Corporeality, Actions and Perceptions in Gestural Performance of Digital Music

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ABSTRACT

What is the relationship between the performer's body, the instrument, the musical actions and their perception by an audience? And how do they relate when the music is generated by abstract digital processes controlled through actions on technical control surfaces, or gestural, tangible interfaces? This article investigates these questions by examining elements and concepts from physiology, the cognitive sciences with an 'enactive' and phenomenological perspective and from the point of view of an artistic performance practice, which brings these elements together on stage. In a broad arc the investigation covers instrumental and perceptual affordances, the physical senses of the body, different levels of awareness, corporeal states and modes of awareness, the senses of agency and intentionality, and the sense of movement inherent to music. Based on these insights, the contradiction between the corporeal space of performance and the abstract, codified domain of the digital sound processes is revealed. By looking at the prevalent metaphors, but also the interaction concepts and models of control and their shortcomings, it becomes evident that they need to be refined, possibly based on the perceptual and corporeal criteria developed here.

1. INTRODUCTION

The physicality and presence of the performer on stage is a central characteristic of all performing arts. Apart from social dimensions of the concert form and the culturally charged space of the stage [1], the corporeality of the musician is one of the central anchors that help to constitute the moment of performance both for the musician and the audience. Presence in this context is more than the mere physical occupation of space or the physical attendance of an event. It is an attitude, which informs on a subconscious level the intensity of the act of communication that any performance represents [2, p. 171].

In this framework there are two possible points of view to be adopted. From the first position, attempts can be made to be objective and stand outside of the situation as much as possible (objective distance). Traditionally, the observation and analysis would take the perspective of the audience or the spectators (interestingly the modalities of lis-

tening and seeing are already implied in these terms). By looking at the situation from the position of an observer, the outer forms and expressive qualities, as well as the musical contents of a piece and the effects they produce on the perceiver can be analysed. In a concert this holds true both for the auditory and visual domains, as well as for the somatic-kinaesthetic sense modalities. When focusing on this latter modality as the channel of communication, which subtends the perception of presence and enables emphatic participation for the public, corporeal effects of sharing a music performance become apparent.

The second perspective is subjective and can be regarded as problematic. By taking the point of view of the central actor, the performer, only individual perceptions and subjective experiences – as opposed to inter-individually verifiable 'facts' – can be retrieved.

However, and this shall be a central topic of this article, the primary site of physicality in a performance is located with the musician who is performing in front of and for the public. Unless there is an explicit form of audience-participation, the performance situation is intended to facilitate the expression by the musician and its perception by the public. [1] This can be called the communication space of the performance, which is framed by these two positions. The performer(s) and the audience enter into a coded situation of joint attention and common knowledge [3], albeit in an asymmetrical manner.

The situation of the performer represents a unique set of circumstances, which sheds a light not just on the discipline of live music but in general on the divide between music perception and its multimodal nature and the current cultural practice of music consumption in technologically mediated forms, for example through recordings.

From my point of view as a performing musician working with Digital Music Instruments (DMIs) and gestural forms of 'interaction', I have a number of questions that need to be addressed, in order to more fully understand the implications of my physicality during performance [4]. The constellation described above applies to any form of (western) music performance. In computer music and other technologically mediated forms of stage action, such as video-augmented dance or theatre, an additional factor enters into play. One of the core elements of music practice fundamentally changes, thus adding to the complexity of the situation. The instrument – the method for producing sound – loses its rooting in the physical world and gener-

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[1] The flow in the other direction is not usually practiced, although it is implied and present in any concert even before the applause.

ates an additional space, which the musician has to negotiate in addition to that of the stage. This is the invisible and intangible domain of symbolic processes and number manipulations that constitute digital sound generation. For the player to fully interact with the instrument, a channel from the physical to the symbolical domain is required, a way of conveying intentions and executing actions that can modulate or modify the sounding outcome. The instrument – the outer shell or tangible object, the methods for interacting it offers and the models for generating sound it performs – has become fragmented and exists in more than one modality, divided between physical characteristics, sensorial affordances and abstract thought processes.

2. FOUNDATIONS

In this article, I investigate the inherently contradictory situation of performing music generated by digital processes with the gestural abilities and the perceptual foundations given by our bodies. By juxtaposing concepts from ecological psychology with an 'enactive' and phenomenological position in philosophy and practical experiences in artistic processes, I hope to gain insights into the core elements and forces at play in this abstract yet potentially expressive form of performing art. In order to frame this position in a concrete statement about 'embodied action' consider this statement by Varela, Thomson, and Rosch: "By using the term *embodied* we mean to highlight two points: first that cognition depends upon the kinds of experience that come from having a body with various sensorimotor capacities, and second, that these individual sensorimotor capacities are themselves embedded in a more encompassing biological, psychological, and cultural context. By using the term *action* we mean to emphasize [...] that sensory and motor processes, perception and action, are fundamentally inseparable in lived cognition. [...] the enactive approach consists of two points: (1) perception consists in perceptually guided actions and (2) cognitive structures emerge from recurrent sensorimotor patterns that enable action to be perceptually guided." [5, p. 173] For a musician, these perceptually guided actions occur naturally when performing on an instrument. And that this involves cognitive structures that were formed by repeated patterns of engagement with the instrument, is evident when thinking of extended instrumental training. Where this combination becomes interesting is when instrumental actions cease to be exclusively perceptually guided and when cognitive structures emerge that are informed less by perceptually guided actions than by conceptually structured perceptions.

2.1 Affordances

Let's look at the instrument and at what it offers to the musician in addition to the production of sound.

The discourse within the last decade in design in general and digital instrument development [6] in particular has incorporated the term 'affordance' that Gibson [7] defined in terms of ecological potential, as that which an object or environment is offering as actions or resources. "The

affordance of something does not change as the need of the observer changes. The observer may or may not perceive or attend to the affordance, according to his needs, but the affordance, being invariant, is always there to be perceived." [7, pp. 138–139]

Gibson derives his concept from 'Gestalt' psychology's terms of valence, invitation and demand, but criticises that its proponents used the concept in a value-free manner. He emphasises the inherent meaning that arises out of ecological embedding. "An affordance points two ways, to the environment and to the observer. So does the information to specify an affordance. [...] this is only to reemphasize that exteroception is accompanied by proprioception – that to perceive the world is to coperceive oneself. [...] The awareness of the world and of one's complementary relations to the world are not separable" [7, p. 141]

Unfortunately, in digital instrument building an amalgamation of concepts has been made, which simplifies this concept and applies it only to the instruments and almost exclusively to the potential actions, behaviours and sounds they afford. My contention with this point of view is that it ignores the impact an instrument – either physical or virtual – has on the musician on the corporeal, pre-cognitive and cognitive levels. If we want to understand the scope of these *objective* affordances [8] that we can clearly analyse in traditional instruments, and that we have to deduce, combine or extrapolate in dematerialised or technologically split instruments (DMIs), we also have to add the concept of *perceptual* affordances that reside outside the domain of the instrument, yet form part of the constellation of its usage.

Perceptual affordance on a primary level could be defined as the type of perceptions generated when entering into contact with the instrument, without necessarily interacting with it. These perceptions form a multi-modal field that encompasses the traditional five senses of vision, audition, touch, taste, smell. They arise when attentional awareness is guided towards the instrument in any of the sensory modes. An example for such an affordance would be perceiving the tension of a drum skin when holding a frame-drum.

On a secondary level, perceptual affordances could also be seen as the potential for perceptions that arise out of the *interaction* with the instrument. These secondary perceptions could be tied to the five senses as well, if they manifest themselves within the outside perceptual field and in direct relationship with the instrument. An example for this affordance would be the sound generated from playing the instrument, contained in the auditory event that arises out of an instrumental action.

The perceptions or awareness that originates *within* the player when interacting with the instrument, however, represents a separate type of perceptual affordance, which – even though it is derived from contact and action with the instrument – does not exist independently of cognitive or pre-cognitive processes of the performer. The outer contact with the instrument is conveyed by tactile and sometimes vibro-tactile cues, an aspect research and instrument developments are pursuing. In contrast, the inner effects of con-

tact with the instrument are based on a kind of sensing that is active within the body, such as kinaesthetic, vestibular and equilibrial sensing. These effects can not be called perceptions by default, but rather belong to the pre-reflective, pre-cognitive levels of our perceptual system. An example of this type of affordance might be the level of comfort or the complexity of physical adaptation an instrument demands for its proper playing position, e.g. holding the violin clamped under the chin. Or the pre-conscious adaptations to playing due to the perception of vibrational forces transmitted through the body, such as the modulation of a vibrato as felt through the changes in the vibrating string.

2.2 Object and Body Perception

Considering the performance of digital sounds through physical actions and gestures, the question arises of how the physical interface, the surfaces and action-space of the instrument are perceived by the performer. When watching traditional instrument playing, an intuitive understanding of the mechanics and actions of play is present, thanks to a common acculturation process. And even if the instrument is unfamiliar, once the sound-production model has been recognised, it is understood through extrapolation from prior experiences.

For a performing musician the awareness of the instrument happens through an *object* perception. The prime exception to this rule are singers, for whom the instrument and the body coincide and where instrumental actions have a different scope. Yet even professional singers talk of their 'voice' as if it were a separate object that they manipulate through technique [9].

Even though the instrument might be only peripherally perceived, while the focus lies for example on the sound, nevertheless this "object perception involves an experience that is *directed at* the object. The relation at stake here is [...] an intentional relation. [...] one necessary [...] condition is that the intentional relation involves the *identification* of the object as *something*. To perceive involves the ability to pick something out, to identify it as an object or as a state of affairs in some minimal sense." [10, p. 56] Regardless of the simplicity or complexity of an instrument, it is perceived as an object. Shifting the attention from sound to sound production, e.g. by paying attention to the attack of the bow, moves the intentional focus from an outer perception of sound to an object perception of the instrument. In both cases the instrument is peripherally present and the awareness can at any time be moved onto this object. The sense of touch provides a good case with which to illustrate this. "Attention can be directed either proprioceptively or exteroceptively, and it can be shifted from one to the other [...] viewed as an alteration of the balance between focal and peripheral awareness. [...] Even when the attention is fixed firmly on the [...] dimension of tactile awareness, the exteroception dimension remains [...] in background awareness" [11, p. 139] By shifting the attention, the instrument, the musical content or even the body may move to the periphery of the perceptual field or obtain the focal attention as a 'perceptual object'.

This is different for the perception of the body. We perceive our bodies through an inner sense called proprioception and the kinaesthetic sense. We can become actively aware of our body through these senses, for example when paying attention to the position of our limbs, even if most of the time this sense lies below the threshold of awareness. In instrumental training direct perception of the body is necessary but can prove to be an obstruction during performance. However that doesn't mean that while performing there is no bodily awareness, since "it is also possible that proprioceptive awareness can function as a non-perceptual or non-observational self-awareness [...] and as such might be regarded as a more immediate and more reliable form of awareness than object perception." [10, p. 54]

By understanding the interrelationship between the somatic and physiological layers of perception and the cognitive processes deployed to interpret and act on them, an essential part of the communicative aspects of corporeal actions come to the foreground. This corporeal point of view provides an anchor for a reflection on the awareness, the recognition and interpretation of physical presence and expression.

2.3 Levels of Awareness

What kinds of bodily awareness can a performing instrumentalist experience? The lowest level form the neurological/physiological mechanisms of proprioception and the somatic, kinaesthetic sense [12]. At this level, a large number of bodily signals are present and form a system that allows an automatic control of posture, locomotion, and physical actions adapted to specific tasks [13]. These elements together form the basis for the development of body-schemata, which are "a system of sensory-motor capacities that function without awareness or the necessity of perceptual monitoring." [13, p. 24] Somatic and proprioceptive awareness can take both a reflective and a pre-reflective form, a distinction that is important for my argument in the context of the performing electronic musician. If "the first element of broad self-consciousness that somatic proprioception provides is an awareness of the limits of the body" [11, p. 149], then for the instrumentalist the physical contact with the instrument provides a pre-reflective self-awareness that is informed by the instrument, constitutes an element of the sense of agency, and generates a clear context for the bodily awareness [14]. A musician's training aims at imprinting instrumental dimensions and shapes as well as the sound-producing and controlling actions and adaptations into extended body-schemata. They can be extended through habituation as shown by Merleau-Ponty in his example of the woman with the feather in her hat [15, p. 165], and will be executed pre-reflectively during performance. The intentional, object-related actions that are part of playing the instrument build upon this pre-noetic knowledge without showing the necessity of making the body experientially visible. "To be proprioceptively aware of one's body does not involve making one's body an object of perception [...] Proprioceptive-kinesthetic awareness is usually a pre-reflective (non-observational) awareness that allows the body to remain experientially transparent" [13, p. 73].

On the next higher level a peripheral awareness of the body may be transformed into fully focused attention on the body. Since the musician, through instrumental training, has achieved a fusion between body and instrument in the domain of the body-schema, the perception will be observational and begins to constitute a body-image. This "body-image consists of a system of perceptions, attitudes, and beliefs pertaining to one's own body" [13, p. 24].

The level that follows involves the body only indirectly, since it deals with musical awareness. A self-observational awareness is in place, whenever a performance moment occurs. Beyond the somatic or kinaesthetic feedback loop that is guided by sensory-motor adaptations in the instrumental control, the auditive perception guides expressive aspects of the performance through a different feedback loop. "When the status of habituation is reached, the body-image retreats into the background in order to enable the concentration on the sonic-expressive shaping of the entire piece of music, something to which the pre-reflective, proprioceptive and auditive *body*-senses are continuously subjected." [16, p.111; author's translation] This indicates that a lower-level auditory process occurs, which is pre-reflective and which forms part of an overarching musical awareness. Interestingly, the pre-reflective awareness of musical elements can, again with habituation, sink to the level of pre-reflective somatic proprioception and thus close the loop between the musical awareness played out on a metaphorical level [17] and the sensory-motor integration in the body.

2.4 Corporeal States and Modes of Awareness

In concordance with these findings and phenomenological thinking, Legrand proposes the distinction between four types of corporeal states: the *invisible body* is the body that is absent from experience, the *opaque body* is the object of an observational body experience; the *transparent body* is experienced only 'as one looks through it to the world' and the *performative body*, finally, is based directly on a pre-reflective experience of the body [18]. The former two states are either 'objective' and observe the body as a separate entity or do not take the body into account at all. The latter two modes implicitly connect the body with the experience, either as a foundational condition of perceiving the 'world' or as a peripheral body experience below the threshold of perception, a pre-cognitive awareness of one's own corporeal presence. It is precisely this duality which permeates the situation of the performing musician: both modes are active in anchoring the performance experience *at the same time*. The listening to and continuous adaptation of the performance by the musician occurs through the *performative body*, in the first person perspective. The observational awareness, mindfulness and attention, which is directed towards the musical elements, is framed by the *transparent body*, either spatially or even socially.

A different model identifies three modes of consciousness of self that are related to how explicit our self-awareness is [19]. They reflect three main kinds of explicit knowledge. The first mode corresponds to the *performative body* and represents a state that is "embedded within the experience of the environment, e.g. 'affordance', unreflective feeling of location and movement in space, proprioceptive awareness, feeling of acting. [...] Elements within the content are explicit." [19, p.659] The second mode is analogous to the *transparent body*, which constitutes the frame through which the world is perceived, without becoming explicit itself. This awareness presents the self as a subject and perceptively "the content and the attitude are explicit". Lastly, in an analogy to the *objective body* the self becomes apparent. The self-awareness is an element of reflection, and "the content, the attitude, and the self are explicit" [19, p.656].

Through the corporeal state of the performative body and in an awareness mode of explicit content and attitude, the concept of 'performativity' can be understood to apply to the action in such a way that the sense of agency becomes an indispensable element that is constitutive of the experience without becoming explicit. "This performative awareness that I have of my body is tied to my embodied capabilities for movement and action. [...] my knowledge of what I can do [...] is *in my body*, not in a reflective or intellectual attitude" [13, p. 74].

The physical actions of performing music on traditional instruments and the control over the instrument and one's body occur predominantly in a pre-reflective performative body mode, which is guided by motor patterns and body-schematic elements that are acquired as part of extended training and practising. These actions are based on a knowledge about what the body can do, a knowledge which is pre-reflective and situated in the body itself, not on the conscious awareness of it. Thus the specific controls of the body parts necessary to produce, sustain and expressively control sound are all integrated on a level below that of conscious control: "expressive movement [...] is necessarily embodied – enabled and at the same time constrained in specific ways by the structure and performance possibilities of the motor system. Topokinetic properties of expressive movement [2] (and this includes, for example, movement required to perform or respond to music) still necessarily depend on some degree of body-schematic functions" [13, p. 246]. Since the adaptive feedback concerning both the auditive and the tactile or kinaesthetic loops [16] continuously affect the performance at a pre-reflective level, the body takes over most of the control, running in a mode of performative awareness.

2.5 Agency and Intentionality

Apart from these levels of perception and consciousness there are two other elements that form an essential part of the musician's interior perspective. The first is the sense of agency, that is, "of oneself as the agent of action" or the fact "that when I'm aware of my actions and experience them as mine, I thereby experience myself: an experience of myself as agent." [20, p. 50] The sense of agency is important for the higher level of self-awareness that is necessary to perceive and maintain the perceptions and actions that make up a controlled musical performance. The sec-

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[2] "Aspects of movement that have to do with precision in regard to spatial location and accurate movement to targeted external points"

ond element necessary for an interior perspective is that of intentional control, something which becomes important when addressing musical actions on devices and processes that can potentially produce sound without any input from the musician.

The same way as with the bodily awareness, which occurs on physiological and somatic levels as pre-reflective self-awareness, the sense of ownership and agency comes from low-level processes that the body establishes to guide actions: "the sense of ownership for actions depends on sensory feedback for proprioceptive, visual tactile sources. It is generated as action takes place. The sense of agency, however, is based, in part, on pre-motor processes that happen just prior to the action." [13] The bidirectional afferent and efferent streams of sensory information are continuously compared and integrated in the lower regions of the brain and produce a regulatory feedback that forms part of our awareness of actions. "To the extent that consciousness enters into the ongoing production of action, and contributes to the production of further action, *even if significant aspects of this production take place non-consciously*, our actions are intentional." [13, p.238] So even if a large part of fine-motor adaptations and body control remains pre-reflective, a higher-level awareness of musical contents fills the perceptual field of the performer. And as we saw earlier, shifting the awareness focus from music to instrument to body demands intentional investment, in particular for paying attention to perceptions which would normally occur below the threshold of awareness. A consequence of how the sense of agency is constituted, is that a self-determined action on stage creates a heightened level of awareness, both on the pre-cognitive and cognitive levels, thanks to a pronounced sense of agency and intentionality.

2.6 Music as Kinaesthetic Perception

Coming back to the dual perspectives outlined at the beginning of this article, let's examine briefly the audience's point of view, in order to better understand what it is they perceive.

The exterior point of view in music perception is characterised by the multimodal nature of sensory content. Even though on the surface the entire event of a concert is optimised for the undivided and intense *auditory* perception of music, partaking in the physical presence and instrumental performance of the player forms a crucial part of the experience for the spectator. The musician's performance and its expressive aspects are perceived as much through the physical movements as through the sound, perceptions that can occur visually or kinaesthetically. The music itself is perceived aurally from its acoustic characteristics and interpreted as an abstract subject that has its own agency in an acoustic environment. The perceptual interpretation based on listening alone is a translation from the aural domain into perceptual elements that can have spatial extension, position and displacements, imagined visual aspect and may even generate tactile sensations. These elements combine into a kinaesthetic perception that suggests actual movement. "Music is perceived as dynamic in the sense that the perceived properties evolve through time and gen-

The author performing gestural electronic music (under Nikolai Tesla's gaze at Troubleyn/Antwerp, May 2014). [3]

erate in our perception segregated streams and objects that lead, via the subjective sensing of the subject's body motion, to impressions of movement, gesture, tensions, and release of tension. [The] multi-sensory integration and sensorimotor feedback" [21] that these cross-domain interpretations are based on, provide both the performer and the audience with the ability to recognise and empathise with musical forms on a level of physical actions and gestures as well as musical content.

3. TANGIBLE OBJECTS, INTANGIBLE PROCESSES

The point of view from which this article is written stems form a specific musical background, tradition and performance practice. The style or type of performance with digital sound processes and gestural, movement-based actions has its roots in the computer music and electro-acoustic tradition that emerged from the 1960's onward, but is also inspired by open-form and improvisational approaches to music, which are more closely related to subcultural, experimental, and even noisy forms of music. The gestural performance practice in electronic music involves the use of technical interfaces and digital sound processes, a combination which generates an inherent contradiction between the corporeal space of performance and the abstract, codified domain of the digital sound processes.

A convincing example of this type of actions were the gestural performances by Michel Waisvisz. [4] The advanced level of integration of his instrument with his body-schematic processes and the inclusion of the affordances of his instrument into his body-image was clearly discernible. His style consisted of a mixture of instrumental control and physical movement combined with direct treatment of vocal sounds. It generated an expressive performance that in my opinion appealed as much on the physical as on the auditory level.

3.1 Instruments and Awareness

The focus in the argument presented her lies on this specific type of computer music practice and real-time gestu-

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[3] For videos of these performances see: http://www.jasch.ch/island.html

[4] Video can be found online on STEIM's page http://www.steim.org/michel/media.html and youtube http://www.youtube.com/watch?v=SIfumZa2TKY URI's valid in April 2014.

ral performance style. Yet, even when applied to other musical paradigms that are based on a different conjunction of hardware with software, e.g. any modern smartphone, the fundamental configuration of elements and their potential for gestural action remains the same. What changes are on the one hand the expertise of the user and on the other hand the intended effect or outcome of the 'interaction'.

The digital musical instrument (DMI) exists on the one hand in an abstract, symbolic domain but on the other hand needs to provide a tangible surface or interface suitable for 'interaction' [22]. [5] By itself, this interface has no intrinsically compelling connection to the modes of sound-production apart from the necessity to provide a gestural and metaphorical action space. This connection is 'composed' and reflects the affordances but also the conflict between the tangible surface and the requirements of the abstract sound process.

This contradiction poses the question about the possible role of non-reflective instrument- and body-awareness during such a performance, both for musician and audience. Previously, the physical actions and adaptations that made up instrumental playing were imprinted into the musician's body-schemata and corresponded closely with the instrument's physical, sonic, i.e. objective affordances as well as its perceptual affordances in terms of cognitive and pre-cognitive processes.

In DMIs, regardless of their complexity, only a limited number of affordances can correspond to body-schematically acquired skills. And those that do are generic and don't correspond to the characteristics of traditional physical playing and coherent sound production physics. As a consequence, this (pre-)cognitive dissonance or discrepancy between affordances and action spaces, object representations and actual instrument complexity may lead to a break-down of bodily self-awareness and instrumental object-awareness during performance.

Gestural actions in the performance of electronic sound can be considered to occur in a sort of expressive and perceptual no-man's land. The gap presented by the unknown must then be bridged by the perceiver, who can only extrapolate on the basis of prior experience. Thanks to her physical presence and bodily actions, however, the corpo-reality persists and permits the performer to project musical intentions, if not expressions, thanks to the shared bodily presence with the audience.

For the performer, the intentionality that is necessary to play a traditional instrument remains unchanged, but the sense of agency that the feedback through a non-reflective body perception of physical sound production enables can disappear or be diminished. For the audience, recognition of instrumental actions may be inhibited, and other culturally guided or previously acquired individual experiences may come to substitute the missing schema.

Both the performer and the audience remain exposed to perception on the bodily level and thus have the opportu-

nity to share the experience. The instrumental gestures and actions occur within the 'world' through a body and in relation to an object or tool or instrument. And even if their targeted effect should manifest itself through abstract digital processes, they are still informed by our innate and acquired capabilities of acting through tools and instruments.

The British improvising guitarist Derek Bailey, although active in a different style and aesthetics than that of computer music and digital sound processes, put the role of the instrument in a relevant manner when he said: "It is the attitude of the player to this tactile element, to the physical experience of playing the instrument, to the 'instrumental impulse' which establishes much of the way he plays. One of the basic characteristics of his improvising, detectable in everything he plays, will be how he harnesses the instrumental impulse. Or how he reacts against it. And this makes the stimulus and the recipient of this impulse, the instrument, the most important aspect of his musical resources. [...] The instrument is not just a tool but an ally. It is not only a means to an end, it is a source of material, and technique for the improvisor is often an exploitation of the natural resources of the instrument." [23, pp. 97–99] What he describes is a relationship with the instrument that is dialogic, ecological, and embodied, much in the way we have seen exposed in Gibson's concept of affordances.

3.2 Metaphors and Models

The continuous search for *new* 'interaction' models or *new* interfaces indicates that there is a deficit in the quality of the connection in a DMI between the action and gesture domains, and the sound producing processes. Beyond the attempt to resolve this problem by always adding new techniques and tools, the question that should be asked is this: can this deficit or conflict be converted into a fruitful tension and how?

The literature on musical gesture provides a rich set of categorisations and classifications that deal mainly with the types and effects of actions on musical instruments labeled as 'gestures'. Delalande's classification offers three categories of 'gesture' ranging "from purely functional to purely symbolic" [24]. Cadoz' classification of the 'gesture channel' differentiates between the three functions of the 'ergotic' [6], the epistemic and the semiotic, and orders the instrumental 'gestures' in the three categories of excitation, modification and selection [25]. Godøy formulates the distinction between body-related and sound-related 'gestures' [26], that Jensenius then categorises into sound-producing, communicative, sound-facilitating and sound-accompanying 'gestures' [27]. These authors all take into account the bodily basis for these actions, sometime also the perceptual effects, but the don't address the pre-reflective effects inherent to acting and perceiving agency through the instrument.

Without going into the concepts of mapping [28] and sensors, let's examine a few basic principles of connecting the physical world of actions and 'gestures' with the abstract domain of digital sound processes.

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[5] I deliberately put the term 'interaction' into quotes, because I believe that for a true 'interaction' to occur, two subjects need to be present that enter into an intentional and active exchange. I believe that most digital music concepts today don't fulfil this condition. Exceptions exist, but a discussion of this issue will have to be the topic of a different article.

[6] "material action, modification and transformation of the environment"

The representation of digital processes needs to occur in metaphors, these processes are too complex to be grasped and acted on directly while performing. We have visual representations, such as the display of waveforms or spectrograms, physical metaphors, the levers, wheels, knobs and slider and finally more all encompassing analog device metaphors such as tape-reels, patch-bays and signal-chains. By themselves, these metaphors are useful, the problem is their limiting effect on our cognitive and perceptual capabilities, which we could mobilise better with richer, more differentiated metaphors.

We also have a number of conceptual models about control of digital sound processes, which originate in real-world scenarios and can therefore cognitively be handled through behaviours shaped by everyday experiences. The two main models of control are those of the instrument and the cockpit. The first model builds on the instrument's dependence on continuous energy input to produce sound. Rather than presenting mechanisms for generating larger time-based structures, the instrument offers a palette of options, that need to be actively selected, combined and performed by the musician. The second model of action puts the performer into an observer perspective, where, from a position of overview, single control actions keep the system within the boundaries of the intended output, while the sound processes produce their output without the need for continuous excitation and control. A third and less common model is that of dialogical communication and interaction where generative aspects are part of the sound processes. The most interesting manifestations of this model generate an inter-subjective exchange with some form of autonomous agent.

The types of 'interaction' and their position on the conceptual axis, which ranges from direct parametric control to 'natural interaction', depends on the level at which the musician acts or 'inter-acts' with the digital domain. Different complexities demand different tangible objects or instrumental interfaces.

In the case of one-dimensional and precise parametric control, individual objects such as knobs, sliders or even buttons are cognitively appropriate, since they represent in their physical form the singular dimensional property of the parameter and can be handled discretely.

In the case of higher-dimensional or model-based action patterns, control objects with more degrees of freedom are required. The manner of 'interaction' with more intertwined dimensions should reflect the relationship and dependence of those degrees of freedom present in the digital domain.

The most extreme example of entangled degrees of freedom that we can cognitively handle encompasses our entire body. Leveraging this level of complexity, at least through extraction of information about posture and kinematic qualities of the body, is attempted by the camera-based motion controls for games, where full body movements are used for control. This might be appropriate when the goal is to affect a virtual body that mirrors the capabilities of the natural body. It becomes problematic, however, when the correspondence between the actions in the physical world and the result/reaction in the abstract digital domain is modelled after categories that originate in the abstract domain. Empty-handed and movement-based controls in an allocentric [7] frame work for metaphors of control that reflects spatial qualities. Object-based, instrumental actions with tangible interfaces in an egocentric [8] frame (for example with wearable sensors) or object-centric frame are effective for actions on abstract entities without clear correspondence in the real world. Digital instrument design and interface developments oscillate between these two poles. There is, however, a tendency to shift away from action and behaviour patterns that are based on the bodily capabilities shaped by object 'interaction' with physical instruments towards symbolic and metaphorical projection onto a disjointed digital model.

4. MEANINGS

Having laid out these categories, models and attempts at describing the possible connections between 'embodied action' as a musician and symbolic abstract sound processes, one important aspect should perhaps be brought to foreground more explicitly: The multi-dimensional and multi-modal nature of musical actions, gestures and perceptions may correspond to the richness of the "flowing manifold" [29] of consciousness that is built on pre-cognitive or non-conceptual body perceptions. But the metaphors, models and interfaces we chose in order to generate tangible musical instruments on top of abstract digital processes, possess nowhere near the refinement that is needed to do justice to this richness.

The insurmountable distance and inherently unresolvable contradiction between our perception, its pre-cognitive sub-personal processes, the necessity to relate to objects in a physical, physiological, somatic and kinaesthetic way and the seemingly unlimited possibilities of connecting bodily actions and abstract sound-production processes might be one of the reasons why we are fascinated by this digital performing arts discipline. But this might also be why after an initial phase of interest, the difficulty arises of how to give the musical actions a deeper meaning and stronger impact, both for the performing musician and the audience and spectator that witness and experience it.

A goal might be to generate a tighter link between the corporeal actions that carry intentionality and perhaps even expression and the medium of sound as generated by a technically encoded process.

But in order to reach a next level of development of this practice, we will need to achieve a deeper understanding of how we relate pre-cognitively and in a corporeal way to instruments and tools in general, and how this might alter the way we envision the connection between actions of our physical bodies and abstract sound processes in gestural electronic music performance. After all: "The meaning in and of the music is not verbal or linguistic, but rather bodily and felt. We understand the meaning of longing, desire, expectation for better things to come [...] We cannot

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[7] An outer spatial frame of reference
[8] A spatial frame of reference anchored on oneself

convey it verbally, but it is nonetheless meaningful, and it is enacted via our active engagement with the music." [30]

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