

Determining a Taxonomy of Accessible Phrases During Exercise Instruction for People with Visual Impairments for Text Analysis

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ABSTRACT

Physical activity is an important part of quality life, however people with visual impairments (PVIs) are less likely to participate in physical activity than their sighted peers. One barrier is that exercise instructors may not give accessible verbal instructions. There is a potential for text analysis to determine these phrases, and in response provide more accessible instructions. First, a taxonomy of accessible phrases needs to be developed. To address this problem, we conducted user studies with 10 PVIs exercising along with audio and video aerobic workouts. We analyzed video footage of their exercise along with interviews to determine a preliminary set of phrases that are helpful or confusing. We then conducted an iterative qualitative analysis of six other exercise videos and sought expert feedback to derive our taxonomy. We hope these findings inform systems that analyze instructional phrases for accessibility to PVIs.

CCS CONCEPTS

- **Human-centered computing** → Accessibility; Empirical studies in accessibility.

KEYWORDS

Visual impairment, Blind, Verbal Instructions, Physical Activity, Exercise

ACM Reference Format:

Jeehan Malik, Masuma Akter Rumi, Morgan Deneve, Calvin Skalla, Lindsay Ball, Lauren Lieberman, and Kyle Rector. 2021. Determining a Taxonomy of Accessible Phrases During Exercise Instruction for People with Visual Impairments for Text Analysis. In *The 23rd International ACM SIGACCESS Conference on Computers and Accessibility (ASSETS '21), October 18–22, 2021*,

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ASSETS '21, October 18–22, 2021, Virtual Event, USA
© 2021 Copyright held by the owner/author(s).
ACM ISBN 978-1-4503-8306-6/21/10.
<https://doi.org/10.1145/3441852.3476567>

Virtual Event, USA. ACM, New York, NY, USA, 3 pages. <https://doi.org/10.1145/3441852.3476567>

1 INTRODUCTION

Physical activity is an important aspect of quality of life. However, research shows that people with visual impairments (PVIs) are less likely to participate in physical activity than their sighted peers [3, 4, 8, 9]. Mainstream exercise classes provide opportunities to perform physical activity but are not accessible because instructors give verbal phrases based on the premise that the person can see [11], and cues provided by mirrors are visual. Fast-paced exergames (e.g., [5–7]) can enable aerobics, but social accountability is helpful. We identified a need for extra information in an exercise class and PVIs reported positive experiences in classes with descriptive language with measurements and positions [10]. There is a potential for text analysis to identify when instructor phrases are not accessible, but to do so, we need to produce a taxonomy of phrases. To address this problem, we combined qualitative analysis of video recordings of PVIs performing aerobic exercises and semi-structured interviews to identify which phrases are helpful or confusing. We followed with iterative qualitative coding of existing mainstream video workouts to improve our taxonomy. This taxonomy of phrases will inform future systems that can automatically determine whether an instructor phrase is accessible to PVIs.

2 USER STUDIES WITH VIDEO AND AUDIO AEROBIC WORKOUTS

We selected audio and video aerobic workouts for beginners because audio workouts may be more descriptive. For the video workout, we searched “beginner cardio workout” on YouTube and chose the video with the most views [2] (59 million views). Our audio workout is Cardio Level One from BlindAlive [12], an accessible exercise program for PVIs.

We recruited 10 youth (8 females, ages 12–19) from a sports camp for youth who are visually impaired. Three reported themselves as low vision, 4 legally blind, 1 totally blind, and 1 totally blind in one eye and central vision in the other. One person’s level of vision is

missing due to an audio recording error, but their range is between low vision to totally blind. Eight participants had experience with group aerobic exercise classes. Six often engaged in PE classes, one took part in cross country, swim team, and track, and one had taken few aerobic classes. Seven participants reported using technology during exercise, including listening to music (n=3), step counting (n=3), rowing machine (n=1), tracking via smart watch (n=1), and receiving aerobic workout instructions (n=1). We obtained IRB approval to conduct the user studies and received permission from the director of the camp to conduct the study.

We conducted 30-minute user studies to be compatible with the camp. Participants completed 3 audio exercises or 3 video exercises. Then, we asked questions about their experience. Participants then completed 3 exercises of audio or video (whichever they did not do first). They answered the same questions for the other three exercises. To understand when participants were confident or confused while exercising, we audio recorded and transcribed the interviews.

To record and analyze when participants were in or out of sync with the exercise, we recorded video of the participants while exercising. Two researchers labeled the footage, labeling when participants were in or out of sync. The researchers discussed all labels until they reached agreement. We turned these labels into the percentage of time participants were in sync for each exercise. The average percentage of time when participants were synchronized was 19.8% for video workouts and 24.2% for audio workouts; there were no significant differences using a Friedman test.

3 PARTICIPANT EXERCISE PERFORMANCE ANALYSIS

Our qualitative analysis showed that participants had difficulties doing both audio and video workouts. We identified phrases or methods that made workouts helpful or unhelpful based on our video labeling analysis of each participant.

We found phrases to be helpful in three cases. First, when the workout specified location and directionality with phrases. P10 demonstrated accuracy with the instruction “clap in front of chest” and P8 successfully moved “opposite elbow to knee.” Second, when the workout gave step-by-step instructions to follow in real time. For the exercise plank with alternating leg raise, the instructions first tell people to go into a “push-up position,” followed by “one leg at a time squeeze it up as tight as you can.” P7 could conduct this exercise one step at a time. Finally, when the workout gave exercise phrases. When the description said, “sit into a squat,” all participants we assigned this exercise sat into a squat.

We found phrases to be confusing in three cases. First, when there was ambiguity about which arm or leg to move. With the description “sit into a squat, then come up and tap on right,” all six participants who did the workout could not figure out which foot to “tap.” Second, when the exercise did not give all the information up front. In a workout where people are to pump their arms up and down, initially the workout only said, “arms go up overhead.” P1 held their arms above their head, stationary. Later the instructions said the arms should “keep pushing up.” By that time, P1 did not try the movement – they instead rested their arms due to fatigue. Finally, when the spoken instructions are not throughout the exercise. Participants often paused or froze in place, uncertain about how

to continue. In a workout describing a slow burpee, P8 followed instructions correctly when the workout said to go to the floor and put one leg up, but the instructions stopped. P8 froze before trying the exercise again, but at that point was unable to do it correctly.

4 INTERVIEW FINDINGS

Our interview analysis gave us insights into what participants thought was helpful or confusing. Participants indicated that familiar phrases were helpful, such as “squats” or “jumping jacks.” However, participants also reported unfamiliar phrases as confusing. For example, P9 discussed how fly jacks were difficult until the instructions said to “bring your feet and arms together at the same time.” Similarly, P4 had not done burpees before and pointed out how the video workout “didn’t explain how to do it at all.” Participants were also confused when the instructions did not convey directions or extent of limb movement. After the audio workouts, P3 mentioned being confused when “the instructor is not very descriptive” - they do not know if they are moving correctly. P6 admitted to being confused about the arm movements and suggested doing the workout slower at first. P10 expressed confusion about “how far to bend the knees.”

5 TAXONOMY OF PHRASES FROM FOLLOW-UP QUALITATIVE ANALYSIS

We improved our classifications by selecting six beginner workouts recommended by Oprah Mag [1]. The videos transcripts were acquired and proofread. We sorted each sentence of each workout into whether it is helpful or confusing using our findings. We updated the codebook through an iterative qualitative coding process, where we discussed our disagreements on a weekly basis until we reached full agreement on all codes. Finally, we had two collaborators (researcher in physical education and visual impairment and a blind athlete) proofread and suggest updates to our codebook. We finalized codes that are acceptable in two categories because they specify what to do with the body (Table 1) or when to do an exercise (Table 2). We also have a list of unacceptable categories (Table 3).

6 FUTURE WORK

We will develop a text classification algorithm using our taxonomy to analyze the instructions for accessibility and determine whether the instructor is speaking, first by separating speech from background music (e.g., [13]). This could determine whether instructors are omitting details before an upcoming movement, for example. We will replace confusing phrases with accessible instruction and conduct user studies to investigate the effectiveness. We will study whether the concept of pre-teaching is effective. This will help PVIs and people who cannot see the visuals instruction for other reasons (e.g., head pointed away from screen). There are future research questions including how a taxonomy of phrases may differ between users who have varying levels of knowledge of exercise phrases.

ACKNOWLEDGMENTS

This work is supported in part by National Science Foundation grant IIS-1849822.

Table 1: Acceptable because they specify what to do with your body

Label	Definition	Examples
Familiar Exercise Phrases	Exercise known by a name	squats, jumping jacks
Body Parts	Specifies what body part to move	arms, legs, head
Direction to move	Specifies how to move the body part with directional phrases	move up/left/right/down, put down
Expected Body Sensation	Explains what you should feel in your muscles	you should feel a stretch in your leg
Equipment	Describes equipment one could use	weights, chair, box

Table 2: Acceptable because they specify when to do the exercise

Name	Definition	Examples
Starting an exercise	States when to begin an exercise	getting ready, starting
Stopping an exercise	States when to stop an exercise	it's over, we are done with those, we are done
Duration	States how much time is left in an exercise	so, we have 10 seconds left
Pacing	Cueing every count of an exercise	5 4 3 2 1, down down, up up, in in, hop hop
Quantity of an exercise	Cueing the number of repetitions	two jumping jacks
Transitioning	Transitioning within or between an exercise	Now, next, repeat, another, listen to my cue

Table 3: Unacceptable because text does not specify what to do with body or time (except breathing)

Name	Definition	Examples
Breathing	Reminding the person to breathe	breathe in/out
Encouraging phrases	Encouraging or empathizing with the person	nice job; I'm so hot (temperature)
Inaccessible locations	Instructor giving directions that rely on one's vision	here/there; make sure you can see the screen
Filler	Intros or instructor and "participants" conversing	are you ready Michelle?
Subjective phrases	Not specific to a body movement	stay nice and under control
Unfamiliar Exercise Phrase	Proper noun exercise with unclear meaning	rise, plie squat, chop down, stay in line

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