CBreath: Experience-Oriented Design of Technology for Creating Connectedness

Whether speculative co-design can be incorporated into the experience-oriented design of technology for creating connectedness

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Final Project Title: CBreath
Unit Title: Final Major Project + Portfolio of Writing
Blogs: https://uxdinesyin.wordpress.com/category/fmp/
Course and Year: MA User Experience Design, 2020-2021
Due Date: 25 November 2021
Abstract

The need of connecting the performers in a jam session and the potential of applying collaborative breathing in creating connectedness (i.e. the feeling of being connected with others) in technology led to the design idea of devising a collaborative breathing experience that applies internal, physiological synchronization aided by technology to create connectedness among participants in jam sessions. CBreath presents a new way of using collaborative breathing to create connectedness between the jam session participants, externalizing their synchronized breathing by multi-sensory experiences via light and wind and making such experiences part of the jam session. In this research-led design project, I have demonstrated the feasibility of incorporating speculative co-design approaches into experience-oriented design of technology to generate an technological artifact that prioritized people’s feelings and expected experiences of creating interpersonal connectedness so that people would accept and be willing to interact with it. Further research will be needed to identify more and better ways of applying speculative design and co-design approaches into experience-oriented design of technology so as to generate technological artifacts that can meet the expected experiences that people want.

Keywords: Collaborative breathing, connectedness, multi-sensory experiences, speculative co-design, experience-oriented design of technology
1. Introduction

Breathing is a way of releasing stress of the musicians before and during performance (Amélie et al., 2020; Pasha, 2018; Su et al., 2010). However, breathing is particularly important for the jam session musicians. A jam session is a kind of music performance where the roles of performances and audiences can always be switching depending on whether or when participants decide to go onto the stage to improvise on music by playing instruments or singing (Brinck, 2017; Katz and Longden, 1983). It is a common situation that people who are participating in a jam session have never collaborated before. Since jam session is a spontaneous and unpredictable group process, musicians who participate in will feel anxious and have to rely highly on nonverbal communication methods like mutual gaze to aid their collaboration (Doffman, 2011; Hart and Di Blasi, 2015; Kawase, 2014).

Sharing and revealing physiological information, like breathing rate, can make people feel the connections with others (Feijt et al., 2021; Min and Nam, 2014; Stepanova et al., 2020). Collaborative breathing has been applied for mediating the connectedness, i.e. feeling being connected to others (Choi, et al., 2019, p.450), because people’s affective states are similar when they synchronize physiologically (Heitzer, 2021, p. 8.; Siegel, 2016). There is a potential to develop the connectedness and empathy between jam session participants through collaborative breathing to help with the better improvisation.

Besides, breathing rate as one of the physiological information has been researched to design technologies for create connectedness. Also, because of the potential of collaborative breathing to aid the psycho-physiological synchronization and since joint action is an important strategy for mediating connectedness via technology (Hassenzahl et al., 2012, p. 10), collaborative breathing has been applied in the design of technological artifacts for supporting connectedness.

However, although these technological artifacts designed to communicate breathing signals seem to have taken into account the feelings and experiences to provide (i.e. to feel the connections), few design projects include the research and analysis of people’s actual needs and expectations of how they want to feel the connections with others in the research and generative phases of design (Hassenzahl et al., 2012, pp.12-13). The experience-oriented design of technology, which is the technological artifact development oriented by the consideration of people’s experiences and feelings, for creating or mediating connectedness would require sharing physiological information (Hassenzahl et al., 2012; McCarthy and Wright, 2004a; 2004b). It needs more insights into and thorough understanding of the expectation, acceptance, and willingness of people (Feijt et al., 2021, pp.23-24; Hassenzahl et al., 2012, p.15).
These contexts lead to the design idea of devising a collaborative breathing experience aided by technology that applies internal, physiological synchronization to create the feeling of connectedness among participants in jam sessions. This research-led design project is a collaboration between me and my project partner, Vanessa Van. My specific focus of this project lies in investigating the experience-oriented design of technology, with which I explored the potential of developing technological artifacts that incorporates collaborative breathing for mediating connectedness based on people’s expected experiences. With this research focus, I have looked into whether and how speculative co-design approaches can help with the experience-oriented technology development.

This paper reviews the literature on experience-oriented design of technology, technologies using breathing for supporting connections, and co-design and speculative design. The paper then outlines the key methods and the related key findings following the literature and practice review. The final design and feedback are then set out, concluding in an evaluation of the whole project.
2. Literature Review

2.1 Experience-oriented Design of Technology

Much technology design has traditionally been function-oriented, that is, putting functionality at the core when designing technological artifacts (Hassenzahl et al., 2012, p.2; Stander and Stappers, 2008; 2014a). Experience-oriented design of technology is a way of devising new technology that put the feelings and experiences of people, not just the feasibility of technology, in first place, which means it uses expected experiences to guide the technology innovation (Hassenzahl et al., 2012, pp.2-3).

The idea of experience-oriented design of technology follows the suggestion of McCarthy and Wright (2004a, pp.183-184) to “turn consideration of technology towards experience”. They encourage people to “see technology as experience with technological artifacts” (McCarthy and Wright, 2004b, p.42). McCarthy and Wright (2004b) also suggest designing for affective aspects of experience, such as feeling, cultures, and values (O’Kane, 2011, p.925). However, McCarthy and Wright (2004a, 2004b) and Hassenzahl et al. (2012) focus more on the theoretical aspects without providing practical methods for conducting experience-oriented design of technology.

Dalsgård and Halskov (2006), followed the concept of experience-oriented design of technology, created an interactive installation through participatory design. They engaged “stakeholders” who will eventually engage in the interaction with the installation in their inspiration card workshops for developing design concepts before ideation and in the discussion of the possible design ideas before prototype making (Dalsgård and Halskov 2006, p.333). O’Kane (2011, pp.925-926), in the experience-oriented design for the evaluation of trust towards a museum companion device, applied observation and semi-structured interview for getting insights about visitors’ opinions of the resulting experiences and their use of the technological artifacts.

Nonetheless, these projects are still missing some empirical explorations that engage the potential participants throughout the whole process of the design, which is in line with the findings of Hassenzahl et al. (2012) indicating that most of the current experience-oriented design of technology only incorporate preliminary empirical explorations of resulting experiences. Although the design by Dalsgård and Halskov (2006) have people participated in the early stage of the experience, they still applied the “design for” mindset to create the technological artifacts that “they think” people want without more user testing and evaluation in generative stages (Stander and Stappers, 2008, 2014a).
2.2 Technologies for Creating or Mediating Connectedness

In experience-oriented design of technology, some designers, caring about people’s need and feelings of connecting with others, have been exploring and generating technologies artifacts to create or mediate connectedness (Hassenzahl et al., 2012). In many of these designs, the technological artifacts incorporate the explicit externalization of physiological information to help people create connectedness with each other (Feijt et al., 2021).

Connectedness, according to Choi et al. (2019, p.450) and Hassenzahl et al. (2012, p.3), is the feeling of being connected or related to each other. Sharing and revealing physiological information, or “biosignals”, like breathing rate, heartbeat, and electroencephalography (EEG), can help people to establish internal psychological synchronization and thus the connectedness with each other (Feijt et al., 2021; Min and Nam, 2014; Stepanova et al., 2020). Also, the phenomenon of psychophysiological synchronization implies that when people’s physiological signals synchronize, their affective states will also be similar (Heitzer, 2021). Therefore, the feeling of connectedness can be reinforced if designed technological artifacts can afford real-time physiological communication (Feijt et al., 2021, p.22).

Breathing rate, or “respiratory rate”, as one of the physiological signals, has been explored for a long time as an important mediator in the design of technological artifacts to make people feel connected to each other, whatever their geographical proximity (Choi et al., 2019; Kim et al., 2015; Stepanova et al., 2020).

Exhale (Schiphorst, 2006) is a wearable costume design that visualizes and sonifies one person’s breathing to the clothes of the other person, which speculates the new possibility of interfaces in embodied interpersonal interactions. Since Exhale requires cables and wires to connect all the components, the experience happens in co-location (ibid.). The interactive installations Coligopulmogram (Martin et al., 2017), reSpire (Choi et al., 2019) and JeL (Stepanova et al., 2020) are also designed for co-location experiences. But differently, Coligopulmogram (Martin et al., 2017) visualize the collaborative breathing patterns on paper through a low-tech wireless breathing cyborg that connects four participants to a drawing machine; reSpire (Choi et al., 2019) externalize the breathing by using a movable wind machine to inflate and shape the fabric along with projected images and sound, which provides people with multi-sensory experiences to perceive the resonance of two people’s breathing; while JeL (Stepanova et al., 2020) made use of VR technology to foster the feeling of intercorporeal connections with other humans and the nature by allowing two participants to synchronize their breathing to light up the virtual “corals”. WearBREATH (Min and Nam, 2014) and BreathingFrame (Kim et al., 2015), instead, are technological devices designed to afford the remote affective connections. WearBREATH transforms the breathing of the other party to vibrations using
a set of wearable artifacts (Min and Nam, 2014), while *BreathingFrame* (Kim et al., 2015) makes use of visual and haptic senses of people and creates an inflating frame that mimics the belly movements triggered by the other party’s breathing.

These designs have presented different sensory experiences of revealing or exchanging breathing signals in technological artifacts to mediate connectedness between people. Meanwhile, *Coligopulmogram* (Martin et al., 2017) and *JeL* (Stepanova et al., 2020) also showed the feasibility of applying collaborative breathing and breathing synchronization to make people feel the connections with others, which is also consistent with the finding of Hassenzahl et al. (2012) showing that joint action is one of the important strategies of creating and mediating connectedness in technology.

However, these design projects rely highly on secondary research as theoretical support for motivating their design of technological artifacts. Even though they might still be categorized as the experience-oriented design of technology as they seem to have considered the feelings and experiences to provide, the evaluation of people’s willingness and acceptance of participating in the experiences or using the devices is lacking throughout the whole design process (Feijt et al., 2021, pp.23-24; Hassenzahl et al., 2012, p.15).

2.3 Co-design and Speculating Possible Experiences

The close relationship between technology innovation and people’s expected experiences as well as the higher priority of people’s experiences in technology design lead to the need for new design methods (Forlano, 2017; Sanders and Stappers, 2008, p.10). Dunny and Raby (2013) argue that we could design to inquire into how things could be in the future. Such a speculative approach would lead us to current design decisions that make the “imaginative world tangible” (ibid., p.164). Co-design is an actual, hands-on design approach for people to speculate the future experiences and construct artifacts that illustrate the possible experiences they want, which emphasizes collaborative making (Sanders and Stappers, 2014b, p.5-6).

In co-design, designers no longer “design for” but “design with” the “end-users”, i.e. the people who will finally participate in the experience or be served (Sanders and Stappers, 2008). And so, people who are not the designers of the design project will have an active role participating in the design process providing knowledge, generating ideas, and most importantly, developing artifacts (Sanders and Stappers, 2008, pp.11-12). The made artifacts by people are not the future product but mediators for explaining the expected experiences and inspiring the further design of experiences and artifacts (Sanders and Stappers, 2014b, p.6). This is consistent with the idea of “counterfactual artifacts” in material speculation, which is the not yet existing technological artifacts that blur the boundaries of the actual and possible world for speculating and critiquing the possible future (Light, 2021; Wakkary et al., 2015, p.97). Although Standers
and Stappers suggest the use of toolkits, i.e. the physical artifacts made up of 2D or 3D components (2014b, p.9), for people to make artifacts about or for future, there are still various materials that can be used in the co-design process. Biskjaer et al. (2017, p.842) note that plain materials like cardboard, paper or constructed materials like toolkits, prototypes can all be applied in creativity. Therefore, co-design could be considered as a collaborative, speculative process with various materials.

Besides, co-design incorporates the concept of research through making or research through design, and the roles of designer and researcher get mixed in co-design. (Sanders and Stappers, 2008; 2014a; 2014b). The artifacts designed by participants can be used as sources for designers to conduct design synthesis, figure out people’s needs, and frame the design problem, which can further inspire designers’ ideation and prototype making (Sanders and Stappers, 2014b, p.9). Then, prototypes made by the designers can be in turn used for testing and evaluation, through which people can participate in the experience, interact with the prototypes of technological artifacts, and provide feedback for evaluating the design for subsequent design optimization (ibid.). Such a process is always iterative in different phases of design until there is a relatively satisfactory outcome (Sanders and Stappers, 2014b, p.6). And thus, besides following ethical guidelines to inform people about the potential risks in an experience (Benford et al., 2012), co-design can also be an effective, ethical method to avoid the unacceptable uncomfortable experiences that may harm people either mentally or physically.

My research, therefore, looks at the potential inherent in incorporating speculative co-design into the experience-oriented design of technology. The project focuses on creating and mediating connectedness by collaborative breathing through technological artifacts.
3. Methodology

The purpose of this project was to evaluate the potential of incorporating speculative co-design in the experience-oriented design of technology to identify appropriate ways to apply collaborative breathing to establish connectedness. Therefore, the concept of co-design has been applied throughout the whole design process. Speculative co-design workshops, prototyping, and testing with participants were the three main methods we used in different stages referring to the concept of co-design (Sanders and Stappers, 2014b).

With regard to ethical issues, consent forms and information sheets were given out to all participants for each participatory activity. It informed the possible uncomfortable experiences in accordance with the ethical guideline provided by Benford et al. (2012). Also, permission was asked from the participants to make documentation for each activity in the form of moving and still images for further analysis.

In each speculative co-design workshop, instead of providing constructed materials like cards or toolkits (Dalsgård and Halskov 2006; Sanders and Stappers, 2014b), plain materials like bottles, cotton, balloons, and wires were prepared to assist the participants in making artefacts, as inspired by Biskjaer et al. (2017, p.842). The artifacts made by people in this workshop were kept or documented as inspirations for our later experience design and prototyping, while the prototypes have been tested with people for getting feedback for improvement in an iterative design process (Sanders and Stappers, 2014b).

In Figure 1, the triangle shows how the speculative co-design workshops and the prototyping and testing led to the final design in this project, while the circle illustrates how the two rounds of ideation, generation, evaluation, and optimization iterate with these methods.
3.1 First Round: Identifying design context and testing different possibilities

3.1.1 Speculative Co-design Workshop

The first speculative co-design workshop was conducted after initial primary and secondary research on breathing and technologies for connectedness. This workshop aimed to figure out the missing experiences in people’s use of current technologies for supporting connectedness and to encourage people to speculate on the experiences related to breathing that they would want for connecting with others. There were eight participants from different backgrounds in the workshop, such as computer science, neuroscience and design. The workshop’s framework is shown in Figure 2, while the synthesis of the notes and designed artifacts produced from the workshop is shown in Figure 3.

**Key Findings**

Through the speculation and designs of the participants in the workshop, we found a gap in the current designs in the context of jam sessions from a participant who wants to improvise on music online with different people but often feels lacking the connections with others, which influences the smoothness of performance. This is in line with the study of Hart and Di Blasi (2015) indicating the unpredictability in improvisation and the need of connections between performers. Also, it was revealed that people wanted to experience the physical proximity and have mutual awareness with others through multiple senses, not just visual and auditory experiences, and preferred joint activities with others for feeling connections, which was consistent with the finding of Hassenzahl et al. (2012). These findings were helpful for our later ideation and prototype making.

Viewing the results of the artefact making in this workshop, although all the participants designed sensory experiences related to establishing connections, most of them ignored the theme of “breathing”. This reflected the need to improve the workshop design.
3.1.2 Prototyping and Testing

Based on the findings in the speculative co-design workshop and referred back to *Coligopulmogram* (Martin et al., 2017) and *JeL* (Stepanova et al., 2020) that apply collaborative breathing and breathing synchronization to create and mediate connectedness and *WearBREATH* (Min and Nam, 2014) and *BreathingFrame* (Kim et al., 2015) that support remote connections, we had the initial idea of designing an online collaborative breathing experience for connecting the jam session participants. To consider about the possible technological artifacts to detect and transform people’s breathing signals remotely, we brainstormed some metaphors related to breathing and generated a sketch accordingly (see Figure 4).

Three sets of prototypes were designed accordingly for experiencing collaborative breathing and perceiving the synchronized breathing signals remotely to create connectedness with other jam session participants (see Figure 5). The first prototype uses a sound sensor in the form of the instrument for inputting breathing signals while outputting synchronized signal with a light, while the second prototype also uses the sound sensor but in the form of the mask connecting to a fan to inform the synchronized breathing. The third prototype makes use of the electromyography muscle sensor to detect the breathing movements while still outputting the synchronization of breathing using a fan. Two musicians, a pianist and a saxophonist, were invited to test our prototypes and answer some of our follow-up questions as a way of providing feedback (see Appendix A).

![Figure 4 Metaphors related to breathing and sketch about sensory experience design. Credit: Ines Ziyou Yin (2021).](image)
**Key Findings**

According to the two musicians' feedback, an experience in the same location may be better than an online one since most performers “prefer participating jam session on-site” as the saxophonist said. There is an existing need to establish connectedness among jam performers in person since mutual gaze may sometimes be blocked by obstacles. Besides, using wireless devices in collaborative breathing to support connectedness with other performers sounded appealing to them, since they agreed that a collective feedback of the synchronized breathing will be better than exchanging breathing signals. Also, they thought sound sensor would be better as the input device for detecting the breathing and wanted to know whether it is possible to design for connecting all participants throughout the performance, but they were also worried about the influence of the sound during the performance and suggested reconsidering the form of the sound sensor.

**Figure 5** Three sets of the prototypes: Sound as input and light as output (left), sound as input and fan as output (middle), and muscle movements as input and fan as output (right). Credit: Ines Ziyou Yin (2021).
3.2 Second Round: Optimizing the experience and technology and conducting testing event

3.2.1 Speculative Co-design Workshop

After getting more insights from the first round of co-designing, making, and feedback, we held the second speculative co-design workshop to explore more metaphors related to breathing for experience and aesthetic design, and to jointly speculate a more appropriate experience. Based on the limitation found in the first workshop, we redesigned the framework of the second workshop (see Figure 6) to ensure the outcomes would be highly related to the theme of collaborative breathing. Four people including music performers and audience members were invited to the workshop.

Key Findings

People mentioned clouds, waves, dandelions, and inflating objects as the metaphors related to breathing, which were helpful for the form design of the input and output devices. In terms of the possible multi-sensory experiences that people wanted in relation to the collaborative breathing for creating the connectedness, haptic and visual sensory experiences through vibrations, lighting, and inflating things were revealed as the expected, acceptable ways of informing people about synchronized breathing. The co-created artifact about the possible setting for the speculated experience implied that the breathing experience and the jam session can be integrated into a single experience, so that the technological artifacts that assist the collaborative breathing experience for establishing connectedness can also be as part of the stage (see Figure 7). These highly relevant results also reflected the importance of adjusting the workshop framework to make the activity more related to the purpose and theme of our design.
3.2.2 Prototyping and Testing

With the insights got from the second workshop, we adjusted our design idea from devising an online collaborative breathing experience to creating a co-location collaborative breathing experience for the jam session participants to feel the connections with each other right before the performance. A four-phase experience was designed that started by the participants feeling their own breath, then feeling each other’s breathing and trying to achieve respiratory synchronization, then the main performers collaborating to improvise on music, and finally, everyone collaborating on a song together. The prototype consisted of four sets of breathing sensors in the shape of a flower (considering the metaphor “dandelion”), four small fans that were put together outputting wind and inflating the fabric to inform people about the synchronized breathing, and a projected visual cue was made for envisioning our design idea and supporting the designed experience.

A total of 13 music lovers, two of whom were the main jam performers, were then invited to engage in the experience and test the design idea and the prototype we made (see Figure 8). The prototype was mainly applied in the second phase of the experience, with which four participants held the breathing sensors while the rest of the participants each held the fabric covering the machine over the four sets of fans when conducting collaborative breathing. Following the suggestion of a neuroscience student, we collected feedback after the experience one by one to avoid the participants influencing each other with their opinions. Meanwhile, participants were asked to mark down their feelings of connection with others in the different phases on a foam board.

Figure 8 Participants engaged in the experience and tested the prototype. Credit: Ines Ziyou Yin (2021).
Key Findings

The outcome of testing was synthesized into two boards (see Figure 9). The result indicates that the participants who held the breathing sensors and the participants who were performing felt more connected with the others. People appreciated the joint actions (breathing and singing together) which they thought were helpful for feeling connectedness. These suggest that externalizing the collaborative breathing signals and supporting joint action in the experience by the designed technological artifact were conductive to the feeling of connections among the jam session participants (Hassenzahl et al., 2012; Stepanova et al., 2020). However, people pointed out that the position of the visual cue and the forms of output could be re-considered. They also suggested making the connection of the breathing experiences and the jam session stronger by applying the technological artifact in both parts of the experience.

With this feedback from the participants, we optimized our design and finalized the experience, which is presented in Section 4 below.

Figure 9 Synthesis of participants' feedback on the feeling of connections in different phases of the experiences. Credit: Ines Ziyou Yin (2021).
4. Final Outcome

4.1 Design

Our final design, CBreath, is a technology-mediated collaborative breathing experience capable of linking five to ten musicians in a jam session (see Figure 10). The experience was designed to include a collaborative breathing ritual for building the connectedness between the musicians and an improvised performance as a jam session following the ritual. The bases of the whole experience consist of the technology design that supported the whole experience, as well as the aesthetic and stage design.

The main design of technology for supporting the collaborative breathing experience was a wireless breathing cyborg. It incorporated four sets of breathing machines with sound sensors and fans that could detect people’s breathing rates and gave out a joint outcome of the synchronized breathing, a set of central controller which could receive the signal of each machine and provide feedback on whether the breathing is synchronized to each machine, a big fan, and a color-changing light. Since the four machines and the central controller were assembled using an Arduino ESP32S WiFi board respectively, they could be connected wirelessly and be placed separately in different spots within the same space. A simple testing was conducted to ensure the feasibility of the technology before aesthetic and stage design, which indicated that the color-changing light was useful as visual cue to help people adjust their breathing tempos and achieve the breathing synchronization more quickly.

The aesthetic design took inspiration from the metaphors that the participants mentioned during the speculative co-design workshops, such as “dandelion”, “clouds”, and “waving and inflating things”. The sound sensors were designed into the form of a flower, the stands for the sound sensors and the boxes for the fans were decorated using cotton, and the big fan at the center of the stage was covered by balloons, which looked like clouds; and at the same position of the big fan was a light that could change colors according to the state of the synchronicity of the people; while on the top of the stage hung a piece of fabric containing serval balloons, which can react to the blowing winds from the big fan at the center.

Here is the link to the website of CBreath: https://invanism.wixsite.com/cbreath .
Figure 10 Final design - CBreath. Credit: Ines Zilyou Yin (2021).
4.2 Experience

Six participants who could play instruments were invited to a theater to participate in the designed experience. Information sheets and consent forms were provided to and signed by the participants before the experience in accordance with the ethical guidelines (Benford et al., 2012). In order to ensure an autonomous experience to the greatest extent, Vanessa and I provided little additional verbal guidance throughout the process except for the project briefing at the beginning of the experience.

In the experience, participants sat down in a circle, with four of them sitting facing a breathing machine. When the experience begins, everyone started the collaborative breathing ritual by feeling their own and each other’s breath in a quiet environment. They tried to synchronize their breathing with the help of the color-changing light as a visual cue. Once the participants’ breathing was synchronized, the fan system (the four small fans and the big one) was activated, along with the light turning warm white. As the fans were activated, the participants could feel the wind from the side, and at the same time the fabric at the top was blown by the wind, which caused the balloons above to fall. Such a real-time, multi-sensory feedback of the synchronized breathing could make people feel the internal connections between each other, so as to establish the connectedness (Feijt et al., 2021; Min and Nam, 2014). The participants could then play with the balloons together and gradually began their improvised jam session. The experience ended when the participants felt like they had experienced a pleasant collaboration.

4.3 Evaluation

The whole process of the experience was recorded with permission from the participants for analysis. A short followed-up interview was conducted individually with the participants to get feedback about the experience and the potential of the technology (see Appendix B).

In terms of feeling connectedness, participants agreed that the collective breathing experience at the beginning improved the connectedness between them. Also, the multi-sensory experiences brought by the chain reaction triggered by the synchronized breathing enhanced their enthusiasm to participate in the follow-up performance tacitly and smoothly.

Regarding the technological artifacts, most participants were curious about the application of the technology online to connect people in different spaces. They expressed the desire to experience this idea to help them feel the connections with others, instead of being limited to jam session. Although they expressed concerns regarding the network stability, as they thought it would require effort to handle with.
5. Discussion

The feedback of the final experience of CBreath showed that the collaborative breathing experience with the support from the designed breathing cyborg was helpful for building the connectedness between jam session participants. It not only reflected the practical value of applying the theory of establishing internal synchronization by collaborative breathing to enhance the feeling of connectedness between people (Heitzer, 2021; Stepanova et al., 2020) but also reflected the feasibility of integrating the speculative co-design approach in the experience-oriented design of technology.

In terms of the overall experience design, the multi-sensory experiences, such as visual and haptic experiences with lighting and wind, as the feedback of the synchronized breathing, as well as the interactions with other people and the setting, such as hitting the balloons together, provided people with a novel way to feel the internal, physiological synchronization between each other. Such an experience was conducive to the subsequent improvised performance. This benefited from involving potential participants throughout the design process. Getting insights into the expected experiences directly from the artifacts created in the speculative co-design workshops gave us the chance to identify what sensory experiences related to breathing for connectedness were preferred (Stander and Steppers, 2008, 2014b). It then helped us to devise the experience and the relevant technological artifacts for creating connectedness that could meet their expectations. The testing process was beneficial to improving the whole experience and the supportive technological design, which also served as a channel to understand people’s acceptance of and willingness to participate in the experience, avoiding the potential ethical problems (Feijt et al., 2021, pp.23-24; Hassenzahl et al., 2012, p.15).

In terms of the technological development, it was shown not only in the final experience but the whole process of our research and design that people cared not only about the feasibility of the technological artifacts but also the experience related to or supported by such artifacts. This implies that technology design should, indeed, follow the lead of the designed experiences (Feijt et al., 2021, pp.23-24; Hassenzahl et al., 2012, p.15; Stander and Stappers, 2008, p.10). The feedback of the final experience also indicates the potentials of applying our designed technological artifacts within daily life for building and mediating the connectedness between people in different locations.

There is still some room for improvement. In terms of the design of the speculative co-design workshops, it is important to clearly describe our purpose and illustrate the process of the workshops, as well as to provide more relevant materials so that people can
provide enough detailed information and better design that is really relevant to our research in order to help us better develop satisfactory experiences and technological artifacts. Additionally, a stable connection to the network was required to ensure that the technological artefacts could work which was important to the success of our designed experience. Research can be continued to determine a way that can do with the problems with the Internet, or do without the use of internet if possible, so that we can play around with more possibilities of developing technologies to meet the expected experience that people want.
6. Conclusion

CBreath presented a new way of using collaborative breathing to create connectedness between the jam session participants, externalizing the synchronized breathing by multi-sensory experiences via light and wind. My main contribution was to evaluate the feasible methods for generating an experience-oriented technological artifact that prioritized people’s feelings and experiences so that people would accept and be willing to interact with it. Through this research-led design, I demonstrated the potential of incorporating speculative co-design approaches in the experience-oriented design of technology to create interpersonal connectedness. Engaging people in speculative co-design workshops to conduct generative work helped to gain insights into the gaps in the current technologies for creating connectedness, the multi-sensory experience they wanted, and the forms and functions of the possible technological artifacts that might support their expected experience. Having people participating in the testing with the made prototypes enabled us to further grasp people’s needs, and to optimize the experience and technology in a new round of design iteration. People’s feedback on the final experience implied the possibility of applying the technological artifacts in the design experience to other aspects of daily life to establish the feeling of interpersonal connectedness.

The limitations about the workshop arrangement revealed in this project suggest that more attention should be paid to the provision of materials and the planning of activities in the speculative co-design workshops, so that people can speculate an experience more in line with the purpose and theme of the design and make artifacts that are more inspiring to the designers. Furthermore, since the technology design in CBreath experience requires the support of a stable network, more research is needed to identify a more convenient way to connect multiple devices within the same location or in remote locations, so as to provide people with better interactive experiences for feeling interpersonal connections. Moreover, follow-up research can be conducted to focus on how to better apply speculative co-design approaches into experience-oriented design of technology.

To sum up, in the experience-oriented design of technology, experience design has a driving role in the technology innovation and makes people’s feelings the priority in technology design. The key role of speculative co-design in the experience-oriented design of technology is supporting experience design that can meet people’s expectations by allowing people to participate in each phase of the design and always putting their expectations, needs and feelings in the first place. If we keep exploring the practical ways of researching for and conducting the experience-oriented technology design, there will be more chances to generate new technologies that could provide people with satisfactory and memorable experiences in the future.
Acknowledgement

I would like to express my sincere gratitude to the people who have been so supportive to me in not only in academics but also in life and the people who have contributed to this project for their collaboration, feedback, and instructions thus helping me complete this project successfully.

I would like to first express my deepest gratitude to my parent for supporting my overseas study not only financially, but also mentally. They have always believed in me and eased out my anxiety when I feel not confident enough about myself, which provides me with stronge motivation to accomplish my Master’s study in London.

I would like to extend my deepest appreciation to my project partner Vanessa Van. Her enthusiasm in making artifact has been influencing me, and at the same time, she trusted my ability in technological design, so that we were able to finally achieve a design outcome that were satisfactory to both of us.

I would also like to express my thanks to all the participants who set aside their time and engaged in the project for generating idea and artifacts together with me and Vanessa. Their unrestrained imagination and idea as well as the creative artifacts they made in the workshops have brought us a lot of inspiration, and their feedback has played an important role in our subsequent optimization. Special thanks to Gavin and Shu who have not only participated in the workshops and testing, but also provide help and instructions on coding and other technical aspects in the project.

I also wish to thank all the fellow classmates for their continuous feedback and selfless help. I am so grateful to be able to study and have fun with them during this 1.5-year period.

My thanks should also be given to my friend Catalina who has been supporting me in my wirting and helped with the proofreading.

Last but not the least, I would like to express my most sincere gratitude to my tutors – Dr. John Fass, Mr. Alaistair Steele, Ms. Mor Bakal, Greg, Tiffany, and Wan for their encouragement, insightful comments and suggestion, challenging questions, and support for motivating my progress. They have also warmly cared about my life and health throughout the whole period of my Master’s study. They are truly supportive in both academics and my life.

Above all, thank everyone who has been encouraging and supporting me in my study and life that keeps me motivated.
References


Appendix A: Follow-up interview with the two musicians

A-1. Interview with the Pianist

Q1: If there are artifacts like this for enhancing connectedness and synchronization, what will be your attitude? Helpful or not?

These are cool! I think it will definitely be helpful if it is for choir or ensemble. I would say synchronization is so important to start at the same time in a same tempo, and the feeling of connectedness could help to perform and collaborate more smoothly when performing.

Q2: How do you achieve synchronization and build connections with your fellows when performing? What about online practicing?

For singing, there is usually someone leading the choir (the lead singer/vocal). For instruments playing, people usually look at the conductor who is always standing in front of the group. However, it is still so hard to synchronize, because people may not see each other. There are sometimes more than 50 people or even more than 100 people performing together as well. Therefore, issues about synchronization not only happens online, but also happens on the stage.

Q3: What do you think about the outputs? What kinds of output do you think will be better for the breathing practice?

Something happens when we achieve synchronization will be better than perceiving the breathing patterns of each other though. As for specific outputs, I would prefer sound and something visual.

Q4: What about inputs? How do you think will be interesting to detect our breath?

Breathing into something will be good but detecting the body motions can be an acceptable way as well. However, I think gestures or motions may vary from person to person, so it may not necessarily be a good choice at the end.

As for the shapes of the tool, it might be better to make it a bit more related to music, like music notes or something like that, or just consider other more suitable forms.
A-2. Interview with the Saxophonist

Q1: Since you often participate in jam session, what do you think about the connections among you and your collaborators? What are the current skills you will use for building your tacit understanding on the stage?

Jam session is usually not that formal and small scale. We will just have mutual gaze if we can stand face-to-face. There is room for jam session that I usually go to where we can sit in a circle. When some of us want to improvise music, we can stand up freely to perform. But if it is on the stage, it is a bit hard to actually see each other.

Q2: Would you practice breathing with others online to build the connectedness with them if there are some artifacts or tools like this available for you? What will be your attitude?

We do practice breathing, but usually just practice alone with the metronome on our phone. We may gather together in person and practice breathing right before the jam session starts. We prefer having jam session on site and rarely organize online jam session, except for during pandemic period.

Having some wireless devices like this still sounds cool to me. But I would personally prefer something for building connections in co-location, or even make it on the stage for providing the vibes. And I think it would be helpful for us to have it on stage as well because such devices will give us some feedback informing us about whether or not we are connected.

Q3: If we have the artifacts on the stage for supporting the experience of creating connectedness, what input and output methods would you prefer?

I think sound sensor will be better than muscle sensor, since it is more related to breathing I think. And I play saxophone, so I think exhaling through something will be more relevant to me. But I would concern about how it will look like.

As for the output, I think having wind and something visual when our breathing synchronizes will be interesting.
Appendix B: Follow-up interview about the final experience CBreath

Q1: How do you feel about the whole experience and the support technology?

A: I think the overall experience was very novel and interesting, and I had a strong sense of immersion. Technology is a very important part of supporting this experience and helping us to feel the connections. I would like to have such an experience again!

B: The experience was so amazing! With those multi-sensory feedback, I felt that I had stronger connections with others. It is also fun to interact with the balloons! I think the design surprised me again and again and made me feel like I was connected with other and wanted to improvise on music with them.

C: At the beginning of this experience, everyone was breathing. In a quiet environment, I could hear everyone’s breathing gradually becoming consistent. I felt very surprised when the synchronized breathing triggered the devices on the stage and created chain reaction of wind, light and the falling balloons. It made me directly feel the connections between each other. I think it aroused my excitement and help me get into the improvisation faster.

D: Because of the visual cue and since we can vaguely hear the breathing sound of people nearby, I can feel my breathing rates had been changing and the feeling of connectedness was getting stronger and stronger. After triggering the chain reaction of the devices, I felt that my feeling of connectedness reached its peak, and thus naturally began to improvise on music with others.

E: I think what I felt was not only the enhancement of the connections with others, but also the increase of courage to improvise on the melody with others after feeling the connectedness. We sort of had the tacit understanding with each other.

F: The overall experience was really interesting. From the collaborative breathing experience to the improvisation, the whole experience was very natural and smooth. It seems that we started playing naturally once we felt the connections with others and received feedback of the breathing synchronization.
Appendix B: Follow-up interview about the final experience CBreath (Cont.)

Q2: What do you think will be the potential of the technological artifacts that support today's experience?

A: I think it's a novel way to connect with each other by collaborative breathing, and it seems that many of today's technologies have not yet applied such things (at least I haven't seen one). So, I would like to know if it is possible for using this set of technological artifacts for online interpersonal communication and connection building.

B: I think it can be used in different scenarios. But this set of wireless devices requires network support. I will concern about the situation when there is no internet connection or the network is unstable, although I understand it is hard to deal with this problem.

C: Today's experience is carried out within the same space. I would wonder if it is a collaborative breathing experience in different spaces, will the feeling of connections between us increase more or less? I would like to have further exploration.

D: Using this set of technological artifacts online could be even more appealing to me if I want to team up with someone from a different location, but I know the network problems seem to be hard to address.

E: If we make these technological artifacts smaller and portable, we may have the chance to use it to connect with others whatever our distance.

F: As part of the stage design, I think the design of this technology is very good and support the whole experience including the jam session so well. There is a potential for you to adjust it and use it in other scenes to increase people’s connections as well.