VIBRA - Technical and Artistic Issues in an Interactive Dance Project

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ABSTRACT

The paper presents the interactive dance project VIBRA, based on two workshops taking place in 2018. The paper presents the technical solutions applied and discusses artistic and expressive experiences. Central to the discussion is how the technical equipment, implementation and mappings to different media has affected the expressive and experiential reactions of the dancers.

1. INTRODUCTION

VIBRA is a project exploring expressive and artistic possibilities of interactive dance involving a group of artists based in Trondheim, Norway (www.vibra.no). The acronym VIBRA is Norwegian and translates to Video/visuals, Interaction, Movement, Space and Audio. The project started with several activities in 2017 (although, at the time, not under the name of VIBRA), involving the first and second authors and two dancers. This paper will focus on two workshops held during the spring of 2018 involving a total of eight participants.

1.1 Aims of the project

The main aim of the project from the beginning has been to explore interactive dance as artistic medium. Even if the project has had the artistic development at its core, it has also involved several technological components. Thus, the research questions that we aimed to answer in the project has been both of artistic and technical nature:

- How can different sensors be used in combination so as to convey movement data that corresponds well with experienced movements and how can this data be shared orderly and effectively to accommodate different mappings and media?
- How can different sensors and different mappings affect the movements of the dancers?
- How can musical and musical-spatial mappings be designed that work well for two or more dancers at a time?

It has also been important for the project to work with an inclusive conception of dance, where different bodies, abilities and levels of training are seen as productive ingredients rather than obstacles of the creative process. Several of the project participants have been working with such inclusive conceptions of dance in earlier projects [1]. For the first author, the use of sensor technologies and interactive music systems has been an important tool in expanding the embodied expressive palette of people with different abilities [2]. Openness to dialogue with, and participation from, the audience has followed from this inclusive view of dance, and has been central to our approach since the beginning.

1.2 Participants

Since the first collaborative projects in 2017, a total of eight people have been engaged in the project at different stages. The first author has figured as initiator, project coordinator, artistic director, programmer and composer/ sound designer and been involved in all of the events. The second author has mainly been involved in the sensor communication, including programming the VIBRA-hub application. The third author made interactive computer graphics for the second VIBRA workshop and participated in the first, testing data communication and mappings. Gina Sandberg was responsible for documenting the workshops in audio and video. All project participants were considered a part of the creative team in that they could contribute in discussions and reflections happening in the workshops.

Four dancers have been involved, Arnhild Staal Pettersen, Luis della Mea, Tone Pernille Østern and Elen Øien. The three former have professional training and are also active as choreographers, while Øien is an active amateur wheelchair dancer, but has also done productions with professional dancers. All of them have danced together earlier in different projects, but have had little or no experience with interactive dance prior to the start of the project in 2017. It must also be noted that Della Mea is active both as musician and composer. Henceforth, the dancers will be referred to by the first letter of their first names (A, L, T and E).

2. BACKGROUND

2.1 Interactive dance

Variations V from 1965, involving John Cage, Merce Cunningham, Max Mathews, Nam June Paik and many others, started a revolution when it comes to exploration of the collaboration between music, dance and technology, with dancers exerting as much influence over the sonic landscape as the musicians [3]. Following in Cage's footsteps, the term *interactive dance* has often been applied to artistic expressions in the same vein, especially as they implemented digital technology and computers from the late 1980's and onwards [4]. Mullis has defined interactive dance as "performances in which a dancer's movement, gesture, and action are read by sensory devices, translated into digital information, processed by a computer program, and rendered into output that shapes the performance environment in real time" [5] . Such environments can include media and technologies such as interactive music, lights, video, computer visuals, electro-mechanical instruments, pyro-technics, smart fabrics, internet interfaces and more, in combination with non-interactive elements or not [4–10].

A particular trait of interactive dance is that it makes little sense to apply a fixed choreography in the creation process. Without some freedom for the dancers to go beyond a strict choreography, e.g. moving freely or using structured improvisation, the interactive system will produce a more or less fixed output [6, 11]. Thus, interactivity can be seen as something that increases the creative control of dancers [12] and gives them more freedom of expression, especially in the temporal domain [4].

3. OUR APPROACH

While there have been many technological challenges to the VIBRA project, the core of it has been to explore and develop the artistic possibilities and experiences of interactive dance. In that it aimed to generate knowledge through an embodied and situated artistic practice embedded in artistic and academic contexts, our approach has affinities with Borgdorff's conception of *artistic research* [13]. However, since we consider our workshops more as work-in-progress, and since we haven't at this point conducted a deeper analysis and discussion of them, we don't regard our work as a completed artistic research project.

Our work also has affinities with approaches such as *practice-as-research*, *practice-based* or *practice-led* research [14]. In making the case for the latter of these, Grey discusses the role of what she calls the "practitioner-researcher", and this role seems highly fitting for the first author's role in this project: "The role is multifaceted - sometimes generator of the research material - art/design works, and participant in the creative process; sometimes self-observer through reflection on action and in action, and through discussion with others; sometimes observer of others for placing the research in context, and gaining other perspectives; sometimes co-researcher, facilitator and research manager, especially of a collaborative project" [15]. Ideally, the reflective part of the research process could have been made epistemologically more robust by inviting all project participants to observe and reflect on the documentation of the workshops, but this was unfortunately not practically possible at this point. The dancers' experiences and reflections are therefore implied from analysis of the video material, where the alternation between dialogue/reflection and practical exploration still attests to the importance of reflexivity, dialogue and common artistic development throughout the workshops.

Finally, it is not difficult to argue that the kind of knowledge production Borgdorff refers to above is processual and *embodied* [16]. It is only by moving, listening, feeling one's own body and observing others' that one can develop knowledge of the most important aspects of interactive dance. Therefore, it has always been important for the project to let all project participants experience the interaction.

4. TECHNICAL SETUP AND VENUES

4.1 Venues, workshop structure and documentation

The first workshop took place over two days at DansIT (http://www.dansit.no/), a dance studio owned by a network organization for dance in the region going under the same name. The workshop was conducted in a very open and exploratory manner, where the focus was on including all the participants in a collective creative process developing material for a showing at the end of each workshop. In the process, the dancers got to test and respond to different sensors and mappings, and then develop movement material through improvisation. The structuring of this material for the showings was done collectively. We also made room for conversations during and at the end of each workshop day, so as to sum up the salient experiences of all participants. The experiences and reflections then guided the further development of instruments and mappings, which happened before and in-between the workshop hours.

For the first workshop, the focus was on the audio part of the interaction, although the third author was present and making tests of his setup for computer visuals. Due to the available equipment at the venue, and that the technical setup required quite a bit of setup time, we used the available stereo PA system at the venue.

The second workshop took place at Verkstedhallen, a black box theatre in Trondheim (http://www.verkstedhallen.no/). In addition to the mentioned sensors and the action-sound mappings, this workshop also integrated computer visuals and 8-channel spatial audio (See fig.1).

Both workshops, were recorded in audio and video by the videographer, Gina Sandberg, using two cameras; one on a stand, and the other handheld. The audio and video documentation, along with notes and computer files applied in the technical setup, form the material that is the basis for this paper.

4.2 Sensors

In the two workshops discussed, we have explored two types of sensors:

1. NGIMU sensors, 9DOF IMU sensors with on-board sensor fusion algorithms for absolute orientation

2. Myo armbands, combining 8 EMG electrodes and 9DOF IMU sensor

These were chosen because they were lightweight and robust, they were easy to fasten on the dancers and had wireless communication with low latency. In addition, they both supported, directly or indirectly via available and easy-to-use software, the OSC-protocol, something which greatly facilitated the data communication (see sect. 4.3).

4.2.1 NGIMU

The NGIMU sensor [1] communicates with OSC-messages over Wi-Fi networks, both for transmitting sensor data and for configuration. The use of Wi-Fi technology allows higher data rates, longer operating range and higher transmission power at the cost of higher power consumption and shorter battery life compared to competing technologies such as ZigBee and Bluetooth [17].

The AHRS sensor fusion algorithm provides several measures of absolute orientation, but we focused on the Euler angles (roll, pitch and yaw) that presented stable results in most cases. A noticeable exception was the case when pitch approached $\pm$ 90° leading to erratic measures of roll and yaw (the gimbal lock problem). In order to stabilize the orientation measures we discarded incoming measures of roll and yaw when pitch approached the critical angle.

Another problematic issue appears when the sensor is rotated. Both roll and yaw display discontinuous jumps between -180° and +180°. In most practical cases it is sufficient to unwrap the angle values by adding or subtracting 360°when a jump is detected (in our case defined as a value change exceeding a threshold of 320°). It is not a permanent solution, but it holds for the typical movement patterns of our dancers.

4.2.2 Myo armbands

The Myo armband [2], with its combination of EMG and IMU sensors in one compact wearable armband, has been explored both as a DMI [18] and also more relevantly here, in dance contexts [10, 19–21]. The Myo armband communicates over Bluetooth LE, but several software tools are available for mapping Myo data into OSC. We chose Myo Mapper that incorporates several useful functions for filtering, scaling, calibration and error correction [22]. One Myo Mapper instance can communicate with only one armband, but up to three instances may run on a single computer.

4.3 Data Communication

The technical setup involved three computers in order to distribute tasks, responsibilities and load among the three authors (see Fig. 1):

1. First author controlled the interactive instruments and spatialized sound output.

2. Second author controlled sensor communication and data distribution.

3. Third author controlled computer visuals.

The computers were interconnected through a router that also served as a wireless access point for the NGIMU sensors. The three computers all needed access to the same sensor data, but the sensors communicated exclusively with a single host. Hence, we decided to establish a hub for data distribution on the second computer, the *VIBRAhub* (See fig.1). This is an application written specifically for this purpose. [3] OSC-messages sent from the sensors to the hub are immediately passed on to all connected receivers, but with a unique address prefix added to identify each sensor. We have not implemented message filtering at this stage.

The *VIBRAhub* communicated directly with all NGIMU-sensors. It also took care of the Euler angle issues discussed in section 4.2.1 before passing the data on. We also found it useful to monitor the battery status of the NGIMU sensors in the *VIBRAhub* graphical interface, as a reminder to recharge when required during a long workshop.

The Myo armbands communicated over Bluetooth to their designated Myo mapper, which translated the data to OSC messages and passed them on to the *VIBRAhub*. Due to the limitation of three Myo mappers on a single computer, one of the four Myo armbands had to connect to a different computer. Nevertheless, all Myo messages were sent to the *VIBRAhub* and redistributed from there to the connected receivers.

4.4 Interactive instruments and Mappings

All of the interactive instruments were programmed using Csound. [4] The data from the VIBRA-hub were received via an Ethernet connection for minimal latency, using the OSC implementation in Csound (OSClisten opcode). The setup in Csound was flexible in that data from all sensors could be routed to the different instruments, and also in that every instrument could be set up with different parameters to create variations in their sonic qualities. However, due to the particular nature and structure of the EMG data, some instruments were designed particularly for the data they provided. Four simple instrument sketches were developed prior to the first workshop, whereas the majority of the instrument development happened in response to what happened in the workshops. A total of eight instruments were used in the workshops, where five used different methods of sound synthesis and three used different kinds of processing of sampled sounds. The interactive instruments and their mappings have been described in more detail in a blog post on the vibra.no website, including video examples. [5]

The instruments also varied with regards to which sonic parameters that were modulated and the degree of temporal synchronization in relation to the input data. The instruments we called *MultiSine* (used with the Myo EMG) and *Noizer* (used with the NGIMU) were perhaps the most unclear and clear with regards to causality, respectively. For the *MultiSine* instrument this was due to using the values from the EMGs without any gating, so that the base tension

[1] http://x-io.co.uk/ngimu/

[2] https://support.getmyo.com/. The product has been discontinued since Oct 2018.

[3] Available as open source at https://github.com/ssaue/Vibra

[4] https://csound.com

[5] https://www.vibra.no/blogg/interactive-instruments-and-mappings-used-in-the-vibra-workshops

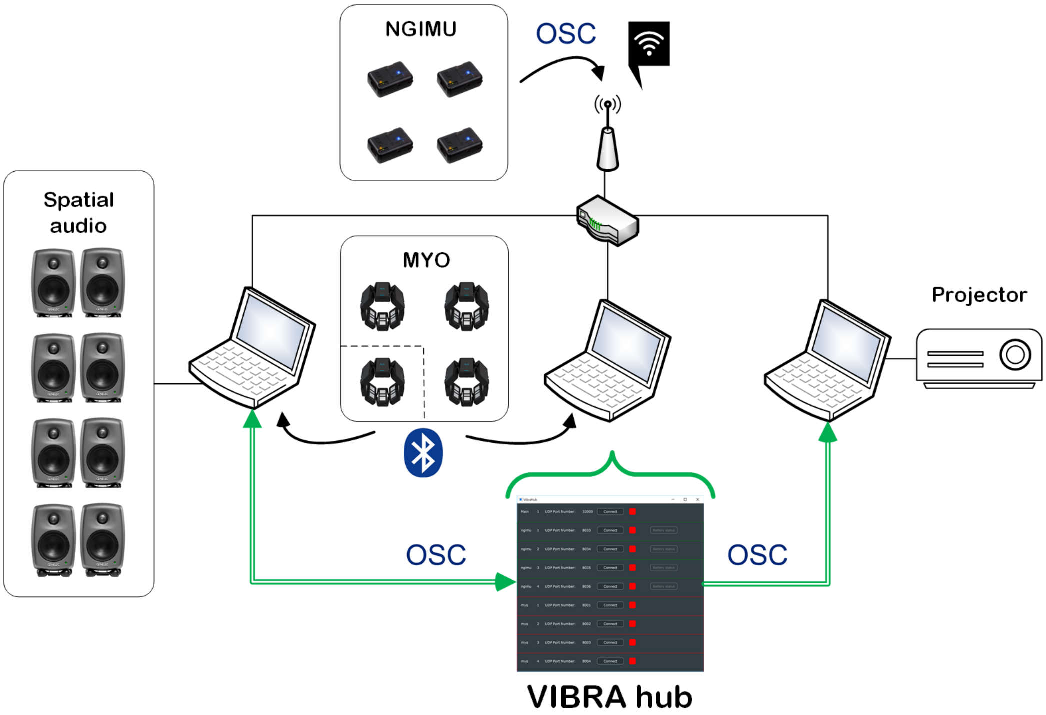

Figure 1. The VIBRA setup. A central computer communicates with NGIMU and Myo sensors and distributes sensor data to the computers controlling sound and visuals.

in the muscle would produce sound, and that the triggering of a new sine tone would have to wait until the already playing tone was finished.

4.5 Sound Spatialization

In the second workshop we used a 8-channel speaker setup with eight Genelec 8030A speakers in a circle configuration around the dancing area. The audience was localized along the rim of this circle, but we were careful not to place anybody in front of any loudspeaker. In this way, the audience would not experience any surround sound, but rather a complex spatial image in front and to their sides. Moreover, this spatial image would differ depending on the placement of the individual spectator.

The sound spatialization at the second VIBRA workshop was implemented using IRCAM Spat running in Max [23], with spatialization parameters sent from Csound to Max internally in the computer using the csound∼ object in Max. We used the vector based amplitude panning as implemented in the spat.spat∼ object with the vbap2D panning method with 8 individual sources. This enables control of azimuth, distance and spread for each source, and offers many settings to adjust the audible characteristics of the simulated reverberation.

We tested a number of mappings between the sensor data input and the spatialization parameters through a flexible user-defined-opcode in Csound, where we could choose mappings and parameter settings. Having tried out a relatively straightforward mapping in which the direction of the torso of the dancer controlled the azimuth angle of the spatial image at an earlier collaboration [6], we wanted this time to use a less direct mapping with more movement and variation. The gyro values of the NGIMU and Myo sensors were used to get the change in angle of the body part wearing it (arm and calf), and we tested how this could be used to control the location, the speed and direction of rotation, as well as the distance of the individual sound sources.

All in all, the spatialization added spatial dynamics and interest, as well as clarified the source separation for each of the dancers. Since it perhaps was the least developed part of the performance, it will not be discussed in further detail in this paper.

4.6 Computer Projections

The computer projections were set up for the second of the VIBRA workshops, and were controlled partly through the use of sensor data from the dancers, and partly manually controlled by the third author. As for the former part of the technical setup, it consisted of a simple receiver matrix to accept all sensor data coming out of the VIBRA hub controller system. The incoming data was then sorted and smoothed, before being routed to Processing [7] and VDMX [8] running shaders and FFGL plugins, using OSCulator [9] for internal data communication. Within these environments the data was mapped to triggers for different actions, large and small, generative and affective. As for the manual control, the third author would observe the dancers' performance with his fingers on the faders of his

[6] http://folk.ntnu.no/andbe/Sound-Space-Movement
[7] https://processing.org
[8] https://vidvox.net
[9] https://osculator.net

MIDI controller hooked up to his computer, adjusting the routing of sensor data according to his own aesthetic preferences. The computer visuals were projected onto a black stage carpet hung on one of the walls in the black box using a Panasonic 10 000 lumen projector.

5. ARTISTIC EXPERIENCES AND REFLECTIONS

After the technical setup in each workshop, the structure was quite open and exploratory. Besides simple explanations of the functionality of the two sensors and some help of attaching them to their bodies, the dancers had no specific instructions or choreography. However, since all of the dancers had extensive experience in improvising, the implicit expectations were that they improvised freely within the interactive system. With an open showing at the end of each workshop, it was also implied that the group developed some material to be presented there.

5.1 Experiences of Individual Causal Relationships

The initial focus for the dancers after putting on the sensors and starting the interactive instruments was to establish causal relationships between their individual movements and the sonic feedback it caused. All of the dancers intuitively started to move the limb with the sensor and listened to identify their individual sounds. However, in those cases where the initial instruments were relatively similar in sound quality, they had some problems discerning which dancer made which sound. After a suggestion from one of the dancers, they decided to dance only two at a time, to make the causal relationships between movement and sound clearer.

However, after the initial causal relations had been established, the nature of the relationships was something that both interested dancers as well as audience. The dancers would express how they found *variation* in the degree of directness of the mappings interesting. And, during the de-brief after the showing at the first workshop, one of the spectators observed how the time between movement and sound differed between the different instruments, and found it exciting to ponder which movement caused which sound.

5.2 Placement of Sensors Affected Movements

In several of the sessions during both workshops it was interesting to observe the degree to which the positioning of especially the Myo sensor seemed to have an affect on how the dancers moved. In the first workshop, three of the dancers tried to have the Myo sensor positioned on their calf.

L in particular seemed to be very conscious of how he could activate the muscles in his calf to affect the sensor values: He often put the weight on the leg not wearing the sensor, and then carefully stretching out the sensor leg towards the floor and pushing the heel up and down. Frequently, he put all his weight on the leg with the sensor, seemingly to achieve a peak value. At other times, he lifted it the sensor leg from the floor, thereby minimizing muscle activation and consequently reducing the auditory feedback to the minimal. With the foot lifted from the ground, he would also rotate, bend and stretch the foot, as well as keeping it completely still and kicking forcefully into the air. In this position, naturally, the muscle activation would be freed from efforts of standing or putting weight on the foot. Generally, it was notable how L in this phase of the workshop appeared to act as a musician ”playing” an instrument. [10]

It was also interesting to notice how T's improvisations were quite different when she wore the sensor on her arm compared to when she wore it on her calf. For instance, she frequently emphasized the movement or the position of the limb wearing the sensor through either following it with her eyes, keeping the rest of her body still while moving it, moving it more, moving it with a more emphatic quality (often stretched out/erected) than the rest of her body, or positioning it with some distance from the rest of her body. This emphasis appeared quite differently with the sensor on the lower arm than on the calf. The same type of emphasis was also apparent with the NGIMU sensors, but since we just tried localising it in the hand or on the lower arm, the difference was not so striking.

Lastly, it could sometimes be observed how, especially when wearing only one sensor (most of the time in the second workshop they would wear two), the dancers were able to clearly separate the sound playing body part from the rest of the ”dancing” body . In particular A, when wearing one Myo armband, would sometimes relax the muscles in her sensor arm, while moving the rest of her body, and then, in response to that, initiate a movement with the sensor arm activating the muscle and thereby the sonic response. Thus, she seemed to engage in a creative dialogue between the ”playing” and ”dancing” parts of her body.

5.3 Playing Gestures are Included in the Repertoire

An analysis of the movements of the dancers during the workshop also showed that many of the types of movements that the dancers initially used to explore the sonic affordances of the sensors on one of their limbs, were later also applied in the body parts not wearing sensors as a part of the improvisation repertoire. In a sense, the playing gestures were treated like musical motifs first being introduced with a focus on the interaction with the sound, and subsequently taken up and developed further in interplay with body parts without sensors and other dancers.

One example was a duet with T and A in the first day of the first workshop. Here, T in her initial exploration of the sonic affordance space of the Myo armband started to push her arm towards the floor to get a sonic response. After T had explored several other ways of heightening the sonic response through touching the floor - pushing, sweeping, stroking - A then took up the motif by standing on her knees and hands, and then crawled over the floor, alternately pushing both hands emphatically towards the floor in a rhythmical manner - simultaneously creating a clearly audible pulse. The motif was further emphasized when T then picked up the rhythm by repeatedly pushing her right

[10] It might be that his background as a musician and composer has affected his approach to the interactive instruments.

Figure 2. Tone (left) and Arnhild (right) synchronously pushing towards the floor.

hand towards the floor while moving in the opposite direction (see Fig.2). The simultaneous interplay both movement and sound made this a particularly heightened point in the improvisation. [11]

5.4 Character of Instruments Affected Movements

The instruments used with the different sensors employed in the two workshops were quite different in character. Some of the instrument had a relatively tight coupling between the effort or energy in the movement or muscle activation and the intensity and character of the sound, whereas others had a more indirect coupling. It could be observed that the more direct couplings often tended to motivate faster and more abrupt movements with more effort, whereas the latter tended to have more flow and less effort.

One instrument, which we called the ”Noizer”, stood out in that respect. The instrument featured four layers of differently modulated and filtered noise, rendering a relatively complex texture. The intensity and character of the noise was mapped to a normalized acceleration vector, using an algorithm for intensity ported from the IRCAM's RIoT-intensity Max object [12] to Csound. The quite immediate coupling between the energy/effort of the movements and the intensity of the sound appeared to often instigate movements with high effort, speed, energy and/or abruptness in the dancer's improvisations. Interestingly, this could also be observed during the audience's tryout of the sensors after the first workshop.

5.5 Artistic Expression through Chairs

Dancing in a wheelchair naturally presents different affordances for movement and expression in space, time and dynamics than other forms of dance [1,24]. While E defintely had an ample expressive possibilities with the Myo and NGIMU attached to her lower arms in the first workshop, her arms were nevertheless restricted by the need of navigating the wheelchair in the dance quite frequently. At the beginning of the second workshop, we wanted to better capture salient features of wheelchair dance and thus extend E's expressive possibilities. To do this, we kept the Myo on E's arm, but also attached a NGIMU sensor on one of the wheels. By using the delta of the orientation we got a value correlating with the speed of the wheel. Playing the instrument called *Bipp-a-chu*, this value was mapped to the frequency of an impulse generator which modulated continuous sound samples, producing a sort of sonic analogy to the ticking of spokes in a wheel. With these new possibilities E started moving the wheelchair a lot more and with higher speed and with more pirouettes than during the first workshop. She also started to explore going up on the back wheels and balancing there, something which was eventually included in the final showing before the audience at the end of the workshop.

The extended expressive possibilities of the wheelchair also spurred an idea to also let T use a chair in her dance, and then make it into a duet with two chairs; one with legs and one with wheels. We attached a NGIMU sensor to one of the legs of the chair, and used it to play the *Noizer* instrument discussed above. T could then play the chair by moving it around. Often she played the chair by lifting it into the air, rotating it and swinging it from side to side. While the chair as an object to sit in normally is a passive and stationary object, it's role in this context was radically changed and estranged. Although this ”Noizer-chair” both had very different sound and movement affordances than the wheelchair, the fact that both were objects to sit in, created an interesting conceptual link that gave an interesting artistic perspective, inviting the audience to reflect on what chairs can be.

5.6 Aesthetic Considerations of the Computer Visuals

The computer visuals were in the end perhaps assigned a less salient function in the interactive experience than the audio part, with which the dancers had worked the entire first workshop. Projected on a black stage carpet covering one of the walls in the performance area of the second workshop, it provided mainly a visual accompaniment to the dancers, who still from time to time were projected upon when they approached the wall. The role of the visuals were still considered important, in that it provided the performance with an additional aesthetic element that framed and interacted with dancers movements, especially when they were projected upon.

Mapping a lot of the raw sensor data directly to the computer visuals would create a very direct correlation between cause and effect, which can in some cases be considered too ”obvious” and perhaps of limited aesthetic interest. Instead, the third author's approach was based on an analysis of the different dancers' movement strategies, especially the sensor data with slower changes in the values, and this was combined with manual routing to parameters of the

[11] This can be seen in the video demonstrating the WarbleSine instrument at https://youtu.be/jrh7-PXjVdk

[12] http://forumnet.ircam.fr/product/bitalino-r-iot/

graphics software. In this way, the visualizations could take a more over-arching role in relation to the movements - sometimes working more in a contrapuntal rather than mimicking fashion - depending on the third author's subjective aesthetic preferences and emotional response.

6. DISCUSSION

During the two workshops we had a clear experience that when working with dancers controlling sensor-based musical instruments, the sense of clear causality was an important factor. Especially when starting to work with a sensor and a particular instrument, it was important for them to establish who made what sound. For the computer visuals, however, it was a point that the relationship between the projected material and the movement of the dancers was not too direct, even though the data from the sensors was actually affecting the output.

This touches a central aesthetic point in interactive dance, and interactive art in general, namely the *experience* of correlation, correspondence, similarity or causality between the input (here: the dancer's movement) and the output (here: the computer visuals and the sound) [25]. There are several terms for this in the writings about interactive dance: Mullis calls it ”birectionality”, Wilson and Bromwich uses the term ”awareness”, and Rizzo and colleagues refers to it as ”feedback” [5, 10, 12]. No matter which term is used, it is important to focus on the *experiential* aspects of this relationship rather than the factual, both from the audience and performers' perspectives. On one side, there can exist a factual coupling between sensor data and the sonic or visual output even if it can't be perceived, and on the other side, the dancer or audience member can experience a causal relationship out of pure coincidence. One could see this as translatable to a continuum from very clearly experienced causality to the complete absence of experienced causality, e.g. by being random, asynchronous or nonexistent [4]. These poles can also be linked to aesthetic judgments where clear causality might be seen as ”simplistic”, ”banal” or ”naïve”, and the opposite pole as ”opaque” or ”inaccessible”. However, the latter pole can also be seen as undermining the very idea of interactivity, in that it inhibits the reciprocity of cause-effect that is implied with interaction. [13] This also mirrors different aesthetic approaches within choreography, with choreographers like Lopukhov on one side, arguing for a ”complete union between dance and music” (Lopukhov 2002, 142, cited in [26]), and Cunningham, who in 1952 argued for the individual autonomy of dance on one side, and music on the other [27].

Not surprisingly, we could observe in our workshops how both the type of sensor, its placement on the dancer's body and the instruments used affected the dancers' movements, and thus that the ”allowance”, ”bidirectionality” or ”feedback” definitely was an active and most often observable component of the interaction. What was interesting, was that the movements that were directly related to the interaction entered into the improvisational movement repertoire, both for each individual dancer, but also in between dancers, thus creating a dialogue between the active/ controlling and the passive/contextual movements - what Wilson and Bromwich refer to as ”online” and ”offline”, respectively [12].

At times, the separation of the body parts ”playing” and ”dancing” appeared to allow for a more marked division of ”offline” and ”online” body parts, and this was then actively used in creative interplay. When we placed the sensor on the chair that T was playing with, her ”playing” and ”dancing” could naturally be completely separated if needed. Conversely, when E danced with a sensor on her wheelchair, she *had to* make sound whenever she moved it. Hence, issues of control, empowerment, freedom and coercion are all at stake in interactive dance.

7. CONCLUSIONS AND FUTURE WORK

During the two VIBRA workshops, we experienced a process in which four dancers familiarized themselves with interactive technology that eventually enabled them to let their dance movements affect spatialized musical sound and computer visuals in a performance. The workshops highlighted issues related to causality and interactivity, and how these can be differently expressed along a continuum from clear to opaque causal relationships. Moreover, we saw how ”dancing” and ”playing” could function as more or less independent components in the interactive dance expression.

Lastly, even if the long term goals have been to develop artistic productions, the focus so far has been on developing technological solutions for complex setups and media mappings with multiple performers. Moreover, rather than working from preconceived artistic ideas, we have emphasized exploration of the artistic possibilities related to the technical materialities of these setups. Thus, we see the discussed workshops as stepping stones towards more developed artistic productions intended for public presentation in the future.

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[13] Admittedly, and often a case in interactive art, providing the audience with an explication of the causal relationships through liner notes, programmes, etc. can also affect the experience of correlation.

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