#8 EMBODIED GESTURES: SCULPTING SONIC EXPRESSION INTO MUSICAL ARTIFACTS

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8.1 Introduction: Sonic gestures and acousmatic music

The cultural context of the 'Embodied Gestures'[1] [2] artistic research project is acousmatic music. Within this musical field, sonic artworks are commonly described through 'gestures'. For instance, a composer could assert that a musical passage was produced from the combination of sound gestures (Paine, 2004). The concept of 'sound gesture' is tied to the aural perception of sonic dynamics. The changing characteristics of a sound event during a period of time can be perceived as a trace, as a gesture (Van Nort, 2009).

Composers in acousmatic music (Schaeffer, 1966; Smalley, 1997; Vande Gorne, 2018) have described the tendency that listeners exhibit to deduce gestural activity from sound material. They observed how perceived temporal changes in sound materials—often called sonic morphologies—would always refer back to sensorimotor sensation. This particular effect has offered acousmatic composers a creative playground for exploring musical inventiveness, creating suggestive mental images, sonic sensations and associations. Interestingly, these observations are compatible with the experimental findings in embodied music cognition. In the embodied mind theory (Noë, 2004), perception is not something we receive. It is something we actively do. During the action-in-perception loop, external stimuli would be incorporated as mental simulations, as reenactments of

[1] This article is an extended and revised version of the paper *Embodied Gestures: Sculpting Sonic Expression into Musical Artifacts* previously published by the authors at the International Conference for New Interfaces for Musical Expression NIME 2021, Shanghai. This article extends the sections *Interface Design*, *Musical Outcomes* and *Discussion* providing further documentation.

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what we perceive. It is particularly important that these simulations can involve sensorimotor activations. For instance, neuroscientists (Haueisen & Knösche, 2001) have observed how pianists activate their motor cortex when they only listen to piano music. If auditory perception can also be tied to sensorimotor sensations, a natural explanation for the perception of 'sonic gestures' would be the inherent production of sensorimotor simulations. This is probably why it is so natural to describe sound morphologies (e.g. temporal changes in pitch, volume and timbre) as physical activity, as movements.

How do acousmatic composers practically deal with the sonic gesture notion? Annette Vande Gorne developed a theory of *energy-motion* models building on previous work by Schaeffer, Bayle and Reibel (Vande Gorne, 2018). According to her theory, *energy-motion* models are motion archetypes inspired by natural actions like oscillation, friction, flux, pressure, etc. For Vande Gorne, the application of these energy-motion models must begin at the very early stages of the musical piece's conception. Composers should devise sound materials following a well-defined energy-motion model. For instance, during a recording session, the composer first chooses the model and then performs the 'sounding body' (e.g. objects or musical instruments) having this model in mind[3]. The objective of this process is the production of expressive gestural sound materials for an acousmatic composition. Citing Anderson (2011),

> through the energy model, the composer can develop a voluntary awareness of the internal stimulus which motivates and governs the energy flow unfolded through physical movement that results in gesture. Gesture would be articulated by and at the service of a particular energy model.

Vande Gorne methodically identified the following energy-motion models: *percussion-resonance, friction, accumulation of corpuscles, oscillation, swaying/swinging, rebound, flux, pressure-deformation/flexion, swirls, rotations* and *spiral*.

Another relevant framework especially conceived to describe sonic gestures is Denis Smalley's (1997) 'spectromorphology'. In electronic music, audio processing can result in sound materials displaying remote relationships to any known sound-producing source. For instance, a recorded human voice digitally processed through convolution can be morphed into a radically different sound. Addressing this issue, Smalley proposed a framework to describe the rich variety of sonic content in electroacoustic music. He called it 'spectromorphology', as it would consist of a set of tools for 'understanding structural relations and behaviours as experienced in the temporal flux of [electroacoustic] music' (1997). Within this framework, the spectromorphology of a musical piece (i.e. temporal spectral flux of music) is mostly discussed in relation to 'gesture'. For Smalley gesture is an energy-motion trajectory creating spectromorphological life. Smalley specifically describes how listeners always tend to deduce gestural activity from sound and introduces the notion of 'gestural surrogacy', a scale of relationships between sound material and a known gestural model (e.g. first, second or third order and remote surrogacy). As we have seen, the notion of gesture is central in two of the most influential frameworks for composing and analysing acousmatic music. In the following section we will discuss 'sound gesture' from the perspective of embodied music cognition.

[3]For a better understanding of the concept of 'sounding body' we refer the reader to Thomas Gorbach's interview to Annette Vande Gorne in this book.

8.2 Sonic gestures, artefacts and embodied cognition

Many scholars have studied the multi-modal gestural images created by auditory information. The fundamental question of these studies has been elucidating what kind of physical gestures listeners associate with various musical sounds. The central hypothesis of these studies is that sound affords a form of memory recall to cultural and physical referents that themselves afford certain kinds of actions. One major problem in Western musical thought is the lack of an appropriate apparatus for describing holistically experienced musical sound. For this reason, researchers have often employed graphic methods, which facilitate the characterization of aural experiences. For instance, Godøy recorded participants drawing spontaneous gestures to various musical excerpts (Godøy, 2008). In this case the intention was studying the gestural rendering of what participants just heard. Musical experiences can be very complex and densely packed with events. With this experiment Godøy showed divergent results for steady pitch sounds with timbral changes, with some listeners drawing just a straight line and others drawing various curved lines. Indeed, some listeners expressed frustrations when they were asked to draw multi-dimensional sketches of what they experienced.

Caramiaux and Susini (2011) studied causal perception through movement. In particular, they tracked people's movements while listening to identifiable environmental sounds. Their results indicate that when the causing action is highly identifiable, participants mainly mimed the sound-producing action. When no clear action could be associated to a sound, participants traced contours related to sound acoustic features (e.g. pitch, volume, density, timbre, etc.). These dynamic features are typically called the temporal morphology of a sound.

There are also studies conducted towards understanding bodily gesture during sound production. In particular, Godøy, Haga, and Jensenius have developed experiments for analysing how people move while they mime musical control (Godøy et al., 2006). This gestural 'mimicry' has been described as performing 'air instruments', or making sound-producing gestures without making physical contact with any instrument or object. Nymoen developed a study for tracking participants' hands while they played 'air instruments' (Nymoen et al., 2011). He showed that the most significant parameters mapped by participants were pitch, frequency centroid and amplitude dynamics (volume).

Due to the lack of language for describing sonic events, participants often showed a tendency to look for association in order to understand sound. Users tried to describe sound examples in terms of familiar objects. Even in the absence of an object, they described sound in terms of artefacts. Tanaka (2012) asserts that the cognitive mappings enacted during these types of studies are always informed, mediated and inspired by the actual materiality of the controller used (i.e. size, material, shape, acoustic properties, etc.) According to Clarke we all have some ecological knowledge on how sound-producing actions relate to sound (Clarke, 2005). As Caramiaux has shown, musical cognition is always situated and sonic memories allude to certain objects to explain interaction. In sum, during the spontaneous rendering of movement people also envision artefacts (Caramiaux et al, 2015).

In conclusion, all these examples illustrate a clear tendency: humans tend to deduce gestural and sensorimotor activity from sonic gesture. In other words, we are inclined to determine the sound-producing gestures from what we are hearing and the possible objects producing this sound. Sound perception would also be referred back to some type of material or artefact. This tendency became the working hypothesis of the 'Embodied Gestures' project. With the aim of exploring a new possible paradigm for interface design, our research builds on the parallel investigation of embodied music cognition theory and the praxis of acousmatic music.

8.3 The Embodied Gestures Project

We argue that a fruitful path for approaching musical interface design—especially towards the creation of gestural music—could be the incorporation of archetypal sonic gestures as design patterns. Musical interfaces following this design paradigm would afford the same type of physical gestures that a sound material inspires when it is listened to. Our hypothesis is that such interfaces would be especially suitable to emphasize a performer's gestural embodiment within an instrument. For instance, for performing a sound passage made from the circulation of elastic sonic movements in space, we would design musical interfaces affording by themselves, and through their physical affordances, similar 'elastic' physical gestures to their performers.

The crucial question at the outset of this project dealt with finding successful ways of shaping the affordances of specific objects for suggesting particular body gestures. First, it was necessary to understand how listeners spontaneously envision sound-producing actions and physical materials from specific sound morphologies. After gaining this knowledge, we could then develop a number of interface designs. For this reason we planned a methodology based on user-studies and experiential evaluation which could help us identify suitable solutions according to design patterns. In particular:

1. A large size user-study to understand how listeners envision sound-producing actions and physical materials while they try to mime control of gestural acousmatic music.
2. A second phase informed by the previous user-study where we would design and build digital instruments emphasizing a number of energy-motion models.
3. Practice-based evaluation through the commission of musical performances and compositions to external collaborators.

8.4 Ideating interfaces from spontaneous cognitive mappings

In the early phases of this research project, we planned a study on 'gestural mimicry' especially designed to emphasize the material aspects of listening experiences. The aim of this user-study was to understand how people envision and materialize their own sound-producing gestures into physical characteristics when designing musical interfaces. Our hypothesis was that if participants are asked to mime sound-producing gestures while they listen to acousmatic music examples, they would also envision artefacts to produce that music. If we were able to find a quick way to mock up those envisioned objects, we could collect a repertoire of compatible sound-producing actions and artefacts for particular sonic gestures. This information would inform the subsequent phases of our project.

In the user-study that we originally created, we asked participants to produce physical mock-ups of musical interfaces directly after miming control of short acousmatic music pieces. We composed five sonic examples in the form of short acousmatic compositions emphasizing one of the following motion energies: *oscillation/rotation, granularity, attack/repetition/resonance, friction* and *pressure*.[4]

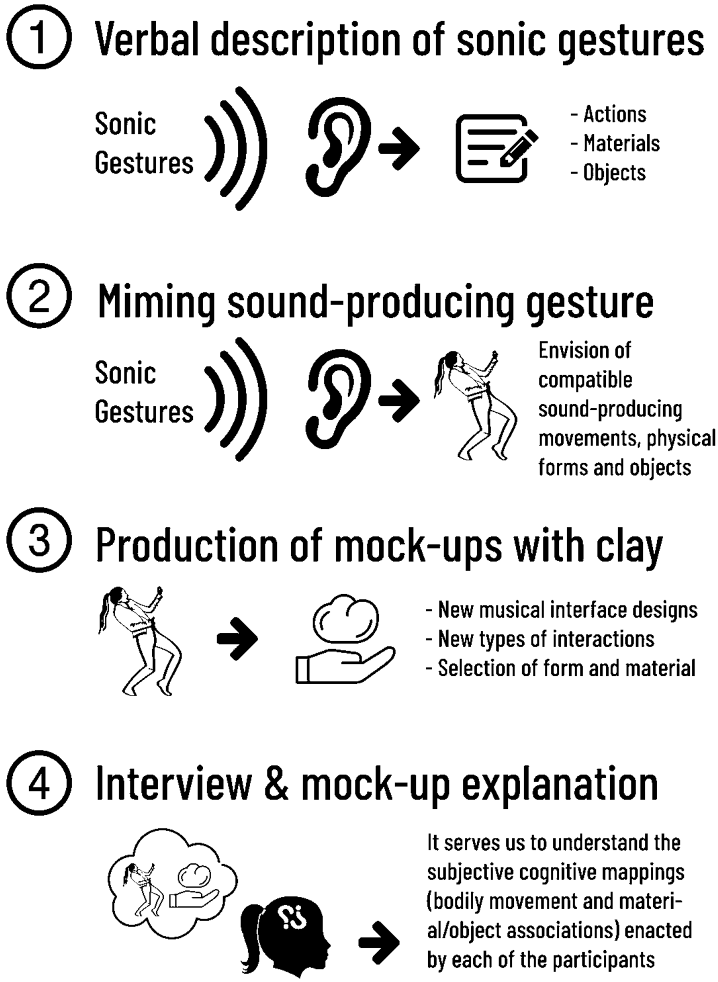

Figure 8.1: ***Resume of the Embodied Gestures user-study***

[4]These sound examples can be accessed from our website: https://tamlab.ufg.at/blog/embodied-gestures-methodology (accessed: 1/12/2021)

As illustrated in figure 8.1, the user-study begins with a warming-up session where participants verbalized material aspects of the sonic examples (of each of the five short compositions). In particular, participants filled online forms to outline the gestures they perceived and the possible properties of the physical materials used to produce the sounds. After this phase, they were invited to stand up and mime control over the compositions. Directly after this, they spent approximately ten minutes producing a mock-up with clay. Once they finished it, they were video interviewed to obtain an explanation about their cognitive processes and the objects they envisioned (Figure 8.2). This process was repeated at least four times with four or five musical examples.

Figure 8.2: ***Participants of the Embodied Gestures study miming control of acousmatic music and explaining the mock-ups produced (Photo: Enrique Tomás, 2018, CC BY)***

During four workshop sessions, 60 participants from five different creative backgrounds (music, arts, dance, computer science and administration) modelled more than

Figure 8.3: ***Examples of mock-ups produced for four different energy-motion models (Tomás & Gorbach, 2019) (Photo: Enrique Tomás, 2019, CC BY)***

200 physical artefacts (see examples in Figure 8.3). Participants were filmed and interviewed for the later analysis of their particular multimodal associations about music. Participants were divided in groups of three to five persons during the experiment. Each session had a duration of approximately two hours.

From the analysis of our video recordings, we were able to categorize patterns of physical gestures produced during the mimicry phase (Table 8.1).

Categories	Actions observed per sound example	*Oscillation*	*Granular*	*Attack-Resonance*	*Friction*	*Attack-Pressure*
Malleable	**Pressing**	2,38%				
	Stretching	4,76%		2,77%	2,63%	
	Bending		2,77%		5,26%	**46,87%**
Playing with composed objects	**Rummaging**		**27,77%**			
	Droping objects		11,11%			
	Digging in		5,55%			
	Breaking		5,55%			
Touching with performer's fingers	**Linear**	**9,52%**		5,55%		
	Circular	**14,28%**				
	Free	**9,52%**		2,77%		3,12%
Scratching with objets	**One hand linear**	**19,04%**				3,12%
	One hand circular	**16,66%**	**19,44%**	5,55%	**52,63%**	
	Between two hands		5,55%	2,77%	**31,57%**	
	Free	2,38%				
Mechanisms	**Cranks and wheels**	7,14%	5,55%		2,63%	
	Spinning	2,38%		2,77%		
	Air pipes	7,14%				
	Water streams		2,77%			
	Buttons					3,12%
	Sliders			2,77%		
	Colliding		2,77%			
	Hinges				2,63%	
One object's movement	**Balancing**	2,38%	5,55%	13,88%	2,63%	
	Shaking		5,55%			
	Rotation around the body	2,38%				
Drumming	**Finger drumming**			**19,44%**		9,37%
	Drumming with mallets			**41,66%**		**34,37%**

Table 8.1: ***Repertoire of sound-producing actions per energy-motion model observed during the Embodied Gestures user-study***

Sound-producing gestures have been well studied by Godøy, Haga, and Jensenius who identified two main types (Godøy el al., 2006). First, those human movements made with the intention of transferring energy to an instrument (excitatory gestures). Second, those human movements made with the intention of modifying the resonant features of the instrument (modulatory gestures).

From the results, we can say that participants firstly (and quickly) envisioned excitatory gestures. In the great majority of the cases, it took them less than ten seconds to spontaneously find a compatible sound-producing gesture for the sonic gesture they were listening to. Interestingly, participants easily engaged their bodies into various possible actions and internally evaluated whether these movements were compatible with the sonic gestures they were listening to. During a second phase, approximately twenty to thirty seconds later, and only after self-confirming the central sound-producing action, participants introduced additional features to their repertoire of movements. Each participant added other necessary bodily movements to perform the sonic transformations present in the music (i.e. progressive changes in pitch, volume, timbre). For instance, frequency changes were accommodated by producing the excitatory gesture at different heights. Volume was often controlled by modulating the speed of the sound-producing gesture. Certainly, this logic would allude to the causal schemes found in traditional musical instruments. We also observed the ways sound transformation was engineered in the artefacts that participants envisioned. Usually, they added an additional or complementary affordance to the initial form or configuration of the artefact they imagined (i.e. a new degree of freedom to the object) like knobs, sliders, buttons, additional sensors, acoustic effects, change of materials, etc.

Figure 8.4: ***Embodied Gestures interfaces produced (Tomás & Gorbach, 2021). Note: oscillation and granularity (top), friction and flexion (bottom) (Photo: Elisa Unger, 2020, CC BY)***

8.5 Interface design

The following phase in our artistic research project was centred around designing and building musical interfaces emphasizing four sonic gestures used during the user-study: *oscillation, granularity, friction* and *flexion*.[5] From the knowledge gained with the user-study, we proposed a different solution pattern for each of the sonic gestures present in the music. These solution patterns are compiled and explained into detail in the table 8.2.

Energy-motion Model	Sound-producing action and technological implementation	Gesture modulation and technological implementation
Oscillation	Linear or circular trajectories of the hand between two poles	Pressure in a handheld object and wrist rotation
	Two joint Gametrak controllers measuring the distance of the hand to the poles as well as its horizontal and vertical angles	Force is measured with two FSR sensors. 3D wrist rotation is measured with a BNO055 orientation sensor
Granularity	Stirring objects in a bowl	Rotation and vertical displacement of the bowl
	Contact microphones and thresholding electronics measure the activity on the bowl: every impact and vibrating activity over a threshold	Rotation is measured using a BNO055 orientation sensor. Vertical distance is calculated with a VL53L1X ToF sensor
Friction	Pressure effectuated on an object held between the player´s hands and its rotation around one axis	Not needed
	A FSR pressure sensor and a rotary encoder	Not needed
Attack + Flexion	Attack (finger drumming) on a surface	Flexion of a rigid surface (a thin metal plate)
	Large size FSR sensor detecting attack and its velocity	BNO055 orientation sensor on deformable parts of the surface

Table 8.2: ***Solutions adopted for designing Embodied Gestures interfaces***

From these solution patterns, we built various technical versions during the project. The visual aspect of the interfaces produced in 2020 are shown in Figure 8.4.

The interfaces' technical core is an Espressif ESP32 WROOM microprocessor. It captures data from sensors and transmits this information wirelessly to a host using the Open Sound Control protocol. In our implementation, the host is always in charge of defining a sound synthesis strategy.

[5] Although a fifth sonic gesture, (attack and resonance) was used in the user-study we did not implement it

Figure 8.5: ***Theodoros Lotis performing* Voices *with the friction interface (Photo: Elisa Unger, 2020, CC BY)***

8.6 Musical outcomes

To evaluate our project, we commissioned three musical works for ‘Embodied Gestures’ instruments. The first work was commissioned to the composer and performer Theodoros Lotis. In parallel, Jaime Reis composed an acousmatic piece with our instruments. Finally, the ensemble Steel Girls (Angélica Castelló, Tobias Leibetseder and Astrid Schwarz) prepared an improvisation for three instruments. Additionally, two of the authors (Enrique Tomás and Thomas Gorbach) produced two improvisations for two of the instruments. All of these works were premiered and performed on various occasions in festivals in Austria and Greece.

We contacted these artists eighteen months before their respective premiere concerts. After a one-week training workshop, the artists worked independently for more than six months with copies of the four musical interfaces. Some captures of these musical works can be observed in figures 8.5 and 8.6.

8.6.1 *Voices*: composition and live performance by Theodoros Lotis

Theodoros Lotis composed and performed a musical work for one friction interface and interactive music system.[6] Most of the sound material in *Voices* (Figure 8.5) consists of recordings of syllables and phonemes of an invented proto-language and audio recordings

[6]For a complete review of this musical piece, we refer the reader to the chapter *Gestural and Textural Approaches in Composition and Performance with the Embodied Gestures Instruments* in this book

of dancers' movements. Lotis studied the friction interface and introduced a taxonomy of possible trajectories in what he called the *gesture-field*, the spatial limits of the energy-motion model. They are illustrated in figure 8.6.

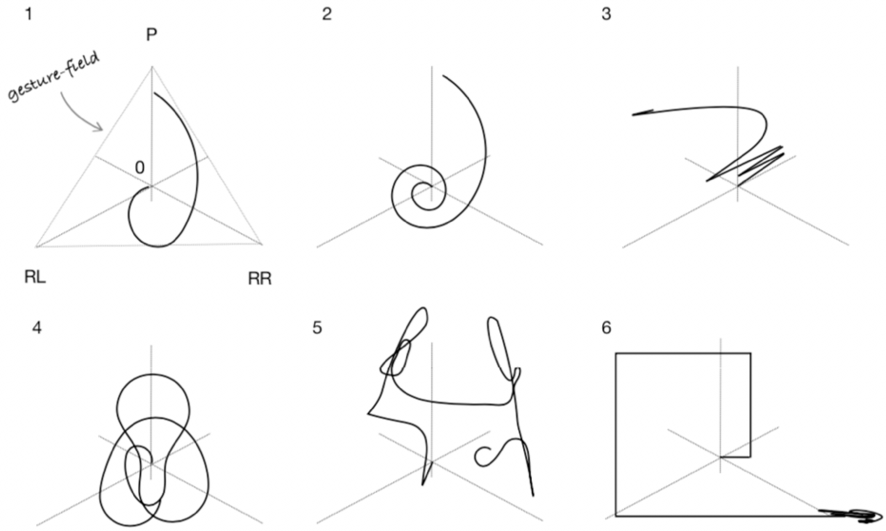

Figure 8.6: ***Taxonomy of motion profiles and gesture fields as they were used by Theodoros Lotis in* Voices *(Tomás & Gorbach, 2021) (Photo: Theodoros Lotis, 2020, CC BY-NC 4.0)***

Theodoros Lotis explains that the gestural typology in *Voices* does not seek to divide time into small or larger linear temporal structures but rather to establish a style of floating narration.

The accompanying interactive sonic system in *Voices* consists of a Markov Chain model which stochastically selects the sound contents to be played. The interface's rotation and pressure values are sent to a mapping network application where they are weighted. This strategy is intended to mimic the overlapping one-to-many and many-to-one gesture-to-sound mappings found on acoustic musical instruments.

8.6.2 *Magistri Mei - Bruckner*: composition for fixed media by Jaime Reis

The composer Jaime Reis explains the origins of this work:

> 'I had this idea for ages to think about polyphony of gesture and space, and then to actually have a lot of layers and polyphony and so on. This is one of the conversations that I so often had with Annette [Vande Gorne] which is, what are the limits of space lines? How many movements can you listen to at the same time?'

Magistri Mei - Bruckner is a sixteen channel acousmatic composition. Interested in exploring Anton Bruckner's sonorities and polyphony, Jaime Reis extensively used our interfaces to generate sound materials for this composition. In particular, following the acousmatic compositional method, Reis recorded many hours with a particular sounding body: our interfaces sculpting the sound of a number of GRM audio players loaded with a recording of Bruckner's *Missa solemnis*. After this, Reis worked on the organization of the recorded sound materials and on a complex spatialization strategy inspired by Bruckner's idiosyncratic use of polyphony.

For Reis, the process of sound material generation was comparable to the ones he usually develops with acoustic instruments and objects. However, he described the difficulties he found in defining 3D spatial trajectories with our interfaces. Reis usually elaborates them in a highly parametric way, calculating complex spatial trajectories on the computer. Reis would have required the development of a dedicated computer application able to map his movements to complex 3D spatial trajectories.

8.6.3 Improvisation for Embodied Gestures instruments by Steel Girls

The Steel Girls is an electroacoustic improvisation group formed by Angélica Castelló, Astrid Schwarz and Tobias Leibetseder. With a long experience in the scene, the Steel Girls members show a clear physical and acoustic approach to improvisation as they usually perform with amplified objects. In this case, our interest lay in evaluating how our interfaces could be used by a small ensemble of improvisers.

Figure 8.7: ***Steel Girls performing with oscillation, granularity and flexion interfaces during the Embodied Gestures premiere concert (Photo: Elisa Unger, 2020, CC BY)***

The Steel Girls prepared an improvisation for three of our interfaces: oscillation, granular and bending (Figure 8.7). Castelló controlled the oscillation interface and mapped the handheld device movement to a tape speed effect resulting in a typical sound-scratching effect. The device's angle and orientation were mapped to the central frequency of a number of resonant filters. Leibetseder performed a bending interface for controlling six parameters of a granular synthesiser. Schwarz played the granular bowl in order to trigger and transform the pitch of cascades of short sound recordings (100 milliseconds approximately) which were previously taken from the same bowl. Their improvisation resulted in a brilliant exercise of musicianship and communication on stage. As they did not plan anything apart from how to begin their performance, each member of the trio explored the different dynamic ranges of gestures afforded by the interfaces. Angélica Castelló, who usually does not perform with digital instruments, asserted before the premiere:

> For me, performing with computers is not sexy, but these instruments, they really are. Maybe they will reconcile me with the digital world!

8.7 Discussion

What are the main differences between composing or performing with these interfaces or with other musical controllers? From the interviews we carried out with our collaborators we can consolidate the most important observations:

1. Gestural mapping: our collaborators explained to us that for elaborating equivalent energy-motion profiles or sonic gestures in the past, they usually had to program complex routines (in Max, Pure Data, Supercollider, etc.) or they were forced to systematically simulate these movements with commercial fader interfaces. With the 'Embodied Gestures' interfaces, gestural ideas are directly embedded into the dynamics of the interfaces, in the temporal flux of the movements we perform. Therefore, the interfaces directly provide access to these sonic gestures through compatible physical gestures.

2. Agency to structure performance: the physical gestures afforded by our interfaces highly structure temporal play independently of a composer's original intention. For example, Theodoros Lotis described how these interfaces quickly suggested to him the use of 'loops', a compositional resource he had never seriously employed before. The interfaces afforded back and forth exploration of the same physical movement, creating a tendency to explore the space between gestural extremes, which therefore resulted in loops. Lotis discovered that his compositional attention focused mostly on changing the dynamics of these looping gestures (e.g. duration and amplitude) just like another compositional material.

3. Limited affordances and constraints: Theodoros Lotis explained to us that

   > these instruments have limits, and, after the limitless computer, it is good to go back to limits. All acoustic instruments are limited, like their tessitura and possibilities to articulate sound. And these interfaces have limits too. The way you push, the way you move around the objects, dictates how far you go with your time, with your temporal structures of music, and with the gestural structures. This was a good thing for me.

   The apparent simplicity of our interfaces constituted a meaningful creative constraint for the collaborators. It stabilized crucial aspects of interaction which fostered musical exploration and inventiveness.

4. Tacit knowledge: quoting the words of Tobias Leibetseder, of the Steel Girls ensemble:

   > 'These instruments tend to put you immediately in a specific bodily movement, and I like that because it is like beginning to perform or dance with the instrument with a really clear plan.

   In our opinion, these types of interfaces benefit from the extraordinary tacit knowledge that many performers usually carry. In the case of Tobias Leibetseder, he is not only an experienced musician but also a dancer. For a performer who has experience in exploring bodily gesture there will be many possibilities for transforming musical intention into physical movement, and then finally through these interfaces, into expressive synthesized sound. In that regard, we observed how the straightforward functionality of our interfaces lowered certain early barriers. No manuals, no menus, no special computer music culture is required to operate these interfaces. If the devices are well set up and powered, any group of people can benefit from their tacit knowledge to create or perform gestural music.

5. Interpersonal variability: as we have explained, the user-study revealed a great interpersonal variability of results. Participants' mental mappings are highly dependant on the person's cultural background, on his or her corporeality and other social factors (e.g. temperament, emotional status, etc.). Thus, a pertinent question would be whether it is possible to conduct more systematic and broad experimental studies collecting data on people's musical gestures and mental mappings, and utilise such larger datasets to better model robust inclusive interfaces. Our results indicate that, using our design method, it is possible to ideate highly idiomatic interfaces for specialized communities of users. However, two different persons will never have the exact range of corporeal abilities and cultural contexts (e.g. elderly and disabled people). We advocate here for a less language-oriented type of user-centred design based on spontaneous bodily mappings; that is, a type of design oriented towards what is spontaneously innate and natural in the users's actual sensorimotor system.

6. More than idiomatic interfaces: not all musicians who compose or perform digital, electroacoustic or even acousmatic music are interested in producing music from a gestural viewpoint. Therefore, our interfaces could be described not only as idiomatic, but as highly specialized.

7. Musical aesthetics: Our design paradigm presupposes an interest in sculpting the (spectro)morphologies of recorded sound material or lively synthesized sound. If the interest of the musician relies on composing within the discrete lattice of pitches, rhythms, durations and timbres, the application of our paradigm will probably result in a low resolution version of the musical intentions that one could perform with our interfaces.

8. Orchestration: each of our interfaces is specially designed to emphasize only one particular sonic gesture or energy-motion profile. In consequence, composers and performers may require sets of 'Embodied Gestures' interfaces for composing with a diversity of sonic gestures. Although this issue could be understood as a limiting factor, we also see it as an opportunity for the creation of interface ensembles.

8.8 Conclusions

Within the field of NIME and HCI we sometimes address complex and overwhelming issues. For instance, designing digital systems that enhance a performer's embodiment with the instrument. In this project, we escaped from elaborating complex or intricate interfaces. Our methodological approach began with experiencing—as opposed to understanding—the idiosyncratic ways of doing in our musical field. In other words, we first collected experiential expertise in what performing acousmatic music concerns (e.g. user-studies, workshops with composers, studio visits, concerts, building speaker systems, etc.). Only then were we able to define what a possible and intuitive solution for the issue in question could be. This is what Andrew Koenig called 'idiomatic design', advocating a solution not only by understanding the nature of the problem but also how the solution will be used, taking into account the constraints and cultures hindering its implementation (Koenig, 1996). We consider the incorporation of sonic gesture models into interface design as an idiomatic solution to the complex issue of disembodiment within the field of acousmatic music. This was done, in fact, at the risk of limiting and filtering the affordances of the physical artefacts we built. These limitations were perceived in this case as idiomatic, as creative constraints. However, we are aware that they could be evaluated differently from the perspective of other musical genres. Not all musicians who compose or perform digital, electroacoustic or even acousmatic music are interested in producing music from a gestural viewpoint. For instance, our interfaces will not be effective for the production of textural, ambient and drone music. Therefore, our interfaces could be described not only as idiomatic, but as highly specialized for the production of gestural acousmatic music. Finally, it is important to remark that our interfaces were specially designed to emphasize only one sonic gesture. As a consequence, composers and performers may require sets of these interfaces for composing from a diversity of models. Although this issue could be understood as a limiting factor, we also see it as an opportunity for the creation of interface ensembles, a plausible solution towards improving onstage communication between performers of digital music.

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