

Mapping Social Interaction through Sound: Conceptual Framework, Technological Development, and Real-World Studies

Berlin, November 27–28, 2020

Funded by the Berlin University Alliance

Zoom Link: <https://hu-berlin.zoom.us/my/benjaminstahl>

Friday, November 27, 2020

1:30 – 1:45 pm

Jin Hyun Kim—Welcome Address

1:45 – 2:00 pm

Marta Rizzonelli and Pascal Staudt—Virtual “Sentire” Demonstration

Symposium I: Promoting Social Cohesion through Communicative Interaction

Chair: Benjamin Stahl

2:00 – 2:45 pm

Stefanie Höhl—Getting Attuned: Neural Synchrony in
Caregiver-Child Interactions

2:45 – 3:30 pm

Moritz Köster—Aligning with Others through Culture: The Case for
Cultural Transmission in Early Development

Break

4:00 – 4:45 pm

Ian Cross—Affiliative Interaction in Music and Speech

4:45 – 5:30 pm

Jin Hyun Kim—Musical Dimensions of Communicative Interaction

Break

6:00 – 6:45 pm

Podium Discussion with Speakers of Symposium I

Host: Andreas Roepstorff

Saturday, November 28, 2020

Symposium II: Exploring the Suitability of Movement and Sound in Psychotherapy

Chair: Benjamin Stahl

9:30 – 10:15 am

Susanne Metzner—A Sense of Relation in Music: Some Observations from Music Therapy with Patients Suffering from Acute Psychosis

10:15 – 11:00 am

Jörg Fachner and Clemens Maidhof—Shared Emotional Processing of Important Moments in Music Therapy (GIM): Situated Cognition and Insight in an EEG Hyperscanning Setting

Break

11:30 – 12:15 pm

Anne Milek—Evidence-Based Couple Therapy: Current Status and Future Directions

12:15 – 1:00 pm

Podium Discussion with Speakers of Symposium II
Host: Benjamin Stahl

Lunch

Symposium III: How Can Sound Mapping Adequately Reflect Social Interaction?

Chair: Jin Hyun Kim

2:00 – 2:45 pm

Atau Tanaka—Sonic Intersubjectivity: The Non-Transparency of Social Sound Mapping

2:45 – 3:30 pm

Marcello Lussana—“Sentire”: Proxemics and Body Perception

Break

4:00 – 4:45 pm

Federico Ghelli Visi—Building and Exploring Multimodal Musical Corpora: From Data Collection to Interaction Design Using Machine Learning

4:45 – 5:30 pm

Podium Discussion with Speakers of Symposium III
Host: Jin Hyun Kim

Symposium I: Promoting Social Cohesion through Communicative Interaction

Organizers: Jin Hyun Kim and Benjamin Stahl

The crucial role of social cohesion in modern society has shaped the debate on the impact of digitisation that, apart from revolutionary benefits, may also be discussed in light of risk factors contributing to isolation of individuals and prevalence of mental disorders. Funded by the German Federal Ministry of Education and Research, the project “Social Interaction through Sound Feedback—Sentire” uses digitisation to promote embodied and situated human-computer interaction in artistic and musical contexts (www.sentire.me). Participants connect in a physical—as opposed to a virtual—environment by wearing specific bracelets that provide instant sound feedback depending on distance and touch between individuals. Based on central premises of “Sentire,” the present interdisciplinary symposium focuses on current attempts to overcome the challenge of social cohesion in modern society by using embodied and situated human-computer interaction in artistic and musical contexts. In particular, questions of the symposium include: How does communicative interaction—describable as “musical” in both a literal and metaphorical sense—establish a sense of mutual affiliation? Are these processes relevant to social cohesion? And if so, how can communicative interaction inform social cohesion in aspects of everyday life?

Speakers: Stefanie Höhl, Moritz Köster, Ian Cross, and Jin Hyun Kim

Symposium II: Exploring the Suitability of Movement and Sound in Psychotherapy

Organizer: Benjamin Stahl

According to early 20th century psychoanalysis, the “unsaid” becomes apparent in the relationship between patient and therapist, as well as in metaphors and symbols revealed through unintended utterances, imaginative techniques, and dreams. To convey emotions and thoughts, this method relies on the use of spoken language. Likewise, spoken language remains central to the practice of psychotherapy in subsequent decades, as clinicians and researchers sought to translate and transform major claims of psychoanalysis into newer paradigms, the most prominent of them being cognitive-behavioral, client-centered and family-systems psychotherapy. Inspired by somatic psychology and neuroscience evidence, more recent approaches focus on body and movement to target the “unsaid” beyond spoken language. As illustrated in Symposium I, the “Sentire” system uses sound to provide immediate feedback for physical distance and touch between individuals (www.sentire.me). Exploring the adequacy of “Sentire” as a potential means to complement existing methods in psychotherapy, questions of the present symposium include: How can movement and sound expose the “unsaid” without the use of spoken language? How can “Sentire” uncover the intricacies of social interaction in a meaningful way to identify unmet needs in couple relationships? And how can interaction between body movement and sound effectively add to previous clinical research in this field?

Speakers: Susanne Metzner, Jörg Fachner, Clemens Maidhof, and Anne Milek

Symposium III: How Can Sound Mapping Adequately Reflect Social Interaction?

Organizer: Marcello Lussana

As outlined in sessions of Symposium I and II, “Sentire” is a digital system that mediates body movement and musical sound through a machine interface that enables two (or more) persons to interact with one another in a physical environment. In particular, this system can detect and sonify proximity and touch between two users. Providing feedback to body-mediated interpersonal interaction, such a multimodal experience may enhance proprioceptive and kinesthetic awareness of self and others. Two or more individuals, perceiving their own behavior and that of others in a shared social context, serve as a basis for social interaction. Such social context can afford or constrain how each participant selects his or her own behavior. Within this conceptual framework, the “Sentire” research team aims to create a mapping of body movement and sound. Questions of the present symposium include: Which aspects of a sound mapping can facilitate proprioceptive and kinesthetic awareness of self and others? How can such sound mapping be designed to offer an intuitive user experience for potential real-world applications? And to what extent can experimental outcomes contribute to real-world applications?

Speakers: Atau Tanaka, Marcello Lussana, and Federico Ghelli Visi

Getting Attuned: Neural Synchrony in Caregiver-Child Interactions

Stefanie Höhl—University of Vienna, Austria

Caregiver-child interactions are characterized by interpersonal rhythms at different timescales, from nursery rhymes and interactive games to daily routines (Markova *et al.*, 2019). These rhythms make the social environment more predictable for young children and enable interpersonal biobehavioral synchrony with their caregivers. By using simultaneous measures of neural and physiological activities from caregiver and child during live interactions, e.g., dual-ECG and dual-fNIRS, we can deepen our understanding of early interactional dynamics and their rhythmicity. I will present our recent research identifying factors critical to the establishment of caregiver-child synchrony (Nguyen *et al.*, 2020), such as affective touch in infants and mutual reciprocity and verbal turn-taking in preschool-aged children (Nguyen *et al.*, 2020a, 2020b). I will further discuss some of the potential functions of interpersonal neural synchrony in early social-cognitive development, from social learning and communication to effective cooperation and interpersonal coordination.

References

- Markova, G., Nguyen, T., & Hoehl, S. (2019). Neurobehavioral Interpersonal Synchrony in Early Development: The Role of Interactional Rhythms. *Frontiers in Psychology, 10*, 2078.
- Nguyen, T., Bánki, A., Markova, G., & Hoehl, S. (2020). Studying parent-child interaction with hyperscanning. In *Progress in Brain Research* (Vol. 254, pp. 1–24). Amsterdam: Elsevier.
- Nguyen, T., Schleihauf, H., Kayhan, E., Matthes, D., Vrticka, P., & Hoehl, S. (2020a). The effects of interaction quality on neural synchrony during mother-child problem solving. *Cortex, 124*, 235–249.
- Nguyen, T., Schleihauf, H., Kayhan, E., Matthes, D., Vrticka, P., & Hoehl, S. (2020b). Neural synchrony in mother-child conversation: Exploring the role of conversation patterns. *Social Cognitive and Affective Neuroscience*, nsaa079.

Aligning with Others through Culture: The Case for Cultural Transmission in Early Development

Moritz Köster—Free University of Berlin, Germany

Humans are a uniquely cultural species and share with those individuals around them a set of beliefs and behaviors. Shared beliefs and behaviors facilitate social interactions within groups of individuals, rendering those groups cultural groups. How do we acquire the beliefs and practices from our cultural group? A central mechanism for cultural transmission is the early-parent child interaction. Parents, being the primary social interaction partner for most children, provide a model for social learning but also actively provide an interpretational structure about the world and scaffold certain behaviors in their children. Here I will present our recent work in this field, demonstrating that the early parent-child interaction is the cradle for culture-specific ways of perceiving and interacting with the world and how parental behavior varies across cultural populations, providing their offspring with diverse learning experiences and thereby laying the ground for culture-specific developmental pathways. To conclude, looking at early cultural learning processes is key to our understanding of how we align our beliefs and behavior with others through cultural transmission in early development.

Affiliative Interaction in Music and Speech

Ian Cross—University of Cambridge, United Kingdom

Most research into language-music relationships has privileged language in the comparisons that it makes between the two domains. Music has generally been explored as though it were a sonic domain made up of complex patterns that can elicit aesthetic or hedonic responses, while studies of language are founded on its capacity to express complex propositions that can reflect states of affairs in the world. While music may resemble language in its combinatorial properties, in comparison with language it lacks the all-important property of compositionality; it thus appears to be a pale analogue of language with limited utility and little relevance outside the realm of entertainment. This view is, however, completely controverted by the fact that across cultures music is encountered as a participatory medium for communicative interaction with diverse and significant functions. Participatory music displays features and involves processes that equip it to manage social relations by inducing a sense of mutual affiliation between participants. At least some of those features and processes are present in other modes of human interaction, particularly those genres of language concerned with establishing or continuing mutual affiliation or attachment, generally termed “phatic.” I suggest that music as an interactive medium intersects so significantly with speech in the phatic register as to be indistinguishable from it. I hypothesize that affiliative communicative interaction need be neither music nor speech, but that these are best construed as culturally-constituted categories of human behavior; the superordinate and generalizable category into which both fall is that of human affiliative communicative behavior, which can be claimed in different cultures to be music, speech, or any one of a range of other categories in other possible taxonomies of human communicative behavior. This talk will survey the evidence from ethnomusicology, linguistics and the cognitive sciences of music that support this hypothesis, and will introduce results of collaborative research into spontaneous interaction in speech and music that is taking place in my Center which provide further evidence in its favor.

Musical Dimensions of Communicative Interaction

Jin Hyun Kim—Humboldt University of Berlin, Germany

Current interdisciplinary research on empathy, pre-verbal interaction and social coordination offers new perspectives on the dimensions of communicative interaction that, although not articulated in propositions, is nevertheless considered to be meaningful. This talk proposes a musical paradigm to describe behaviors and phenomena that can be characterized as coordination (including attunement, entrainment, empathy, and joint action) and understood within the course of experiential re-enactment. The role of coordination in social interaction has come to the fore in recent research on proto-musical and proto-linguistic behaviors. In developmental psychology, the coordination that emerges during caregiver-infant interaction is considered to be based on “communicative musicality,” an ability linked to “our innate skill for moving, remembering and planning in sympathy with others that makes our appreciation and production of an endless variety of dramatic temporal narratives possible” (Malloch & Trevarthen, 2009). The concept of “the musical”—understood as a coordinated praxis which structures shared experiences and proves to be meaningful although it does not carry any representational meaning—proposed in this talk enhances this concept of communicative musicality. This talk places special focus on dynamic forms of musical phenomena and behaviors that are shaped in relation to others. I claim that musical phenomena and behaviors that do not have representational semantics can be merged into a meaningful unity—which I refer to as “musical forms of vitality”—by virtue of being related to one another, as well as to the world. The term “forms of vitality” was coined by the developmental psychologist Daniel N. Stern to refer to the relational experience of vitality; because forms of vitality emerge relationally, i.e., through interaction with others, musical forms of vitality that resemble human forms of vitality could act as a basis for investigating the social dimensions of musical phenomena and behaviors. The extent to which communicative interaction—which can be described as “musical”—serves as a medium through which one understands the forms of one’s own experience and engages with others is a central research question investigated within the scope of our ongoing research project “Sentire.” This talk concludes with a brief introduction of our approach designing the experience of both social relations between interactants (including social cohesion) and the emergence of the self as dependent on others, called Artistic Human-Computer Interaction (AHCI) Design.

References and further reading

- Clayton, M., Jakubowski, K., & Eerola, T. (2019). Interpersonal entrainment in Indian instrumental music performance: Synchronization and movement coordination relate to tempo, dynamics, metrical and cadential structure. *Musicae Scientiae*, 23(3), 304–331.
- Coplan, A., & Goldie, P. (eds.) (2011). *Empathy: Philosophical and Psychological Perspectives*. Oxford: Oxford University Press.
- Keller, P., Novembre, G., & Hove, M. J. (2014). Rhythm in joint action: Psychological and neurophysiological mechanisms for real-time interpersonal coordination. *Philosophical Transactions of the Royal Society B*, 369(1658), 20130394.
- Kim, J. H. (2013). Shaping and co-shaping forms of vitality in music: Beyond cognitivist and emotivist approaches to musical expressiveness. *Empirical Musicology Review*, 8(3–4), 162–173.
- Kim, J. H., Reifgerst, A., & Rizzonelli, M. (2019). Musical social entrainment. *Music & Science*, 2, 1–17.
- Malloch, S., & Trevarthen, C. (2009). Musicality: communicating the vitality and interests of life. In S. Malloch & C. Trevarthen (eds.), *Communicative Musicality: Exploring the Basis of Human Companionship* (pp. 1–11). Oxford: Oxford University Press.
- Seifert, U., & Kim, J. H. (2008). Towards a conceptual framework and an empirical methodology in research on artistic human-computer and human-robot interaction. In I. Pavlidis (ed.), *Human-Computer Interaction* (pp. 177–194). Vienna: In-Tech.
- Stern, D. N. (2010). *Forms of Vitality: Exploring Dynamic Experience in Psychology, the Arts, Psychotherapy, and Development*. New York, NY: Oxford University Press.

A Sense of Relation in Music: Some Observations from Music Therapy with Patients Suffering from Acute Psychosis

Susanne Metzner—University of Augsburg, Germany

After a short description of psychodynamic music therapy and an overview of music therapy with patients with psychosis, two studies of process research are summarized. Goals and objectives deal with musical attunement within free improvisations, with the conditions of their development, time points of appearance and their quality in correlation with psychotic symptoms. Findings show the co-creative processes of patient and therapist. They are interpreted within the concepts of psychoanalytic therapy of psychoses, process features discovered by the Boston Change Process Study Group and by the phenomenological concept of intercorporeality. The results are discussed in the context of research on movement and gesture synchronization.

Further reading

BCPSG—Boston Change Process Study Group (2002). Explicating the implicit: The local level and the microprocess of change in the analytic situation. *The International Journal of Psychoanalysis*, 83, 1051–1062.

Dümpelmann, M. (2018). *Psychodynamische Behandlung psychotischer Störungen: Wenn die Grenze der Fall ist*. Stuttgart: Kohlhammer.

Fuchs, T. (2016). Intercorporeality and interaffectivity. *Phenomenology and Mind*, 11, 194–209.

Kupper, Z., Ramseyer, F., Hoffmann, H., & Tschacher, W. (2015). Nonverbal synchrony in social interactions of patients with schizophrenia indicates socio-communicative deficits. *PLoS ONE*, 10(12), e0145882.

Metzner, S. (2018). Über Einstimmungen: Erkenntnisse musiktherapeutischer Prozessforschung aus leibphänomenologischer Perspektive. *Psychodynamische Psychotherapie*, 4, 222–231.

Metzner, S. (2016). Psychodynamic Music Therapy. In J. Edwards (ed.), *The Oxford Handbook of Music Therapy* (pp. 448–471). Oxford: Oxford University Press.

Metzner, S., Jaeger, U., Masuhr, O., Olschewski, U., Gräfe, E., Böske, A. C., et al. (2018). Forms of attunement during the initial stages of music therapy for

patients with psychosis: A multicentre clinical study. *Nordic Journal of Music Therapy*, 27(5), 360–380.

Stern, D. N., Sander, L. W., Nahum, J. P., Harrison, A. M., Lyons-Ruth, K., Morgan, A. C., *et al.* (1998). Non-interpretive mechanisms in psychoanalytic therapy: The “something more” than interpretation. *International Journal of Psychoanalysis*, 79(5), 903–921.

Tostmann, J., & Metzner, S. (2017): Ko-kreative Momente und Transition: Eine qualitative Studie zu den Entstehungsbedingungen rhythmischer Abstimmung in Erstimprovisationen mit an Psychose erkrankten Patienten. *Musiktherapeutische Umschau*, 38(4), 356–366.

Shared Emotional Processing of Important Moments in Music Therapy (GIM): Situated Cognition and Insight in an EEG Hyperscanning Setting

Jörg Fachner and Clemens Maidhof—Anglia Ruskin University, United Kingdom

Several randomized controlled trials (RCTs) and systematic reviews have shown that music therapy works with different patient groups and several attempts have been made to explain how the treatment may work (Aalbers *et al.*, 2017). As music is considered to be the language of emotions we may also use brain data generated in experimental research to approximate the effects of music in therapy in order to explain general processes of emotion processing in music therapy (Koelsch, 2009). However, what these approximations are lacking is in-situ data that was gathered during the music therapy process in order to understand how change in therapy is happening (Fachner, 2014). As in psychotherapy research one of the main working factors discussed is the therapeutic relationship and the therapeutic alliance in a healing contract between the patient and the therapist (Fachner, 2017; Tschacher *et al.*, 2015). As change processes seem to gradually build up or may happen as spontaneous insight into a complex problematic, we need tools that adapt to the normal practice of doing music therapy and allow us to capture continuous interpersonal interaction between the therapist and the patient.

To analyze how emotions and imagery are shared, processed and recognized in Guided Imagery and Music, we measured the brain activity of an experienced therapist ("Guide") and client ("Traveler") with dual-EEG in a real therapy session about potential death of family members (Fachner *et al.*, 2019). To our knowledge this is the first in-situ study of a music therapy session. Synchronously with the EEG, the session was video-taped and then micro-analyzed. Four raters identified therapeutically important moments of interest (MOI) and no-interest (MONI) which were transcribed and annotated. Several indices of emotion- and imagery-related processing were analyzed: frontal and parietal alpha asymmetry, frontal midline theta, and occipital alpha activity.

Session ratings showed overlaps across all raters, confirming the importance of these MOIs, which showed different cortical activity in visual areas compared to resting-state. MOI 1 was a pivotal moment (Grocke, 1999) including an important imagery with a message of hope from a close family member, while in the second MOI the Traveler sent a message to an unborn baby.

Generally, results seemed to indicate that the emotions of Traveler and Guide during important moments were not positive, pleasurable or relaxed when compared to resting-state, confirming both were dealing with negative emotions and anxiety that had to be contained in the interpersonal process. However, the temporal dynamics of emotion-related markers suggested shifts in emotional valence and intensity during these important, personally meaningful moments; for example, during receiving the message of hope, an increase of frontal alpha asymmetry was observed, reflecting increased positive emotional processing. EEG source localization during the message suggested a peak activation in left middle temporal gyrus.

Interestingly, peaks in emotional markers in the Guide partly paralleled the Traveler's peaks; for example, during the Guide's strong feeling of mutuality in MOI 2, the time series of frontal alpha asymmetries showed a significant cross-correlation, indicating similar emotional processing in Traveler and Guide.

Investigating the moment-to-moment interaction in music therapy showed how asymmetry peaks align with the situated cognition of Traveler and Guide along the emotional contour of the music, representing the highs and lows during the therapy process. Mobile imaging tools allowed to capture in-situ an authentic music therapy session and enabled us to analyze a real music therapy session. Combining dual-EEG with detailed audiovisual and qualitative data seems to be a promising approach for further research into music therapy.

References

- Aalbers, S., Fusar-Poli, L., Freeman, R. E., Spreen, M., Ket, J. C., Vink, A. C., et al. (2017). Music therapy for depression. *Cochrane Database of Systematic Reviews*, 11, CD004517.
- Koelsch S. (2009). A neuroscientific perspective on music therapy. *Annals of the New York Academy of Sciences*, 1169, 374–384.
- Fachner J. (2014). Communicating change—meaningful moments, situated cognition and music therapy—a reply to North (2014). *Psychology of Music*, 42(6), 791–799.
- Fachner J. (2017). Music, moments and healing processes: Music therapy. In R. Ashley & R. Timmers (eds.), *Routledge Companion to Music Cognition* (pp. 89–100). London: Routledge.
- Tschacher, W., Haken, H., & Kyselo, M. (2015). Alliance: A common factor of psychotherapy modeled by structural theory. *Frontiers in Psychology*, 6, 421.

Fachner, J., Maidhof, C., Grocke, D., Nygaard Pedersen, I., Trondalen, G., Tucek, G., *et al.* (2019). "Telling me not to worry ..." Hyperscanning and neural dynamics of emotion processing during guided imagery and music. *Frontiers in Psychology*, 10, 1561.

Grocke, D. (1999). Pivotal moments in guided imagery and music. In J. Hibben (ed.), *Inside Music Therapy: Client Experiences* (pp. 295–305). Gilsum, NH: Barcelona.

Evidence-Based Couple Therapy: Current Status and Future Directions

Anne Milek—University of Münster, Germany

In this talk, an overview of the current science of couple therapy will be presented, emphasizing empirically supported treatments for distressed couples and new directions in couples research (e.g., online therapy), including illustrative case examples. Couple therapy comprises an essential component of mental health services. Research demonstrates its effectiveness in treating generalized relationship distress as well as comorbid relationship problems and individual emotional and behavioral difficulties. However, 25 to 30 percent of couples show no benefit from couple therapy. Hence, the questions “how does couple therapy work?” and “for whom does couple therapy (not) work?” will also be discussed. Going beyond the current status, I will close with reflections on how integrative efforts to include music into couple therapy could be a fruitful approach bearing the potential to increase the impact of traditional couple interventions.

Sonic Intersubjectivity: The Non-Transparency of Social Sound Mapping

Atau Tanaka—Goldsmiths, University of London, United Kingdom

The human body exists within environments. Music is, more often than not, a social activity. It thus might make sense to apply methods of sonification to understand the dynamics of non-musical social interaction. This talk will explore what that entails, and suggest that the act of mediation will leave an imprint on the social phenomenon itself.

Social situations take a subject out of isolation and situate them within an environment. This environment may include other subjects. Or it may include other aspects—space, objects, and non-subject entities. Varela and Maturana (1987) describe autopoiesis as the becoming of an organism in relation to its surroundings. Haraway (2016) extends this to propose the notion of sympoiesis, where an organism does not stand alone in its environment, but is part and parts of groups of other organisms engaging in forms of collective becoming. How might we think of sonic sympoiesis?

To musically or aurally map the body entails methods of sonification. Mapping the sonic body in a social setting could mean one or multiple things: sonifying each individual body; sonifying the social interaction; or sonifying the environmental interaction. In all cases the social setting implies that we are trying to create a sense of shared experience—a situation that is meaningful first to its participants, and then by association to any eventual observers. The constitution of shared experience supposes creating the conditions for shared meaning making and shared subjectivities. I propose thinking of this as sonic intersubjectivity.

I would like to connect traditions of pragmatic and phenomenological philosophies to understand sonic intersubjectivity. Johnson (2008) suggests that meaning making can be embodied and not just propositional. This embodied, immanent form of meaning making recruits the body and its sensorimotor histories. He recalls Dewey's principle of continuity to circumvent the propositional nature of semantic logic, to propose naturalistic logics. Dewey (2005) describes artistic experience as an expressive gestalt that goes beyond representation. This helps us access the potentially pre-linguistic nature of the corporeal social interaction we seek to sonify.

Intersubjectivity is described in clinical psychology in the context of therapy. In sound studies, Kassabian (2013) evokes new forms of listening in environments where constant sound mediation brings about forms of distributed subjectivity—

where there may no longer be a classical subject as such. Lähdeoja and Montes de Oca (in press) explore musical intersubjectivity as the space between musicians mediated by action-perception. These forms of mediation are perhaps instructive to understanding the risks of sonifying the social. Sonification may be proposed initially as an invisible extension, following Merleau-Ponty (1982). However, Magnusson (2019) evokes Ihde (2007) in noting that a musical instrument is not a transparent extension. If we follow Barad (2007) in her posthumanist reading of quantum physics, we understand that the very act of observation affects the phenomenon itself. So, in whatever mapping we create, it will not be transparent—it may impinge, facilitate, or color the social corporeal interaction we seek to sonify.

References and further reading

- Barad, K. (2007). *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning*. Durham, NC: Duke University Press.
- Dewey, J. (2005). *Art as Experience*. New York, NY: Penguin.
- Haraway, D. J. (2016). *Staying with the Trouble: Making Kin in the Chthulucene*. Durham, NC: Duke University Press.
- Ihde, D. (2007). *Listening and Voice: Phenomenologies of Sound*. State University of New York Press.
- Johnson, M. (2008). *The Meaning of the Body: Aesthetics of Human Understanding*. University of Chicago Press.
- Kassabian, A. (2013). *Ubiquitous Listening: Affect, Attention, and Distributed Subjectivity*. University of California Press.
- Lähdeoja, O., & Montes de Oca, A. (in press). Co-sounding: Fostering intersubjectivity in electronic music improvisation. *Organised Sound*.
- Magnusson, T. (2019). *Sonic Writing: Technologies of Material, Symbolic, and Signal Inscriptions*. London: Bloomsbury Academic.
- Maturana, H. R., & Varela, F. J. (1987). *The Tree of Knowledge: The Biological Roots of Human Understanding*. London: Shambhala.
- Merleau-Ponty, M. (1982). *Phenomenology of Perception*. London: Routledge.
- Parkinson, A., & Tanaka, A. (2013). Making data sing: Embodied approaches to sonification. In M. Aramaki (ed.), *International Symposium on Computer Music Multidisciplinary Research* (pp. 151–160). Berlin: Springer.

Small, C. (1998). *Musicking: The Meanings of Performing and Listening*. Middletown, CT: Wesleyan University Press.

Tanaka, A. (2012). The Sound of Photographic Image. *AI & Society*, 27, 315–318.

“Sentire”: Proxemics and Body Perception

Marcello Lussana—Humboldt University of Berlin, Germany

Proxemics is the study of interpersonal and environmental space. Edward T. Hall coined the word proxemics, defined as “the interrelated observations and theories of man’s use of space as a specialized elaboration of culture” (Hall, 1966). The technological development of the last half century extended our relationship to interpersonal and environmental space, as well as to other humans, enriching our possibilities for social interaction, but also making them more complex and sometimes unclear (McArthur, 2016; Greenberg *et al.*, 2011; Mueller *et al.*, 2014). A brief overview of the current state-of-the-art on proxemics in media technology will be given, and the “Sentire” system will be introduced. “Sentire” is a digital system that mediates body movement and musical sound through a machine interface enabling two (or more) persons to interact with one another in a physical environment. In particular, this system can detect and sonify proximity and touch between two users, thus shaping the proxemics experience. Such a multimodal experience may enhance proprioceptive and kinesthetic awareness of self and others, depending on how “Sentire” is designed—i.e., how proximity and touch between users control sound parameters. After a short explanation of common sonification strategies, a few examples of the design of the “Sentire” system will be presented.

References

- Greenberg, S., Marquardt, N., Ballendat, T., Diaz-Marino, R., & Wang, M. (2011). Proxemic interactions: The new ubicomp? *Interactions*, 18(1), 42–50.
- Hall, E. T. (1966). *The Hidden Dimension*. Garden City, NY: Doubleday.
- McArthur, J. A. (2016). *Digital Proxemics*. Bern, Switzerland: Peter Lang.
- Mueller, F., Stellmach, S., Greenberg, S., Dippon, A., Boll, S., Garner, J., *et al.* (2014). Proxemics play: Understanding proxemics for designing digital play experiences. In *Proceedings of the 2014 Conference on Designing Interactive Systems*, 533–542. Vancouver, BC: Association for Computing Machinery.

Building and Exploring Multimodal Musical Corpora: From Data Collection to Interaction Design Using Machine Learning

Federico Ghelli Visi—Luleå University of Technology, Sweden

Musical performance is a multimodal experience, for performers and listeners alike. A multimodal representation of a piece of music can contain several synchronized layers, such as audio, symbolic representations (e.g., a score), videos of the performance, physiological and motion data describing the performers movements, as well as semantic labeling and annotations describing expressivity and other high-level qualities of the music. This delineates a scenario where computational music analysis can harness cross-modal processing and multimodal fusion methods to shift the focus toward the relationships that tie together different modalities, thereby revealing the links between low-level features and high-level expressive qualities.

I will present two concurrent projects focused on harnessing musical corpora for analyzing expressive instrumental music performance and design musical interactions. The first project is centered on a data collection method—currently being developed by the GEMM research cluster at the School of Music in Piteå—aimed at bridging the gap between qualitative and quantitative approaches. The purpose of this method is to build a data corpus containing multimodal measures linked to high-level subjective observations. By applying stimulated recall (a common qualitative research method in education, medicine, and psychotherapy) the knowledge of music professionals is systematically included in the analytic framework. Initial results suggest that qualitative analysis through stimulated recall is an efficient method for generating higher level understandings of musical performance.

The second project—a joint effort with the Computing Department at Goldsmiths, University of London—consists in a sonic interaction design approach that makes use of deep reinforcement learning to explore many mapping possibilities between large sound corpora and motion sensor data. The design approach adopted is inspired by the ideas established by the interactive machine-learning paradigm, as well as by the use of artificial agents in computer music for exploring complex parameter spaces. We refer to this interaction design approach as Assisted Interactive Machine Learning (AIML). While playing with a large corpus of sounds through gestural interaction by means of a motion sensor, the user can give feedback to an artificial agent about the gesture-sound mappings proposed by the latter. This iterative process results in an interactive

exploration of the corpus, as well as in a way of creating and refining gesture-sound mappings.

These projects are representative of how the development of methods for combining qualitative and quantitative data, in conjunction with the use of computational techniques such as machine learning, can be instrumental in the design of complex mappings between body movement and musical sound, and contribute to the study of the multiple facets of embodied music performance.