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Sounding bodies: Exploring sonification to promote physical contact

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ABSTRACT

In this paper, we investigate the impact of sonification on the willingness for physical contact. For this purpose, we introduce a novel system designed to explore this impact within a performative art setting. It consists of a MIDI controller which detects physical contact between two dancers and transforms it into sounds. We use it in a preliminary experiment aimed at investigating whether sonification of physical contact in contact dance improvisations influences participants' behavior and their experience. Three sonification strategies are explored with 10 participants performing improvisations with the professional dancer. Questionnaires, interviews and quantification of touches were utilized to compare experimental conditions. The results suggest that sonification of the physical contact influence participants' behavior and experiences, although this effect may depend on type of sonification.

CCS CONCEPTS

• **Human-centered computing → Sound-based input / output**; **Empirical studies in HCI**.

KEYWORDS

multimodal interaction, full-body interaction, touch, interactive sonification, dance improvisation, dance therapy, physical contact

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1 INTRODUCTION

A relatively new research area in Human-Computer Interaction (HCI) is movement sonification, which consists in converting movement related data into sounds. This technique finds various applications, including well-being and rehabilitation [2, 13], performative arts [5, 10], and even creativity training [11].

In this work, we propose a novel system to explore the impact of sonification on the willingness to engage in physical contact. The existing literature shows important role of the role physical contact for well-being. In particular, the touch is often explored in dance/movement therapy (DMT) [7] with several successful use cases [8, 14]. One form is contact improvisation, i.e., movement practice in which the dancers communicate spontaneously through touch, weight and balance in partnership with the physical forces [6]. Recent studies shows benefits of contact improvisation [3, 6]. Moreover, it was explored in previous HCI studies [9]. Taking into account the benefits of contact dance and physical contact in general, our long-term aim is to examine whether the sonification may facilitate such contact, potentially reinforcing the healthy benefits of the touch. In other words, we aim to determine whether physical contact sonification influences individuals' willingness to engage in physical interaction with each other, and if so, whether this effect varies depending on the type of sonification employed.

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2 SOUNDING BODIES

The core assumption of this study is that sound can influence individuals' willingness to engage in physical interactions, especially in contexts where it's hard to communicate in other ways. Contact improvisation [6] involves a dynamic, spontaneous movement where participants decide how to move the body part touched by their dance partner. This form of nonverbal communication requires a heightened awareness of the partner's movements and encourages a reciprocal exchange of physical energy. Integrating sonification into contact improvisation allows us to examine how auditory stimuli affect the dynamics of physical interactions.

Technical setup. To sonify physical contact, we develop a system based on existing technology: the TouchMe device [12] from Playtronica and Ableton Live 11 Suite [1]. TouchMe is a simple and intuitive haptic interface for exploring tactility designed for performative arts that measures the intensity of touch between people and turns it into sound. Each physical contact between the dancer and the participant generates sounds in real-time. The physical contact is detected using two skin patches placed on the dancer and the participant, and the synthesized sounds are prepared in Ableton and played through speakers placed nearby. During the trials cables are attached to one of the participants' feet. The participants can freely move their hands, head, and torso, shift their body weight, and turn around. However, they are restricted from walking freely in the space and maintaining significant distances from each other. This setup permits the exploration of the impact of sonification within a controlled environment and repeatable conditions. Next, two sonifications were chosen, perceived differently in terms of valence (as pleasant and unpleasant), according to a pre-experiment survey involving 49 participants. The following sonifications were used in the final experiment: A) high tone with a bright timber, that

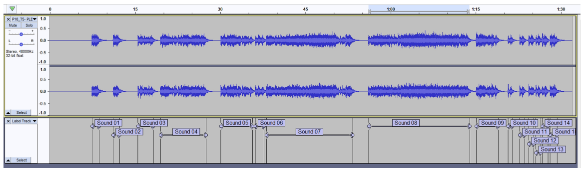

Figure 1: The example of the automatic audio segmentation performed in Audacity. In the image, the audio of one trial is segmented into sounds and pauses (see third channel).

has smooth and soothing percussive tone to generate impression of something magical; B) a rich tone with orchestral sounds composed with strings and a Brass Orchestral Section; it is playing "staccato" with short and fast notes that might elicit tension or stress in listener. The two sonifications are notably distinct, aimed at exploring potential variations in their impact on participants' behavior.

Experimental conditions. Participants undergo three experimental conditions, each condition is repeated, resulting in six trials in total, each lasting 90 seconds. Two trials (condition NO_S) involve no sound, serving as a baseline to observe "natural" interaction patterns. Two other trials incorporate sonification A (Condition POS_S), while the remaining two involve sonification B (Condition NEG_S). The trials sequence is randomized to minimize order effects. The experiment was performed in a big empty dance hall. Apart from the dancer and the participant, only one experimenter was present during the trials to control the correctness of the experimental protocol. The participants were informed before the experiment that the skin patches and cables were necessary to perform some measurements. The decision to not disclose how the system works before the experiment was made to avoid biasing the participants. Each participant interacts with the same professional dancer. The role of the dancer was to guide the experiment. The dancer was instructed to initiate the same number of physical interactions across different trials.

A convenience sample was recruited from the researchers' networks, including friends, relatives. Participants were provided with clear information about the experimental procedures, potential risks, and their rights. We stressed the importance of confidentiality by anonymizing data to safeguard participants' identities. Each participant signed the consent and had the choice to decline video recording during the interaction to maintain their privacy.

Results. After all trials, participants filled a questionnaire and participated in a brief semi-structured interview. The questionnaire focuses on the level of comfort, pleasantness they felt during the experiment, and the clarity of instructions. We used a 5-point Likert scale. More than the half of the participants gave the highest score to the pleasantness and the feeling of comfort of the activity which makes us believe that they have enjoyed the experience. Regarding the interviews, the most interesting feedback was about how the sound served as a means to play, akin to a game. All participants, except one, reported that the curiosity about the types of sounds they could produce became their primary motivation.

Since we do not have video recordings to perform video-based annotations of physical contact, we estimate the amount of contact by analyzing the generated audio during each trial. We count the number of sound segments corresponding to physical contacts. The automatic segmentation procedure included in Audacity software (see Figure 1) was used with following parameters: threshold level -30 dB, minimum silence duration 0.5s, minimum sound interval 0.5s, threshold measurement with two methods average and RMS. The 0.5s threshold was chosen as reliable estimation of what can be the shortest intentional physical contact time. The same procedure was applied for the no audio (NO_S) condition. In that case, the audio was actually generated in the same way as in the other two conditions (i.e., using one of the two sonifications described above, chosen randomly for each trial), but it was not played loud. The corresponding audio file was recorded on the laptop. Randomization was used to prevent specific sonification from influencing the results in NO_S condition. We extract the number of sounds for each trial. The one-way ANOVA indicates a significant difference (($F(2, 57) = 3.21$, $p < 0.05$) in sounds quantity between three conditions, when utilizing the average threshold for segmentation. LSD post-hoc tests reveal that the number of sounds in the POS_S condition was greater ($POS\_S = 21.45$) than in the other two conditions ($NO\_S = 17.8$, $NEG\_S = 18.25$). Also, we noticed substantial differences between individuals' scores, with a standard deviation of 5.15, indicating that people have different reactions based on their individual characteristics.

3 DISCUSSION

This study provides valuable insights into the potential impact of sonification on physical interactions in contact improvisation context. Our findings suggest that sonification influence participants' experience and behavior, but this effect may depend on type of sonification. Many participants reported a difference in perception and behaviour when contact produced sound versus when it did not. The statistical analysis suggests that the effect might depend on the type of sonification (positive impact was observed only for sonification A). It aligns with previous research on movement sonification [2, 4, 11]. Some limitations include a small participant pool, the utilization of only one sonification per condition, and the absence of precise quantification of physical contact duration. Due to a limited sample size, it was not feasible to investigate the novelty and habituation effects (i.e., the impact of repeated use of the same sonification). Nevertheless, certain participants' comments suggest that the novelty of the experience might have had a positive influence. Furthermore, including video recordings would enable a more comprehensive and nuanced analysis of participants' movements and interactions (e.g., intensity and duration). Future works will prioritize expanding the participant pool, incorporating a wider range of sonification models, and developing specialized software for analyzing TouchMe data. Expanding the research to diverse populations, including those with specific therapeutic needs or conditions, could provide valuable insights into the potential therapeutic uses of contact sonification. The other applications include social robotics, and creation of interactive multimodal systems.

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