Project Deliverable 1: User and Domain Research

The dance community could benefit from an auditory feedback system to encourage effective training techniques and enhance instructional methods. The dance community is vast and is comprised of young dancers learning in neighborhood studios, dancers and instructors training at collegiate levels, and professional companies. The content of the domain is also very diverse, covering many variations of formality and style including structured, refined ballet and expressive, unrestricted improvisation. In formal western dance practices, studio rehearsals and dance classes are commonplace. Classes are often organized with dancers practicing fundamental skills under the instruction of a dance professional. The instructor provides consistent critiques to the group and individuals, and students adapt dynamically to their feedback. In ballet, specifically, the most important aspects of training rely on alignment, line work, proprioception, and balance.

According to the International Association for Dance Medicine and Science, proprioception is an individual's body awareness and knowledge of their body in space [1]. This is often colloquially referred to as the "sixth sense", and it is related to the idea of muscle memory. A study by Lewton-Brain observed that a strong kinesthetic understanding allows dancers to attain proper alignment and achieve the desired illusion of ballon, an element of ballet where dancers appear to float on air [5]. In ballet, alignment is related to posture and body positioning, and it is crucial to injury prevention. Lewton-Brain's study also notes that proper alignment and astute proprioception can allow for greater expression and further development of advanced skills. Unfortunately, proprioception can be difficult to develop and refine, and research suggests that some common pedagogical tools may hinder its development.

Wall mirrors are common accessories in a dance studio. They provide students immediate visual feedback to observe their lines, movement, and placement [7]. They also provide instructors an increased field of view of their students. However, the International Association for Dance Medicine and Science suggests that mirrors may be detrimental to the development of proprioception, in addition to causing distractions relating to self-confidence during movement. Dancers may pay too much attention to the mirror and how they look causing them to break their lines and take them out of touch from their body [7]. Studies show that young dancers should not be instructed using a mirror when learning fundamental, technical skills, so that they may better develop proprioception. The International Association for Dance Medicine and Science also

recognizing the helpful nature of mirrors for skilled and professional dancers, but they endorse the importance of the guidance of an instructor and the development of proprioception for dancers in training. This raises an issue for student dancers practicing skills outside of the studio without mirrors or the watchful eye of an instructor.

In conversation with Naomi Costanza, a Musical Theater major, Dance minor, and nine-year student dancer, Miss Costanza elaborated on the problems she faces while developing her ballet skills both in and out of the studio [8]. Miss Costanza described issues with understanding and refining her mind-body connection. She stated that, while she is rehearsing alone, it is often hard to tell whether or not her body is in proper alignment. She found this particularly concerning because of the relationship between improper technique and injury. To assist her independent rehearsals without a mirror, Miss Costanza video records herself. She says that although videos can be helpful to see problem areas, the delay in feedback makes it challenging to apply adjustments. Miss Constanza commented that even though she understands and can recognize correct and incorrect form, it is difficult to identify while she is performing without consistent feedback because of learned bad habits. 4Dancers.org echoed Miss Costanza's sentiments stating that is difficult to become aware of one's balance and alignment deficits potentially due to habitual movement that a dancer may believe feels right even though it is incorrect [6]. Miss Costanza also noted that these issues, though amplified when rehearsing alone, are still present in the studio even with instructors. It is difficult for instructors to consistently provide individual feedback, and though it is easy to say what's right and wrong, it is hard to explain how or why the technique is wrong. Other problems that Miss Costanza shared were issues involving awareness of others in the space, understanding incorrect landings in jumps, and alertness to the amount of energy and effort she uses while practicing.

In the dance community, auditory displays have proven to be effective. A study by Großhauser and Bläsing demonstrated the value of sonification in the ballet education setting [3]. In the study, the researchers developed wearable sensors that sonified a performer's movement. Using pressure sensors, goniometers, and gyroscope sensors, they captured data including weight distribution, the force of jumps, and the angles of joints, and they sonified the data using the SuperCollider programming language [3]. The system emulated the closed-loop interaction between a dance teacher and student, where the dancer performed a movement, heard the sonification from the system, performed the movement again with adjustments based on the

audio cues, which resulted in sonification by the system, and so on. The system was received well by the dancers and instructors in the study, recounting that the system allowed dancers to pinpoint errors and increased the instructor's awareness of student performance [3]. Another study by Landry and Jeon used a similar closed-loop system to sonify dance. In this study, the researchers used the Vicon tracking system with 12 infrared cameras to capture a dancer's position, velocity, acceleration, proximity to other objects, and affect [4]. This data was synthesized using Wekinator and sonified through Pure Data and Ableton Live. The goal of this study was not to sonify for dance training but to introduce more artistic interactions within the sonification field. In a cyclical relationship, the dancer moved to the music created by the system, while the system was influenced by the dancer's movement. A final study involving the sonification of dance is from Fernström and Griffith in which they developed an auditory display of footwork called LiteFoot. The LiteFoot project was created to record and analyze traditional Irish dance [2]. The LiteFoot dancefloor utilized a matrix of optical proximity sensors and an accelerometer to track multiple dancers' placement and force of steps. From user comments, the LiteFoot had potential dance training, performance, and recreation opportunities.

Drawing from past work and conversation with Miss Costanza, an auditory display system would encourage effective dance training techniques. The system would aim to help student dancers advance their proprioception and help instructors better understand their students' performances. As mentioned above, the best and most important time to train kinesthetic awareness is during fundamental skill development, and auditory feedback may be most helpful when it is the primary audio stream. As such, the system would be designed to support users while training fundamental skills like bar or floor work, and the system would provide the only audio information necessary. To aid dancers, the system could sonify EMG, motion capture, location, and force data. Sonifying EMG data would inform users of proper muscle contraction throughout the legs, hopefully providing a clearer mind-body connection. Sonifying motion capture and location data would inform users of alignment issues and appropriate placement. And, sonifying pressure sensor and force data would inform users of technique while jumping and leaping. Based on the studies mentioned above, the system would be a closed-loop system, and it would provide continuous auditory feedback to the user. In this way, the dancer could adapt and correct their movement according to incoming auditory data, allowing them to become a more skilled dancer.

Project Deliverable 1
Jocelyn Kavanagh

References

[1] Glenna Batson. Resource Paper: Proprioception? Retrieved from
https://www.iadms.org/page/210

[2] Mikael Fernström, Niall Griffith. 1998. LiteFoot - Auditory display of footwork. *Proceedings of the International Conference on Auditory Display - ICAD 1998* (1998).

[3] Tobias Großhauser, Bettina Bläsing, C. Spieth, T. Hermann. 2011. Wearable Sensor-Based Real-Time Sonification of Motion and Foot Pressure in Dance Teaching and Training. *Journal of the Audio Engineering Society* (2011). DOI: 60(7):580-589

[4] Steven Landry and Myounghoon Jeon. 2017. Participatory Design Research Methodologies: A Case Study in Dancer Sonification. *Proceedings of the 23rd International Conference on Auditory Display - ICAD 2017* (2017). DOI: http://dx.doi.org/10.21785/icad2017.069

[5] Peter Lewton-Brain. 2009. Dynamic Alignment, performance enhancement and the demi-plié. *The IADMS Bulletin for Teachers* (2009), 8–10.

[6] Emily Kate Long. 2013. Balance, Proprioception & Alignment: On Stage & In The Dance Studio. (September 2013). Retrieved from http://www.4dancers.org/2013/09/balance-proprioception-alignment-on-stage-in-the-dance-studio/

[7] Sally Raddell. Resource Paper: Mirrors in the Dance Class: Help or Hindrance? Retrieved from https://www.iadms.org/page/400