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User-Centered Design of Sonified Balance Biofeedback

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***Abstract*— This abstract summarizes user-centered design approaches in progress to develop sonified biofeedback that facilitates older adults (re)learning balance strategies during walking and turning maneuvers.**

***Clinical Relevance*— This abstract shares trends from focus group interviews with physical therapists who provided insights and impressions about sound-based rehabilitation approaches.**

I. INTRODUCTION

Our goal is to develop rehabilitation technology that honors an older adult's ability to (re)learn dynamic balance strategies in partnership with a clinician. This goal will be achieved if the technology is aligned with end-user priorities and capabilities. Sonified biofeedback– conveying biological signals through sound – has emerged as a promising modality for balance training [1]. It may leverage audio-motor coupling [1] and it allows the visual system to navigate environments during concurrent biofeedback, which is especially important during turning maneuvers. Further, sonified biofeedback can motivate patients through its potential to use musical elements [3] including the potential to tap into the benefits of rhythmic cueing (such as singing [2] or Rhythmic Auditory Stimulation) [3]. We started focus groups with physical therapists to learn their insights and impressions about using sound-based rehabilitation approaches with older adults to inform our design process. This abstract reports the methods used and emerging trends from this focus group research.

II. METHODS

Thirteen Physical Therapists (PTs) volunteered to participate in this research in accordance with the IRB. The PTs have been licensed for an average of 20 yrs (range 6-39 yrs) and had varied expertise across neurological, gerontology, and orthopaedics. A series of four focus groups (n=2-3) and three structured one-on-one interviews of up to 1-hour were moderated by AZ and recorded on Zoom. There were three phases of questions about: (1) a video example of an older adult performing a Timed Up and Go test, (2) patient motivation and the use of music, sound, and rhythm in the clinic, and (3) sonified biofeedback and its potential use with older adults. In phase 3, sonified biofeedback was defined and three divergent example excerpts (~30s) of sonified biofeedback were provided: (Ex1) electronic sonification of muscle activation during running, (Ex2a-b) balance measures sonified during turning while walking (either 2a. string instrument frontal-plane angular momentum and/or 2b. brass instrument mediolateral distance between the center of mass and edges of the base of support; participants not aware that Ex2a-b were our design prototypes in order to avoid bias), and (Ex3) sonification of walking with an ocean soundscape. Further details and sonification examples are available: www.tinyurl.com/AZFocusGroupAbstract.

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III. RESULTS

For brevity, this section provides an overview of PTs' sound-related responses. When asked if they use sound, rhythm, or music in clinical practice, all shared first-hand experiences. Clinical experiences included playing music (n=10), using metronomes (n=5), incorporating dance (n=4), PTs singing/creating their own music (n=2), cueing symmetric footfalls through treadmill ground-contact sounds (n=2), etc. After introducing sonified biofeedback and providing the examples as "props" for discussion of initial impressions, nine PTs provided generally positive or interested responses (using words like "*cool*", "*perfect*"), while four PTs initially responded negatively or with concern (*"too much of a triple dual task for me"*, *"older patients would not like this at all"*, etc.). Seven PTs expressed concern about increased cognitive load during sonified biofeedback. PTs expressed that the sound should: avoid high pitches (n=7), be selected by the patient (n=7), not be startling/scary (n=5), and be "distinct" or "easily distinguishable" (n=2). Further, PTs brainstormed potential benefits and pitfalls of using familiar natural sounds (like Ex3), vs. familiar music, vs. musical instrument sounds (like Ex2), or non-musical computerized sounds (like Ex1).

IV. DISCUSSION & CONCLUSION

Focus groups provide a systematic way to capture first impressions and generate ideas through conversation.

Next, we will fully quantify responses from these focus groups in a multidisciplinary team to improve our prototypes. In addition, we will begin focus groups with clinicians who have therapeutic music certifications and with older adults.

Continuing this user-centered research will refine design goals for the development of sonified balance biofeedback for older adults to ensure it is helpful and usable.

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