Dancing in the Dark

Creating new opportunities in dance by moving the emphasis away from the visual

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Abstract

This thesis presents the design and testing of a system that moves the emphasis from the visual aspect of dance to the breathing of a dancer through music. Through this, we have explored the impact that this has on professional contemporary dancers, in a pair improvisational setting. The system was developed and designed by building on existing related work and multiple rounds of formative testing. 8 dancers participated in the testing and 4 dancers participated in the final evaluation.

Through the formative testing, a multi-round experiment was designed to provide the dancers with the desired experience. After the final experiments, the participants were interviewed and the results were analysed via the thematic analysis method. This analysis showed that the system was successful in its mission to create a focus shift from visual to internal. In addition, it was seen that there was a positive impact on the participants who appreciated the aid with focusing inwards on breathing, the space for creative exploration, the lack of judgement, and the possibility of an intimate but distanced connection with their partners, even without being able to see them.

The experiment confirmed the strong emphasis that is currently placed on the visual aspect of dance and the creative and experiential potential that exists when this is shifted to allow for other forms of non-visual creation and engagement using the body.

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1. Introduction

Dancing as an activity and eventually, an art form is quite fundamentally a part of human existence and has found a space in cultures across the world, for centuries (Georgiev, n.d.). It is more than simply moving one's body, it involves culture, emotion, context, and a connection to music and the body. It is also a form that is experienced from different perspectives, by different people, at the same point in time- performers, audience members, choreographers, producers, and others. As an experiential form, depending on exact definition, dance has existed longer than most other forms of expression but was the last that could be recorded and be experienced in non-live settings. "Before man expressed himself with pictures, before he had words to say, before he had letters to write on a page, he had his body." (Georgiev, n.d.). And this body could move and dance but could not be exactly captured like paintings, music, and so on. It could only truly be experienced in the moment and did not have to leave any trace of its happenings. This idea that dance is a form that has to be experienced and not just viewed, whether you are a performer or an audience member, is what makes it an interesting subject for study and exploration. The distinction being made here is viewing a dance performance vs viewing a dance performance live. Though viewing a dance performance later through video still allows you to experience it, much of the energy and sensations that can be felt and experienced in the live setting are lost and this pushes it to be seen more as a visual form as opposed to an experiential one. This is further detailed in sections 1.1 and 1.2.

With the increase of such video type content, dance has become increasingly focused on the form and visual aspect of dance. I believe that this detracts from the experiential nature of the form and it is now less about how the person who is dancing feels and more about what the people watching perceive believe the person dancing must be feeling. This shift has consequently created a shift in dancing culture the world over. Today dance is restricted by modes of recording and playback, along with strict ideas around form. I think there is potential for both new forms of non-visual creation using the body and new ways of choreography and movement. Consequently, a system needs to be built to allow for this focus shift away from the visual and this is what we will ideate and develop through this thesis.

To develop this, one of the questions that this paper will be exploring and asking is since the visual has such a strong role to play is, what impact does removing the visual aspect of dance have on the experience of dancers? And following that, can you create something tangible, aside from a visual display, while dancing?

Dance and dancing are also quite closely related to music. Historically, music and rhythm have been used to enhance and inform dance, movement, and the storytelling involved in the diverse dance forms that exist around the world. It is no surprise then that multiple dance technology systems have been built recently that connect dance and music, or more specifically, music-making. Using the body and dance to control music has been an interesting subject and

foundation for many of these systems and some of these will be discussed further in this paper in the Related Works section (Nijs et al., 2012; Yamaha Artificial Intelligence, 2018; Morales & Dannenberg, 2014; Miley & McFadden, 2006). In what seems to be a majority of these systems, however, the main point of the system is to find ways to use the body as an instrument and they are optimised to allow for that. Since this is often the goal, more dynamic sections of the body like limb movement are usually used to create said music.

This thesis draws from this existing work while taking a slightly different approach. As opposed to the goal being simply music-making, we explore the creative outlet that body controlled music-making can have when the visual aspect of dance is removed. And as mentioned earlier, the shift in focus is really to the bodily experience of the performer themselves. In specific, here has been described the process of building and testing a system that helps explore the impact that moving the emphasis from the visual aspect of dance to an internal body rhythm (breathing) through music has on professional dancers in a pair setting. First, the background and motivation for choosing this research space are described followed by the defining of the specific research questions. Following that, a literature review is presented along with related work that describes existing systems in the space. The system that was built is then described in detail along with a description of the testing of technology and experience. Finally, the final evaluation experiment, possibilities for future work, and conclusion are presented to finish off.

The background and motivation sections described in 1.1 to 1.6 are an overview of the basis of this thesis and the themes mentioned here are detailed further with literature in section 2.

1.1 The Performance, The Personal and The Social

Based on personal experience and existing literature on dance, it is possible to conclude that there seem to be three broad motivations for dance - Performance, Personal, and Social. They are like concentric circles with the Personal at the centre, the social around that and the performance as the last circle. The Performance is when performing for an audience (usually a passive non-interactive audience), is the main goal. In this, the dancer or performer is viewed almost as an object by an audience which leads to a higher emphasis on the visual of the body and its form. The dancer here is fundamentally a performer and is trying to express and communicate emotions and expressions to the aforementioned audience. For this, they have to carefully plan, choreograph and execute movements with the knowledge that they are being actively judged and perceived by an audience with a certain context and expectation. This leads to a higher focus on the visual and form of the body by the performer themselves as well. This is usually seen in professional dance spaces where audiences buy tickets specifically to watch dancers perform. This is also why it is the external most circle. Since here there is still some focus on the experience of the dancer and making connections it has the Personal and Social within it, the added layer of this performance space and structure reduces the emphasis on the other two.

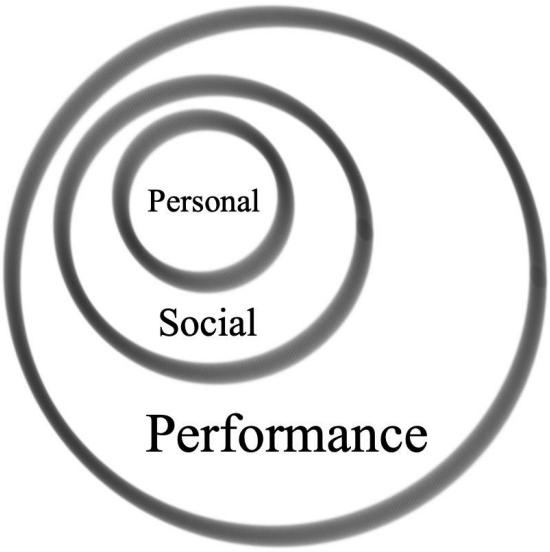

Fig 1. Motivations: The Personal, The Social, and The Performance

In contrast, the Personal deals specifically with the experience of the individual who is dancing and having that be the main motivation for the activity. Here the form of the body can be relevant since there are fewer external distractions if that is what is important to the dancer and that's why it is the innermost circle. However, it does not have to be the priority. The internal experience of movement and expression that the dancer has is given the main priority and seen as the purpose. This allows for a lot more experimentation without external judgement however the judgement of the dancer themselves often still holds. This complete internal focus on bodily experience is hard to create however is often trained by some dancers. We also see this in spaces where people are dancing for the sake of dancing, alone in spaces without mirrors. This removal of the option of focusing strongly on form can help move the focus inward to the experience. The middle circle is The Social. In this situation, dancers are not dancing alone, but also not for a passive audience. This usually happens in spaces where dancing can be used as a tool for connection and engagement between people on an equal field, without the separation or hierarchy of performer and audience. All the dancers are performers and audience members and hence the pressure of being perceived by people whose main task is to perceive does not exist. This creates a midway between the experiences and focuses of The Performance and The Personal. Here the idea of one's own form and body visual is not completely removed however it is not the only focus as there is also focus on the energy and form of others around you. The response received from the other people also provides more real-time interaction and feedback that helps shape how the dancer is moving and will continue to move.

The big takeaway from this is the impact that visual perception has on a dancer. The amount of focus placed on the audience, whether active, passive or even just the dancer themselves, changes the experience of movement of the dancer and the decisions they make while dancing.

1.2 The Visual of Dance

In professional dance spaces, the visual of a dance show or dance, in general, has always had priority since often the training and choreography is done to put on a show. However, until recently, these shows had to be watched live. With this new addition of recording, it is no longer about just being perceived by an audience, it's about the visual of the dance being recorded and made permanent. This moves the focus even further away from the experiences of both the performers and even the audience and to simply what the performance *looks* like. Parviainen discusses in detail this visual focus and cites Martin Heidegger referring to the modern epoch as the 'age of the world picture'. Here she says Heidegger refers to the importance and priority of the visual image in today's times and how everything can now be represented using image or now perhaps also moving image (1998). This ability and importance also have led to a trend of things being brought back to purely their visual representations. In addition to this it has been argued by Levin that development of technologies like televisions and other vision and screen-based systems, has been influenced by the Cartesian gaze (Parviainen, 1998). This has led to these technologies becoming the way in which we now see the world, with the visual gaining dominance of other senses. Also implying that in many ways we now see the world more than experience it using all of our other senses. This distinction also is often made with the understanding that seeing and sight is the main intellectual sense which is separated from the other non-intellectual, lower, experiential senses of touch, smell, taste, and hearing (Parviainen, 1998).

With respect to dance, we see the role that these sight-based technologies and also social media platforms have played when it comes to steadily increasing the emphasis on the visual aspect of dance, even in individual dance settings. TikTok is one of these platforms that has created a significant impact in this space. "The phenomenal rise in TikTok's cultural visibility during the Coronavirus crisis can be seen to contribute to the transformation of girls' 'bedroom culture' (McRobbie and Garber, 2006) from a space previously conceptualised as private and safe from judgement, to one of public visibility, surveillance and evaluation." (Kennedy, 2020). This bedroom space is one of the spaces where previously dancing in The Personal domain could be done. Where the focus was on dancing with and for oneself. With this cultural shift, dance has, even more, become an activity that is done to be recorded, rather than experienced. This constant awareness of being perceived and also this motivation to try and create dance for the purpose of people watching (not live) has also caused this to further become the case.

1.3 Phenomenology

Going back to the idea of sight as an intellectual sense, earlier philosophers like Plato and Descartes had a strong belief that we as humans are intellectual beings or thinking things (Ruspoli, 2010). That was how they believed that people made sense of the world around them,

based on the ideas and knowledge they had in their minds. They did not give much attention to the body and further, it was seen more as a vehicle for this mind that could be controlled, almost mechanically. Heidegger, on the other hand, had an opposite approach. He proposed that we experience the world through more than just ideas in our minds. Our idea of the world around us is based on the experiences we have while being in it (Ruspoli, 2010). This idea of being in the world, or Dasein, is an important concept that he brought up that is extremely relevant, especially when talking about spaces like dance that rely so much on making sense of the environment by engaging the whole experiential body. The main difference between these approaches is the idea of 'having' a body vs 'being' a body (Ruspoli, 2010). More on Phenomenology is discussed in the Literature section.

So from a phenomenological perspective, dance is more than just the visual. It is the experience of being in the world at that moment in time, for the dancer and the audience. However, as mentioned above this experience has become diluted or at least different due to the shifting emphasis on visuals, especially due to the option of recording and preserving. This can heavily distract from the bodily experience of audience and dancer and once again lead the lived body and other senses to take a backseat. This brings us again to this question.

What if we could find a way to remove the visual aspect of dance? What would this do to the experience of dancing for a dancer in an individual or even social setting?

Simply removing the visual can already be impactful however providing a different way to create while dancing that is informed by the body, but not its form, could provide even more insight. As we saw in section 1.1, dance is often a social form and when moving away from the visual, that aspect does not have to necessarily be removed, even while shifting the focus to the internal experiences of the performers. The two aspects left to consider to make this possible are - how can you create with the body in a way that doesn't directly link to physical form, and what medium would be possible to create that allows for some creation and interaction between dancers even without the visual.

1.4 Somatics

Taking the first aspect and looking for a body rhythm that could inform this new creative process, we are led to Somatics as our ideal starting point. Somatics, just like Phenomenology, deals specifically with the idea of a living body and can provide further insight here. It also deals heavily with being in conversation with one's body and the value that listening to your body holds. Listening to the body can mean many things but overall doing so is believed to help us work more efficiently, move more easily, and be more expressive. These are all valuable assets for dancers, especially in professional settings. This is because being able to use their body efficiently and openly improves the quality and quantity of movement that they can provide.

But how does one listen to their own body, especially when it comes to movement? What would be the best way to listen? Breathing is an important bodily rhythm that is part of various Somatic practices (Eddy, 2010; Roubicek, 2010). It also is one of the only bodily rhythms that does not reveal the actual physical form of the body, only perhaps the state of motion it is in. In addition to this breathing can be controlled, to a certain extent, which allows a person to have some agency, creativity, and mental involvement, if they so please. Listening to your breathing and engaging with it, however, does not necessarily come naturally.

When we talk of dancers, especially professional modern and contemporary dancers who are the main target group of the system this paper aims to describe and discuss, there is some more experience with breathing control than with the average person. These dancers engage with breathing exercises in their professional training so as to enhance their movements and be able to develop better stamina and perform longer. However, past that, there is not much emphasis on engaging with breathing as a way to listen to your body. Encouraging this emphasis would allow for more exploration of the body and perhaps provide dancers with more ways in which they can engage, perform, and experience movement. This could help aid the impact as often dancers are not trained to dance when removing the visual. Helping move the emphasis to breath could guide them and help them look internally for cues for movement.

Now returning to the second aspect mentioned at the end of section 1.3, what medium could be used to allow for creation via the chosen body rhythm of breathing? Is there a way in which we can make breathing more tangible and allow for creation using it so as to assist dancers in focusing less on the visual and more on their own bodily experience while moving?

When we take visuals out, the main two senses left to possibly engage are touch and sound. Touch in itself could provide more restriction when it comes to dance as it could mean centering the body around a specific object. Sound on the other hand does not have this and is perhaps a more natural sense to engage since dance often happens to and along with music. In this project specifically, we will be seeing if making breathing tangible by connecting it to the music, which is an external stimulus that dancers are used to responding to, helps dancers better connect to their own breathing and bodies.

1.5 Sensemaking and Participatory Sensemaking

Sensemaking is an enactive concept that in some ways follows from phenomenology and at a very base level refers to the fact that we as the ‘cogniser’ or cognitive being make sense of the world based on the experiences we have with it (de Jaegher & di Paolo, 2007). This is relevant also in the domain of dance. Dancers often make sense of the world around them and also inside them, through their movements. In this sense, dance can also often be seen as a conversation between people or the dancer and the environment they are in. This would also make sense when talking about dance culturally, especially forms that are rooted in storytelling.

Going back to sensemaking, in an individual sense it already connects well with everything that has been described previously; however, there is potential to build further on this.

De Jaegher and Di Paolo delved further and developed and defined ‘participatory sensemaking’ which is the extension of sensemaking into the social domain. Fundamentally participatory sensemaking refers to the interactions between people that allow them to make sense of the world in ways they could not do individually. They also argue that this interaction has the potential to be autonomous from the people involved in the interaction (de Jaegher & di Paolo, 2007). Participatory sensemaking will also be further described in the next section.

1.6 Research Question

Combining the questions we asked previously in the phenomenology sections we arrive at the combined question of

How can we design a system to explore the impact of removing the visual aspect of dance while moving the emphasis to one’s own body on a dancer?

This is a valuable question to ask and explore as it allows us to make the dancer’s bodily experience the main priority even for the dancer themselves, during movement. Creating a system and space that would allow dancers to interact and focus on their bodies without the distraction of the visual could potentially increase the connection a dancer feels to their body. In addition to this, as mentioned before, allowing for new forms of creation using dance and the body that are not visual or linked to the form of the body opens multiple possibilities for new types of creation in the domain of dance and movement. It provides an opportunity to expand past what currently exists and allows the option for more experiential creation and performances for dancers and other creatives.

We also discussed that to bring the focus to one’s own body, breathing would be the optimal body rhythm to harness. Additionally, making this breathing tangible through music which is a recognised stimulus for dance was chosen as a valid option for this.

So,

How can we design a system that moves the emphasis from the visual aspect of dance to the breathing of a dancer through music?

and

How can we use this system to explore the impact that this has on a dancer?

When we return to the initial domains of the Personal, Social, and Performance we see that though the visual aspect of dance has relevance in the personal domain, it really has a stronger impact when there are other people there to perceive you. In addition to this, in a majority of situations, dancing has a social aspect of some sort. Removing the visual does not and should not imply entirely removing that aspect of the form. Further discussing participatory sensemaking and the idea of potentially needing more than one person to make sense of certain

interactions, especially non-verbal, prompts another potential layer to these questions. To engage with these points we expand the question from thinking about an individual dancer to considering a pair of dancers and their individual and shared experiences and creations.

How can we use this system to explore the impact it has on two dancers in a pair setting?

Or if we elaborate this and combine all the questions,

How can we design a system that can help us explore the impact that removing the visual aspect of dance and moving the emphasis to breathing through music has on dancers in a pair setting?

This is the main research question that this thesis will be focusing on and trying to answer. The development of such a system would help us understand if the visual is as important as we have seen it to be for dancers, especially in a pair setting and whether creation and connection are possible without it. It will also allow us to see if moving this emphasis allows for new forms of creation, connection, and potentially a stronger relationship to the body.

2. Literature and Related Work

In preparation for this thesis, a number of literature works as well as related systems were reviewed to gain a better understanding of the space. The main themes that were explored through literature were embodiment, culture and storytelling, Participatory Sensemaking, Phenomenology and movement studies like Somatics. These were chosen as they were seen as all incredibly relevant when talking about the central themes of music, movement and embodiment. An important part of this process was also defining each of these concepts and seeing how they relate to each other. In addition to this, this background research allowed me to narrow down this research question and what was specifically required to back it up. The rest of this section was submitted previously as a literature report and is presented here to provide background and context for the reader.

Through the sections below, it will become clear that there are strong connections between the fields presented in the diagram. This will provide a good background also for the system that is being built, which is a system that uses technology to try and explore the impact that removing the visual aspect of dance has on dancers and more specifically professional modern and contemporary dancers. The ideas under embodiment are very connected to the ideas of participatory sensemaking and phenomenology and movement as they all are connected to the body and the experience of a body. They also highlight how dance is closely linked with these fields and hence fits in here as well. Breathing is an important part of the system that we aim to build and it comes in via the concept of Somatics that is also strongly linked to dance and movement. Music and its relation to dance are described in one way when talking about culture and storytelling. This was important to demonstrate the cultural connections and associations we as people make to forms of dance and music, based on our backgrounds. Further, the related works section describes multiple similar systems that engage music with movement and show how they can and have been connected.

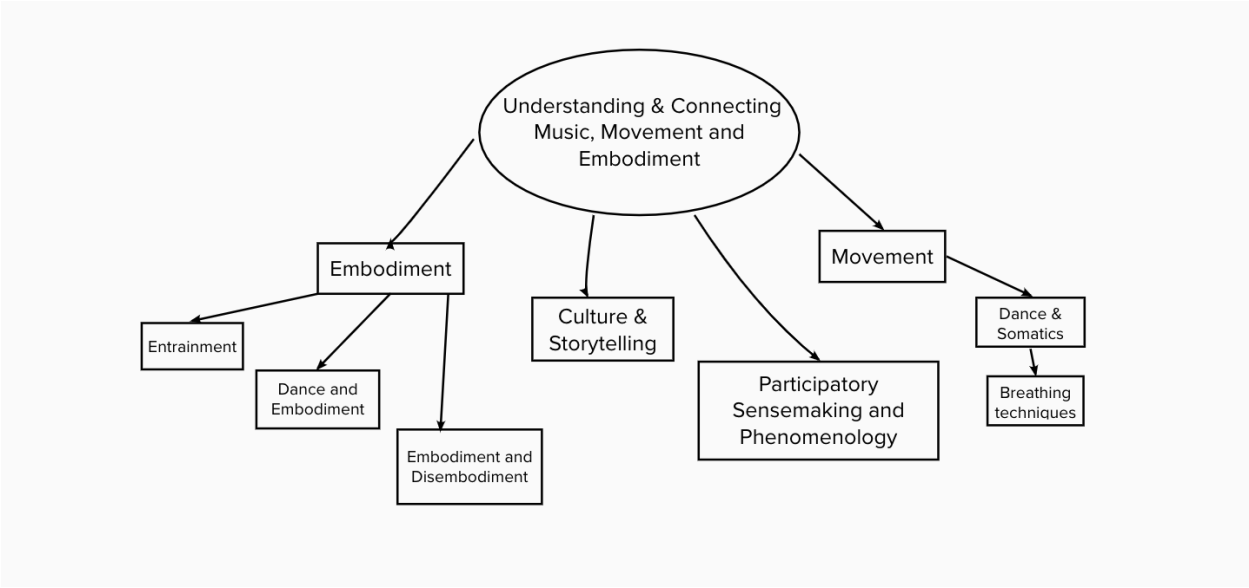

Fig 2. Structure of Literature Review

2.1 Embodiment

2.1.1 Entrainment -

Martin Clayton defines entrainment as the process by which independent rhythmical systems interact with each other (2012). He says that entrainment extends beyond simply musical research and also happens in the biological world and in other mechanical systems. Various systems and creatures are constantly moving and changing in sync with each other. Entrainment does not imply that all the parts of a system always have to be on the exact same rhythm but even just that there is some constant relationship between the rhythms of the various actors in the system. Clayton's paper defines entrainment in this general sense, then briefly explores its significance for human behaviour, and for music-making in particular. The final section outlines a research method suitable for studies of entrainment in interpersonal coordination. It also, with reference to published studies, suggests that the study of musical entrainment can be a source of rich insight also for the study of human social interactions and their meanings.

Entrainment is quite relevant when we talk of music and musical research. When people play music together, they entrain so they end up playing on the same rhythm. This is interpersonal entrainment. Intra-personal entrainment on the other hand occurs internally for example when one notices and entrains with their own breathing. Much of this interpersonal entrainment happens via sound but visuals also play a part. Visual information can play a significant role when many people are playing together in real-time. The paper mentioned above, by Martin Clayton, also discusses a research method that can be used for studies of entrainment

in interpersonal coordination (2012). According to this method, entrainment can be seen by first identifying quasi-periodic rhythms and extracting time series data, then calculating the relative phase relationships from pairs of time series data and finally investigating entrainment using the relative phase data. This system could also potentially be used in measuring entrainment between two people or systems.

In a different paper, Bruyn discusses another form of quantification of embodiment and music (2008). The methodology here was based on wireless motion capturing, using Wii Nintendo Remote sensors, and subsequent statistical analysis. The synchronization is measured first when done individually, then when separated by screens and finally when there's a group of four together. This is a paper that also talks about children's embodiment of music that also goes on to discuss the difference between embodiment individually and embodiment in a group setting (Bruyn, 2008). We could also say that one reason why they can be considered different situations is the visual element of being able to see other people embody the music while you also try to. The group setting lends itself to this idea of entrainment between different people versus individual entrainment with music. This embodied entrainment to music and other people also directly leads to the idea of movement and dance.

Dance in itself is often moving and choreographing to music and hence can be seen as entrainment as well. An example of this can be seen when we look at audience entrainment while watching a non-rhythmic and slow contemporary dance performance (Bachrach et al., 2015). In this paper, they look into entrainment in the forms of cognitive and physiological entrainment. This brings up an interesting point about entraining physiological rhythms via dance that we will come back to later on in this paper. Some interesting results that were observed are that there was a positive relationship between psychological entrainment and attention to breathing and also a positive relationship between cognitive entrainment and attention to their own breathing along with the muscles of the dancers (Bachrach et al., 2015). From this, we can conclude that these results imply that breathing plays a significant role in entrainment, especially in a dance space.

This paper also quite strongly ties in this idea of entraining with a dancer, to the visual aspect of dance. This makes sense as while watching a dance performance, the visual is a large aspect of the experience. However, it also draws a connection between the entrainment of people in a dance setting and their breathing. Would this connection be as strong if the dancers could only be heard? Or would this lead to the 'audience' in this setting being less engaged due to the lack of visuals? Another question that could be asked here is, is the music helping the audience entrain with the dancer? Since the dancer is entraining with music. Or does the music not influence the audience's entrainment with the performing dancer.

Another example of visual entrainment of movement or dance between two bodies is a paper that describes a human-robot dance-based entrainment interaction. The paper focuses on the entertainment robot called QRIO. An Entrainment Ensemble Method was designed and also presented in this paper which also is potentially relevant (Tanaka & Suzuki, 2004).

One interesting point this paper brings up is the fact that mutual imitation is an important part of this entrainment. Since both parties are moving together, they both must watch and imitate but also put out new content so as to create a back and forth of both bodies entraining with each other as opposed to one simply following the other continuously. When two humans are dancing together also, a more similar experience is had, that lasts longer when both parties are giving and taking while finding a common rhythm which is often guided by some music, but this is not a compulsory aspect. This is different from the audience entrainment situation as there the audience is simply receiving information and entraining to it. Their experience is clearly very different from the dancer's. Their experience also is not one of active interaction with the dancers that are on stage. What would be the connection between breathing and entrainment of two parties that are both actively interacting with each other, similar to the robot and the human, as mentioned before? How would this also be affected if the visual aspect was removed and these two parties could not see each other during the interaction? Does this imply that it would be possible for two moving bodies interacting through breathing to feel a connection? These are some questions we will come back to later in the paper.

2.1.2 Dance and Embodiment -

Dance is definitely related to entrainment but it is also a form of embodiment in general. Betty Block and Judith Less Kissell provide some good insight into this and also discuss how the ideas of embodiment and embeddedness are linked. They say " *An analysis of movement, and particularly of dance, helps us to see in an extraordinarily effective way the meaning of embodiment"* which further cements the place of dance in the exploration of a system involving music, entrainment and embodiment (Block & Kissell, 2001).

This paper also explores and brings up interesting points about body awareness and thinking through one's body. It sees dance as a way to really see and experience the world more deeply and talk about how embodiment in many ways is knowing something not just cognitively, but also neurally and with your whole body. Communication can also be movement-based and not simply verbal. This engaging via your body and listening to your body are big parts of the foundation of dance and hence dance does seem to be the essence of embodiment. A lot of dancers as well are better at thinking through their bodies as they live more fully with their bodies already while outside of dance we are often taught to suppress this embodied knowing and thinking. They also talk about how the idea of being embodied also implies being embedded since we all as humans are fundamentally embedded in a society with existing structures, ideas and meanings that are tied to the physical, kinetic, spatial and temporal (Block & Kissell, 2001).

One question that is brought up by Block and Kissell in the same paper is, what is the difference between movement and dance? Also, does this distinction matter while talking about embodiment and embeddedness or are we all already somewhat embedded in our society? Following this, in a different paper, Marc Leman and Pieter-Jan Maes talk about why this idea of embodiment is relevant in our perception of and experience of music. They present ongoing research in the space of embodied music cognition and focus on some studies being conducted at

Ghent University, Belgium. Their findings in this paper show that embodiment is one of many components in a network of systems including sensory, motor, cognitive and affective, that play a role in music perception (Leman & Maes, 2015).

The influence of music on movement but also the effect of movement on music perception are both discussed in this paper. They say that there are two ways to highlight the role of embodiment in music perception - the first is to show that embodiment itself has a big part to play in an interconnected network or cognitive and emotive functions and the second is to show that embodiment is not just the effect of music on action. Both these methods are different but they complement each other and are required to further develop this space. Similarly, the paper also discusses the encoding of expressive gestures into sound and the decoding of sound into expressive gestures. This shows once more how linked music and movement can be. There is also more about how when various listeners are asked to move along while listening to music, they observed some commonalities in their movements which could be because people mirror parts of the music in themselves. Similar representations of emotions and ideas could also be due to the fact that, as mentioned before, we are embedded in a society and culture which is our basic context that may influence the way we automatically represent various emotions and concepts. In this way, even without visually seeing the other people moving, each person is somehow already entraining with them and moving simply via the music itself.

Another study that is referenced by Leman and Maes is one to do with the vigour-entrainment effect. People were asked to walk along to multiple pieces of music with the same tempo but with varying musical expressions. The conclusion of the study showed that some music made the subjects walk faster while some calmed them down. The adaptation of muscle strength to music seemed to be influenced more by the characteristics of expression in the music and less by the actual metronome ticks or the beat (2015). Music perception clearly has a large impact on how people choose to embody music. This also follows in choreographed dance pieces where movements are planned around this expressiveness of the music and based on the emotions it triggers in the people who are choreographing the piece and how they choose to represent them in movement. This is an interesting point to have while exploring the idea of connection since usually, dancers connect to music via the rhythm, or alternatively the emotion of the music. If this rhythm isn't a constant predictable rhythm, can they still make a connection to the music?

2.1.3 Embodiment and Disembodiment -

With the embodiment of music and embodied music, there also exists the idea of disembodied music. Disembodied music can refer to various ideas but the general concept however talks about music being disembodied for a listener in the sense of they perceive it as just the music in isolation, without ideas of who is playing it or culturally where it comes from (McMullen, 2006). This is interesting as it brings up the thought that music can be embodied by one person, who is the performer while being perceived very differently by an audience, however they are both still engaging with the same music. A paper by Tracy McMullen talks about some of the things

mentioned above and more. It discusses the pros and cons of recorded music and what that means for the perception of certain types of music. There is also a discussion of how visuals often cause people to 'listen with their eyes' (McMullen, 2006). This leads to biases that are unrelated to music having a heavy influence on the perception of the music itself. McMullen talks about intercorporeal interactions which seem to stem once more from social entrainment and the musicians playing in time together while facing each other. The question that this brings up for us once again is does this face to face element add to or take away from the overall music experience for both the musicians and audience?

In the paper, she starts by discussing the story of Abbie Conant who in 1980 got chosen by the Munich Philharmonic to play solo trombone. However, a big part of why she was chosen was the fact that she chose to play from behind a curtain and so had to be judged purely on her musical skills and nothing else. This meant that no one in the selection committee knew she was a woman, which otherwise would have been a problem (McMullen, 2006). Hence, the disembodied music allowed for the perception of the music to be more objective. However, in other settings, the music being played live and being embodied in context can be important, especially in music that is embedded in culture. A good example of this is Capoeira. Greg Downey wrote a paper on capoeira where he says *"One of the most bothersome issues regards the phenomenology of hearing. I fear that by presenting an objectified recording as "the music," I may seem to imply that the musical object alone determines musical experience, that when my audience hears a mechanically reproduced sound event, they hear the same "thing" as the performers or listeners who produced that performance. The boldest audience members often throw this question back at me: "What exactly are we supposed to be hearing?"* (2002, p. 487).

Downey's paper has many insightful points but this quote seemed most interesting and relevant. It also brings up the idea of phenomenology more which is definitely relevant in a conversation about the embodiment of music. This also contradicts in some respects the points discussed above about the visual aspect taking away from the music, here the visuals (along with the whole experience) seem to better explain what the audience is 'supposed to be hearing'.

Clearly, both embodied and disembodied music have their own impact on the people who are engaging with the music. The difference really lies in the kind of experience you would like the audience and the performer to have. Thinking about dance again, a follow-up question would be, does a performer embody music differently when they are being visually perceived by an audience, compared to if they were dancing alone in a room where even they cannot directly see themselves? When dancers dance together or duet, the synchronization comes from the visual of them dancing and the common music they are dancing to. What if there was a way for dancers to synchronize while getting non-visual cues and feedback from one another?

However, there is another paper that talks about a disembodied choir where the sounds of singing are controlled by hand gestures. The disembodied system works using a Kinect sensor to allow for gesture-based musical performance. The software that has been developed by the

authors converts these gestures into events that are ‘sung’ by a virtual choir (Mandanici & Sapir, 2012).

Here, ‘disembodied’ is used as you see people moving but you don’t see anyone singing, yet you hear the singing. This definition however is not something that seems to be the most robust as this would also imply that someone playing a keyboard that has a setting to sound like a guitar is also disembodied. This is interesting to think about also in the context of dance as it implies that even if the dancer can be viewed by an audience and is controlling the music with their movements then the music is still disembodied as it is not naturally coming from the dancer itself. However, if the sounds the dancer is making are fed back into the music that is being output, would that potentially make it embodied once more? Is it possible for a system to be embodied for the person using it while also being disembodied to an audience that simply cannot view the performer?

2.2 The Role of Culture and Storytelling

When we talk about music and movement, we have to also discuss culture and the embeddedness of music and movement in culture. Most dance forms are heavily influenced by the daily lives of the people who have developed them since dance fundamentally is a form of storytelling. Music also provides an outlet for people to express themselves and their emotions in different ways. Following this, seeing a piece of music or dance in isolation or separated from its context takes away a large part of the essence of the piece. While moving to music in an embodied way, one of the main aspects of the music that is being embodied is the emotion and feeling so separating that from this discussion would not make sense. Does this make the movement meaningful? Would making this connection between movement and music and culture stronger be a way to enhance an individual’s perception of music or dance and help them perceive it as one combined immersive experience? The paper to do with Capoeira that was mentioned above discusses this interconnectedness and provides an example of how a dance style was born out of struggle and real situations that people lived in (Downey, 2002). The music also is so tied into the act and the culture that these things cannot be considered without each other.

Leon Botstein has written another interesting paper on memory and nostalgia that looks into how music can be used to understand history and also discusses how linked music is to community and the people who initially started playing and listening to it. It then talks about the ideas of nostalgia and how music has been used to create nostalgia and how that also links it to history and people (Botstein, 2000).

Many dance forms are taught as forms of storytelling and are also closely linked to theatre. When listening to music or watching a dance piece with the knowledge of the larger context it is a part of, more attention is often paid to it since it is less abstract and instead is relatable. Taking music out of the realm of just notes and beats may allow for it to be better

understood and perceived by people, including people who want to study music. Also the historical connections of why certain dance moves evolved, why certain instruments were used in different parts of the world and how music was used to bring together communities are interesting points to keep in mind. Is music fundamentally a group activity? Is that the way it is to be experienced as well? A paper about community and an Appalachian Dance Style provides an example and some insight into the ideas of tradition and community and how they are linked to dance. This paper discusses the idea of 'community' itself and what that means for its members and the kind of activities they partake in. It explores the idea of tradition and what can truly be called traditional. It also, via the case study it analyses, shows how styles of music and dance come about from communities and then continue to develop as time goes on (Thomas, 2001). This reinforces the idea that in many ways music and dance are group activities that through history have been known to bring communities together. It also shows the influence and context that music and dance styles have on people based on their past experiences. So creating a space that allows for movement which does not influence the movement choices of the dancer, is also a challenge. For an interaction between two dancers to be solely based on their own bodies and the fact that they are in a space together, what cues need to be avoided to make sure pre-existing cultural biases do not influence the experience.

2.3 Phenomenology and Participatory Sensemaking

Phenomenology is a philosophical study that is built around the idea that people gain meaning from the world through how they experience it. It does not believe in the idea of objects and the preconceptions of them and structures, it is based on the experience. Martin Heidegger, a german philosopher, was one of the main contributors to this approach. One of the concepts he explored was the idea of 'Dasein' or 'being there". When applied to music this means that music is not the notes and sound waves but in fact, it is the experience of the individual who is perceiving it (Ruspoli, 2010). When looked at this way, removing music from context to play it or even people listening to recorded music while sitting down leads to completely different perceptions of a piece of music which seems to imply that the music is then different. Heidegger also talks about how the mood of a person has a large effect on how they experience the world. Another interesting term to consider here is the idea of 'noema' proposed by Edmund Husseri which refers to the specific visualizations, thoughts and transformations of consciousness that arise as a consequence of interaction with stimuli (Herbert, 2016). The idea of phenomenology is brought up a lot when discussing the difference between live and recorded music - this is also why it makes sense in the context of capoeira. A short film called 'Being in the World - on the Subject of Heideggerian Dasein' by Tao Ruspoli discusses many of the concepts mentioned above, especially in the context of music, performance and experience. Through the film, they interview various artists and musicians and through this shows the difference between live and recorded music and the sensations they create in both the performer and the audience. Some of the interviewed artists were people who only performed live as they felt like that experience was the

music and it could not be just recorded elsewhere and listened to by someone later who was not in that space at that time (2010). In her book 'Everyday Music Listening: Absorption, Dissociation and Trancing', Ruth Herbert has a chapter called phenomenology where she also expands on these ideas and the different ways in which we perceive music based on how we listen to it (2016).

Another interesting framework to bring in here is Participatory Sensemaking. It draws from the idea that we are all individuals who are autonomous and self-organizing as we are constantly taking care of ourselves and we have our own intentions and space we live in and argues that the interaction between people often also takes on an autonomous form. We as individuals are sense makers since we are making sense of our world through our interactions. However often when multiple individuals interact they are trying to also make sense of what the other person is doing and this leads to the interaction taking an autonomous form. When people perceive or experience music together, this becomes quite relevant as their interactions become autonomous, often due to or in sync with the music. People interacting while listening to or experiencing music also lends itself to this even more as many of the interactions are non-verbal.

In their paper on enactive intersubjectivity, Hanne De Jaegher and Thomas Fuchs further explain the idea of participatory sensemaking. According to them "This process may be described (1) from a dynamical agentive systems point of view as an interaction and coordination of two embodied agents; (2) from a phenomenological approach as a mutual incorporation, i.e. a process in which the lived bodies of both participants extend and form a common intercorporeality." (2009, p.465). In other literature, we also see how participatory sensemaking has an impact on Design Research itself. Designing for participatory sensemaking has its own challenges as one has to understand how the autonomous interaction may come about and/or how to trigger it. Designing for participatory sensemaking also seems to often lead to a different understanding of the concept itself (van Dijk & Hummels, 2015).

2.4 Dance and Somatics

Speaking of forms of non-verbal communication, dance is definitely one of them. Dance itself is both internal and external. While dancing you are often being externally perceived by other people and also engaging in non-verbal interactions with them via your body movements. However, dance also is very much about one's own body. Being aware of your body is extremely important when it comes to dance. When discussing the idea of being aware of your own body, we can also discuss the study of Somatics. Somatics is a field that deals with the idea that if we perceive our body and are in dialogue with it, we can learn to be healthier, more efficient and more expressive beings. Somatic inquiry also relates back to phenomenology and has a history that dates back to the 20th century but was discussed in different ways even before that. A big part of somatics is listening to your body and allowing it to guide you. Practicing somatics can lead to much higher levels of body control which relates well to many dance forms. Bodily awareness is very important for movement, and hence somatics and dance are very linked. One

aspect of dance and somatics is breathing technique. Breathing is something that is often taken for granted but that can make a substantial difference in how freely and wholly a body moves while dancing or even otherwise. Somatics, as one could imagine, discusses being acutely aware of one's breath and flowing with your body accordingly.

A paper written by Martha Eddy on the history of Somatic practices provides a good foundation of the concept. In the paper, she traces the history of the field of Somatics and various somatic practices. She also describes well the connection between somatics and dance, specifically modern dance. Later somatics and modern dance are shown in relation to how somatics is used in other spaces of movement including Sufism and various martial arts (Eddy, 2010). Fundamentally these techniques are generally good for enhancing any experience that involves the body as they teach you how to see, listen to, understand and be aware of your body while experiencing things. When talking about martial arts and somatics, the Japanese martial arts Aikido and Kashuma Ahinryu Kejutsu are also relevant as a breathing practice that comes from them called Hara breathing can also be applied to dance practice and education. This breathing technique and others are often used to help change one's awareness and help validate a sense of self. Both of these aspects can have a significant impact on dancers if they put the breathing techniques into practice (Roubicek, 2010).

Talking about breathing also relates back to the paper discussed in section 5.2.1 about audience entrainment while watching a dance performance. There they found a significant connection between breathing and entrainment in the context of the audience's breathing entraining with the dancer (Bachrach et al, 2015). To look into this further, it would be interesting to see if the breathing of the dancers who are performing are also entrained with each other. Since the music is not extremely rhythmic it would be easier to see if the dancers are entraining with each other as opposed to just a common musical rhythm. Would more control over their own breathing and more awareness of the breathing of other dancers change the experience of dancing for the group and for individual dancers? Would it be possible to help dancers focus more on this as opposed to the visual of dance?

Based on the literature about breathing and somatics it seems like being aware of your breathing heightens not only your awareness of yourself but also your awareness of your breathing in relation to the breathing of others and could hence heighten your awareness of the whole system of you and the other person. This is similar to what was discussed previously when talking about the idea of entrainment through the sounds of breathing another person makes while moving as opposed to just watching them. If breathing can be such a fundamental part of movement and collaboration - could that be the basis of a system? If your breath controlled the music, it would potentially allow you to control your breathing more intuitively and also move while consciously breathing more naturally. This would help dancers but also other people who engage in any form of movement, be more in tune with their bodies from the inside.
Building upon this idea and going back to the idea of collaboration and connection, could people collaborate by moving to the music produced by the breath of someone else? Especially since breath is a way of really feeling someone in the space around you in a more tangible way as

compared to just seeing them through a screen - or even just seeing them. This combination of breath and music will also allow people to interpret the emotions of the other person and the music and draw from that as well. This could allow for a disembodied but still in some ways embodied experience of music.

2.5 Preliminary Study of Existing Systems

In this section, we will discuss systems that already exist in the spaces that we discussed in the literature above.

2.5.1 Real-Time Composition -

Currently, there exist a number of systems that allow people to control music in real time using various inputs. Often this controlled music is then further also used to control something else like visuals. Some examples of real-time composition do involve using the body or dance to compose. Many of these involve systems that track actual body motion using cameras or sensors. For example, Yamaha's Artificial Intelligence choreography allowed a dancer to play the piano through four types of sensors attached to his body (Yamaha Artificial Intelligence, 2018). This kind of system focuses on the entire body of the dancer and is suitable for dance styles that involve more full-body movement. The software Wekinator was released in 2009 and is a software that allows users to easily use machine learning to create virtual musical instruments that use gesture tracking, another use case example the wekinator website talks about is to create and play music in Ableton using a Kinect. The Kinect is used as a tool in multiple papers that use body movement to control certain output. Some examples of these include Optik which is a London based performance company that is developing collaboration between real-time granular synthesis, video processing and live site-specific performance. The collaboration involves live performers but also electro-musical processes. The authors Barry Edwards and Ben Jarlett describe it as "The building blocks of granular sound are captured live from pitched and textural instrumentation and ambient sound. This emergent sound score is part of the fluid dynamics within the live performance, inter-acting with similarly emergent live-action moments generated by the company's dancers and actors." (Edwards, n.d.).

Another example is a system called SICIB that's capable of music composition, improvisation and performance using body movements. It uses data from sensors attached to the dancers and couples gestures with music via if-then rules. The choreographic elements considered by the system include position, velocity, curvature, jumps and even torsion of movement, among others. The musical elements that can be affected by them through two different composition systems- Escamol and Aura- include intensity, tone and music sequences. This system and the possibility of gesture and music coupling allows for a good amount of interaction between choreographers and composers who are planning out the show (Morales & Dannenberg, 2014). Another slightly different example is a system that uses ultrasonic SONAR

as a way to determine the position of the dancers and then converts this information into multichannel MIDI output, hence allowing for live control of music (Miley & McFadden, 2006).

Aside from the hardware that is used to provide the input, when working with real-time composition, the software that is used is also extremely important. One of the most commonly used software for sound is Ableton Live. Ableton allows for various inputs to be turned into sound and also integrates well with other software that allow for this interactivity including Max/MSP/Jitter and also TouchDesigner. Another example of a system that uses Ableton along for real-time composition along with visuals is Laura Kriefman's 'Kicking the Mic' show. Here sounds are triggered by sounds of the taps of the performer which allows for live composition (Hellion Trace, 2018). There is also a looping function that allows for even more complexity.

2.5.2 Embodiment and Music Making -

The reason why this section is separate from the previous one is because it is more focused on systems that are controlled by people making music in an embodied way and just the idea of embodied interaction itself. This is still relevant as it involves an embodied experience of music that involves some movement. One example of this is the Music Paint Machine. The Music Paint Machine allows the user to create a digital painting while playing music and moving around on a dance mat. The music itself that the user is playing is picked up and analysed alongside the movements of the musician themselves. These parameters are then further used to control visual aspects of the painting experience like thickness, colour opacity of the line (Nijs et al., 2012).

The following papers are interesting due to the insight they provide about designing interactive and embodied experiences in general. Any embodied music-making is first an embodied, interactive experience so this is definitely relevant here.

In the paper "Moving and Making Strange: An Embodied Approach to Movement-Based Interaction Design", Lian Loke and Toni Robertson discuss a design methodology that is an approach to movement-based design, which centres around the body itself. From this paper it seems more comprehensive than some other frameworks and provides a good set of things to consider while designing something that involves movement-based interaction (Loke & Robertson, 2013). Another reference is a paper about themes for Interaction Design. This highlights useful concepts, some of which are quite relevant to the current discussion, like Thinking through Doing and Performance (Klemmer et al., 2006). Both of these are useful concepts that back up the ideas presented in this paper and the potential system that will be built in the following Thesis.

Another interesting product that is manufactured by a company called Playtronica is the Touch Me MIDI controller. This is also very interesting as it allows two users to become part of a system that closes when they make contact and hence allows them to make music by touching each other (Playtronica, n.d.). It creates a different but very embodied experience of music for both users.

A similar company is Bare Conductive. They create various electronic products that can be easily integrated into spaces and hence allow for seamless interactive experiences. They also have a board that can be used with a raspberry pi along with conductive paint that makes it easy to create interactive music walls that can be interacted with by multiple people (Bare Conductive, n.d.).

2.5.3 Somatics -

Somatics is fundamentally the experience of the self in the present moment. It involves movement but also the sensation of one's own body. It places a much higher value on the experience of the movement as opposed to the visual of the movement. This is something that was encountered previously in this paper as well. Reducing the value of the visual and seeing what impact that may have is also a question that is being asked in this report. Kelly Ferris Lester discusses the idea of self-awareness and internally feeling and moving beings integral parts of somatics in quite some detail. In addition to this, she explains in more detail how dance and somatics are truly connected and relevant to each other. Especially how somatics is extremely relevant and influential when talking about dance practice (2017).

For further information and insight into somatics, I contacted two students, Sarayu Krishnan and Nainika Dinesh, who studied performing arts and somatics as part of their Bachelor degrees at Ashoka University, India. From the interviews with them one strong point that came out in support of this potential research was the fact that breathing is definitely an extremely important part of somatics and body awareness so fixating on breathing as the core is a good starting point. A big part of somatics is not listening to external music but listening to your own body and moving accordingly. Starting from your body and allowing it to be the centre and the guide is crucial. Based on this, any system that is developed has to also have the dancer's body as the centre and should provide tools in which they can better listen to their own body. This also means that what this system could serve as is an entry into awareness of breathing and somatics for existing dancers who have not trained in this. It allows them to start becoming aware of their breath but potentially makes it easier as they can do it while concentrating on something that is more intuitive to dance to. Slowly however they should then be able to move off from this system and also continue this practice of breathing when it is just them and their body as well.

Since the core of somatics is to have the body at the centre and to allow for direct intimate contact with one's own body, adding a technology-based system with external feedback in the middle is not exactly in line. However, if it is used as an onboarding tool to show people who otherwise would not engage with this, the benefits of breathing awareness while also making it easier for them to be aware of their breathing while moving, there is a large benefit to such a system. Breathing right can help lengthen the muscles during exhales which in turn helps the body expands more while dancing and moving. Breathing from the diaphragm is also important so if a sensor can also track where the breath is coming from it could add another

benefit as well. When breathing is done right while moving, more of the body is used and engaged in all the movements, also there is better awareness of more parts of the body in the dancer themselves. This could potentially lead to them taking up more space as a dancer since they are less restricted. Somatics also discusses spatial awareness along with body posture which also improves when there is better breathing. Somatics definitely makes sense to discuss in this space as it is more about the experience of the dancer than of the audience and focuses less on the visibility of how a dancer would be perceived. This is also important for this system.

People have previously looked into research involving somatics and technology as well. Some examples of this can be found in the research thesis of Thecla Schiphorst. In this, she mentions multiple projects involving somatics including one specific one called ‘exhale’ that also works with breath. Exhale is a project that was based on designing ‘a-wearable’ body networks for public spaces and used the rhythm of group breathing as the interface for the interaction. The networked breath of the audience or participants was used to trigger responses in small fans, vibrators and speakers that were in the lining of large skirts. This project is relevant specifically because of this idea of group breathing or a network of breath. It also builds upon the idea of connecting bodies via breath and draws from the ideas of somatics and somatic practices (Schiphorst, 2005). This provides a good reference for any further work in this space.

2.5.4 Tracking Breathing during Movement -

Looking at existing work and breathing sensors, breath sensors have a few different forms. One basic form is similar to a spirometer where the user has to breathe into a tube for their breath to be recorded. However, this is a slightly difficult sensor to use in a situation where the user will need to have freedom of movement. Another option that is used in some existing literature is simply the integration of a mic. This especially can be influential when there is physical activity involved and hence the breathing is louder. This could potentially be an option however the mic itself would have to be strapped on to the user and then somehow isolated to only pick up sounds from the user’s nose and mouth and not the music it will be triggering or the sounds of the user’s body moving. One way to do this would be to have the music feedback be sent through earphones to the dancer so they can have the experience themselves.

In a discussion about this project with Peter Bennett, a researcher and lecturer at the University of Bristol who works also with music and creative coding, the idea also came up that this mic format may also allow for the breath sounds themselves to be recorded which means they could potentially be integrated into the music feedback itself. This would allow for the mic to do even more than just sense breath which is something that other breath sensors would not be able to do. He also mentioned the possibility of using a white noise filter as breath itself could come across as white noise. This may help and allow for this to work even without the earphones being a requirement.

A good example of another system is Vrengt. Vrengt is described as a shared body-machine instrument for music-dance performance. It focuses on the boundaries between

standstill and motion along with silence and sound. The goal with Vrengt was to provide a real partnership between a musician and a dancer and to allow for co performance via a system or instrument. It was developed using a participatory design approach so that the expressions of the dancer and musician could be considered and taken into account. Also in this system, the dancer is wearing a headset that records their breathing (Erdem et al., 2019). It provides a lot of interesting background to what we are looking into with respect to breathing and two-person collaboration in this space.

Infrared cameras have also been used on occasion as breath sensors that work from a distance. This could be an option but needs to be further looked into to see how much of an impact it would have if there is also movement.

The two types of sensing that seem like they would lend themselves to this kind of project are the wearable sensors. These sensors often can be worn on the body and are Bluetooth enabled so they allow for a much larger range of movement. The issue that remains to be seen with these is what the lag would be between the actual breath and the triggered sounds. One type of wearable sensor that is used is textile-based. Here, the textile itself expands with breathing to help track and sense breath. The other wearable device is a band that can be worn around the chest and tracks the changes in chest circumference. This seems like so far the most accessible option that could provide helpful data to build the system. These wearable sensors have often been used to track breathing rhythm and ECG for health reasons but are now being integrated into T-shirts and other wearables wirelessly which provides a lot more scope and possibility (Jourand et al., 2009).

When looking at related work, the closest thing to this system that was found while searching was a system that is a wireless breath-training support system for Kinesitherapy as this also involves breath tracking while moving and exercise. The breath sensor used in this paper is the band that measures chest circumference, as mentioned above. This system was developed in Japan and consists of an optical sensor, accelerometer, a microcontroller, a Bluetooth module and a laptop. The optical sensor is placed on the chest of the patient and is used to measure the circumference. This system enables a quantitative training evaluation and calculation of the volume of air that is inhaled and exhaled to and from the lungs (Tawa et al., 2009). Another similar system is a wearable sensor that works towards helping with stress management in real-time. It estimates stress level via heart rate and provides relaxation exercises to help manage the stress. It also uses a breathing template matching algorithm which helps identify and recommend the best breathing exercise for users (Chen et al., 2015).

This other paper looks into breath control for amusement park rides and more specifically a bucking bronco. It is relevant due to the fact that it is tracking breath during large amounts of movement, which a lot of other breath sensors do not always do well. This system looks into allowing the control of individual seats on amusement rides via breathing. They conclude in this paper that breath control is feasible and appropriate for controlling rides, and unpack its important characteristics. It also allowed the researchers to see the tactics of the riders on the ‘bucking bronco’ ride, simply via breathing (Marshall et al., 2011).

This question and response in an Arduino forum also bring up some interesting ideas of sensors that could be connected to an Arduino to measure breathing. The two ones that seemed interesting were a stretch sensor which would work similarly by being on the chest of the individual and also a temperature sensor in the nose that can track breathing by tracking the temperature inside a nostril.

Overall from these works we can see that there are multiple ways to track breath based on the context as well as the desired data. For this system in particular the sensing through microphones seems like the most feasible and desirable due to the simplicity, range of movement, and the option of breathing as feedback. The final system that uses this method of sensing is described in further detail in the following section.

2.6 Conclusion

Through this detailed literature review, each of the themes mentioned in the introduction of this chapter has been detailed, along with the connections between them, and related systems that have so far been built. From this, a more comprehensive story was drawn, as could be seen in the motivation chapter, that helped inform the final research question. Aside from this, while designing the system, lots of the literature from this section was engaged with and built upon. Embodiment and Disembodiment were seen as a high priority for the system and experiment design so as to combat ‘listening with your eyes’ and really allowing for experience. It also is the basis of the research question. With respect to the connections between dance, music, and culture we saw that associations people have from their background and upbringing can colour how they interpret various sounds, situations, and movements. To allow for a neutral space that would not create multiple other references and emotions it was important to make sure while designing the system that the sounds used did not have any strong associations to existing musical culture. Phenomenology and Participatory Sensemaking, as we already saw in the motivation section, are quite integral to this experiment as we want to focus not only on the experience of the individual dancer in a space but also the interaction and potential connection between the two dancers. Both of these theories provide a foundation for this exploration. Somatics and somatic enquiry are the basis of using breathing as a tool in the final system. The value of breath control and its connection to the body and listening to the body in general and with respect to dance specifically are valuable insights that influenced the development of the final breath tracking system.
When looking at related systems, the systems that allowed for real-time composition allowed for inspiration for the functionality and sound choices for the system as well as the possible interaction between dancer and system. This also extended to the systems that involve embodiment and music-making. Our system however focuses less on embodiment for music-making and instead focuses on music-making to enhance embodiment. Finally, related work in breath tracking was used to determine what type of breath tracking would be optimal for a system like this that would require a large range of motion for the dancers. Based on everything presented, microphones were finally chosen for the final system. As seen here, the literature has

proved to be invaluable for the design and conceptualisation of the final system. This system is described in detail in the next chapter.

3. Description of System

The literature and related works described in the previous section helped inform the design process of the final system that was used to explore, as mentioned in the research question, the impact that removing the visual aspect of dance and moving the emphasis to breathing through music has on dancers in a pair situation. The related work was used as a basis for the technology of the system itself while the literature was used to develop the desired experience that was to be created for participants. In this section, a detailed description of the resulting system that was built and tested has been provided along with its architecture and initial results. In terms of architecture, the system is broken down into Hardware, Software, and the connection between the two. After this, the analysis and results from the preliminary testing of the technology are presented.

3.1 Introduction and Considerations

As mentioned above, the aim was to create a system that would allow for exploration into what the impact of removing the visual element of dance can be on dancers and the connections between them. In addition to this, the system would also need to engage with a different output from the dancers' bodies so as to still allow for awareness and connection. In this case, breathing was chosen. As seen in the literature previously, breathing plays a large role in body awareness and in dance in general. Being able to control your breathing can allow for more ease of movement and movement options as well. When talking of connection, since breathing is a body rhythm that can be manipulated by an individual more easily than some other rhythms, like heart rate, it provides an interesting mechanism for dancers to try and make connections via. It also is a rhythm that can help provide a heightened connection to one's own body.

The system was designed for professional modern and contemporary dancers however it can also be used by other groups. This group was chosen as they have an existing focus on body awareness and to some extent breathing in their training and practice. They also have a higher sensitivity to music and experience improvising to different types of music (or silence), especially more irregular or experimental music, as a majority of them do this kind of activity as a part of their training. All of this allows for them to have a more specific experience using the system that focuses mainly on shifting the focus from the visual to breathing instead of having many new experiences at once.

While designing a system for dancers that is to be used while dancing, freedom of movement is the highest priority. Freedom of movement would include, range of movement of individual limbs, torso or head, along with the ability to move anywhere within the given space without being tethered. Any obvious restriction there will affect the dancers' experience of the system and will distract from the actual experience of the system. This was actively kept in mind during the planning and prototyping phases. Due to the current COVID-19 situation, the system

had to be designed in a way that allowed for it to be COVID safe so people could use and test it without putting themselves at risk.

3.2 Breath Tracking

Various methods were considered while deciding how to track breathing including some mentioned earlier in the literature. However many of these methods provide issues when it comes to freedom of movement which as mentioned before, is an important consideration. The first method that was considered involved a box with an Arduino in it that had a tube attached to it. The user or participant would have to blow into this tube and a sensor attached to said Arduino would track various aspects of the breathing. This system can prove to be very useful, especially if more specific data is required about the breathing, however for this particular system, it was not fit. The main issue here is the restriction of motion. To be able to track a dancer's breathing while they dance, they have to have freedom of movement. Tethering them to a specific physical system would not allow for this. In addition to this, all that's needed for this system to perform and provide the necessary results is the recognition of breath and the rhythm of breathing. At this point in this exploration, more details about the breath are not that required. If a more complicated response system is to be built in a further iteration of this, a sensor that provides data could be looked into, as long as there is a reasonable range of movements.

A second potential sensor option was a sensor that tracks the chest diameter so as to register a person's breathing and breathing rate. This system can be done using Bluetooth and hence does not have the issues the previous system has of keeping the dancer tethered to a specific spot. However, it has some limitations of its own. While dancing, and especially in modern and contemporary dance, the torso of the dancer moves and twists a significant amount. This type of stretching and movement itself will cause the measurement of the band to be inaccurate. Its coils also potentially lead to slipping or loosening of the sensor during movement. The ideal system for this would allow the dancer to move without actively thinking about or noticing the technology that is doing the tracking. If the technological intervention in itself is distracting, it will take away from the experience that is trying to be created by the system and skew the data and interviews taken after.

Finally, a simple Bluetooth microphone was chosen to track the breathing via audio peaks. Though this method collects relatively less data about the breathing itself, there isn't a need for more detailed data at this point to create the desired experience. It works best as it provides no restriction to movement at all since the dancer is both untethered to any fixed physical system and can move in the space as they wish. It also provides freedom of movement to all the limbs, torso, and head as it can collect the data accurately regardless of any movements of these body parts, unlike some of the previously mentioned methods.

3.3 Final System Overview

The final system that has been designed allows for two dancers to dance simultaneously in a dark space and lets them each control a specific set of notes with their breathing. Each person's breathing notes are different and are only controlled by them. There is a neutral background sound but no other sounds outside of the ones that they can create using their breathing or more specifically, their exhales. The sounds that are output are played over a speaker system in the room so both dancers can hear them without wearing headphones. The breathing is tracked using the mic on a Bluetooth headset that is placed within two different types of facemasks. The breathing is recorded on a computer with the help of programs in Max MSP and Ableton Live and triggers the corresponding midi notes in Ableton Live as well. The system actually allows for each person to have control of two separate sets of notes, one for inhaling and one for exhaling, however, for the purpose of this paper, only the ones for exhaling are relevant.

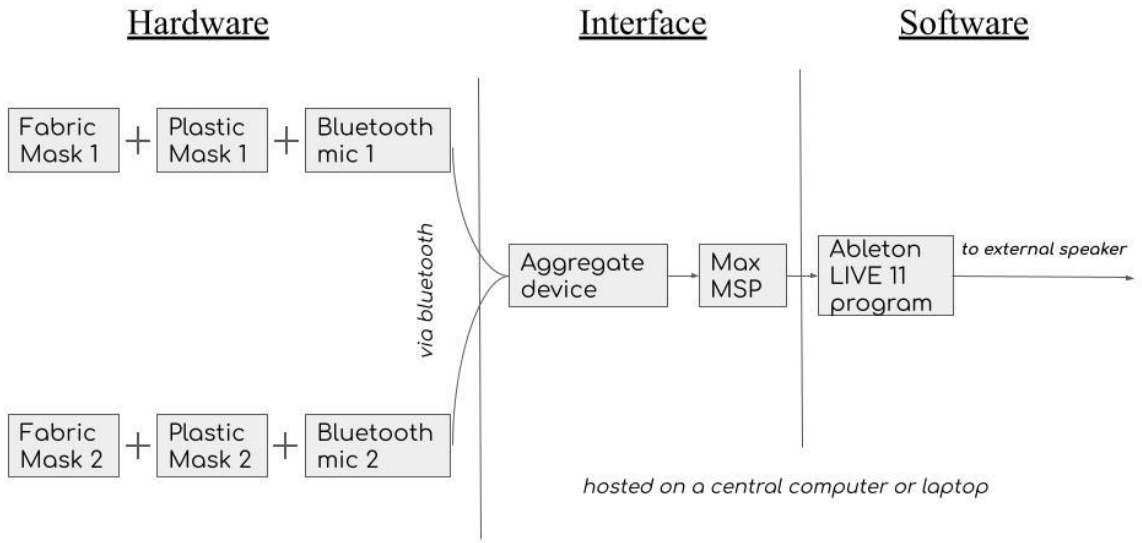

Fig 3. Overview of Architecture of Final System

3.4 Hardware

The system has 3 main physical pieces that each dancer will have to wear while using it. These are a pair of Bluetooth headphones, a plastic mouth mask, and a fabric mouth mask. They are used together to create an optimal setup that allows the user's breathing to be recorded while also keeping out other sounds and the output sounds that are played out loud.

Fig 4. Hardware of the System

Bluetooth headphones -- The Bluetooth headphones used for this experiment are the Live Loose Wireless Bluetooth Earbuds from Jam. There are two pairs used in the system and when they do need to be distinguished as mic A and mic M. They are connected to the central computer via Bluetooth and consist of two earbuds connected by a wire with control buttons and a mic in the centre. They are sweat-resistant which is an added benefit since they will be used in an active space. They have a mic, which is why they were chosen, and that is the main element that's being used in the system. The earbuds themselves are not as relevant as the final decision for the system was to play the music out loud and not through the earbuds. This will be discussed more in the section on Preliminary Testing of the Technology.

Plastic Mask -- The plastic mask is a mouth mask that has more recently become commonly available due to the COVID- 19 pandemic. It consists of a semicircular piece of plastic that is on a curved frame that is balanced on the chin and secured with elastic around the head. For the purpose of this experiment, the elastic band has been removed. The plastic mask has been used specifically to securely hold the mic of the headphones in place in front of and between the nose and mouth of the user. This way it is at the optimum position to recognize all the types of breaths, from both the nose and mouth of the user. In addition to this, it adds a layer between the outside and the chamber where the breath is, hence removing some of the external sounds which helps make the system more accurate. Another option was to attach the microphone directly to the fabric mask however the lack of stiffness in the fabric mask means that often the rustling of the fabric itself during movement can skew the output sound from the system as it can also be interpreted potentially as audio peaks and breathing sounds. The structure of the frame of the plastic mask also makes sure the mic is kept at a fixed distance away from the face and does not have direct contact with the user's skin. A measured hole that is the same size as the mic section of the Bluetooth headphones was cut into the plastic mouth masks.

This hole is located slightly above the mouth of the user and just under the nose. The exact position it ends up varies from person to person however it is always approximately at this point. The mic is then fitted into this hole with the receiver facing in towards the user. The wires and earbuds are then taped down to the mask or just tucked into the band of the other face mask, so they stay out of the way. In a higher quality prototype potentially Bluetooth mics without added headphones could be used so as to avoid these additional wires.

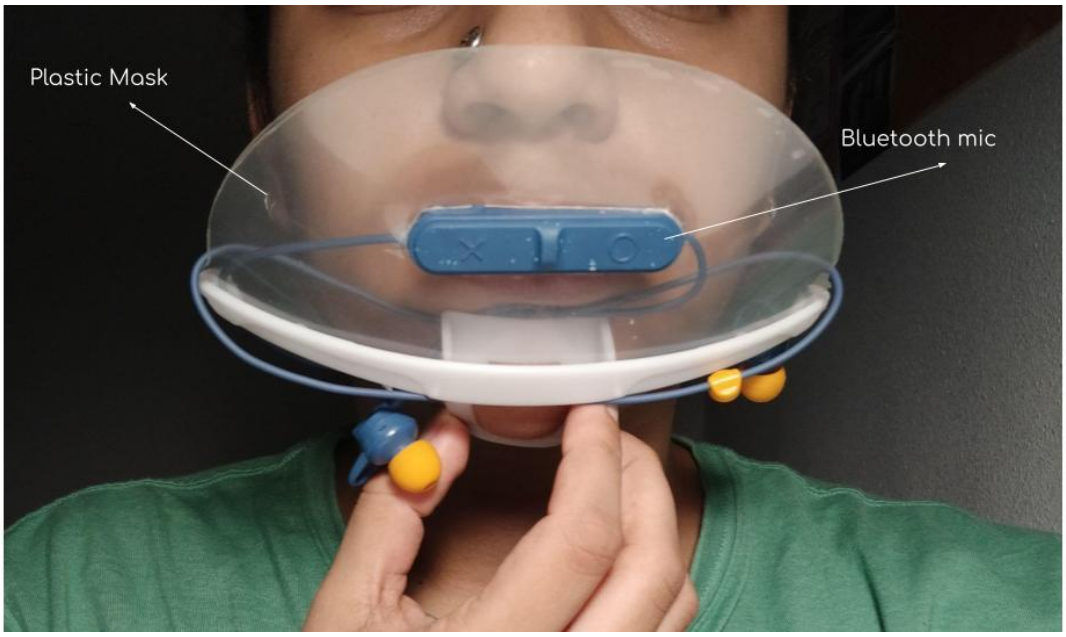

Fig 5. Example of placement of the first two elements of the hardware of the system

Fabric Mask -- Since the elastic band on the plastic mask has been removed, it is held in place using a fabric mouth mask. In most cases the users can just use their own masks as there isn't much specification outside of a fabric mouth mask, however, the surgical mouth masks do not work as well. In addition to securing the mic and plastic mask, the fabric adds another layer of soundproofing and encloses the system. Without it, the plastic mask is quite open on the side and the top which allows more sounds to get through. The stability and size of the plastic mask keeps the fabric taut and makes sure it does not rustle or make any additional noise. Due to the current situation in the world as well, people have become more used to wearing mouth masks of all types. This helps make the system feel less intrusive. Covering the system with a fabric mouth mask also keeps the technology itself hidden, hence making it feel more organic visually for the dancer, even before they start. This is important as ideally, they need to feel like they are dancing like they always do and the physical system on them should not create a distraction from the experience of dancing that they have when they dance with the system.

These three pieces are fitted together as mentioned above and worn by the user. Since there are two users at a time, two of these setups are necessary every time the system is used. Between trials, the mics and the plastic mouth masks are disinfected. The users can on most

occasions use their own fabric face masks, so they do not need to be separately disinfected. This system is worn by first holding the plastic face mask in place on the chin and then pulling the fabric facemask around it to secure. The system is not permanently attached together to allow for an easy switch of fabric mouth masks and charging and connecting of mics. It also allows for modularity and switching between plastic mouth masks in case one is required with a higher space for the mic, based on the user's facial structure.

3.5 Software

The hardware system that has been described above is further connected to a central computer that runs the main software programs of the system. The software is fundamentally an Ableton Live 11 file that processes the breathing sounds and triggers MIDI notes in response. In addition to this, an aggregate device and Max MSP patch also had to be created to allow for the main software to be connected with the hardware, however that will be further elaborated upon in the next section.

Main Program -- As mentioned the main program was created and used in Ableton Live. Live is a fluid and flexible software for music creation, production, and performance. It has multiple features including libraries of instruments, MIDI sounds, filters, and other creative features that can be used to create any kind of music. Since it can also be used for performance it allows for real-time responses and modifications which is optimal for this system and the experience it aims to create. Ableton programs allow audio tracks and MIDI tracks based on the inputs received. The current system is a Live file with two audio-in channels. In addition to this, there also are 3 MIDI channels, two of which are connected to the audio channels and one which plays a standard MIDI sound as the background for the system.

The audio-in channels are each routed to one of the MIDI channels. This routing is done using a plugin called Trigg.me developed by Yehezkel Ras (4liveme.gumroad.com) and allows them to trigger that channel and the MIDI notes. Trigg.me is a two-part system with senders and receivers. The senders are placed in the audio channels while the receivers are placed in the MIDI channels. Multiple pairs can be used and matched by labelling 'Send 1' - 'Receive 1', 'Send 2' - 'Receive 2', and so on. The 'send' elements of the plugin have a movable threshold level that measures the audio level of the input audio of that channel. This can be used to decide the peak of audio that will result in a message being sent to trigger the MIDI notes in the MIDI channel. This can be set before running the system but can also be adjusted in real-time while the system is running. This way it can be adjusted based on each person's natural breathing volume and intensity.

The 'receive' elements are triggered when the audio hits the threshold of the corresponding 'send' element. The 'receive' elements also allow you to map to any specific pitch or note, based on where you have mapped your desired MIDI notes. In this project, they have all been mapped to C3. This pitch/note itself is not exceptionally relevant, it just is an indicator for where to place the MIDI notes.

Aside from the ‘send’ element of the plugin, the audio-in channels have no other filters or elements on them. They simply output the same breathing audio that is input into them. The actual breathing audio is output at a low volume so as to not distract from the notes themselves. However, it is left in to provide a more organic energy to the overall music and to allow for a little more intimacy in the sound itself. The MIDI channels on the other hand have more modulation.

MIDI Channel 1 -- The first MIDI channel is the most simple and is also the one that is not connected to either of the audio channels. This channel plays a single sound that was sourced from the Ableton Live 11 sound library and is called ‘Wet Air Pad’. This specific sound is non-rhythmic and non-melodic. It provides a level of background white noise over which the other notes can be played. It has been used and added to provide more atmosphere and depth to the overall sound and experience of the system.

MIDI Channel 2 and 3 -- The second MIDI channel is connected to the audio channel with input from mic A, using the send-receive pair 1. The idea here is that whenever the dancer wearing mic A exhales and the audio peaks and hits the threshold, the MIDI notes are triggered. The same applies for MIDI channel 3 and the input from mic M. The sound name used for both is ‘Wavetable’ and it is also from the Ableton Library. These channels have a random filter that randomly plays notes in this sound from a particular scale. The scale that has been chosen for this system, for both the MIDI reaction channels, is the Lydian scale with the lowest note a C2. This scale is a 7 note scale and is similar to a major scale but has one note deviating. This allows it to not create a very specific positive or negative mood. This is important to create a system and environment where the artist can fully listen to their own body, the notes and sounds that are chosen should not actively influence their movement choices.

The sounds in channels 2 and 3 are similar but have variations. The notes in channel 2, have a low pass filter applied on them so they sound a little more muffled or like they are underwater. The notes in channel 3 on the other hand are a bit sharper and have some higher-pitched sounds in them. The reason for this is to make sure that when both sounds are played at the same time, the resulting music does not sound too noisy, and can still be easily danced to. Having both channels in the same scale but with these small differences helps allow for this. The differences however are loud enough for the sounds to be easily distinguished from one another.

Together these MIDI channels trigger sounds based on the breathing that is then output to external speakers through which the dancers hear the music.

3.6 Connecting the Hardware and Software

Ableton Live itself had some issues connecting even one Bluetooth audio device to the system as input, let alone two. So some extra steps had to be taken to make sure this was possible without

increasing the delay between the exhale and the notes being triggered. To do this, an aggregate device had to be created and a Max MSP patch.

Aggregate Device -- Mac OS devices allow for aggregate devices to be created that can combine multiple audio interfaces so they can be used at once by software applications as a 'single device'. Ableton Live only allows for one audio input, so creating an aggregate device helps get around that issue.

However, an aggregate device of just the two Bluetooth microphones isn't enough to make a working connection that allows the inputs to be the two microphones and the output to be external speakers. The other issue as well is that the frequency of Bluetooth input does not work when directly input to Ableton. To make the aggregate device work, Blackhole 2ch had to also be added to it. Blackhole 2ch is an audio driver that specifically helps reroute audio between applications and has 2 input and 2 output channels. The final aggregate device has two inputs from the two Bluetooth mics, two inputs from Blackhole and two outputs also from Blackhole.

Max Patch -- Since the inputs from the Bluetooth devices cannot be directly used in Ableton they first need to be rerouted using a patch that's programmed in Max MSP. This patch fundamentally maps the Bluetooth mic inputs to the two Blackhole input channels. This way the audio is not being input to Ableton from the Bluetooth device directly and BlackHole itself can be chosen to be the audio input for Ableton. Since the two inputs are split between two input channels in a single audio interface, using Mono inputs, each input can be individually assigned to an audio channel which allows the two peoples' breathing to be processed individually so that the system can work as planned.

3.7 Preliminary Testing of Technology

Once the basic system was built, tests were done with two sets of pairs, just to see if the technology itself was working. The main issue these tests brought out was the need for a loud output speaker so that the audio was clear to the participants. During these tests, it was also considered to play the audio back on the earphones connected to the Bluetooth mic since they were on the participant anyway. This was technically a challenge to do but also did not aid the experience of the participants. Playing the audio back into their ears specifically forced the dancers to be more closed off and also made it harder to create this studio dancing environment that most dancers are accustomed to. It also did not let them engage with the space as a shared space since having the audio as earphone feedback made it feel more like they were an individual with some music playing. The external speaker allows the system to function like an installation which helps the dancers engage better with the system. There is also the issue of earphones often coming loose while the dancers are performing the movements, which could also hinder the experience of the dancer.

The addition of better external speakers brought up the issue of feedback since the mics could pick up the output audio and feed it back into the system, causing a feedback loop. However, the addition of a fabric mouth mask to hold the plastic mouth mask in place helped

solve this problem. In addition to this since only peaks are being recorded, the two masks are enough insulation for the external sounds to not be registered that loudly.

Fig 6. Demonstration of Two Participants Wearing the Full System Before the Experiment

The first trial of the system also had four MIDI response tracks instead of just two and had different sounds for the exhales of each dancer and the inhales. This was to allow more dynamic options for the dancers to play around with. Unfortunately, this proved to have some issues. Firstly for the experience of the participants itself, instead of allowing more space, in this initial experiment it caused mostly more noise and confusion. More on this will be discussed in the next section. Another reason why this did not work out so well is since for inhales, the thresholds had to be lower and the audio did not peak as high, there was more chance of feedback loops occurring in a system that did include the two extra MIDI channels. When the fabric mouth mask of the participant was thick enough and large enough to encase the plastic mouth mask and Bluetooth mic entirely, this was much less of an issue. This implies that in further interactions of this system and project if more dynamic options are to be added in, it is possible as long as the outer insulation is sturdy enough.

Apart from these issues, from a technology standpoint, the system worked quite well during all the preliminary technology tests. With this positive result, it was then possible to move on to the formative testing of the experience of the system that is explained in the following chapter.

4. Formative Testing of the Experience of the System

Once the preliminary testing of the technology was done and the system itself was seen to be technically sound, further testing was done to help understand whether the experience the system was creating was what was desired and to see what impact the system was having. In this section of the thesis the process, updates, and results of the formative testing are described along with reasoning for any of the changes made.

4.1 Introduction

Formative testing was done of the system described above with 8 people, so 4 pairs. This was done to test the experience the system was provided, to find out the ideal experiment design and interview topics and questions, and to make any changes required to make the final experiment optimal. The formative testing was done over two weeks so that changes could be made between tests and the impact of these changes could already be seen. For the formative testing itself, it was not possible to get all professional dancers. The test group was a mixture of professional dancers and people who have experience in movement and dance. The majority of the dancers were people who were comfortable improvising and that was used as the main criteria for the users for the formative testing of the overall experience of the system. Each test had a slightly different experiment plan, based on the results of the previous tests and other options that were to be tried out. The results of these tests are described below. Overall all the tests involved the dancers using the system for around 15 minutes. In the formative testing stage since not all the dancers were professional, sometimes the test ended up being a little shorter as not all the dancers were fully comfortable with improvisation for long periods of time. However, even with this, all participants did manage to successfully use and engage with the system at some level and all technical glitches were avoided which led to tests without any interruptions. After they tested the system they were interviewed about their experience. This was an open interview with fixed themes as opposed to fixed questions. Participants were encouraged to talk about their experience and thoughts and were sometimes prompted by the researcher so as to make sure they did also discuss themes that are relevant to this research.

4.2 The Space

The formative testing was done in a room at the DesignLab at the University of Twente. This room allowed for there to be a separation between the dancers so they could not see each other and it had no reflective surfaces so they could not externally see themselves. However, there was

no possibility of making the room itself dark due to large windows. Due to restrictions from COVID, a studio space with that option could not be found for the formative testing. One thing that was noticed during these tests is that the presence of light and other objects in the room created a distraction for the dancers. It did not allow for the complete experience of the system. The addition of windows also allowed the feeling of potentially being seen or perceived by someone from the outside and added more pressure that should ideally have been removed. The presence of the researcher in the room was also more obvious in a well-lit space, as compared to a darker one.

Fig 7. Reenactment of Formative Testing done at DesignLab with Pairs of Dancers

The more space provided for the dancers, the better. Most dancers got more invested in the system when they had more space in which to move. Allowing for enough space per dancer, especially that allows them to do floor work and jumps, helps improve the experience for the dancers as they need to be less concerned about hitting the walls or edges and can focus really on extending their bodies with the help of their breathing. Between tests 2 and 3, more furniture was cleared out of the room to allow for more space and less distraction which helped with the focus on the system. The audio feedback in the space for formative testing came from a central speaker that was powerful but not enough to provide surround sound. This also meant that the dancers

were more focused on the centre of the room so that they could actively hear the music. A studio with an in-built sound system seemed like it would be more appropriate for the experiment and the system as it provides a more immersive experience. That immersive sound and lack of light were two things that were very much taken into consideration when planning for the final experiment and evaluation of the system.

4.3 The Audio

In the initial formative test, instead of simply one sound for each exhale, there were sounds for each dancer's inhale and exhale which implied in total there were 4 separate MIDI channels being triggered while the experiment was being conducted. This allowed for dancers to have three sound options - exhale sounds, inhale sounds, and silence. As mentioned in the technology testing section, this didn't prove to be ideal. Though the technology issues were solvable overall the experience this provided was not ideal. Having this many sounds made it much harder for participants who were engaging with this system for the first time to really understand what was happening and what they were influencing. These many sounds also meant that pauses or silences could only be achieved when both dancers were holding their breath. This noisiness of the feedback sounds actively took away from the experience of the dancer's as they paid much less attention to the control they had which overall made the system less intuitive to use. In a longer-term experiment where dancers would have more time to engage with the system, this is something that could potentially be brought back in.

The MIDI notes assigned to the two microphones during the initial formative tests were not the final two that were mentioned in the description of the system above. The initial sounds were two completely different sounds, as opposed to the same sound but filtered and unfiltered. Here the filter made one of the sounds sound like an underwater or muffled version of the other sound. Though this made the sounds more distinct, it also was quite jarring when the sounds played at the same time. This noisy situation made it hard to encourage mindful movement with breath awareness as the sounds themselves were distracting. In the later tests, the final sounds were used and they provided much better results. One of the participants likened the sounds to that of water droplets and another commented on the peaceful, non-intrusive nature of the sound which is what was desired while building the system.

4.4 Experiment Design

One decision that had to be made with help of formative tests, was whether participants should be informed beforehand about how the system works or if they should be allowed to just use it and see if they can make sense of what is happening. Both options have value for what we are trying to explore. Option one is where the participants are kept in the dark about how the system functions. They are told that the microphone is just for tracking data that will later be analysed. In this setting, it can really be seen whether the system is immediately intuitive and obvious to a

user or not. In the formative tests where this experiment plan was used, it was not very obvious to the participants what was happening. In some cases, one of the two would notice and this was usually the person who had had more dance training. This helped reinforce the idea that this system and also this experiment design could get results when tested with professional dancers who have more experience with breath control. Option two is when they are told from the beginning that they can control the music in real-time using their breathing. Here because of the information, we can test the moving of this control from visual to breathing and also see if it results in the participants really paying more attention to their own bodies. What do they try to do? What does this increased power over the system lead to? However, getting them acquainted with the whole concept and the system and new sounds all at once often can also be a little overwhelming and it was seen that it took some time for participants to get used to the system and get into a flow. In conclusion, option one tests whether the system makes sense and has an impact option two allows for more conscious engagement with the system by the user.

The optimal situation, based on the formative testing, was seen to be a combination of options one and two. Having option one as the first round of the experiment allowed participants to first warm up their bodies and also get acquainted with the sounds and space. This allows them to get into a dancing mindset before they are given more information which means they are already a little comfortable when they are told about how the system works. Then once they are given the new information, an added layer, they are already in the flow and take this and engage further. Another benefit that having both options provides is that the participants themselves have a before and after scenario where they can immediately see the difference between dancing with no awareness and dancing while being mindful and trying to listen and engage with their breathing.

4.5 Results and Discussion

Aside from testing and updating the experiment and system design, the formative tests were also important for understanding what the experience of the participants was like. Each participant was interviewed for approximately fifteen to twenty minutes after the experiment was over to get this information.

4.5.1 Usability and Intuitiveness -

The participants found that the system was intuitive to use and allowed flexibility. Especially once it was explained to them how the system worked. The experience was well-received by all the participants who didn't have any issues with how to use the system and the experience it provided in response to their movements. The system provided a good amount of freedom in terms of movement but also in terms of prompting which most participants found refreshing but

some did say it could potentially be intimidating. Aside from this, the experience was labelled as enjoyable, experimental, and comfortable but a little uncomfortable all at once.
This response was taken as positive as it seemed to imply that the system was doing what was planned, allowing participants freedom while also pushing them to engage differently.

4.5.2 Presence and Connection -

It was clear to all the participants that it wasn't them dancing alone in a space. They felt both another presence in the space and that the presence was or could be another person in the space with them, even though they couldn't see them. Since the space wasn't optimal, and there was some light, some of this awareness came from the fact that they knew there was another person but they also specifically mentioned that the system and the music also prompted this feeling. The participants didn't just feel this presence, a majority of them said they also felt connected to the other participant, especially once they could process that it was their breathing. Some of them said they felt connected even before they knew what was happening simply due to the nature of the music and underlying breathing sounds. It was difficult to judge the value of the answers to do with presence because of the issues with the lighting of the space; however, the ability to feel and make connections is an interesting result that would ideally be carried on into the final evaluation.

4.5.3 Communication or Co-creation -

When asked about whether they felt like engaging with the other person and the sounds the or breathing was making, the responses were split. Half of the participants felt an active need to engage and respond to the other person's set of sounds. A few participants said they were trying to create something that would weave together with the other person's sounds but did not feel an active pressure to be constantly engaged. The remaining two participants said that they tried to or wanted to but it was difficult to distinguish things and they felt more comfortable just naturally reacting to the music as a whole. The participants who did feel like engaging also said that this engagement made them feel like they were communicating with the other person, or entity in the space even without being able to see them.

Overall the consensus was that the experience felt more like a conversation as opposed to creative collaboration or creation. The final product was not necessarily the focus but more the potential of hearing the other person engage and respond to you, while you also try to do the same. Some participants however did feel individually like creators simply because of the power they held to influence the music, this creation idea just didn't continue when discussing the connection with the other participant.

When asked to compare the connection they felt here to the connection they usually feel while dancing in the same space as someone, there were varied responses. More than half the participants said they felt more connected while using the system. One of them reasoned this out

by saying that more attention had to be paid to the other person and what you could engage with, and this effort and intention on both sides led to an increased feeling of connection. It was also mentioned by two participants that shared context between the dancers may make a difference. One said that if the participants had had the chance to warm up together and then were separated, this context would've helped increase the connection. On the other hand, another mentioned that because they had known their partner for a while, they felt less pressure to listen to them as intently and make space for them as intentionally. Overall most of the participants here allowed themselves space to listen to their partner and themselves before simply throwing themselves into the music.

4.5.4 Movement Choices -

With regard to movement choices, there were some strong differences noticed by the participants because of the lack of visual elements. One important one that stood out in most participants' answers was the inability to physically mimic or feed off of facial expressions and cues of the other person in the experiment. Generally, this is how people expect to engage or communicate in a dance setting. Removing this mimicry option made the experience more open and exploratory and allowed for many more ways to engage with the other person and one's own body without focusing only on the form of the other person in the experiment. This new form of dueting that relies on sound and breathing for developing connection provides very different prompts and cues that participants felt provided interesting options. This system allows more room for interpretation of what the other person is doing which made participants feel more creatively engaged, in some situations. There were also two participants who felt like short term this didn't have too much of an impact on them as they engage with exercises like dancing with their eyes closed on their own as well. These two participants also are the ones that felt the need to engage with their breathing and the other person's breathing the least as they said that they were used to experimental music and so they didn't feel like they had to figure this out. They could just dance as they normally do.

Speed was an interesting element that also played quite a large role here. When participants did not know that they had control over any real-time elements, they often felt this need to try and catch up with music which resulted in them moving with more speed which only caused them to breathe more and louder. This resulted in the system also creating more sounds hence forming a vicious cycle. A few of the participants specifically commented on this and how once they knew there was no need to catch up with anything external and that they had the control, they slowed down. They said this allowed them to move more mindfully and without any pressure to match an external stimulus. This also led them to try new things and feel less pressure about making mistakes. Based on observations by the researcher, it was also seen that once they knew about the system, multiple participants had moments of standing still and pauses in their movements that otherwise are not as common or desirable in an improvisation setting.

4.5.5 Focus Shift -

In normal improvisation, the participants said they focused mostly on the music and, as mentioned previously, the visual of a partner. They said their movements and movement choices were mostly informed by the rhythm and emotion in the music. In this situation, due to lack of standard rhythm and emotionless music, their focus shifted to finding patterns in the music and in one's own breath. So they were still trying to get what they could from the music, but this led them to focus internally. The focus on the music also allowed them to focus on their partner in a different way. One participant talked about how they listened to the music more intently with the intention of finding ways to engage and connect with the other person. This adds more intention in the search for connection and leads the user of the system to be more mindful of themselves and the other person involved.

When it came to connection to breathing all the participants felt more connected to their breathing than they usually do while improvising otherwise. Participants who engaged in other breathing exercises felt a less significant improvement but one did mention that generally, the focus on breath is to keep it from becoming something that would hold them back and in this situation it was more using it to control and slow down when required. This is an even more specific focus shift but a relevant one all the same.

4.5.6 Bodily Experience -

The majority of the participants said that though they feel quite connected to their bodies when they usually dance, they did feel even more connected or at least more engaged while using the system. This was a harder topic for participants to talk about directly as it was a bit layered. One participant specifically mentioned that while dancing normally you allow your body to get lost in the music and hence feel very connected. However, it is a connection without thought of any form. Here, the whole system prompted more thinking and allowed more control, so there was less opportunity to lose yourself in the music. So here the connection to the body was a more aware and thinking connection which in some ways felt more connected while in some other ways felt less. Some other participants also described similar experiences and thoughts. This awareness-based thinking, which is not a tiring or stressful form of thinking, and rather just a more mentally engaged way of moving is quite interesting. It is a different type of consciousness from say, test-taking, or any situation with right or wrong answers, but it still requires you to be mentally present and engaging. It also is an interesting prompt when thinking about some of the Philosophy concepts earlier. When both mind and body are engaged in an experimental space as a unit where they are equally involved and have no ability to do wrong, does it feel even more so like we are lived bodies and that there is no separation between our minds and the so-called ‘vehicles’ they inhabit?

4.6 Conclusion

The formative testing described above provided multiple useful insights into the experience of the participants and helped optimize the final system. The space in which the formative testing was done did not allow for complete darkness. This was definitely taken into account while deciding on a space for the final experiment as the importance of this was clearly seen. The system was also simplified from a 4 channel system with separate channels for each participant's inhale and exhales to a 2 channel system that only registered exhales. This was done to create less noise and confusion and overall a more intuitive experience with the system. The final experiment design itself was very influenced by results from the formative testing as this showed that allowing the participants to warm up and use the system without knowing how it works and then allowing them to use it again once they understand it, helps them to fully engage with the system and also really understand the impact that the system itself can have on their experience of dancing. There were many positive results when it came to the interviews about the experiences of the participants. We saw that all the participants found the system intuitive and easy to use, especially after they knew what was happening, and they also did feel the presence of another person along with some of them feeling a connection to the said presence and/or person. This was encouraging as this was the experience the system hoped to allow for. Some interesting additional results included the experience being likened more to a conversation as opposed to co-creation, which dueting or joint composition can otherwise feel like. Speed being important as the difference between understanding the system and not also was something that was kept in mind and watched for in the final experiment as well. Mostly to see if the engagement with speed differed between professional and amateur dancers due to levels of body control and engagement. As a final positive outcome of the testing, we saw that all of the participants felt more connected to their breathing while dancing with the system and a majority of them also in some ways felt more connected to their bodies. This formative testing allowed us to see that the system could and was providing the desired experience, especially after all the interactive updates that were made through this process. The next chapter details the final experiment design as well as the results from the final experiment.

5. Final evaluation

The formative testing provided some interesting results which helped us improve the system, optimize the experience, and understand how people were choosing to interact. As seen in the previous section, through the testing the system was continuously updated till it reached a point where the experience it was creating was the desired experience that was planned for. Once it was seen that technically and otherwise the system was providing the experience we had hoped to provide, the final evaluation was conducted. The format of the final experiment and evaluation along with the results recorded are all detailed in this section.

5.1 Method & Background

For the final evaluation, the experiment was held twice (two dancers per run), with a total of four professional dancers who work and perform with Introdans, a contemporary, modern, and ballet dance company based in Arnhem, the Netherlands. As professional dancers, they all have training in ballet and contemporary dance, have experience with some amount of breath control and improvisation, and perform regularly. These dancers signed up voluntarily to take part in the study and were briefed fully about the experiment, according to the ethical approval. The experiments were held over the course of one morning at one of Introdans' studios in Arnhem. Each experiment took between one and one and a half hours and consisted of three rounds of movement and individual interviews with each participant. During the experiment, the participants were also observed by the researcher and their breathing was recorded by the system for analysis. This is further detailed through the rest of this chapter.

Reflexive thematic analysis (Braun & Clarke, 2019) was used to analyse and code the interviews after their transcription. This was chosen due to the qualitative nature of the data and the fact that one of the themes we were dealing with was Phenomenology. This method is often seen as preferable when these are the criterion of the study. The results and discussion points gotten from the analysis are presented at the end of this section.

5.2 Final Experiment Design

The final plan for the final experiment was developed based on the feedback, responses and observations collected during the formative testing. Many changes were made so as to make the experience provided in the final test as ideal as could be. The details of the final experience are detailed below.

Fig 8. Reenactment of the Final Evaluation Experiment: Two dancers wearing the mics of the system in a space dancing while facing away from each other. The reenactment was not done in the same studio as the evaluation due to lack of access. In addition to this, the final evaluation was held in darkness, the reenactment was not to allow for photos to be taken. The movements done by the dancers here are reminiscent of movements done by participants in the final evaluation. In contrast to formative testing, here there is no physical barrier.

5.2.1 The Space -

The space in which the final tests were held was different from the space the formative tests were held and hence did not have some of the limitations that the latter had. One big change that was possible to make is that in the final test, the space did not have windows and thus could be made almost entirely dark. Instead of creating absolute darkness, 4 very dim blue spotlights were added in just so the dancers did not crash into anything in the space or each other. Not adding this could have potentially led to too much disorientation or even injury. This light however was too dim for it to create any visual cues. It also still did not allow the dancers to clearly see each

Fig 9. The Studio lighting for the Final Experiments

other. When instructed initially they were also told to ideally dance facing away from each other so they had no prompting from each other outside of the audio. This dim light also allowed for the researcher to see the figures of the dancers enough to take notes while also not interfering with the experiment. The room also had mirrors on the walls however these were all kept covered to remove the visual entirely.

A second limitation that did not exist anymore was with the external audio speakers. Since this space was a studio at a dance company, it was fitted with a sound system that allowed for surround sound. In this form, the music could encompass the space and not just be rooting the dancers to the centre of the room like what happened previously. This allowed for an immersive experience for the dancers while still allowing them not to wear earphones, which was what was the desired outcome.

5.2.2 System Demo -

As mentioned in the formative testing section, it was seen that the most effective way to have people engage with the system and experience was to first let them use the system without knowing what they can control and then let them use it again with the information. This was carried forward to the final experiment design except another round was also added in to allow for warmup. Before this, the participants were first introduced to the experiment with the information that it was a study being done to explore the impact of removing the visual aspect of dance on dancers. They were told they would be working two at a time and were given the mic

and mask systems and instructed to wear them. At this point they are not explicitly told what the function of the system or the mics are, however they are informed that the data being collected is for later analysis once the experiment is completed. Once they are comfortable with the mask and have no additional questions, the warmup round commenced. For the warmup round as well, the main lights are turned off and the dim lights are turned on as shown in the figure.

The warmup round -- The purpose of the warmup round is both to allow the dancers to warm up their bodies in the dark so they feel more comfortable dancing but especially in the space and to help the researcher calibrate the system to the dancers. Since different people have different breathing patterns and intensities often the thresholds need to be adjusted based on the participant. The threshold for each participant was chosen so that their normal exhale volume would create a sound while their normal inhale value would not. If this isn't done then they will not trigger the music accurately with their breathing and it will make it much harder for them to engage with the system and experience. To allow enough time for the system and dancers to be ready, the warmup round is around 3 minutes long. The dancers are instructed to simply do any warm-up exercises they would like and to get themselves ready physically and mentally to dance and improvise. Adding this in helps them really focus on how they usually do before being told about the system which helps them see the contrast in their reactions and their experiences before and after, more strongly. The music also is started up during the warm-up so as to help with calibration, but also so that the dancers get acquainted with the sounds as well.

Test Round 1 -- After the warm-up, they are given a minute to ask any questions, and then the first Test Round is started. This round goes on for around five minutes. For this round, the dancers are just asked to start improvising in the space and they are told how long the round lasts. No more prompting is provided here and they are just allowed to start. The purpose of this is to see if any of them picks up on the functionality of the system and to really see the difference that the system itself makes to the experience of the dancer, as an added layer over just the removal of the light and visual.

Test Round 2 -- Once Test Round 1 is over, the dancers are asked if they noticed anything while dancing. Here is when dancers or participants who did notice something in the system have space to talk about what they thought it could be. After that is done and noted down, they are explained about the actual workings of the system. They are briefed about how they control the notes with the music and that their partner also does. They are also shown which sound belongs to them and which to the other person. This allows them to have a better understanding of what their breath is being turned into so they can engage with it if they wish, in the second round. Then the second round is started and they are given another 5 or so minutes to play around with the system and dance.

5.2.3 Final Interview -

The last part of the experiment is the individual interviews. The participants are interviewed separately and the audio of these interviews was recorded for later analysis. In the formative

testing, the participants were asked more specific questions in the interviews however for the final experiment, the interview was less structured questions and more meant to guide and encourage the participants to talk about the details of their experience. Certain themes were planned beforehand that were added into the interview so as to get the required information from them, along with any additional information they could provide about their experience.

5.3 Observations

A conscious decision was taken to not video record the experiment as the idea was for the participants to not be conscious of their form. Adding video recording, even if just for analysis, had the potential to change the way the dancer's engaged and experienced the system. To allow for some reporting and analysis of the actual movements and to see if there were any interesting happenings with that, the researcher observed the participants and took notes. As opposed to looking at the specific form the researcher was looking for any patterns or similarities within the movements of the two dancers that seemed relevant to the study. Also included in this are observations about how the experiment went and the ways in which different participants seemed to use the system.

5.3.1 Types of Engagement -

Though the system overall created a similar experience for all the participants, there were some variations in the way that they engaged with the system. In the test round 1, both participants of experiment 1 seemed to have an idea about what was happening while the participants in round two had no knowledge at all. This made the way they interacted with the system slightly different as the participants in experiment 1 took less time to get settled into round two since they had already been trying to figure the system out in round 1.

The main difference between the way the dancers all moved in round 1 and round 2 was the addition of more dynamics in round 2. In round 2 with the system, all the participants created spaces for standing or being still and interspersed this with more quick movements. This seemed to be the clearest way to cause variation in the system response. We will come back to the importance of this stillness further on in this paper. One participant took it a step further and tried to also create dynamics with their breathing by breathing long breaths followed by short ones. The other participants flowed with the breathing and mostly used the system in a way without any extremes.

5.3.2 Synchronization -

There were a few points of synchronization that were observed in both experiments. In the first experiment, both participants seemed to be creating dynamics between faster sections of movements and slower sections, which also reflected in their breathing. This led to them

occasionally having similar speeds of movement. In addition to this in one section when they both slowed down the breathing, they also both ended up lying on the floor and doing the slow movements for the same section of time. This was quite an interesting observation as there was no way they could prompt each other to do that however they both seemed to relate this more calm movement with floor work.

The other main observation of synchronisation was moments of stillness. The way the system is built allows for moments of no music and only the background white noise track (MIDI track 1) when neither dancer is exhaling. While dancing, as you get tired, it's harder to have long inhales which means finding a moment when both dancers, mid dancing, are still is quite interesting. The silence that is created is also a stark contrast to when the sounds are playing so it creates quite an impact. Both sets of dancers were able to mind such moments of silence, in experiment 1 they often managed to hold these moments for longer. Since stillness in the breathing is hard to create, the movement of the body also has to be slow and calm which means whenever these points of stillness were created, dynamically the dancers were also moving their bodies with similar energy.

These were the most relevant observations recorded by the researcher. Further results from the interviews are continued below.

5.4 Interviews

The four interviews that taken, one per participant, ranged from 20 - 40 minutes each. This time difference was based on how much the participant felt like providing however enough data was got from all the interviews to be able to do this analysis. The results presented here will be divided by broad themes that were touched upon during the interviews and will explain the opinions or thoughts that the participants had. Through the reflective thematic analysis 9 main themes were identified which were - initiations pattern, judgement and form, consciousness and intuitiveness, presence, connection, comparison with standard improvisation settings, internal focus, lack of visuals, and limitations. These themes were reached after first transcribing the interviews, then coding them in a way that allowed for the aforementioned themes to be developed. The coding overall had a semantic and also inductive approach that allowed for what the interviewees said to be analysed in a way that allowed the research space to be continuously refined. The coding was done iteratively which allowed for the final broad themes to be created and presented.

5.4.1 Initiation Pattern -

A theme that was mentioned as the core of the experience by all participants was the change in the general patterns of initiation. As dancers, generally the value of being able to control your breathing is to have greater stamina for performance. To allow for this, dancers let the type and number of movements they do inform how they choose to breathe to be able to successfully do

all the intended movements. So one change in initiation is the breathing initiating movement as opposed to the movement initiating or affecting breathing. One participant specifically said "Normally breathing can be a tool to find that release in the body or to help pace yourself but this definitely was an emphasis. In this situation bringing the awareness that breathing can drive a movement and not just assist it is the big difference.".

Another change is with respect to the music. Often dancers look to the music for inspiration and cues that they can use to make decisions about movement. Instead in this case, though they still can do this, the participants spoke about the awareness they had that their breathing is controlling the music so in many ways the movement and the body itself is dictating and initiating the music.

One participant also talked about how often while improvising you look to your environment for inspiration to initiate movement. However in this case the external environment was not easy to engage with since the usual method of engagement is sight. This allowed for a different approach to creation as the motivation was to create sound that was initiated by breathing that then initiated movement. Here the external environment being used to initiate movement is also fundamentally a representation of the internal environment of the body, plus the addition of another person's body. The additional person adds another layer of complexity that we will discuss further in the presence and connection sections.

Participants said that this switch in initiation patterns created a lot of room for experimentation, exploration, and an ability to create in a new way where the focus was less on the type of movement and physical form and more on their internal experience and breathing.

5.4.2 Judgement and Form -

The setting of the experiment, especially the removal of the visual using darkness had a significant impact on the experience of the dancers. All four participants discussed this impact and more specifically how removing judgement of the physical form changed their focus and the way they moved during the experiment. Form here refers to the shape of the body and the quality of the technique. Form and technique are a very high priority for trained dancers, especially professional ones so removing the focus from this allows for many different and new experiences and possibilities. Moving this emphasis to breathing and one's own body allowed for a reflective and freeing experience. The system and the setting meant that the dancers did not have to be concerned about how they looked to other people. Additionally, it made sure they also could not see their form themselves. This meant that they had to engage with movements and their body, entirely based on how they felt which is not something they often get to do. In the words of one participant, "I felt free, without the visual. Usually, there's a lot of judgement on the form and the form that you think you're making and usually, I'm trying to move away from that, to remove that judgement and I think that this exercise really helped with that.". A different participant also mentioned how important it is for dancers to find their own way of moving and that this system

creates space for that. Finding this can help with overall dancing and confidence, especially for dancers that are newer to a form.

As mentioned in the previous section, dancers while performing see creation mostly as the shape of the body and here due to the ability to create in a new way, they found new types of movements that felt more natural for them to do. These movements in other situations may seem too messy or not interesting enough, but here there was no pressure to align with any expectations. One participant discussed the fact that when removing the visual they found themselves repeating movements multiple times. This was a new experience that seemed possible to do due to the lack of judgement. Otherwise, repetition is often seen as boring and not creative. Here repetition allowed for them to gain familiarity with sensations in the body and explore them at their own pace. Another participant talked about how generally there is so much focus on opening up your body physically and extending your limbs whereas here it was more about opening yourself up. The breathing made the body feel more full while the mind also felt open to more options and possibilities.

The overall consensus across all four participants was that this removal of judgement and reduced focus on the form had a very positive impact on them and allowed them to look inward and move in a way that almost felt more natural.

5.4.3 Consciousness and Intuitiveness -

Consciousness and thinking, and intuitiveness seem like two sides of the same coin; however, in this experiment, the participants had multiple discussions about how the system called for additional thinking and consciousness while also being very natural and intuitive to use.
In terms of consciousness, much more presence of mind and thought was required than in a normal improvisation situation but being forced to think and be present was not a negative. Instead, it sheds light on things that otherwise there is no awareness of. One participant specifically mentioned that when performing they are conscious and thinking about their body but also many other factors. In this situation, the consciousness was heightened but this was because it was directed only towards the body and breathing as opposed to being distributed. The thinking that was required here was mostly to get used to this new type of creation and stimulation. Though overwhelming, it was not an uncomfortable or unpleasant form of thinking or awareness that put any pressure on the participants. It was still possible to fall into a flow, just a hyper-aware flow where you are very cognizant of your own self and rhythms. As one participant described it “It felt very natural to use, I didn’t have to force anything or feel uncomfortable. The warming up stage was just general [...] but in the last one I was completely in the flow and my brain was stimulated so there was no moment of rest in my head. I was just going and I was really forgetting about the body and just exploring.”.

Based on this it would be expected that it is not as natural or intuitive to abandon yourself to the music as in other improvisation situations. However, all the participants talked about how the system was very natural and intuitive to use. Two even mentioned that it was possible at

points to surrender completely and feel your body while trusting it also to create and follow the music it is creating. The complete brain stimulation allowed for a different level of engagement and flow than the participants were otherwise used to. This idea of natural also in some ways came about due to the partial control that participants felt they had. They were aware and trying with the intention to create however they also felt less pressure as they knew there was someone else also playing a role. In this way they did not feel as though they had to create something perfect, instead, they were just trying to feel themselves and the other person - this often led to a natural intuitive flow as well.

The option of stillness and creating while not moving was an aspect that was brought up as it felt right when the body and system were listened to however in other situations it would not actively be considered an option. Two participants said that the conscious decision to create stillness made the experience feel natural. In the words of one of them “It was nice to know that I could even stand still and have fun, I didn't have to be always moving to know I could make things interesting.”.

An additional reason that was given for the feeling of natural movement was the non-intrusiveness of the technology. The participants mentioned that not having their limbs or body restricted allowed it to feel organic even while being technology-based. The chosen sounds also had an organic feel that was reminiscent of nature. One participant specifically mentioned that they felt like the two sounds sometimes felt to them like birds chirping to each other.

5.4.4 Presence -

Presence was an interesting theme as there was a split between the dancers while discussing if they felt a presence, what presence they felt most strongly. All four participants had different entities in mind. One participant said that the only presence that was felt was the other person in the room. The strength of this and this connection was so strong that even the researcher was forgotten about. It felt very much like it was just the two of them alone in the space. Another participant on the other hand said that aside from the other person the main presence and connection felt was to the system itself. Since the system responds to or is triggered by breathing, the interaction with the system also felt like an engagement or a conversation.

A third participant was focused predominantly on their own breath as the main presence that was felt. To them, the breath felt like its own entity, that they suddenly were very aware of and could interact with. The final participant did feel the presence of their partner quite strongly, even though there was distance between them in the space. This was, however, not the primary and close presence that was felt. Instead, the presence most felt was of themself as an entity, close by, through the breathing and other sounds was what most stood out to them when discussing the idea of a presence.

5.4.5 Connection -

With presence, the conversation was more to do with the awareness of a presence or the feeling of a presence in the space around you. With connection, however, it is one level deeper. The participants had a lot to say about how connected they were and the kind of connection they felt to their partners, the music, and even just to themselves. All of these connections are very relevant for this exploration.

When talking of the connection to themselves and connection to their partners one uniform idea that came up was the fact that there was a very clear connection to the other person however there was no pressure to always be concentrating on it. Participants could keep shifting their awareness and energy from the other person's sounds to theirs and their own body and breathing and back again. This allowed for a new type of connection that did not need to be constantly tended to. One participant talked in detail about sensitivity for another person. They said "...because I was trying to get a visual to dance together. Sometimes, when you can see each other it's inherent, this feeling that you're moving together in the space. And this [sensitivity without the visual] is another element that perhaps we can train better. And it was interesting for me to become aware of that using the technology.". When the visual is there the connection is inherent. It is assumed to be, as you can see each other. However, you aren't really as aware or sensitive to the other person's energy. As mentioned, this is a valuable skill to develop and can help with partnering otherwise in standard dance situations as well.

In the observation section of the results, the moments of stillness were brought up. All four participants talked about how they felt the connection the strongest in those moments of silence. They implied that finding this meant that the other person was also aware of you and you were fully aware of their breathing. Three of the participants also mentioned that these moments of connection were incredibly rewarding, even if they were very short because there was no way to plan them. One who spoke most about this idea said "I think you truly connect with your breath, and the sounds and the other dancer. You start to understand the patterns in their breath and I was feeling amazed that I'd stop and the sounds would all stop and it was silent and no one planned it and that was amazing. These are things you always try to develop with people, to listen and to develop this sixth sense...". When each dancer slowed down and almost held their breath to see if it would happen, they had no way to communicate this to the other or know for sure that they would do it as well. So when this was right, as they said, it felt like you were developing a sixth sense of feeling the energy of the other person. There was no need for a constant feeling of complete connectedness since having these moments provided the feeling of not being alone and also allowed time then to focus inward.

Following this, the two dancers in experiment 2 also talked about how though they didn't know what the other person was doing, they could guess the dynamic of it. When moving faster the music was more constant and without a break while when moving slower there was space. This is also what helped them find moments of silence. They could guess that after a moment of speed that there would probably be a pause coming up. This allowed them to follow a similar flow of movement, even if their bodies looked very different. The ability to create while holding still was something that shifted the perspective of the participants and was something they very

much appreciated and mentioned. Within connection, a few other common themes seemed to keep coming up.

Intimate while Distant -- The physical distance between the participants meant that the initial response to this connection to each other was that it was a distant connection. As professional dancers who often practice building connections with partners, the closeness of a body is a big part of creating intimacy, as one would imagine. On the other hand, hearing and following someone's breathing is incredibly intimate as usually, to be able to do that, you do have to be physically close. Moving this away and making it tangible from a distance is what seemed to prompt the participants to feel this connection very closely while also feeling like they are far away in their own space. In addition to this it was mentioned that though the partner couldn't be seen, their energy somehow could still be felt across the distance, which also increased the feeling of intimacy.

Communication vs Collaboration -- When asked to describe or classify the connection they felt to their partner, three of the participants said it felt like a dialogue, or like they were communicating. They implied that as opposed to feeling like co-creators of a piece of music they felt like two entities trying to make sense of a space together. It was also mentioned that the feeling of communication for one of the participants was not just to their partner, but also to themselves and to the system as well. The fourth participant had a slightly different approach and said that for them it felt more like a collaboration. They said they imagined what they thought the other person was doing, based on their breathing, and tried to engage with that. This made it feel like there was more of an effort to work, create, and collaborate together and not just communicate. They did however say that to them the moments of silence still did feel like communication, though collaboration was the overarching feeling of the connection.

5.4.6 Comparison with Standard Improvisation Experiences -

The environment created by the setting and system, as mentioned before, provides a very different experience as compared to more standard improvisation settings.

Two participants discussed how even though improvising or moving in lower light settings is not completely foreign to them, this experiment still made them more aware and reactive to the audio. It seemed very much to increase their sensitivity to the music.

In a more standard improvisation space with two dancers, various channels are used to create connections. An important one is eye contact. Additional ones are the energy, aura, and emotion of the person and of course the shape and forms they make with their body. As already mentioned in the results of the formative testing, this kind of setting often calls for mimicry as a form of communication and connection, which still holds true even in a professional dance setting and was brought up with the participants of the final experiments as well. The removal of these options, apart from perhaps energy and aura, allows for new possibilities in the realm of connection channels. Two of the participants mentioned that it was natural for them to try and imagine what the other person might be doing by creating a version of them in their head. This

version was based on their breathing. This allows for a more open collaboration that isn't as literal. Another participant said "Improvisation is always tricky because it can really depend, and you can be very conscious or try to isolate yourself. This experiment somehow allowed for both - removed judgement and allowed isolation, but also provided a non-visual connection.".
All the participants talked specifically about how during the experiment they suddenly felt open to so many more ideas and possibilities and felt encouraged to explore and try new things. They especially felt intrigued to try movements or even to allow for movements that they otherwise would not. Some of these, like the allowing for stillness and repetition, have already been mentioned in the previous sections. As an added layer, the control and connection to breath that the system encourages and provides allows for added experimentation with the body in terms of movement and breathing. One participant described how they liked how this allowed them to experiment and see how different kinds of breathing affected their movements and even vice versa. External experimentation is something that these dancers felt more acquainted with as compared to the very internal experimentation that they did while using the system.

5.4.7 Internal Focus -

One of the primary reasons for building this system was to explore what impact bringing the focus from external to the internal would have on a dancer's experience. Based on the responses recorded in the interviews, this impact seems to be quite significant. All four participants discussed at length the different sensations that moving the focus inward created. They also related the experience to other meditative and mindful experiences that they had otherwise had. This ability to shut everything else off and be prompted to pay attention to your own body and its movements - internal and external, was extremely valuable. Removing distractions and allowing the internal rhythm to be tangible made it easier for the participants to be able to direct even more of themselves, towards themselves. Without this, it is much harder for an individual to simply listen and pay attention to their own bodies.

One participant brought up the fact that through their dance career they had been told that breathing is something they needed to work on. For this person especially, this was the first time they had been in a space where they really could focus and work on their breathing and connection to it without any pressure and without any other priorities. This helps make breathing something less intimidating to work and engage with which can help improve overall dance performance.

In a classical improvisation setting control or connection with the body is interpreted as the control that can be seen in the muscles or form of the body. This implies that if any part of the body looks like it isn't engaged it seems like the connection is lacking. By removing the visual, like was done in this experiment, and moving the emphasis internally, the whole body can feel engaged and connected to, even if it doesn't necessarily seem so. One participant brought this up and then followed by saying that breathing isn't restricted solely to a part of the body. Breaths can be deeper and reach further. While using this system especially they felt their

breathing in their belly as well which really made them feel like their whole body was engaged, regardless of how it looked.

Overall all four participants felt an increased connection to their breathing as compared to when they usually dance and a different and sometimes increased but sometimes comparable connection to their bodies.

5.4.8 Lack of Visual -

The atmosphere of the experience was very much set by the lighting and audio in the space. All four participants talked about how the ambience created by the dim lighting helped them really get involved with the system and their bodies. One participant said, “ the lights helped a lot, to be in darkness. It felt like being in a bubble and I could focus just on breathing and movement.”. This was an element that was missing in the formative tests and was something that was seen as extremely important for the final evaluation, based on that. Clearly, the impact was strongly seen and it was agreed that it was an element that really affected how the participants experienced every other element of the system.

5.4.9 Limitations -

Overall there were not many comments on the limitations of the system itself since a majority of the participants were quite happy and overwhelmed with the current form of the system as a first introduction into this space. One participant however did mention that they would’ve liked it and also felt more in control if the system reflected more of the dynamics in their breathing. They talked about how once they felt comfortable with the system they tried to breathe in different ways however the system response was still similar. Though on one hand, this created some level of frustration, it also resulted in the participant paying even more attention to their breathing as they said that sometimes it felt different but they weren’t sure if their breathing itself was actually different.

6. Discussion

The results of the interviews, observations, and analysis presented in section 5 bring up some interesting questions and points of discussion that could be further elaborated on. These are described and detailed in this chapter.

6.1 Introduction

Throughout this paper, we have been exploring what impact removing the visual and moving the focus to breathing via audio has on the experience of dancers. The formative and final tests provided some interesting results that, to start with, show that there definitely is an impact and a change in experience. We see this through the interviews and the fact that all the respondents did say that this was a new and interesting experience for them that they can take something away from. Since our initial question or experiment is a detailed question with many parts - removing the visual, bringing the focus to breathing, making breathing tangible using music- it's positive to see that all of these elements played a role in the experience of the participants. This is important as since we were removing the visual in itself, it was always possible that that would create the main experience change and the system itself would not add much.

However in the formative testing, we couldn't fully remove the visual or create darkness but participants still had new experiences that engaged with breathing and encouraged an inward focus, albeit with a potentially weaker connection to the self. This weaker connection could also be due to the fact that the participants in formative testing are not professional dancers and so at a base level are already not as used to experimental improvisation and breath control. On the other hand, we also did see the impact that removing the visual entirely created as was mentioned by all the final participants. The darkness and lack of visual allowed for fluidity and a removal of judgement that in turn allowed for new forms of movement. Dancing in lowlight or darkness though is not a completely foreign experience for professional dancers. It is not necessarily an exercise that is held often but it is one that all of the participants had engaged with at some point or another. This implies that the shifting focus to breathing through music also had to have a significant effect for these dancers to have the impactful new experiences that they described in their interviews. It was also specifically mentioned that the system allows for a new form of listening and engaging with oneself, breathing, and the body, that otherwise could not even be imagined. This adds the last element and shows that the music being created based on the breathing also greatly impacted the experience.

6.2 Has the Initiation Pattern been Reversed or Extended?

As discussed earlier, multiple participants talked about how it felt like the initiation pattern had been reversed. Usually, the body follows the music and now here, the music follows the body. However, on the other hand, we can say that as opposed to reversing the initiation pattern the system perhaps just adds another step into it. Now instead of the body following the external music, the breathing and body inform the music that in turn influences the movement, like in a regular dance situation. Or at least, that was the logic with which the system was designed. The music being a reflection of the body was meant to help participants listen to their bodies by instead listening to the music. In the use case, however, participants were less concerned with just allowing their body to be and focusing on the music as a way to make movement decisions. Instead, they focused on the added control they have in this additional pre-stage. Here the music was listened to as a result or feedback as opposed to the prompting for movement. This shows that perhaps it is easier and more interesting to listen to your body when in a space that reflects the energy level of your body and movement. The music allows for the whole experience to be heightened and also provides an escape for participants to sometimes focus on to help make the overall experience feel more natural and intuitive. Listening to the music as feedback and a space where you could be creative ended up making it a very ‘playful’ space and as mentioned by the participants, allowing for a new form of creation. This situation of the system being seen as more play was also much more significant when talking of the final evaluation results with the professional dancers. Since these dancers are all extremely creative, experiment with their bodies often, and have some context for breath control, they are at a place where they can immediately feel ready to experiment with the system. With the more intermediate, amateur dancers from the formative testing, more of them just threw themselves into the movement and focused less on what possibilities really existed outside of that. The possibility for different people to engage with the system in different ways and to focus on the music created either as a result or inspiration is a positive! It implies that a wider range of participants can use the system and potentially have the same core takeaway, even if their method of use is not exactly the same. So, regardless of the initiation pattern and whether it felt more reversed or extended to participants, the system still helped them to focus on their own bodies and rhythms, which was what was desired.

6.3 Playfulness, Mindfulness or both?

The system seemed to call for experimentation, especially in the final case with the professional dancers. There was a lot of playful energy and aside from getting lost in the experience and their body, a lot of the dancers used it also as a playground of possibility. Experimentation was something that was expected with the system however the level of playfulness that the participants commented on was an interesting surprise. In many ways, it also reinforced the idea that there was less fear of judgement in this space since participants were so ready to be playful. In professional settings especially when dance becomes a thing that is done for work, it can be higher pressure. Bringing back playful energy into movement and the body could help with

individual body perception and just mindful engagement. Speaking of which, along with describing the system as a playground that was very stimulating and with many possibilities, participants said that their experience itself was incredibly mindful and inwards focused. This is interesting as playful can often mean not very focused or deep, and usually involves less concentration. This combination allows for lightness to be brought to an otherwise potentially overwhelming experience that is also immersive. The experience was also described as calm, meditative, and natural which implies that participants didn't feel the need to push themselves and try things that didn't feel natural, in the process of playing with the system. Or that pushing themselves to try new things that they weren't used to did not feel unnatural. In the background, the idea of bringing back the focus to the individual's experience of dancing, albeit in a pair setting, is one of the things that motivated the design of this system. In case the playfulness of the system had taken over and was not balanced by the mindful energy created, this idea of individual focus may not have come across as well to the participants. The decision to remove the separate sounds for inhales and exhales and keep the system to just one sound for the exhales of each person could potentially be the reason for this as providing more options would have provided more diverse feedback and constant sounds which would have shifted the focus more to trying to play around to understand the music as opposed to shifting the focus to the breathing itself. So it seems in this situation, playfulness and mindfulness exist hand in hand and in balance.

6.4 Removing the Option of Mimicry or Mimicry in a New Form?

In both the background, literature, and results of both rounds of testing, we talked about the relevance of mimicry when the visual is available in dance spaces with more than one dancer. Multiple participants talked about how literal mimicry using body shapes is one of the go to ways they engage with other dancers and removing that and moving to breathing based audio removed this option. It also meant that any interaction or engagement would have to be based on what the participants imagined the other participant might be doing, making these responses more interpretation based. However, it is interesting to note that often the engagement created using this system is also fundamentally mimicry. In different sets of participants, we saw that the participants tried to match and feed off of each other's energies and dynamics. We especially saw this with participants speeding up and slowing down together, in breathing and in body movement. There is potentially no real link between the shape and specific emotions of the two participants however their rate of breathing and internal body experience would still be quite similar. A question perhaps is to ask is does this count as mimicry and does this still create a truly different way of interacting? One point which is worth bringing up here is that the visual being engaged seems to put more pressure on the need for constant conscious engagement as opposed to the audio. With this system dancers at least felt comfortable drifting in and out of engaging with the other person's sounds. When the visual is available it is very clear that you are

being perceived and watched by the other person who may have expectations of response. In the audio setting here with the system the difference is that though the participants know they could potentially be perceived constantly again, the setting still allows for a feeling of anonymity, distance and lowered pressure to immediately mimic and engage. In this space, it is somehow easier for people to alternate between both listening to themselves and the other person and they feel less pressure as they can take their time to figure out what they feel like and feel is happening, and how they want to engage, and respond. I would say that this still is in many ways a new form of mimicry but as we saw its form is quite different from mimicry that occurs in a visual setting.

6.5 Are Moments of Silence a Demonstration of Participatory Sensemaking?

In the background and literature, there is discussion about participatory sensemaking.
This system allows us to see participatory sensemaking in action and one thing that seems to be a real confirmation of this is the moments of silence described by the participants. According to this concept, people make sense of the world together through interactions that in many ways have an autonomous form. For two participants to find a satisfying moment of silence, it is quite a different experience from if just one person would use the system and find this. The difference is the partial control that exists in this situation which is the core of participatory sensemaking. In this situation, the partial control is seen more obviously which is what makes it quite an interesting example of participatory sensemaking. Due to this partial control, neither participant is fully controlling what will happen in the system. The interaction they have becomes autonomous as when they do find these moments of silence it is not because either was sure it would happen or actively planned for it. The fact that the other person is required for this non-verbal experience of this space and that the interaction finds its way and creates moments of connection and pause for the participants seems to fully confirm the presence of participatory sensemaking in this system and experiment. This enhances the fact that the dancers are not just feeling an impact when it comes to themselves, but also the impact of the connection to the other person.

6.6 How did Participants Interpret and Feel Presences?

The results that were seen, especially in terms of presence, were quite diverse, which was something worth noting. To start off with, however, all participants did say they felt a presence, or an additional presence. The ones they chose to say were the strongest additional presence differed. This clearly was also related to how people interpreted the system and experience that did have multiple facets and the idea of a presence as well. Two of the participants felt the presence of the other person and the presence of the system. These are mostly due to the

representation of these two in the space around them and the interactions they were having with these external entities. Both the system and the other person even otherwise, do have a presence of some form that can be felt however the experiment creates a heightened experience of that. These were interesting as it was valuable to see that impact could be made and that presence could be felt across distance and without visual cues. The other two participants felt the presence of more internal entities except they seemed to feel them as external. One talked about how their breathing felt like it had a presence of its own and another mentioned that they felt their own presence in the space as an additional. This is possibly due to how the system takes breathing which is quite internal and represents it in an external tangible way. Feeling these as additional presences is a lot easier in such an experiment. The next question that should and could be explored is to what extent is it easier or more difficult to connect or engage with an internal entity when it is represented externally. We can say based on the results of tests that potentially, in a short term space, it seems to be easier to interact with it externally as we are more conditioned to naturally respond to external stimuli. Going back to the idea of the 'age of the world picture' from the introduction, we are used to being overwhelmed by information and content externally. More specifically visual image but everything it comes along with now in the form of television, social media and so on. Internally however it is quite a new sensation for us to engage so much and be internally stimulated. Long term however it might make sense to still slowly switch to engage with internal entities internally and not via external means, to build an even stronger connection. A system like this offers a bridge to make it easier to get there.

When speaking of connection, the same four entities were discussed but participants mentioned that they did feel connected to all. The majority of them said that the connections to the breathing and the other person were the strongest. So it's clear to see that though there was variance in ideas and engagements with the presences felt, the bottom line was the presence of at least a single other presence and the connections felt to them.

6.7 How does One Listen to One's Body?

As we saw, in the discussion on somatics and the discussion above, listening to one's own body can be quite challenging but incredibly rewarding. Something that perhaps needs further discussion is what exactly does listening to your body mean, in a framework like phenomenology. At one level listening to the body seems to imply being a passive listener to a separated entity and responding to its desires and feelings. However often when suddenly focus is put on the body or body rhythms, this awareness leads them to be manipulated. An example is clearly seen in the use of the system. We saw in the Initiation Pattern discussion section that while listening to their bodies the dancers were more trying to see what was possible and all the ways in which they could move, breathe, and listen and engage with their bodies. Does this count then as really listening or is it more active engagement? On the other hand, if we think of ourselves as our body and disregard the idea of a mind-body split then, does trying and experimenting with oneself due to one's desire to do so count as listening to the body? In this

scenario, we can say that the system and experiment greatly help and support dancers and allow them new and novel ways to listen to their bodies or themselves and further engage as well.

In either of the aforementioned scenarios listening to your body, especially in this age, is not easy or intuitive. Even with a system like this that makes it easier, it is not something that can quickly become a reflex. One piece of feedback that varied from formative testing to final testing was the length of the experiment and interviews. In the formative testing, the general consensus was that the 10 + minutes were good enough to see what things were about and if anything perhaps using it more times for similar amounts of time may help get more acquainted with it. The final test participants however all felt that instead of the 15 minutes they used it for, they would've preferred using it for potentially half an hour more. The reason for this is they all felt that if they could use it for longer, they would be able to try new things and also settle into it so as to not feel the need to manipulate their breathing, body or the system. The formative testing interviews also were much shorter than the final testing as the first set didn't have as much detail to provide about their experiences. This perhaps brings us back to the previous point of how potentially for the non-professional dancers, forming a deeper connection and listening and trying new things was not as easy to continuously do as listening to their bodies may not be something they are as conditioned to do. It also happened that them listening to their bodies often resulted in more speed and breathing and fewer moments of slow or silence which perhaps allowed for less interesting dynamic engagement with the system than the professional dancers had.

6.8 Where can this provide value?

At the end of the interview, participants were also asked if they personally felt like the system provided value and where specifically they thought it could be used. This was done to understand the potential of such a system and see where it could potentially have an impact in the field of dance and otherwise. This also provides new spaces in which the system can be researched and tested. The main aspects of the system that were focused on while these answers were given are judgement removal, breathing focus, and the ability to create connection in a non-direct and intimidating space.

For dance specifically, one participant talked about how this could bring value to partners who have to dance and perform together as it would allow them to develop a new sensitivity to their partner so they can feel even closer and more in sync with each other when they do perform and work together otherwise as well. They also mentioned that it would be interesting to see how the interactions would change if the same partners used the system together on multiple occasions. Another option that was brought up was to use it as a way to integrate newer dancers and help them find and understand their own style of movement. In ballet, there is a strong desire for uniformity and not moving in a way that is characteristic of one's individual body. Modern and contemporary dance allow for more freedom but are still rooted in techniques and certain ideas of aesthetic shapes. This can often put a lot of pressure on newer dancers who are still

figuring out how to do these things with their bodies. This kind of space would allow them to try without focusing just on if it looks perfect but also if the movement feels right. It would also allow them to go back to more comfortable spaces of movement that maybe are not the most desirable otherwise in these disciplines. Having this strong connection to oneself and body and movement style can help newer dancers to improve their form and feel more connected to the dance and dance form.

Aside from dance spaces the system also allows connection to be created without dancing, though that wasn't the initial point of it. We breathe even when we are still. Due to the intimate yet distanced nature of the connections that can be created there is potential for this system both in meditative and mindful spaces that are aiming to help people connect to themselves and others and in spaces related to therapy or art therapy. The potential value in the latter comes from the fact that it could be used to ease people who are struggling with connection or opening up to do so without having to look at or touch the other person. The focus on breathing also reduces the pressure even more in these situations as there is also no focus on verbal communication. It would just help create closeness without violating any boundaries.

6. Conclusion

Dance and dancing have been around for many centuries and have existed in various forms all over the world. Fundamentally dance has always been about expression, connection, movement and aesthetics. As described, in this modern age where the value of aesthetics and the image have increased, these other characteristics have also become increasingly centred around visual aesthetics. However, dance is also an experiential art form that has historically been about the experience of both the dancers, and anyone else in the space. The goal of this paper was to describe the design, testing, and evaluation of a system that aimed to bring the focus back to the experience aspect of dance. The system moves the emphasis from the visual aspect of dance to the breathing of a dancer through music. This allowed for the exploration of the impact that this shift has on professional dancers in pair settings. Here, pair setting was chosen to allow for the exploration of connection in a non-visual space since as previously mentioned, dance is often a social activity that involves strong non-verbal connections between people.

The system tackled this by converting each of the participant's breathing into musical notes of differing textures. By making the breathing tangible, the dancers now had a pathway through which they could try and create and connect, even without seeing each other. This experiment with the system in its ideal setting took place in a dark room and involved two participants wearing Bluetooth mics that were held in place using a plastic mask followed by a fabric one. This Bluetooth mic allowed for breathing to be recorded and used to trigger MIDI notes with the help of Ableton LIVE 11 and the Trigg.me plugin. The output sound was played on external speakers in the space.

To test and evaluate this system, first, a set of formative tests were done and then the final system was tested and evaluated with four professional dancers at the dance company Introdans in Arnhem. The tests had a fixed format with three rounds of tests followed by individual interviews. The first two rounds were conducted with no prior briefing and the participants were fully briefed on the system before the third round. Through the analysis of these tests and interviews via thematic analysis, we were able to see the impact that this environment and system had on the experience these dancers had while dancing. Their experience could also be compared to the experience they usually have while improvising alone or with someone else in the room.

It was seen that there was a significant impact. All the participants discussed how this experiment created a different experience since they did not have to focus on their form or think about what movement they had to do next. Instead, this was informed by their breathing and the system which created a freeing environment that allowed for experimentation and openness to new possibilities with their own bodies. In terms of connection, the participants did manage to feel a distant but intimate connection with their partners however it was a connection they could go in and out of which put less pressure on them while still being strong. One criticism that was provided was the lack of options in the system since it only reflected the fact that the person was

exhaling but nothing else about the characteristic of the exhale. The impact created on the whole was positive as all the participants said they believed the system had a large amount of potential when it comes to widening boundaries in the dance world. They also said that it created the possibility of a new dimension in dance that allows for non-visual creation connection.

In conclusion, through the development and testing of this system, it was clear to see that the system was successful in its goals. In addition, it also helped explore the philosophical ideas of whether we are our bodies or whether we simply have bodies. Though this research did not have a large number of participants, based on the sample group it was clear to see that this increased emphasis on the visual aspect of dance in today's world has had an impact on how experiential the form is for a lot of dancers. The ability to create a connection without this visual has reinforced the idea that perhaps the visual does not have to always be as relevant as we make it out to be. It also brings up the idea that dance as form does not have to deal with the creation of an image, the movement of the body can also lead to other forms of novel creation. The value of such explorations was also seen - for research, but also for dancers and the dance community itself.

7. Future Work

The results from this initial research can prompt many directions of further research. From a technological standpoint, the system can be upgraded to allow for more detail. This would allow for more of the characteristic of the breathing to come through in the triggered music and hence allow it to even include things like emotion. This would potentially make the connection between the dancers stronger but may also bring back the pressure to be consistently responding to the other person in the space. This is a space where there are multiple further questions that can be researched based on what additional features the system is given.

If we go back to the spheres of motivation for dance we saw that in this paper we mostly dealt with engaging the personal and the social. However, we did see that in the social sphere connection was possible but also it was not given complete priority. This makes it interesting to think about how this could work if extended further into the performance sphere. This system allows you to control the music with your breathing and breathing is something that we all do even while stationary. In this way, a stationary audience member could also potentially be contributing to the sound, allowing them to be less passive. So here their presence can be felt by the performer, but perhaps they can be hidden and be able to see the performer dimly as well, but not the other way around. It would be interesting to explore the experience of both a dancer and an audience in that space of performance.

One obvious way that this system could be built upon further is finding ways to integrate more participants into the system. The one hurdle here that would have to be dealt with is making the sounds of each performer distinct enough to be recognised but still avoiding jarring noisy sounds when all are triggering the sound together. Here it would be interesting to see if connections are made with specific other dancers or just with the environment and system as a whole. Is it possible to make individual connections in a common space without elements like eye contact being an option?

A last possible research question would be to see how this experience with this system changes over time for a pair of dancers if they use it together regularly over a long period of time. It would also be valuable to see if it has any impact on their relationship or partnership outside of the system when this is a thing that is engaged within a disciplined format. What kind of familiarity can be developed while using this system for longer periods of time? Can connections be strengthened? Does it become easier to predict the rhythm of the other person you work with?

Potentially there are more directions in which this research can be continued but these seem to be the clearest. In addition to these, the system can always be taken and tested in a new domain to see the impact building distant but intimate connections can have on people and their existing or new connections.

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