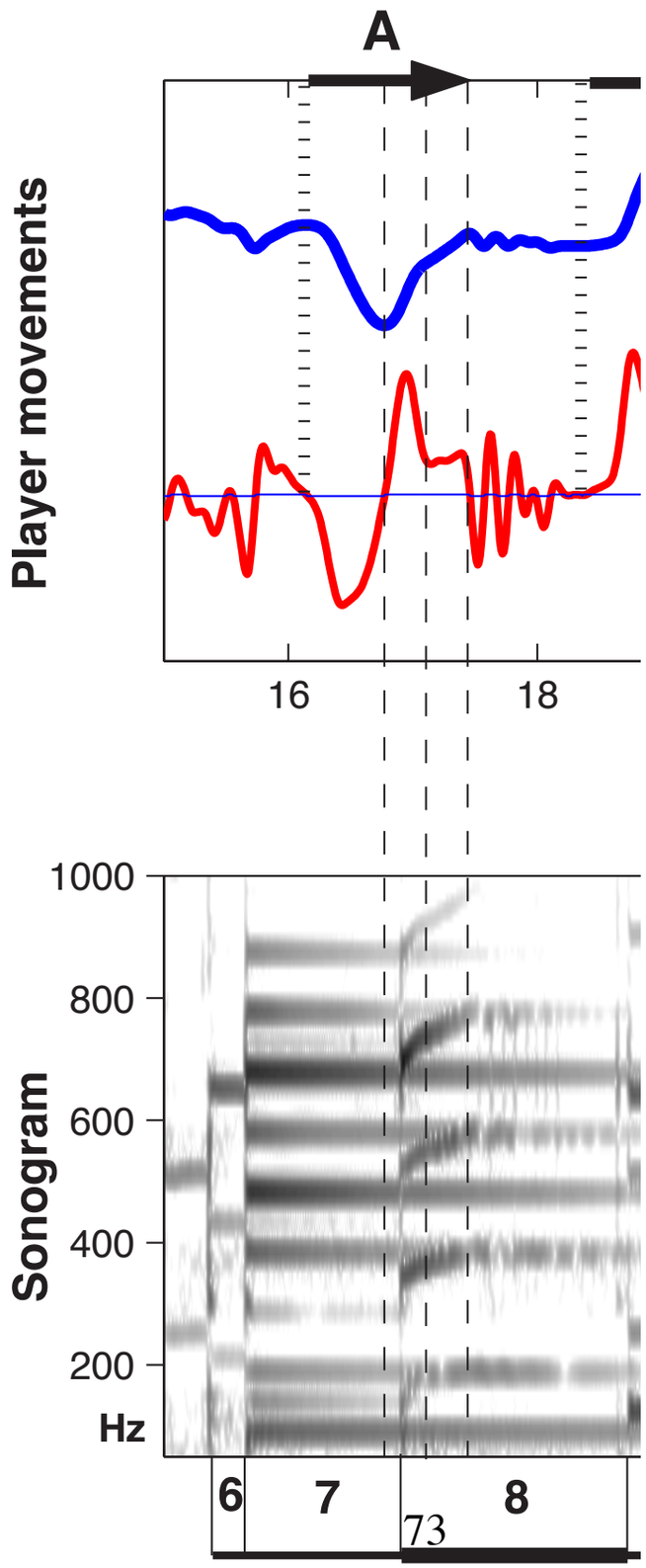

A
Player movements
16
18
1000
800
600
400
200
Hz
Sonogram
6
7
8
73

Chapter 6:

- The first-person perspective:
- An action-based approach to gesture: “a subject’s own action-oriented ontology: that is, the set of things that exist for the subject as agent. For example, if playing a note on the trumpet exists in my action-oriented ontology, then it means that I am able to mentally represent this action as a gestalt, I can imagine this action as it is deployed over time, and that I probably have the capacity to execute this action (even if I in fact have not played the instrument for several years).” p. 134
- Making an overview of sounds and actions:

Table 6.1 Alphabet of pitch contour shapes with the specification of the curvature and the direction

Curvature:		*Direction*:
f: flat	(no perceptible pitch change)	U: upward
l: linear oblique	(pitch-slide in uniform velocity)	(change from lower to higher pitch)
a: accelerated	(accelerated pitch-slide, smooth curve or in 2 fixed velocities: lv_1+lv_2 $lv_2>lv_1$)	D: downward
d: decelerated	(decelerated pitch-slide, smooth curve or in 2 fixed velocities: lv_2+lv_1 $lv_2>lv_1$)	(change from higher to lower pitch)

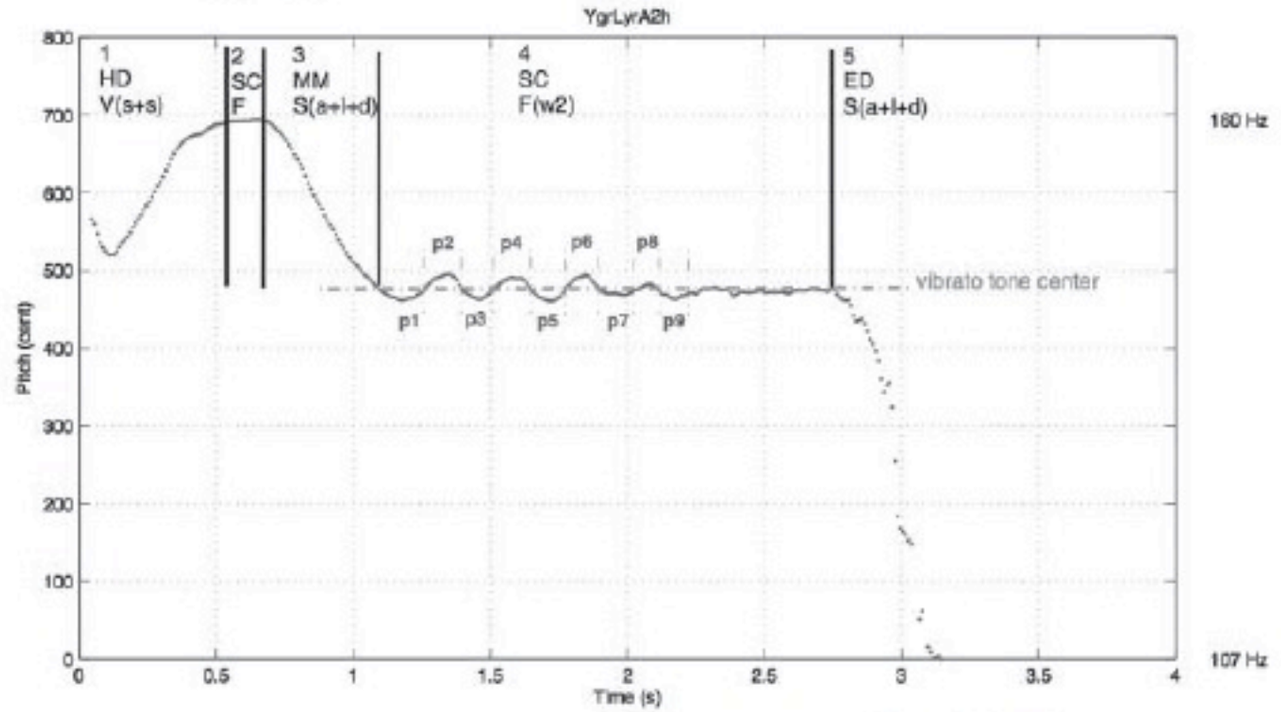


Figure 6.4 Example of a sliding-tone, annotated according to the typology of elementary *guqin* sliding-tone gestures (Li and Leman, 2007).

Chapter 6:

- The first-person perspective:
- The experience-based approach to gesture: “In this interpretation, the focus is on gesture in relation to the subject’s personal experience or sensitivity.” p. 139
- Various accounts of personal experiences, e.g. adjectives, points on a scale, etc.

Chapter 6:

- The second-person perspective:
- “In the second-person perspective, gesture is more explicitly addressed in terms of other people’s engagement with music, or what I call music-driven social interactions.” p. 142
- And: “In this viewpoint, gesture appears as a mediator for musicdriven social interaction or as the vehicle through which a “me-to-you” relationship is established in space and time, through musical engagement.”
- The subjective experience of social interactive gestures: sense of doing together

Chapter 6:

- The temporal deployment of social interactive gesture: “can be studied using sensing technologies. These provide a very powerful (third-person) empirical approach, especially when used in the framework of a (first-person) perspective where interaction is related to experiences of flow, presence, social bonding, and empathy.” p. 145
- Individuals often seem to be entrained to each other
- Conclusion: “Music is Gestures”

Chapter 7

The Functional Role and Bio-kinetics of Basic and Expressive Gestures in Activation and Sonification

Leon van Noorden[1]

Chapter 7:

- Aim of chapter: explore the role of sound and movement in a community of agents, i.e. between anything that moves or acts
- This will be done in two directions:
  - The functional/evolutionary path
  - The bio-kinetic path

Chapter 7:

- The functional/evolutionary path: why is there a relationship between music and movement?
- Sonification = the musician's gestures resulting in sound
- Activation = expression and enhancement of music by movement (dance)
- The bio-kinetic path: the relations between music-related gestures and the kinetics of the human body
- Seems to be a natural resonance in human body movement at around 2 Hertz (two cycles per second)

Chapter 7:

- Functional aspects of music and movement: “Our main assumption is that music and dance are elements of social events. Individuals may have explored or exercised forms, methods, or tools on their own, but the reason that music and dance are universal phenomena among all human cultures is their importance in social events.” p. 155
- Aspects of social events: synchronization and bonding
- The *coalition quality hypothesis* (Hagen and Bryant 2003): music enhances group cohesion

Chapter 7:

- Bio-kinetics of movement
- Quasi-static and ballistic movement of individual agents: resonance. “Movement of the body or body parts can be described with the laws of kinetics. This means that there is a relationship between the forces that act on the (part of the) body and the velocity and position as function of time. The forces that act on the body or its parts are gravity, reaction forces at the connection points of the extremities of the body (such as feet resting on the floor), linear and rotational inertial forces, and muscle forces.” p. 157

Chapter 7:

- “Starting from an equilibrium situation, if the muscle forces are small the body will move slowly and stay more or less stable, i.e. the inertial and restoring forces will be in equilibrium. As soon as the muscles stop changing their position the body will stop moving. This we call quasi-static movement. If, however, the muscles exert a sudden impulse (jerk) the inertial forces will be more substantial and the resulting movement will only stop after all forces are in equilibrium again and the kinetic energy of the jerk has been absorbed by damping. This we call ballistic movement.” p. 157

Chapter 7:

- And: “We suppose that the body normally is in a more or less elastic equilibrium with its environment. This means that the restoring forces towards the equilibrium position increase gradually with the distance from the equilibrium point. Under these conditions, the body will have a characteristic pendulum movement around its point of equilibrium. It depends on the amount of damping whether this pendulum movement will die out quickly or not so quickly after a jerk or other disturbance.”

Chapter 7:

- So: “If the jerks are repeated with a frequency that is in agreement with the characteristic pendulum movement, its amplitude will reach a maximum. If the jerks come too quickly one after the other the body will not be able to follow the jerks any longer and the amplitude will tend to zero. This phenomenon of maximum amplitude at a certain frequency is called resonance: see Figure 7.1.” p. 157
- Indications of the 2 Hertz peak in various activities, but most of all in walking: preference for 120 steps per minute (2 steps per second)

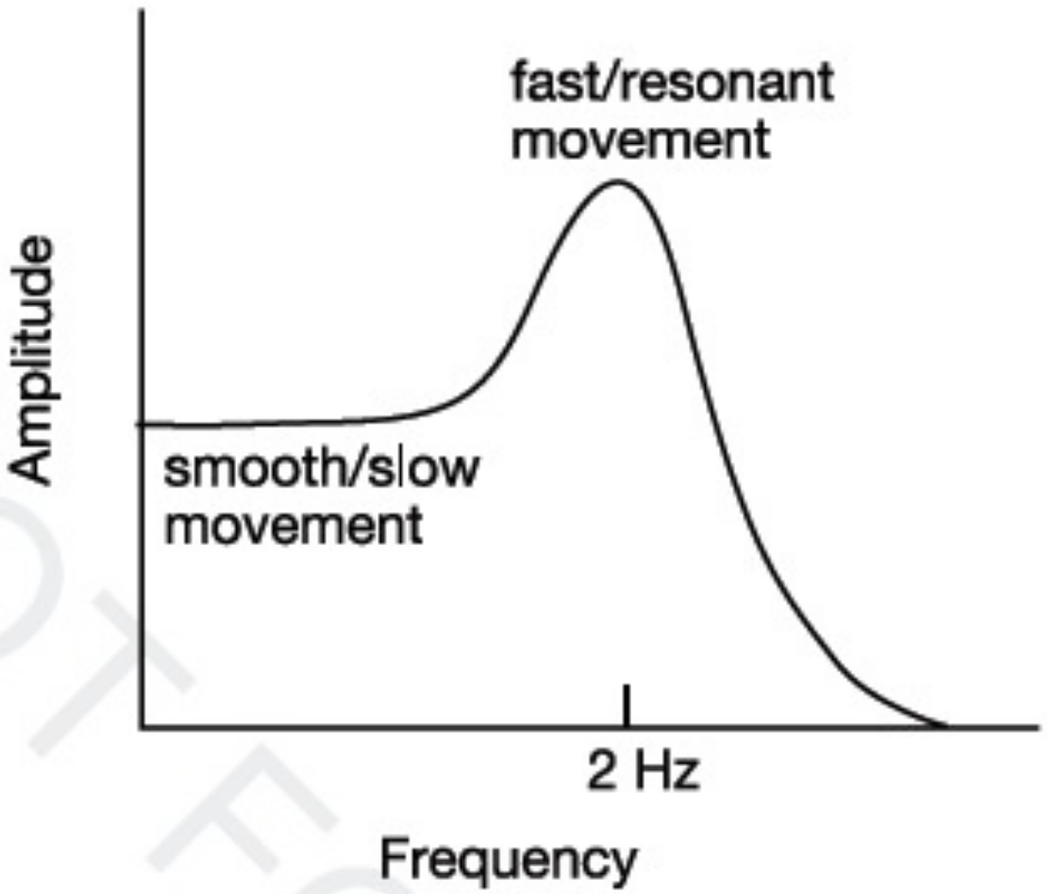


Figure 7.1 Resonant or ballistic movement versus smooth or quasi-static movement.

Chapter 7:

- Movement of agents in social situations: entrainment
- Entrainment in general: objects' movement patterns tend to influence each other and evolve towards synchrony (see metronome video)
- Entrainment in human (and other animal) behavior more complex
- Examples: clapping, walking, dancing, etc. where there often will be a mutual adjustment towards a single frequency

Chapter 7:

- Temporal aspects of music: the perceived pulse of the music
- Overview of the different pulses in Table 7.1, where the 2 Hertz pulse may be seen as the dividing line between slow and fast

Table 7.1 Tempi in the different domains of human activity compared with some relevant measurements

musical tempi	*dances*	*locomotion*	*body functions*	*domin. locomotion*	*histogram tempi*	*polyrh. tapping*	*BPM*
prestissimo			max heart rate		x		220
	quick step	running			x	x	200
presto	jive		max breathing		x	x	180
		jogging		x	xx	xx	160
allegro	bossa nova			xxx	xxxx	xxxx	140
allegretto	west coast	march		xxxxx	xxxxx	xxxxx	120
moderato				xxx	xxxx	xxxx	100
andante	slow waltz	relaxed		x	xxx	xxx	80
adagio			min heart rate		xx	xx	60
					x	x	40
largo		funeral			x	x	30
			min breathing				20

Chapter 7:

- Processes inside the agent: perception of sound linked with movement in the mind of the listener or performer, however this is not yet a well understood process: “An important aspect of the potential of communication between agents is that they can copy movements and other expressions from each other. When a child sees another child hopping, he will “understand” that movement when he can also hop in the same way. In this context, one often mentions the “mirror neurons” as mechanisms that support this mimicking behavior (e.g. Rizzolatti and Craighero 2004). It is an interesting question whether mimicking behavior is more direct in the case of vision and movement than in the case of hearing and movement.” p. 161

Chapter 7:

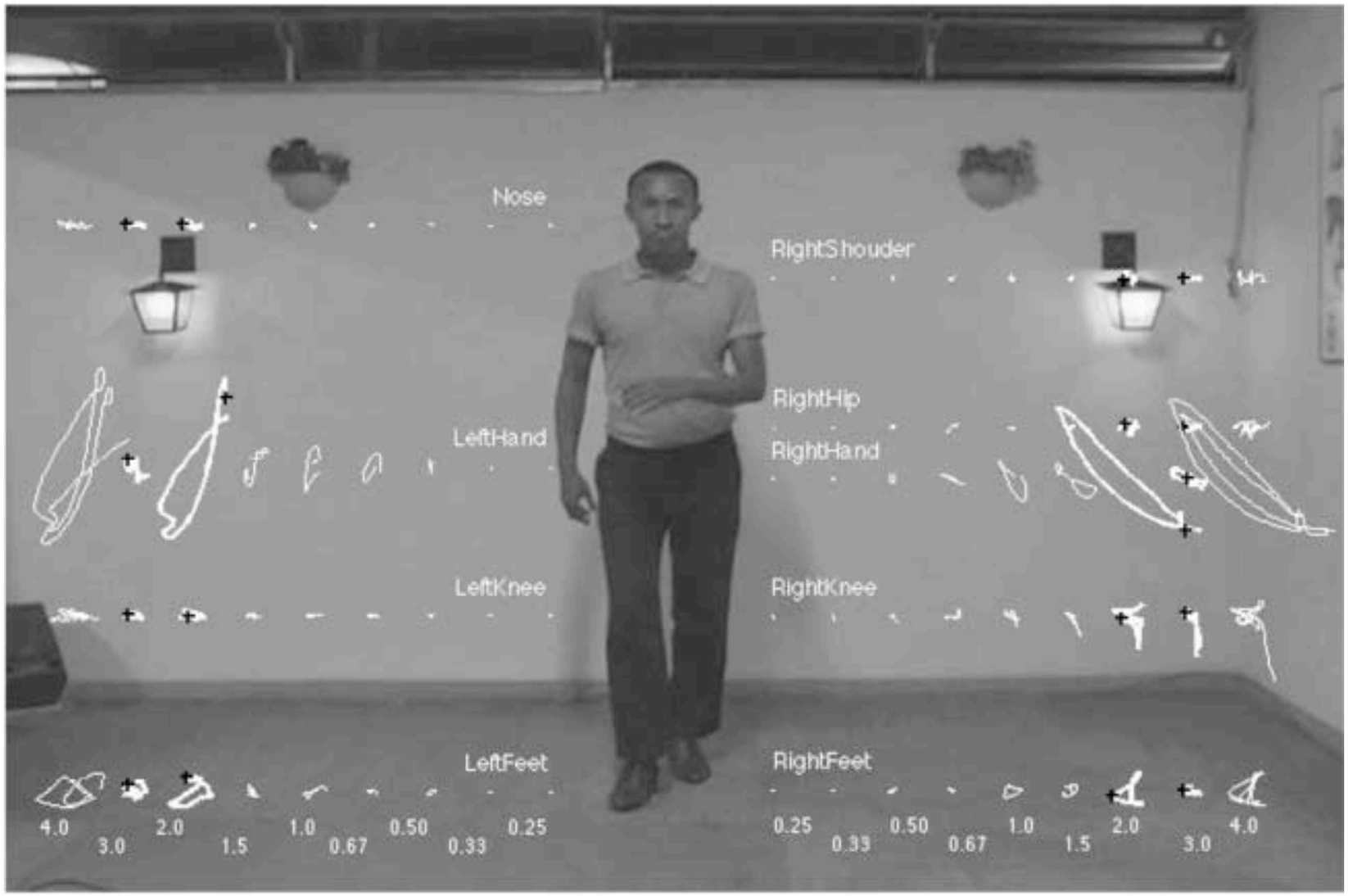
- The idea of resonance in music-movement couplings
- Basic gestures of synchrony can be developed into more expressive gestures where the shape of the gestures are carriers of meaning as suggested by e.g. Becking and by Clynes
- A number of experiments to explore these gesture features have been carried out both in individual and in group (social) settings
- Synchrony represented by wave slicing in Fig. 7.2
- “Becking curves” in Fig. 7.3

Chapter 7:

- Walking to music: peak at around 120 BPM
- Also: music is a more effective activation than metronome clicks (also found in Thaut 2005), see Fig. 7.4 (CI = confidence interval, i.e. Mean walking speed (km/h) with 95% confidence interval as a function of walking tempo (BPM))
- Samba dancing: correlating the various body parts' movements with the metrical grid of the music in Fig. 7.5 and gestures can also be shown as "Becking curves" as in Fig. 7.6

Chapter 7:

- “Figure 7.5 shows the result of such an analysis on the dancing choreography of a professional samba dancer. Different body parts of the dancer have been marked, such as the nose, right shoulder, left hand, right hand, right hip, left knee, right knee, left foot, right foot. The numbers below represent the metrical grid, divided into binary and ternary subdivision and multiples. Number 1 represents the beat, number 2 is the double of the beat, 0.33 is one-third of the beat and so on. For each body component, the movement trajectory is decomposed along the metrical units, and this decomposition then reveals the possible spatial characteristics of the basic gestures.” p. 171


Nose
RightShouder
RightHip
LeftHand
RightHand
LeftKnee
RightKnee
LeftFeet
RightFeet
4.0
3.0
2.0
1.5
1.0
0.67
0.50
0.33
0.25
0.25
0.33
0.50
0.67
1.0
1.5
2.0
3.0
4.0

Chapter 7:

- Children's tapping to music
- Moving to music without and with seeing other people move
- Conclusion: it seems that humans are disposed to synchronize, both individually and collectively, to musical sound, and we have seen some interesting (but of course hard to verify) theories of human evolution trying to explain this

Chapter 8

Gesture and Timbre

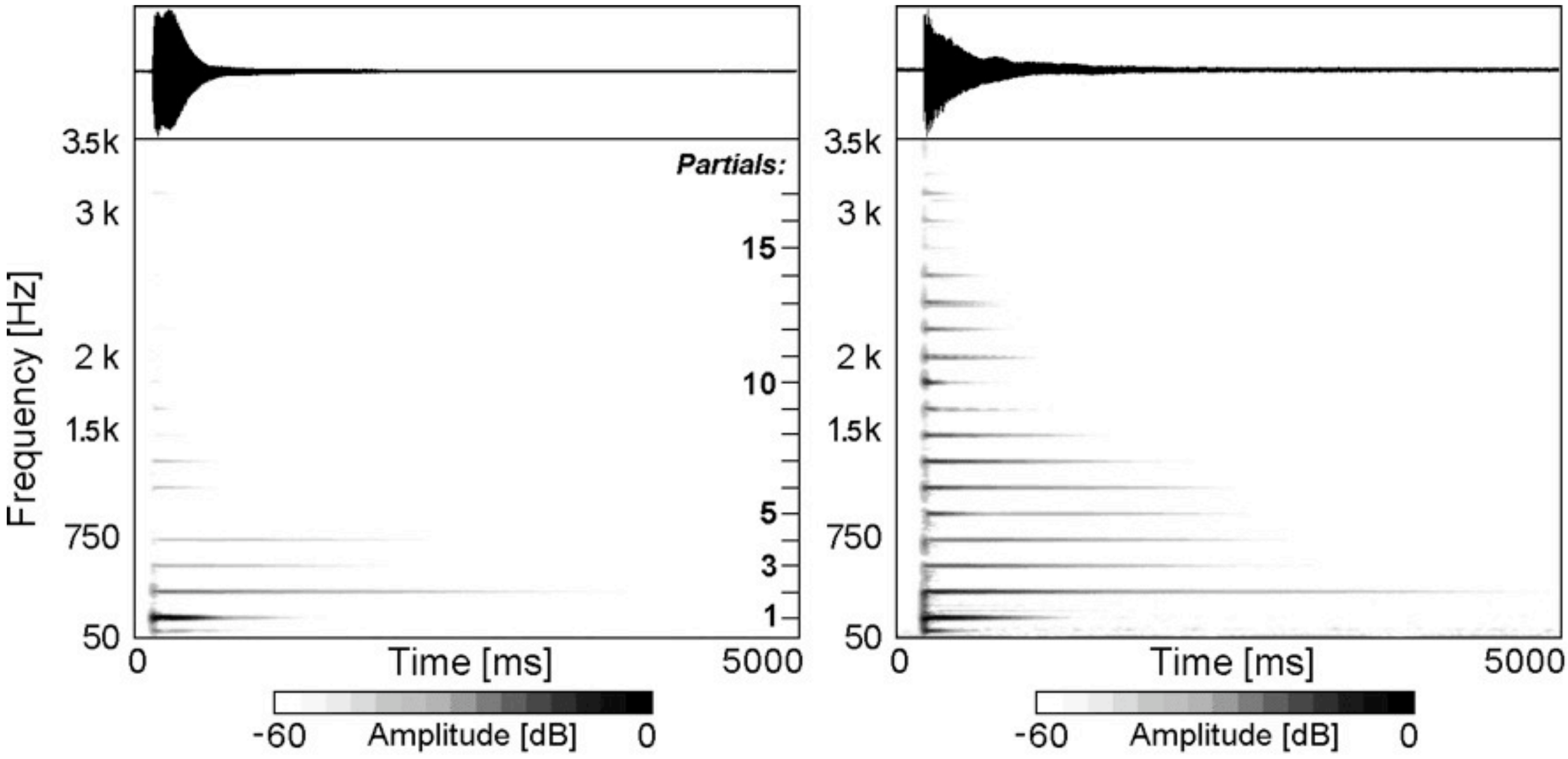
Tor Halmrast, Knut Guettler, Rolf Bader, and Rolf Inge Godøy

Chapter 8:

- Aim: to show something about the relationships between gestures and timbre
- What is timbre?
- Stationary features: additive synthesis
- Transient features: various fluctuations in the course of the sound
- Attack transients: beginnings of sounds particularly important
- Overall envelopes of sounds

Chapter 8:

- Sound types:
- Sustained
- Impulsive
- Iterative
- Bowing
- Plucking
- Striking
- Iterative


3.5k
3 k
2 k
1.5k
750
50
Frequency [Hz]
0
Time [ms]
5000
Partials:
15
10
5
3
1
-60
Amplitude [dB]
0

Chapter 8:

- New electronic instruments:
- In principle, any sound can be made on a computer
- In practice, difficult to control sound-generation
- How does absence of energy transfer change our notions of musical sound?
- Schemes for mapping
- Challenge: to make ecologically well-founded relationships between gestures and sound

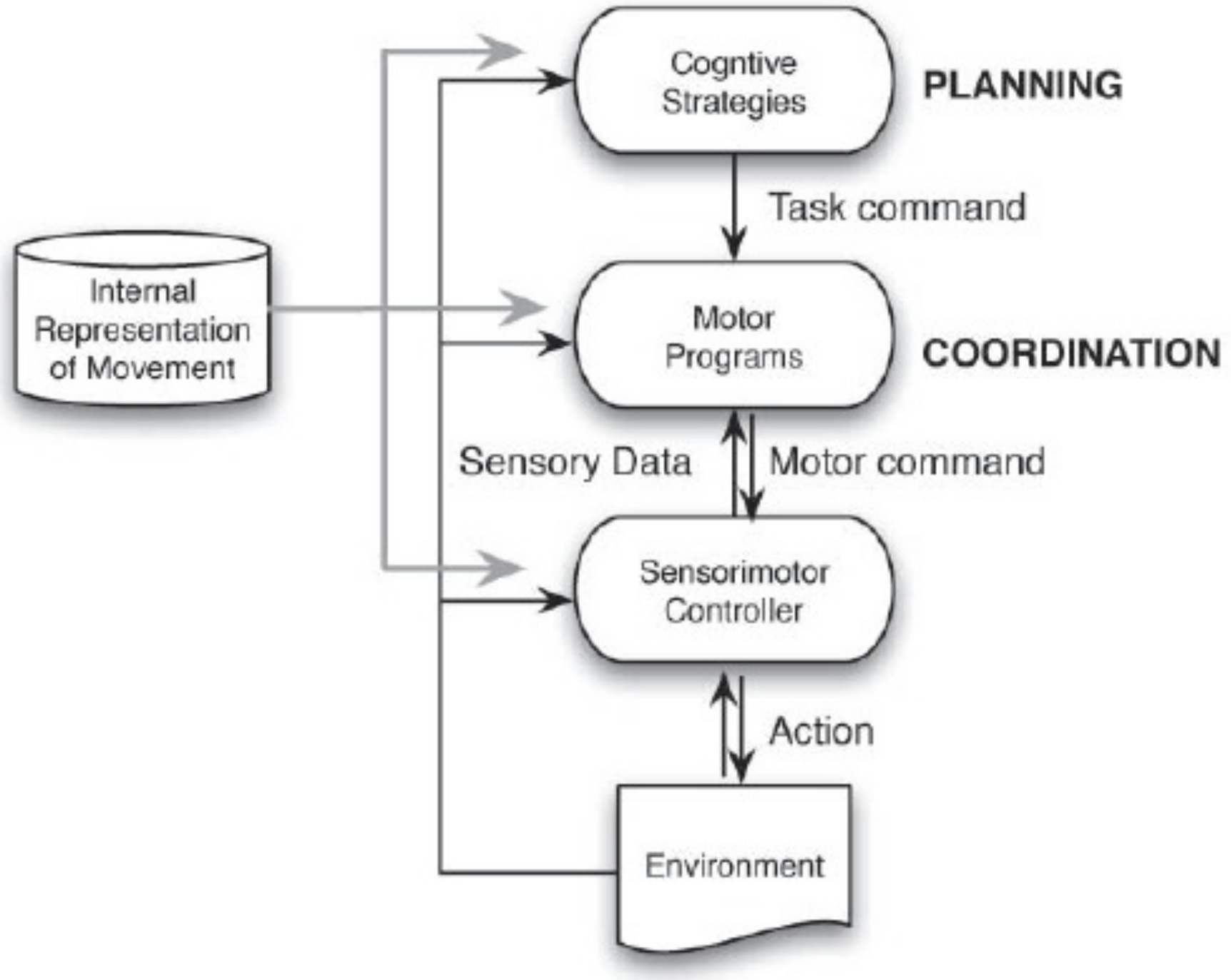
Chapter 9

Sensorimotor Control of Sound-producing Gestures

Sylvie Gibet

Chapter 9:

- Aim: give an overview of biomechanics and motor control in music-related gestures
- Low-level motor control: limbs and muscles
- Principles of movement: muscle synergies
- Muscle activation
- Higher level motor control: goals and strategies
- A multi-level control architecture:


Cogntive
Strategies
PLANNING
Task command
Internal
Representation
of Movement
Motor
Programs
COORDINATION
Sensory Data
Motor command
Sensorimotor
Controller
Action
Environment

Chapter 9:

- Control information flow:
- *Open loop*: much preprogramming, little/no feedback
- *Closed loop*: feedback in the course of the action
- Much controversy in motor control research about the extent of preprogramming vs. continuous control
- One classical concept: *motor programs*
- Motor program = knowing what to do and what messages to send to the muscles before the action starts

Chapter 9:

- The *biomechanical approach*: our bodies are preprogrammed to move from posture to posture (equilibrium points) and can automatically generate the movement between these postures
- The *non-linear dynamics approach*: movement emerges from the interaction of oscillators
- Invariant laws in movement: empirically established features of human movement, e.g. invariance in velocity profile, isochrony principle, Fitt's law, two-thirds power law, etc.
- Internal models: predicting before acting

Chapter 9:

- Simulation with avatars: we can systematically vary the control parameters of a biomechanical robot and see what happens
- Modeling the anatomy, biomechanics, muscle-skeletal system, and various schemes for motor control
- All this can be applied to the synthesis of music-related gestures
- Data-driven synthesis: real human movement as basis
- Model-driven synthesis: simulating the whole system, body, instrument, and sound

Chapter 10

Visual Gesture Recognition

From Motion Tracking to Expressive Gesture

Antonio Camurri and Thomas B. Moeslund

Chapter 10:

- Aim of chapter: demonstrate how to extract movement data from (mostly) video input, and in particular, how to extract expressive data from these inputs
- Humans very good at perceiving movement also with incomplete data (occlusion, bad angle, poor light) and to perceive emotions from movement
- Extracting movement data from video requires several steps and much processing: background subtraction, silhouette extraction, quantity of motion, body mass, etc. estimations

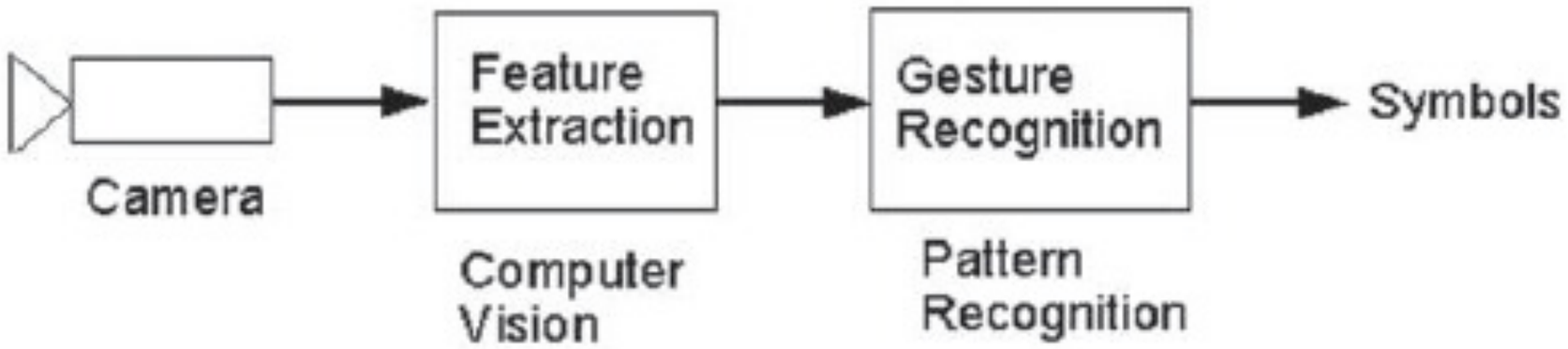
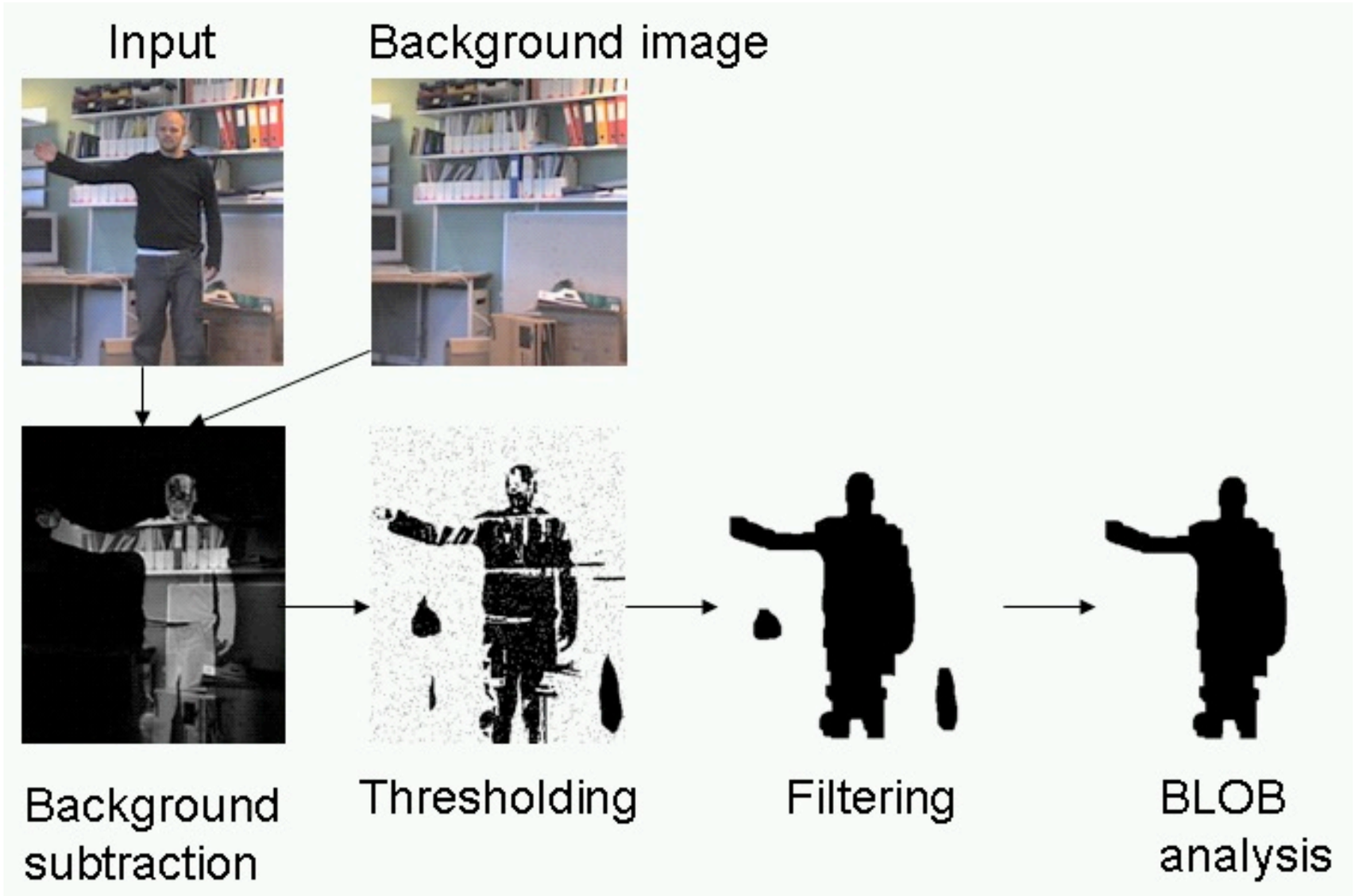


Figure 10.1 The different processes required for visual gesture recognition.


Input
Background image
Background subtraction
Thresholding
Filtering
BLOB analysis

Chapter 10:

- Expressive gestures: how to distinguish different intentions, e.g. between waving good-bye and chasing away an insect
- Clearly necessary to take into account the previous knowledge and context of the perceivers at any time
- Technology can be used to extract expressive gestures by various means, and these can again be used in sound-generation
- Rudolf Laban's effort categories interesting for this research
- A multilayered approach in feature extraction:

High-level expressive information: (Experiment 1) emotions classification (e.g. anger, fear, grief, joy); (Experiment 2) prediction of spectators' engagement.

Layer 4: Concepts and Structures – modeling, classification, prediction; e.g., based on machine learning techniques.

Motion segmentation and gesture representation: e.g., gesture segments, musical phrases, and trajectories representing gestures in semantic spaces.

Layer 3: Mid-level Features and Maps – Techniques for motion and gesture segmentation (e.g., in pause and motion phases), segmentation of the musical signal in phrases, and representations in feature spaces (e.g., energy-articulation spaces, Laban's Effort spaces).

Motion and audio descriptors: e.g., quantity of motion in movement, loudness in audio, amount of contraction/expansion, spectral width and melodic contour, fluency, impulsiveness, and roughness.

Layer 2: Low-level features – Computer vision techniques, statistical measures, and audio signal processing techniques.

Movement detection, trajectories (e.g., body silhouette, trajectories of body parts, trajectories of subjects considered as points moving in their general space – e.g. a dancer on stage), and features from MIDI and audio signals (spectral and temporal low-level features)

Layer 1: Physical Signals – Low-level analysis of video and audio signals, from signal conditioning and techniques for audio and video pre-processing and filtering, to background subtraction, motion detection, and motion tracking (e.g., color blob tracking, optical flow based feature tracking).

Data from several kinds of sensors: e.g., images from video cameras, sampled audio, MIDI messages, accelerometers data, physiological data, etc.

Chapter 11

Conductors' Gestures and Their Mapping to Sound Synthesis

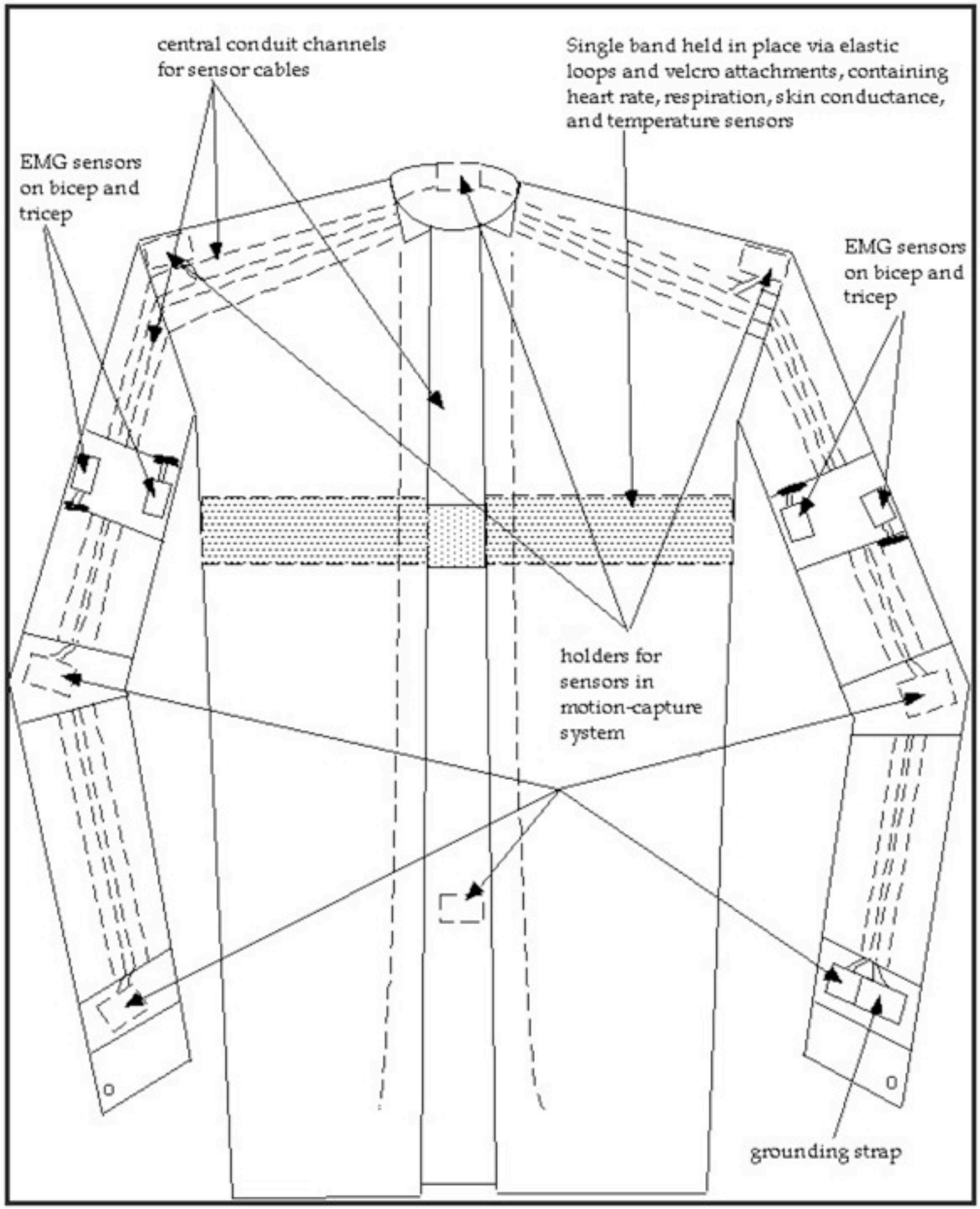
Gunnar Johannsen and Teresa Marrin Nakra

Chapter 11:

- Aim of chapter to give an overview of conductors' gestures used for control of new musical instruments
- First, a review of conducting basics
- Conducting as supervisory control
- Conducting gestures
- Capturing and analyzing conductors' gestures
- Various sensor technologies, e.g. accelerometers, gyroscopes, pressure sensors, infrared sensors, electromagnetic sensors, etc.

Chapter 11:

- But also more integrated systems:
- The Radio Baton System and various similar systems
- The conductors jacket system
- A wearable control data system:


central conduit channels for sensor cables
Single band held in place via elastic loops and velcro attachments, containing heart rate, respiration, skin conductance, and temperature sensors
EMG sensors on bicep and tricep
EMG sensors on bicep and tricep
holders for sensors in motion-capture system
grounding strap

Chapter 11:

- Mapping gestures to sound synthesis
- Mapping in general: assigning some variable to another variable
- Various musical instrument mappings, ranging from more traditional instrument imitation to quite novel mappings
- Various conductor systems for input, for mapping, and for degree of synthesis vs. playback
- Systems for interactive public (installations)