Di Donato (2022, in press) Sign in Human-Sound Interaction. In Drever, J., Hugill, A., *Aural Diversity*, Routledge, ISBN 9781032024998

Sign in Human-Sound Interaction

Balandino Di Donato

B.DiDonato@napier.ac.uk

School of Computing, Edinburgh Napier University

Edinburgh, United Kingdom

ORCID: https://orcid.org/0000-0001-6993-2445

Introduction

Interactivity is a theme widely explored in the field of Sonic Interaction Design (SID) by placing sound at the centre of the design (Rocchesso, et al., 2008). This field of research reflects on several aspects of sonic interaction such as perceptual, cognitive and emotional, product sound design, auditory display and sonification. SID aims to explore *"ways in which sound can be used to convey information, meaning, and aesthetics and emotional qualities in an interactive context"* (Franinović & Serafin, 2013). Whilst SID has previously highlighted the sonic aspects, here is outlined the idea of Human-Sound Interaction (HSI), which focuses on the investigation of human factors in interaction with sound (Di Donato, *et al.*, 2020). In this work, we focused on the perception of sonic affordances and the bodily actions that they evoke, considering our capabilities to perceive them. The term affordance was first used by Gibson (1966), and its principles rely on the possible action that each object evokes based on the characteristics of the objects and the capabilities of the subjects (Gibson, 1979). As in the work of Godøy, *et al.* (2006), Godøy (2010) and Tanaka, *et al.* (2012), sonic affordances are here intended as sound features that evoke a certain bodily action.

This body of work on musical affordances and embodiment of music drove the creation of new technologies for the control of audio-visual processes through body movements that might have a meaningful result in a music context. This work resulted in creating MyoSpat (Di Donato, *et al.*, 2017). MyoSpat is an interactive audio-visual system that enables processing sound through gestural interaction. Precisely, a musician can process live audio in input and lighting projections through arm and hand movements tracked using Inertial Measurement Unit sensors and electromyography (EMG). MyoSpat was used by E. Turner to compose and perform *The Wood and The Water* (2017) and *Start Cluster* by Devaney (2017).

Figure 1Eleonor Turner while playing The Wood and The Water using MyoSpat

In the first piece, Turner uses Sign Language as part of her performance. These aspects were later studied in the context of Aural Diversity (see the following section), the study of sound and music that addresses the full range of human hearing types and what it means for the design of musical instruments (Hugill, 2019).

Gaver (1991) separates affordances in four categories upon the capability of being perceived: (i) *correct rejections* when there is no affordance and it is not perceived; (ii) *perceived*, the

affordance is present and perceived; (iii) *hidden*, the affordance is present but it is not perceived; and (iv) *false affordances*, when an affordance is perceived but does not exist. The discovery of these affordances and the subsequent interactions are driven by a continuous action-perception loop (Svanæs, 2000). This plays an even more important role when considering the diverse spectrum of human abilities to perceive them. In the context of musical affordances, none of the works mentioned above focused on aural diversity, and how others' hearing profile (otologically normal, hearing impaired and D/deaf) can impact the perception of musical affordances. The HSI project aims to bridge this gap.

The following sections of this Chapter will focus on the piece *The Wood and The Water*, and the role that sign-language can take in the design of musical instruments and interaction with them. This second section will briefly introduce signed music performance and some of the issues on this topic. Finally, the conclusion and future directions of this work are presented.

The Wood and the Water by Eleanor Turner

The Wood And The Water, for harp and electronics, is composed by Eleanor Turner using MyoSpat. The piece represents the primary output of the HarpCI project (Di Donato, *et al.*, 2020). The performer elaborates the auditory and visual feedback through hand gestures. Such elaborations make herself and the audience explore the acoustic space and sounds living in it as tangible.

With this piece, Turner aimed to express and communicate some of her personal experiences through an original type of musical poetry. The first step was writing down the foundation poem on paper to establish what she wished to express. Then, using British Sign Language

(BSL), it evolved into a more descriptive and expressive poem that she could sing and play on the harp. The simplest musical gestures in the piece are BSL signs that begin on the harp with the plucking of the strings to create the sound and are completed away from the strings. In fact, they often continue for a long time away from the strings and even away from the instrument - above, around, behind, underneath and on the side of the harp, enabled by the MyoSpat sound spatialisation and delay. Aside from those exact signs that create the poem, the music sets the scene of walking through a forest, hearing the feet crunching through the leaves, atmospheric sounds coming from all around and being alone with one's thoughts. A connecting musical motif takes us further on our walk through the forest; a break from the signed poem and complex electronic effects. The most intense moment in the piece uses spatialisation together with the gesture-controlled effects and the signed poem; all brought about by the discovery of a pool of water calling for Turner's honest, personal reflection. The rhythmical spoken word and music passage that follows is Turner's impassioned response to this challenge and is dense with electronic effects and the complexity of words and music angrily spilling out all over each other.

The Wood and the Water has been recorded in studio and performed in different music festivals and conferences, such as Audio Mostly 2017 and Shanghai's Electronic Music Week 2017 (recordings of these performances are available at https://balandinodidonato.com/). During rehearsal and performances, it was observed that the role of sign language was not only to communicate the lyrics to an aurally diverse audience, but to blend the gestural interaction with audio-visual processes. With this performance, Turner and I scratched the surface of the potential to adopt Sign Language as means of interaction with an interactive system as well as the audience. In the HarpCI project, the interaction with MyoSpat was designed to support the instrumental technique and

inadvertently sign language. The HSI project aims to extend this intuition and explore the use of sign language for interaction design with interfaces for musical expression.

Signed music and Human-Sound Interaction

Painting, literature, dance, literature, and music are art forms that are seen as unique to the human experience. However, communities sometimes redefine these art forms for their ability to produce them or appreciate them. In the case of music, deafness is often considered a debilitating condition (Cripps, *et al.*, 2017). Music, as known to the hearing community, is formed of an organisation of sound that precludes deaf people from any meaningful involvement in its creative practice. Sign Language was born as a means of communication for d/Deaf people. In relation to music, it was initially used to interpret lyrics only. In more recent years, a growing number of Sign Language literate and deaf communities have taken advantage of it as a means to create and appreciate music. This gave life to what is now called signed music and new category of artists: deaf performers (Cripps, et al., in press). This artform is becoming increasingly widespread and recognised by institutions, such as the Royal Conservatoire of Scotland, which opened a BA course in British Sign Language and English (Royal Conservatoire of Scotland, 2021). Sign Language performances were mainly for a d/Deaf audience or highly Sign Language literate. In the last two decades, Sign Language performed music has become popular on online video streaming platforms.
The community of music Sign Language interpreters recognised this issue and are constantly finding ways to build a language, or Sign Language "dialects" that are able to communicate also played music. In her talk on enhancing music through Sign Language, the deaf artist Sun Kim (2015) talks about how movement is equal to sound in deaf culture. She says: *"How is it that I understand sound? Well, I watch how people behave and respond to sound. You people*

are my loudspeakers, and amplify sound. I learn and mirror that behaviour. At the same time, I've learnt that I create sound, and I've seen how people respond to me. […] In deaf culture, movement is equal to sound". She then continues explaining how sound can be experienced visually, through touch or as an idea. As a note cannot be fully captured and expressed on paper, the same holds true for a concept in American Sign Language (ASL). Music and ASL are both highly spatial and inflected. As subtle changes in the instrumental technique of a musician, so a small difference in performing a sign can affect its entire meaning. In a study reviewing the work of two deaf people, Cripps, *et al.* (2017) highlight how signed music constitutes a new and unique form of performance art, maintaining common elements with both Sign Language and music. The amount of Sign Language performed music is growing and growing. For example, YouTube channels of Timm (2006), Signmark (2009), T.L. Forsberg (2015) and Sean Forbes (2006). In recent years we started to see this artform appear in mainstream channels. For example, Dexterity (2017)'s performance of Queen's *Bohemian Rhapsody* at the TEDxSydney, or the several performances of ASL interpreted music pioneer Gallego (2021). Different music artists are working towards making music accessible to deaf people by releasing videos featuring the use of Sign Language. Examples are *You Need Me, I Don't Need You* by Sheeran (2011), *Pride* by American Authors (2016) and McCartney's (2012) *My Valentine Featuring Natalie Portman and Johnny Depp*.

In her article analysing the relationship between Sign Language and Music, Maler (2013) highlights several issues that the popularity of these videos poses, such as the cultural appropriation of the Deaf culture by the hearing community, and the debate on hearing people using Sign Language to "show off". At the same time, signed-music performance can also have a positive impact on Deaf cultural heritage. Signed music can be a catalyser for freeing Deaf communities from oppressive historical processes and disseminate knowledge of this artistic practice (Morêdo Pereira, 2021). With awareness surrounding cultural issues,

the HSI project to bridges research on signed-music performance with the field of interaction design and the making of digital musical instruments.

After an analysis of different song-signing video, in her conclusions, Maler writes,

> "Deaf music provides analysts with a unique opportunity to investigate how people of all different hearing abilities perceive and interact with music in order to interpret and create it with their hands and bodies" (Maler 2013).

She then continues saying "the analogical aspects of sign language and gesture correlate particularly well with the analogical resources of music, while the more symbolic aspects of sign language help us parse meaning with greater ease than if the signer's movements were purely dance. This special property of song signing presents an opening for further analysis in the fields of disability studies, musical embodiment, and music perception."

In reference to my work, these quotations give rise to the following questions: how can we build instruments and design interactions with them, such that they are meaningful to an aurally diverse audience? What framework/s can we adopt to evaluate the relationship quantitatively and qualitatively between Sign-Language gestures and the music, here intended as both lyrics and instrumental parts?

To study sonic affordances perceived by Sign Language translators and gestures enacted to communicate music and lyrics to d/Deaf people, a large dataset that includes motion and sound features of Sign-Language performed music is being created (Di Donato, 2021). This data set, currently under development, is a collection of raw quantitative data, computed

higher-level features and qualitative analysis conducted through coding of visual and audio data (Saldana, 2021). The modelling of this data will then be the foundation of knowledge for designing new instruments performable by signed-music performers. This approach presents a series of limitations, and future work will also build around these. For example, as highlighted by the deaf dancer Yan Liu in (Canadian Cultural Society of the Deaf YouTube, 2016), signed music should be considered an artform in itself. As opposed to conventional poetry, where we have words for which signs are well defined, in music, "signs themselves, the way they move, they create music". Another open question remains the difference between different signed music genres. Like music, we have classical, popular, electronic, rock and other genres, which are influenced by the cultures in which music is composed. The same happens for signed music; performers are influenced by their cultural background and the spoken sign language. In reference to my work, how digital musical instruments can support the music creation process considering the diversity of signs? Future work aims to answer these questions and contribute to the literature on signed-music performance.

Conclusions

This chapter presented the initial developments of the Human-Sound Interaction project in the context of Aural Diversity. In this scenario, HSI aims to bring music-making and experience to anyone, regardless of their hearing profile. The interaction with musical instruments and the audience is fundamental in both the making and performing music; this is a vital element for musicians and the public. Including Sign-Language in the interaction design of musical instruments can make music more accessible to both music makers and the audience. *The Wood and the Water* was the first step in this direction. Importantly, this performance demonstrated the feasibility of blending instrumental music performance with

Sign-Language. Here technologies to be created could play a significant role. New technologies can welcome anyone to create and experience music, regardless of their ability to act and experience the world around us.

References

American Authors (2016) *Pride*. Available at https://youtu.be/7bAaN-LCcHI (accessed April 2021).

Canadian Cultural Society of the Deaf YouTube (2016) *Signed Music Rhythm of the Heart HD*. Available at https://youtu.be/FLazgI_phNQ (accessed 12, 2021).

Cripps, J., Rosenblum, E., Small, A., & Supalla, S. (2017) 'A case study on signed music: The emergence of an inter-performance art', *Liminalities: A Journal of Performance Studies*, 13(2) pp. 1-24.

Cripps, J., Small, A., Rosenblum, E., Supalla, S. J., Whyte, A. K., & Cripps, J. S. (in press). *Signed music and the deaf community. Culture, deafness & music: Disability studies and a path to social justice*. In A. Cruz (Ed.), Culture, deafness & music: Disability studies and a path to social justice. Rotterdam, NL: Sense Publishers.

Devaney, K. (2017) *Star Cluster*. Availabe at https://youtu.be/9ToP33Ki2SE (accessed April 9 2021).

Dexterity, A. (2017) *Queen's Bohemian Rhapsody Performed in Sign Language*. Available at https://youtu.be/1E0VdL9UqtM (accessed April 2021).

Di Donato, B. (2021) *HSI-data*. Available at https://github.com/balandinodidonato/HSI-data (accessed April 2021).

Di Donato, B., Dewey, C., & Michailidis, T. (2020) 'Human-Sound Interaction Towards human-centred cross-modal interaction with sound', *Proceedings of the 7th International*

Conference on Movement and Computing. New Jersy, USA: Association for Computing Machinery.

Di Donato, B., Dooley, J., & Coccioli, L. (2020) 'HarpCI, Empowering Performers to Control and Transform Harp Sounds in Live Performance', *Contemporary Music Review*, 36(6), pp. 667-686.

Di Donato, B., Dooley, J., Hockman, J., Bullock, J., & Hall, S. (2017) 'MyoSpat: a hand-gesture controlled system for sound and light projections manipulation', *Proceedings of the International Computer Music Conference (Shanghai, China)*, pp. 335-340.

Franinović, K., & Serafin, S. (2013) *Sonic Interaction Design*. Cambridge, MA: MIT Press.

Gallego, A. (2021) *Amberg Productions*. Available at https://www.ambergproductions.com/ (accessed April 2021).

Gaver, W. (1991) 'Technology Affordances', *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, New Orleans, Louisiana, USA: Association for Computing Machinery, pp. 79-84.

Gibson, J. J. (1966) *The Senses considered as Perceptual Systems*. Boston: Houghton Mifflin.

Gibson, J. J. (1979) 'The Theory of Affordances', *The Ecological Approach to Visual Perception*, pp. 119–137.

Godøy, R. (2010) 'Gestural Affordances of Musical Sound', in Godøy, R. *Musical Gestures: Sound, Movement, and Meaning*, pp. 115-137. New York: Routledge.

Godøy, R., Haga, E., & Jensenius, A. (2006) 'Exploring Music-Related Gestures by Sound-Tracing: A Preliminary Study', *Proceedings of the 2nd International Symposium on Gesture Interfaces for Multimedia Systems, Leeds, United Kingdom*, pp. 27-33.

Hugill, A. (2019) 'Aural Diversity'. Available at https://auraldiversity.org/ (accessed April 12 2021).

Di Donato (2022, in press) Sign in Human-Sound Interaction. In Drever, J., Hugill, A., *Aural Diversity*, Routledge, ISBN 9781032024998

Maler, A. (2013) 'Songs for Hands: Analyzing Interactions of Sign Language and Music', *MTO: a journalof the Society of Music Theory,* 19(1). Available at: https://mtosmt.org/issues/mto.13.19.1/mto.13.19.1.maler.html (Accessed August 2021)

McCartney, P. (2012) *My Valentine*. Available at https://youtu.be/f4dzzv81X9w (Accessed April 2021).

Morêdo Pereira, J. (2021) *Deaf on stage: The cultural impact of performing Signed Songs.* London: University College London (UCL).

Rocchesso, D., Serafin, S., Behrendt, F., Bernardini, N., Bresin, R., Eckel, G., . . . Visell, Y. (2008) 'Sonic Interaction Design: Sound, Information and Experience', *CHI '08 Extended Abstracts on Human Factors in Computing Systems*, pp. 3969–3972.

Royal Conservatoire of Scotland (2021) 'BA Performance in British Sign Language and English' Available at https://www.rcs.ac.uk/courses/ba-performance/ (accessed April 12, 2021).

Saldana, J. (2021) *The Coding Manual for Qualitative Researchers.* London: SAGE Publications.

Forbes, S. (2006) *Sean Forbes.* Available at https://www.youtube.com/user/seanforbes/ (accessed April 9 2021).

Sheeran, E. (2011) *You Need Me, I Don't Need You*. Available at https://youtu.be/ZXvzzTICvJs (accessed April 2021).

Signmark (2009) *Signmark.* Available at https://www.youtube.com/user/signmarkprod (accessed April 2021).

Sun Kim, C. (2015) *The enchanting music of sign language*. Available at https://www.ted.com/talks/christine_sun_kim_the_enchanting_music_of_sign_language (accessed March 2021).

Di Donato (2022, in press) Sign in Human-Sound Interaction. In Drever, J., Hugill, A., *Aural Diversity*, Routledge, ISBN 9781032024998

Svanæs, D. (2000) *Understanding Interactivity: Steps to a Phenomenology of Human-Computer Interaction*. Norway: Norges teknisk-naturvitenskapelige universitet.

Tanaka, A., Altavilla, A., & Spowage, N. (2012) 'Gestural Musical Affordances', *Proceedings of the 9th International Conference on Sound and Music Computing*, Copenhangen, Denmark. Available at https://research.gold.ac.uk/id/eprint/14647/1/Gestural_Musical_Affordances.pdf (Accessed August 2021)

Timm, R. (2006) *Rosa Lee Timm*. Available at https://www.youtube.com/channel/UCWDxkkg2vNvH0MsAxp3Zf_Q (Accessed April 2021).

Forsberg, T.L. (2015) *TL Forsberg*. Available at https://www.youtube.com/channel/UCrEGub-Em6dT-UJm901SGXQ (Accessed April 2021).