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Accessibility and participation in the use of an inclusive musical instrument: The case of MotionComposer

ABSTRACT

Digital musical instruments (DMI) can make musical practice accessible to non-trained persons or to persons with limitations related to their age, gender or musical experience. The present study explores accessibility and participation in a sample of 266 individuals using a device named MotionComposer, a digital instrument based on motion capture. By experimenting with this device during four minutes in two different environments (one causal, the other one more aprioristically determined), we study the kind of participant interaction that takes place. Results show that MotionComposer allows for a statistically significant similar interaction in people of different ages and genders and with different disabilities. However, there are two exceptions that can be accounted for in connection with the causality-randomness of the two environments where the experimentation takes place.

KEYWORDS

digital musical instrument (DMI)
inclusive music performance
accessibility
interaction
disability
music participation

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1. Introduction

This research attempts to study the level of accessibility of the motion capture-based music device named MotionComposer (version 2.0), and its potential for participation in terms of engaging several types of users in musical practice.

Music education goes beyond the school and the classroom: it may be a lifelong process and it must allow for equal opportunities irrespective of the specific characteristics of individuals. Music constitutes an innate ability of human beings and is therefore within everyone's reach in a natural way. Yet, certain conditions may hinder or directly exclude people from accessing specific musical experiences. Inclusion involves the possibility of participating and experiencing success in these activities, even though there may be difficulties arising due to poverty, class, race, religion, cultural background, gender (Burnard et al. 2008) and, of course, disability of any kind. In fact, for many people who experience some form of limitation access to musical expression may entail improvements in several aspects of their lives (Chamberlain and Gallegos 2006). In the last few decades, the issue of inclusion and a number of initiatives aimed at engaging all kinds of people in the experience of music have become a topic of interest for music education researchers. This implies a considerable step forward if we bear in mind that in our western culture the concepts underlying music education – even in the school context – largely promote competition, a talent-based culture and, therefore, the exclusion of many students (Lubet 2009). In the formal context, the interpretation of current laws may well provide a decisive starting point to take efficient steps leading to inclusion (Damer 2001) since the latter tends to be reflected in our educational legislation in ways that are too general. In this respect, Hammel and Hourigan (2011) point out that the implementation of inclusive policies may encourage not just the development of all students but also the understanding of music education's relevance itself. On the other hand, it is necessary to strengthen the training opportunities and resources available to teachers for the large potential of music to be fully realized in school-related regulatory frameworks (Grenier 2016). It is also needed to find proper arguments for music education advocacy considering inclusive contexts (Peñalba 2017).

There are numerous studies that discuss several aspects that are deemed necessary to attain full inclusion in the music classroom. Hammel (2004) underscores the collaboration among professionals (music and special education teachers and specialized supporting staff), the proper management of physical spaces, the adaptation of teaching materials and the creation of a proper didactic communication. She likewise points to the importance of engaging the involvement of students with difficulties (when possible) in such decisions as well as their parent participation. Adamek (2001) calls for a reflection on the need for music education curricula to promote participation, normalization, autonomy and personal identity. In turn, Sabbatella (2005) describes the conditions surrounding those elements that make up an inclusive environment in music education: the students, the teaching staff, the curriculum and the methodology used to implement the latter.

Several case studies deal with inclusive practices in music education applied in various contexts. The one conducted by Burnard et al. (2008), for example, compares a number of pedagogies for inclusion in difficult settings within the educational systems of Spain, Australia, Sweden and the United Kingdom. Their conclusions point to a number of success factors based on the power of music to generate transforming musical experiences, significant learning environments and positive bonds with students. This piece of research also contains a set of reflections on the concept of inclusion itself, and on the setbacks and benefits derived from conducting comparative studies. Similarly, Bo Wah Leung and Wai-Ying-Wong (2005), in their inquiry into a number of disadvantaged environments in Hong Kong, underline the importance of the teacher's personality, musical skills, teaching philosophy and pedagogical approach to succeed in motivating and involving students in their own learning process and, therefore, in making education truly effective.

Technological developments have also played an important role in accessibility to musical practice, both individually and collectively. In the digital era, the ways of making music have experienced remarkable changes encouraged by ongoing technological advances. DMI artificially produce sound via a computer application and search for new possibilities in sound production and different forms of sound control (Mulder 2000). This in turn enables individuals with no specific musical training or with some motor, sensory or cognitive impairment to have access to music performance, improvisation and creation. In this way, digital instruments can be used by non-trained persons and also adapted to the performer's motor skills, preferences or requirements resulting from his/her limitation. Such an approach to the relation between the performer and the instrument should lead to the former's greater freedom in terms of the choice and development of a personal, gestural 'vocabulary' (Mulder 2000: 315). Unlike acoustic instruments, digital ones disrupt the relation that exists between the sound-producing gesture and the sound itself, so that any gesture may render any sound.

Digital instruments usually include three basic components: a controller (mostly gestural), a sound-generating source and a mapping that relates both, i.e. the software that links together the performer's gestures and movements on the one hand and the resulting sound/musical output on the other. Controllers use one or several sensors that may or may not require direct contact with the device, including pressure, rotational, bend, ultrasonic or magnetic field sensors. Pressure sensors detect the resistance or strength of fingers or hands without any need for movement to take place. Rotational sensors measure the spinning that takes place around their axis producing changes in electrical resistance. Bend or flex sensors contain a plastic-made elastic band whose resistance changes as it bends. Contactless sensors generally resort to ultrasound systems where sounds are captured by microphones. Magnetic field sensors use magnets to measure distances to their magnetic pole. Accelerometers consist of silicone fibres whose inertia-based reaction changes the electric current that runs through them. On the other hand, image-capture systems are most commonly used when there is a need for the controller to be wireless and allow for unlimited movements (Wanderley and Depalle 2004). The second component in a digital instrument, namely mapping, establishes the relations between the performer's gesture and the resulting sound. Gestures captured by the several sensors provide information about pressure, position and rotation – either regarding a very specific part of the body or about the latter as a whole. Simple mapping consists of assigning a sound or sound parameter to a type or a quality of movement, while multilayer mapping creates intermediate parameters that link input and output elements. In this way, if we change the controllers or the sounds that we want to use, we may still keep using this mapping, which is impossible in single-layer mapping (Wanderley and Depalle 2004). The third component in digital instruments is sound. DMIs can use all kinds of sonorities, from soundbanks containing pre-recorded items to sounds synthesized or modified in real time. Some devices also allow for the use of lights, haptic feedback (like vibration, movement) or images.

There are several projects aimed at promoting access to the musical experience, and these are generally targeted at persons with disabilities or elderly citizens. Technological applications have also been documented in gender-related contexts (Magee 2014; Weissberger 2014) or in situations of social disadvantage (Lindeck 2014), although in such cases rather than using digital instruments designed ad hoc, commercial applications of musical software are employed instead. *SoundBeam* (Ellis 2003, 2004; Swingler 1998) is a device that resorts to ultrasonic sensors to detect movement. It consists of 32 pre-recorded soundsets that make it possible to perform several musical genres or to use different sonorities for the purpose of musical improvisation. The device can be programmed, which means that sounds can be customized and saved. It has been used on persons with autism (Ellis and Leeuwen 2000), individuals with diverse disabilities and elderly people (Ellis 1996, 2003, 2004). *Soundscapes* can be used to capture body motion and gesture and amplify them, in the case of persons with disabilities, to create sounds and images. It has been used for therapy-oriented purposes within the framework of Creating Aesthetically Resonant Environments for the Handicapped, Elderly and Rehabilitation (CAREHERE) (Brooks 2011; Brooks and Hasselblad 2005): a European project aimed at creating tools for the physical rehabilitation of patients with Parkinson's disease or other disorders, principally by using drawing as a feedback instrument. SATI is a software application developed within a project by the same name (Mauri et al. 2009) that provides access to musical performancce for individuals with cerebral palsy. By using a motion-capture technology, movement is mapped through two working modules: one is used to upload several audio files containing songs and other compositions to stimulate sound production and the other is used for the processing of sound or voice in real time (Mauri et al. 2009). Multisensory Environment Design for an Interface between Autistic and Typical Expressiveness (MEDIATE) is an inter-institutional project targeted at children with autism. Its purpose is to 'enable boys and girls to play, explore and be creative in a predictable, controllable and safe space' (*our translation*) (Parés et al. 2005: 2). It relies on a large-sized physical interactive environment where children can create sound, visual and tactile experiences by using their own bodies and the possibilities afforded them by space. TENORI-ON is an instrument designed by multimedia artist Toshio Iwai and trademark Yamaha. It consists of a 16 × 16 led matrix that allows users to intuitively create an interface of luminous 'visible music' by touching. Its applications include the field of music, as pointed out in the study by Clements-Cortes (2014). Interviewed music therapists reported an anxiety-diminishing effect and an enhancement of opportunities for socialization and, above all, communication skills. It can be used on people with Alzheimer's disease, dementia, brain injury, chronic diseases, Parkinson's disease, hearing impairment, autism, ADHD and cerebral palsy. A study conducted by Partesotti, Peñalba and Manzolli presents an exploratory review of the possibilities of the use of music technologies in music therapy and discusses their benefits within the framework of the paradigm of Embodied Cognition (Partesotti et al. 2018).

MotionComposer (version 2.0),[2] the digital instrument that has been used for the purpose of this research, is a device capable of capturing movement and transforming it into sound and music. It has been specifically designed for

2. For more thorough technical information, see Bergsland and Wechsler (2013, 2015, 2016), Wechsler (2013). For the new version of MotionComposer 3.0 see http://motioncomposer.de/.

people with functional diversity (Bergsland and Wechsler 2016) and features a strong user-adaptation by providing clients with the possibility of creating music and dance irrespective of their physical or cognitive conditions (Bergsland and Wechsler 2013; Peñalba et al. 2015; Wechsler 2013). The device combines motion-tracking sensors and a sound-generating software run on a computer (Mini- ITX with an Intel i7 processor). It uses a *Kinect* motion controller fitted with a 1.3 megapixel Ethernet camera that sends high-resolution and low-latency images. The *Kinect*'s sensor measures all three dimensions by tracking the user's location and posture. The sensor's images and data are interpolated and analysed by means of a software program called EyesWeb developed by Simone Ghisio and Paolo Coletta at the University of Genoa, and the whole output is then transferred to a sound-generating software in real time. Some of the analysed parameters – relevant for the purposes of sound control – are the amount of movement, the body horizontal axis and body height, and these are combined to generate six environments with diverse possibilities and sonorities. For the purposes of this research, we have selected two out of these six environments: *Tonality* and *Fields*. *Tonality* is an environment where one can perform piano, harpsichord or vibraphone sounds either by moving one's arms of by moving along axis X in a room. It allows modification of the tune or sound sequence in an ascending or a descending order, and the performing instrument. On the other hand, it provides the possibility of assigning different instruments to the left or the right hand in case the sound is produced by the movement of the arms rather than by shifting the user's location in space. In the environment called *Fields*, for example, the space is divided into two areas that, respectively, house two modalities of the selected sound (weather phenomena, idiophones and animals, among others). The device detects the amount of movement and shoots successive layers of sound as the latter increases. It features three sound levels: discreet sounds caused by minimal movements, sounds of moderate intensity and texture produced by broader movements and highly intense and saturated sounds resulting from large movements. The device's mapping is simple and highly causal, which provides the user with the feeling that he or she is controlling sound through movement. Moreover, this environment makes it possible for two people to interact at the same time, which in turn facilitates the development of processes driven by a shared creation and experience among users or, for example, between the subject and his/her music therapist (Bergsland and Wechsler 2016).

Thanks, therefore, to the disconnection between gesture and sound, digital instruments afford the possibility of using a body-language specifically designed for each situation and involving particular gestural types and functions (Cadoz 1988; Cadoz and Wanderley 2000; Dahl et al. 2010; Davidson and Correia 2002; Delalande 1989; Fredriksen 2011; Jensenius et al. 2010; Peñalba 2008; Wanderley and Depalle 2004). The types of interaction studied in this research are as follows:

- Movement-based interaction (MB) (Peñalba 2008). The user moves independently of sonority, and his/her intention when moving is not sound control. With respect to this kind of interaction ancillary gestures can be performed, also known as accompanying (Delalande 1989) or facilitating gestures (Dahl et al. 2010; Jensenius et al. 2010), but similarly, aesthetic gestures (Peñalba 2010), also called figurative (Delalande 1989) and communicative gestures (Clayton et al. 2005; Dahl et al. 2010; Davidson and Correia 2002; Jensenius et al. 2010), which were termed semiotic by Cadoz and Wanderley (2000).

- Sound-based interaction (SB) (Peñalba 2008). The users take as their point of departure an ideal sound that they try to achieve by means of gesturality. Characteristic movements involve feeling about or exploring the instrument's boundaries. Typical of this kind of interaction are instrumental gestures (Cadoz 1988), also called effective (Delalande 1989) or sound-producing (Dahl et al. 2010; Jensenius et al. 2010). Also in this context we may find regulatory gestures (Peñalba and Valles 2015).
- Contingent interaction (CI) (Peñalba 2008). This kind of interaction takes place because there is mutual feedback between gesture and sound. Sound inspires an individual to produce a specific kind of gesture (e.g, an aggressive sound leads the person to move with abrupt, straight, direct, quick gestures). In turn, a gesture produces a specific type of sonority directly stemming from the system's interactivity.

2. Methodology

Participants (*N*=266) are selected by means of non-probability sampling (Mertens 2014). The sample includes children younger than 10 years of age (*n*=96), young subjects between 11 and 30 years of age (*n*=95), adults between 31 and 60 years of age (*n*=38) and older subjects older than 60 years of age (*n*=37). In terms of gender distribution, 46.3% of the participants were males and 56.4% were females. 63.2% of the participants had no disability, while in the remaining percentage, 21.4 had a cognitive disability, 12.4% had a cognitive and physical disability, and 3% only had a physical disability. With respect to their training backgrounds, subjects severally have experience in music (*n*=85), experience in dance (*n*=43), experience in theatre (*n*=24), experience in sports activities (*n*=17) or no experience in dance, theatre or sports.

The experiment consists of improvising on the MotionComposer device for a maximum of four minutes without having been previously exposed to the instrument and without having received instructions as to how to interact with it. A large enough delimited space is used for experimentation purposes. Users are told that they will be operating a device that enables them to create music by means of body movement: they may use any part of their bodies in

Age	Overall total	Percentage
Children (Until age 10)	96	36.09%
Young (ages 11–30)	95	35.71%
Adults (ages 31–60)	38	14.28%
Older (older than 61 years of age)	37	13.9%

Table 1: Age range.

Gender	Number of subjects	Percentage
Male	116	46.3%
Female	150	56.4%

Table 2: Gender.

By disability type	Number of subjects	Percentage
CD	57	21.4%
CD/PD	33	12.4%
PD	8	3.0%
ND	168	63.2%

Table 3: Disability status.

Experience in music	Number of subjects	Percentage
NO	180	67.92%
YES	85	32.08%
Experience in dance	**Number of subjects**	**Percentage**
NO	223	83.83%
YES	43	16.17%
Experience in theatre	**Number of subjects**	**Percentage**
NO	242	90.98%
YES	24	9.02%
Experience in sports activities	**Number of subjects**	**Percentage**
NO	249	93.6%
YES	17	6.4%

Table 4: Experience.

any way they wish for a maximum of four minutes in two different environments: respectively, *Fields* and *Tonality*, there being a pause between them. If they wish to discontinue their improvisation, they may do so any time they wish. Both at the beginning and at the end of the whole process, a brief interview is conducted to the effect of gathering the individual's personal data and his or her impressions after the experience. Subjects conduct their improvisation and answer the interview on their own, so as to prevent them from being influenced by feeling observed by an audience or, in turn, to influence the performance of other possible users. Only in the case of a few underage or disabled subjects was the presence of parents or supporting staff allowed.

Several techniques for data collection were used to facilitate the latter's triangulation, including an interview before and after the experience together with systematic observation. The whole process was video-taped while two members of the research team simultaneously filled in an observation template including:

- Information on the duration of the experiment in both environments – from 0 to 4 minutes
- Information on the type/s of interaction conducted during improvisation (following the classification by Peñalba (2008), in turn inspired by the gestural categories of Jensenius et al. (2010) and Wanderley and Depalle (2004). Observation categories were established to define each of the proposed types
- Notes on the types of interaction observed.

In addition, both during the interview and in the stage of process-observation useful data were recorded with a view to the experiment's qualitative analysis. These are related to the users' mood or degree of satisfaction when using the device, and the remarks made by the subjects about its usefulness and applications. Given the general character of the test performed by way of an approximation to the device, the collection of this kind of information does not seek to carry out a conclusive analysis, but rather to ascertain the extent to which some preliminary considerations on the instrument's features and use (in therapy, leisure activities or as mediator of learning, mood regulator and vehicle for several modalities of artistic creation) match the participants' feedback. This will in turn guide future research targeted at those areas of interest.

The ultimate aim is to evaluate accessibility to musical practice by means of MotionComposer in terms of age, gender, disability status and experience. The initial hypothesis is that of statistical independence, in the sense that we presuppose the device to allow for a similar interaction in all users. To ascertain such a hypothesis, we apply Pearson's χ^2 test, which measures the discrepancy (or goodness-of-fit) between an observed distribution and a theoretical one, indicating through hypothesis testing the extent to which the differences between both, if any, are caused by chance (both variables being independent from each other) or whether there is a relation of mutual dependence.

Similarly, we propose to determine whether there is independence (or, on the contrary, some form of dependence) between the ability to interact with the device and the time spent on improvisation (time of permanence). For this, we divide the sample into several populations depending on whether or not there is interaction, and next conduct Student's t-test to compare those populations with the statistics related to interaction length, the null hypothesis being the absence of differences between populations (meaning that observable differences have a purely random source).

4. Results

Results regarding MotionComposer's accessibility

It can be observed that the null hypothesis is only rejected for interactions within the *Fields* environment by subjects with disability and for interactions within the *Tonality* environment by subjects qualifying as musicians. While this tool, therefore, is generally inclusive, the training and disability variables do seem to influence the kind of response. In addition, the environment *Fields* is heavily marked by causality and requires highly specific physical skills so that persons with a disability, particularly of the physical type, cannot interact at the same competence level as the rest of the participants. On the other hand, subjects with some previous musical training show statistically significant differences with respect to the type of interaction in contrast with subjects without musical training. We will refer below to the specific types of interaction involved here.

	No interaction		Interaction	
Environment	**Average**	**Variance**	**Average**	**Variance**
Fields	2.6	2.3	3	2.2
Tonality	2.6	2.1	3.1	1.8

Table 5: Time of permanence.

Type of interaction		Fields: No music training	Fields: Music training	Tonality: No music training	Tonality: Music training
No interaction	Movement-based	45.6%	54.1%	45.6%	54.1%
Interaction	Sound-based	32.8%	54.1%	32.8%	54.1%
	Contingent	10.6%	16.5%	6.7%	14.1%
		No dance training	**Dance training**	**No dance training**	**Dance training**
No interaction	Movement-based	43.9%	69.8%	43.5%	74.4%
Interaction	Sound-based	42.2%	27.9%	34.1%	18.6%
	Contingent	12.1%	16.3%	10.3%	2.3%
		No theatre training	**Theatre training**	**No theatre training**	**Theatre training**
No Interaction	Movement-based	47.1%	58.3%	47.9%	54.2%
Interaction	Sound-based	39.7%	41.7%	39.7%	41.7%
	Contingent	12.4%	16.7%	8.3%	16.7%
		No sports training	**Sports training**	**No sports training**	**Sports training**
No Interaction	Movement-based	49.0%	35.3%	48.2%	52.9%
Interaction	Sound-based	39.4%	47.1%	30.9%	41.2%
	Contingent	12.0%	23.5%	8.4%	17.6%

Table 6: Interaction according to previous training.

Results according to time spent on improvisation or participants' time of permanence

In terms of the time of interaction, the null hypothesis is rejected, i.e. that there is a relation between the subjects who interact and the time of permanence while interacting in both environments. Those subjects who succeed in understanding how the device functions feel a stronger motivation to sustain their interaction over time.

Results according to previous training and its influence on the type of interaction

In terms of the type of interaction, significant differences can be observed in terms of previous training. Musicians exhibit a higher percentage of sound-based interaction. In other words, they liken the functioning of the MotionComposer device to that of an acoustic instrument. By contrasting the quantitative with the qualitative data, we conclude that musicians start from an ideal sonority that they strive to attain through gesturality. In both environments, on the other hand, dancers engage in a movement-based kind of interaction in a larger percentage than subjects without previous training in dance. With respect to the other training backgrounds, no statistically significant results were obtained.

Variable		Environments (1. Fields. 2.Tonality)	1 DF 99% >6.64	3 DF 99% >11.3	Influence of variables
Age		1		6.5	No
		2		8.5	No
Gender		1	1.3		No
		2	0.4		No
Disability Status		1	9.9		**Yes**
		2	4.4		No
Experience	Music	1	5.8		No
		2	12.3		**Yes**
	Dance	1	1.4		No
		2	2.0		No
	Theatre	1	0.2		No
		2	1.6		No
	Sports	1	0.2		No
		2	0.5		No

Table 7: Analysis of Pearson's χ^2 test.

	Environments (1. Fields, 2.Tonality)	263 DF 95% >2.25	Influence
Time of permanence	1	2.30	Yes
	2	2.79	Yes

Table 8: Analysis of Student's t-test.

5. Discussion

The above results confirm the usefulness of digital instruments in inclusive musical practice since they eliminate a number of barriers due to the users' condition (Brooks and Hasselblad 2005; Clements-Cortes 2014; Ellis 2004; Mauri et al. 2009; Parés et al. 2005). In the case of MotionComposer, there does not seem to be a statistically significant difference in the users' responses in terms of age, disability or gender, a conclusion consistent with Peñalba et al. (2015).

Our study shows differences between a more causal environment (*Fields*) and a less causal, more random one (*Tonality*). The type of interaction that takes place within the *Fields* environment encourages participants more clearly to liken the device's functioning to that of an acoustic instrument, and therefore to continue their exploration in a similar way. From this point of view, physical skills are key to controlling the instrument, so that individuals with physical disabilities do not produce responses similar to those of subjects without disabilities. However, and according to our observations, it appears that the environment allows for the development of a specific gestural language (Mulder

		Fields		Tonality	
Type of interaction		>3.84 1DF 95%	Influence	>3.84 1DF 95%	Influence
Music training					
No interaction	Movement-based	0.9	No	0.9	No
Interaction	Sound-based	6.6	Yes	6.6	Yes
	Contingent	1.6	No	3.6	No
Dance training					
No interaction	Movement-based	5.0	Yes	7.1	Yes
Interaction	Sound-based	1.8	No	2.7	No
	Contingent	0.5	No	2.5	No
Theatre training					
No interaction	Movement-based	0.6	No	0.2	No
Interaction	Sound-based	0.0	No	0.0	No
	Contingent	0.3	No	1.7	No
Sports training					
No interaction	Movement-based	0.6	No	0.1	No
Interaction	Sound-based	0.2	No	0.5	No
	Contingent	1.6	No	1.5	No

Table 9: Results of the χ^2 test (Types of interaction-training backgrounds).

2000) in some participants with a disability. Exploration, on the other hand, of the *Tonality* environment requires a less specialized language, one that is farther removed from the kind of control displayed in the case of conventional musical instruments. This is an important aspect to bear in mind in the design of musical instruments.

In terms of participation, individuals who do not interact with the device remain connected to improvisation for a shorter time than those who do interact. In this sense, there are no differences between both environments, which look similar in terms of the type of involvement and participation they elicit. This may indicate that the level of engagement with the device may not be sufficient in some cases, and this may in turn require mediation by a professional (educator, therapist, artist, etc.) (Bergsland and Wechsler 2016).

Despite the fact that MotionComposer features fine conditions in terms of accessibility and participation, it also has limitations with respect to its potential for collective improvisation, which is one of the standards by which inclusive practices are defined (Burnard et al. 2008). MotionComposer (in the version used in this study) can only be used to perform in pairs and within the *Fields* environment, although the present study did not engage in experimentation in that setting.

In terms of a qualitative analysis, the information drawn from observation and the reports by participants confirms the accessible features of such a digital instrument as MotionComposer. Users report that interacting with the device involves an easy and affordable way of obtaining an active and satisfactory musical experience. Similarly, it can be observed that the experience is in itself motivating, which makes it highly suitable for didactic and therapeutic purposes. However, the fact that a percentage of people remain non-interactive suggests the relevance of considering the causes of such non-interaction and the possible ways of promoting accessibility, for example through the use of instructions, examples or the intervention of another person in a measuring role, as indicated earlier. All of these issues will constitute the object of study in the next phase of our research.

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REFERENCES

Adamek, M. (2001), 'Meeting special needs in music class', *Music Educators Journal*, 87:4, pp. 23–26.

Bergsland, A. and Wechsler, R. (2013), 'Movement-music relationships and sound design in motioncomposer, an interactive environment for persons with (and without) disabilities', Proceedings of the Re-New, Copenhagen: Digital Arts Forum, pp. 56–62.

——— (2015), 'Composing interactive dance pieces for the MotionComposer, a device for persons with disabilities', Proceedings of the International Conference on New Interfaces for Musical Expression, Louisiana: Baton Rouge, pp. 20–23.

——— (2016), 'Turning movement into music', *Soundeffects: An Interdisciplinary Journal of Sound and Sound Experience*, 6:1, pp. 24–47.

Bongers, B. (2000), 'Physical interfaces in the electronic arts interaction theory and interfacing techniques for real-time performance', in M. M. Wanderley and M. Battier (eds), *Trends in Gestural Control of Music*, Paris: Ircam. Centre Pompidou, pp. 41–70.

Brooks, A. L. (2011), 'Soundscapes: The evolution of a concept, apparatus and method where ludic engagement in virtual interactive space is a supplemental tool for therapeutic motivation', *Ph.D. thesis*, Sunderland: University of Sunderland.

Brooks, A. L. and Hasselblad, S. (2005), 'Creating aesthetically resonant environments for the handicapped, elderly and rehabilitation: Sweden', *International Journal on Disability and Human Development*, 4:4, pp. 285–94.

Burnard, P., Dillon, S., Rusinek, G. and Saether, E. (2008), 'Inclusive pedagogies in music education: A comparative study of music teachers' perspectives from four countries', *International Journal of Music Education*, 26:2, pp. 109–26.

Cadoz, C. (1988), 'Instrumental gesture and musical composition', ICMC, International Computer Music Conference, Cologne: Michigan Publishing, pp. 1–12.

Cadoz, C. and Wanderley, M. (2000), 'Gesture-music', in M. M. Wanderley and M. Battier (eds), *Trends in Gestural Control of Music*, Paris: Ircam, Centre Pompidou, pp. 71–94.

Chamberlain, S. P. and Gallegos, J. (2006), 'Judith A. Jellison: Music and children with special needs', *Intervention in School and Clinic*, 42:1, pp. 46–50.

Clayton, M., Sager, R. and Will, U. (2005), 'In time with the music: The concept of entrainment and its significance for ethnomusicology', *European Meetings in Ethnomusicology*, 1, pp. 1–82.

Clements-Cortes, A. (2014), 'Getting your groove on with the Tenori-on', *Journal of Music, Technology & Education*, 7:1, pp. 59–74.

Dahl, S., Bevilacqua, F., Bresin, R., Clayton, M., Leante, L., Pogi, I. and Rasamimanana, N. (2010), 'Gestures in performance', in R. I. Godøy and M. Leman (eds), *Musical Gestures: Sound, Movement, and Meaning*, New York: Routledge, pp. 36–68.

Damer, L. K. (2001), 'Students with special needs', *Music Educators Journal*, 87:4, pp. 17–18.

Davidson, J. W. and Correia, J. S. (2002), 'Body movement', in R. Parncutt and G. McPherson (eds), *The Science and Psychology of Music Performance: Creative Strategies for Teaching and Learning*, Oxford: Oxford University Press, pp. 237–50.

Delalande, F. (1989), 'La terrasse des audiences du clair de lune: Essai d'analyse esthésique', *Analyse musicale*, 16, pp. 75–85.

Ellis, P. (1996), 'Layered.analysis: A video-based.qualitative research tool to support the development of a new approach for children with special needs', *Bulletin of the Council for Research in Music Education*, 130, pp. 65–74.

——— (2003), 'Vibroacoustic sound therapy: Case studies with children with profound and multiple learning difficulties and the elderly in long-term residential care', *Studies in Health Technology and Informatics*, 103, pp. 36–42.

——— (2004), 'Improving quality of life and well-being for children and the elderly through vibroacoustic sound therapy', in K. Miesenberger et al. (eds), *Computers Helping People with Special Needs,* 3118, London: Springer, pp. 416–22.

Ellis, P. and Leeuwen, L. van (2000), 'Living sound: Human interaction and children with autism', *ISME Commission on Music in Special Education, Music Therapy and Music Medicine*, Regina, Canada: ISME, pp. 1758–66.

Fredriksen, B. (2011), 'Negotiating grasp embodied: Experience with three-dimensional materials and the negotiation of meaning in early childhood education', Ph.D. thesis, Oslo: University of Oslo.

Grenier, C. (2016), 'Inclusive music education in Quebec: Shifting paradigms', *Canadian Music Educator*, 57:2, pp. 29–32.

Hammel, A. M. (2004), 'Inclusion Strategies That Work', *Music Educators Journal*, 90:5, pp. 33–37.

Hammel, A. and Hourigan, R. (2011), *Teaching Music to Students with Special Needs: A Label-Free Approach*, Oxford: Oxford Universy Press.

Hourigan, R. (2007), 'Preparing music teachers to teach students with special needs', *Update: Applications of Research in Music Education*, 26:1, pp. 5–14.

Humpal, M. E. and Wolf, J. (2003), 'Music in the inclusive environment', *Young Children*, 58:2, pp. 103–07.

Jensenius, A. R., Wanderley, M. M., Godøy, R. I. and Leman, M. (2010), 'Musical gestures: Concepts and methods in research', in R. I. Godøy and M. Leman (eds), *Musical Gestures: Sound, Movement, and Meaning*, London and Philadelphia: Routledge, pp. 12–35.

Knapp, D. H. (2011), 'The inclusive world of music: Students with disabilities and multiculturalism', *General Music Today*, 25:1, pp. 41–44.

Leung, B. W. (2005), 'Resources for music education advocacy', *International Journal of Music Education*, 23:2, pp. 167–74.

Leung, B. W. and Wai-Ying-Wong, P. (2005), 'El autoconcepto de una profesora de música de secundaria y la percepción de los alumnos sobre la efectividad de la enseñanza, en un contexto desfavorecido', *Revista Electrónica Complutense de Investigación Musical*, 2:1, pp. 1–12.

Lindeck, J. (2014), 'Applications of music technology in a children's hospice setting', in W. L. Magee (ed.), *Music Technology in Therapeutic and Health Settings*, London and Philadelphia: Jessica Kingsley Publishers, pp. 199–216.

Lubet, A. (2009), 'The inclusion of music/the music of inclusion', *International Journal of Inclusive Education*, 13:7, pp. 727–39.

——— (2011), 'Disability rights, music and the case for inclusive education', *International Journal of Inclusive Education*, 15:1, pp. 57–70.

Magee, W. L. (2014), 'Using electronic and digital technologies in music therapy: The implications of gender and age for therapists and the people with whom they work', *Music, Health, Technology and Design*, 8, pp. 227–41.

Mauri, C., García, M. and Bagés, J. (2009), 'Terapia musical y multisensorial mediante las nuevas tecnologías: Proyecto Sistema Audiovisual Terapéutico Interactivo [SATI])', *Sonograma: Revista de Pensament Musical*, 3, pp. 1–16.

Mauri, C., Solanas, A., Granollers, T., Parés, N., Bagés, J. and García, M. (2009), 'Entorno interactivo multimodal para personas con parálisis cerebral', in R. Ceres, L. Calderón, A. Frizera and R. Raya (eds), *IV Jornadas Iberoamericanas de Tecnologías de Apoyo a la Discapacidad*, Madrid: Asociación Iberoamericana de Tecnologías de Apoyo a la Discapacidad (AITADIS), pp. 35–43.

Mertens, D. M. (2014), *Research and Evaluation in Education and Psychology: Integrating Diversity with Quantitative, Qualitative, and Mixed Methods*, Los Angeles, London and Delhi: Sage publications.

Mulder, A. G. E. (2000), 'Towards a choice of gestural constraints for instrumental performers', in M. M. Wanderley and M. Battier (eds), *Trends in Gestural Control of Music*, Paris: Ircam, Centre Pompidou, pp. 315–35.

Parés, N., Freixa, P., Rivas, J. I., Carreras, J., Ferrer, J., Gómez, D., Kruglanski, O., Parés, R., Soler, M. and Sanjurjo, A. (2005), 'Estrategias de comunicación interactiva en un espacio multisensorial para niños y niñas con autismo profundo', *Formats: Revista de comunicació audivisual audivisual*, 4, pp. 1–6.

Partesotti, E., Peñalba, A. and Manzolli, J. (2018), 'Digital instruments and their uses in music therapy', *Nordic Journal of Music Therapy*, 27:5, pp. 399–418.

Peñalba, A. (2008), *El cuerpo en la interpretación musical: Un modelo teórico basado en las propiocepciones en la interpretación de instrumentos acústicos, hiperinstrumentos e instrumentos alternativos*, Valladolid: Universidad de Valladolid.

——— (2010), 'Nuevas relaciones gestuales del intérprete', *Trans: Revista Transcultural de Música, Sociedad de Etnomusicología*, 14, pp. 1–12.

——— (2017), 'La Defensa de La Educación Musical Desde Las Neurociencias', *Revista Complutense de Investigación En Educación Musical*, 14, pp. 109–27.

Peñalba, A. and Valles, M. J. (2015), 'Ritual procesional y teatralización de la sociedad: La música de las bandas procesionales de Semana Santa en Valladolid', in T. Cascudo (ed.), *Música y cuerpo*, Logroño: Calanda Ediciones Musicales, pp. 110–43.

Peñalba, A., Valles, M. J., Partesotti, E., Castañón, R., and Sevillano, M. A. (2015), 'Types of interaction in the use of MotionComposer, a device that

turns movement into sound', in R. Timmers et al. (eds), Proceedings of ICMEM, Sheffield: HRI Online Publications, pp. 1–8.
Plackett, R. L. (1983), 'Karl Pearson and the chi-squared test', *International Statistical Review / Revue Internationale de Statistique*, 51:1, pp. 59–72.
Sabbatella, P. L. (2005), 'Intervención musical en el alumnado con necesidades educativas especiales delimitaciones conceptuales desde la pedagogía musical y la musicoterapia', *Tavira*, 21, pp. 123–39.
Shuler, S. C. (2011), 'Music education for life: Building inclusive, effective twenty-first-century music programs', *Music Educators Journal*, 98:1, pp. 8–13.
Swingler, T. (1998), 'The invisible keyboard in the air: An overview of the educational, therapeutic and creative applications of the EMS Soundbeam', in Second European Conference for Disability, Virtual Reality & Associated Technology, Skövde, Sweden, Reading: ECDVRAT and University of Reading, pp. 253–59.
Wanderley, M. M. and Depalle, P. (2004), 'Gestural control of sound synthesis', *Proceedings of the IEEE*, 92:4, pp. 632–44.
Wechsler, R. (2013), 'MotionComposer: A device for persons with (and without) disabilities: Strategies for coherent mapping in movement-to-music interactive systems. A live demonstration with audience participation', Proceedings of the International Forum on Cultures-Arts-Technologies-Creations-Disabilities, Prague: ICANT (International Center for Art and New Technologies), pp. 1–5.
Weissberger, A. (2014), 'GarageBand as a digital co-facilitator', in W. L. Magee (ed.), *Music Technology in Therapeutic and Health Settings*, London and Philadelphia: Jessica Kingsley Publishers, pp. 279–94.

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