

**Speech Hero: A Rhythm-based Speech Therapy App for Individuals  
With Aphasia**

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## Background

It is estimated that 1 in 6 people worldwide will experience a stroke, with about 30% of those individuals experiencing aphasia, which is a loss in their ability to understand or express language [1], [2]. Aphasia is associated with increased mortality [3], decreased rates of functional recovery [4], [5], loss of productivity, and social isolation [6]–[10]. Broca's aphasia is one of the most common types of aphasia and results in slow, effortful, pauses and disturbed rhythm of language [11], [12]. While intensive therapy can reduce language impairment [13], it is typically administered at suboptimal doses due to lack of coverage, transportation, or limited access to a trained rehabilitation specialist [14]–[17]. Thus, individuals with aphasia often fail to recover to their full potential [18]–[21]. Additionally, individuals with Broca's aphasia often have extremely limited recovery with traditional speech therapy methods due to large lesions in the left-hemispheric language regions of the brain [22]. For these individuals, therapies that specifically engage homologous right-hemispheric regions have the potential to improve the language recovery process [22]–[24]. Rhythm-based treatments are particularly well-suited to engage these specific right-hemispheric regions [25], [26], leading to promising improvements in language recovery [27]–[29]. However, to maximize potential language recovery with rhythm-based treatments, the therapy dosage needs to be much higher than is typically provided [30]. Home therapy options could increase the dosage of therapy individuals receive, but available options are not motivating, lack performance feedback, and have failed to gain widespread adoption.

Recognizing this, we developed an easy-to-use, rhythm-based, home therapy app for individuals with non-fluent aphasia. The app instructs users to tap their left hand and speak aloud with each syllable of a phrase as it scrolls from left to right across the screen. The rhythmicity of the target phrase is cued using a background metronome and the visual spacing of each syllable. The app uses the built-in tablet microphone to detect if the user spoke the target syllable with the correct timing. The app guides users through a set of pre-programmed phrases with fading cues, requiring them to first tap the target rhythm, then tap and speak the phrase simultaneously, and finally to speak the phrase without tapping.

## Study Design

We evaluated the usability of the app in a four-week at-home study with 10 individuals with aphasia in the chronic stage of stroke. All participants were provided a tablet with the therapy app installed and were instructed to perform a 30-minute language therapy session 5 days a week over the 4-week period.

## Methods

Inclusion criteria included a diagnosis of aphasia due to stroke, >6 months post stroke, and sufficient motor function of the unaffected upper extremity to tap on a table while speaking. Exclusion criteria included incidence of other neurological diseases (though individuals with apraxia were allowed to participate) and age <85, as older age may be a confounding variable when assessing the feasibility of a new technology. While we believe it is likely that people with other types of aphasia can benefit from the therapy app, we wanted to keep the inclusion criteria narrow for this initial feasibility study, and the language abilities (e.g., relatively intact comprehension of simple spoken and written language) and needs (e.g., impaired repetition and naming) of people with non-fluent aphasia are well-suited to the therapy app's design.

All participants provided informed consent, with appropriate measures taken to reduce the challenges associated with obtaining consent from people with aphasia who may have both communication and cognitive impairments. Specifically, the consent form was written in plain language, and the researcher obtaining consent 1) read the consent form aloud to the participant while being cautious to maintain a slowed rate and pause frequently, 2) allowed the participant to read the consent form, and 3) used any augmentative/alternative communication format the participant uses when communicating [31]. Further, the app was demonstrated briefly during the consent process to support understanding of what the participant is being asked to do. In situations where a participant did not have capacity to consent, the participant was asked to provide assent and consent was obtained from their legally authorized representative. Participants were then evaluated using the WAB assessment and a short form of the Boston Naming Test (BNT) [32] to establish baseline levels of language impairment. Next, they were invited to use the therapy app under supervision from a study administrator who provided initial instruction on how the system worked and then guided the users through a practice session. Participants played through the game for a few phrases until they had demonstrated that they could play the game on their own.

After the practice session, participants took home a tablet with the app pre-installed and were instructed to complete at least one 30-minute language therapy session 5 days a week (equating to a target dose of 2.5 hours of therapy per week, or 10 hours over 4 weeks). Each therapy session consisted of practicing a single phrase 8 times in a row with progressing difficulty (i.e. 8 attempts “*just tapping*”, then 8 attempts “*tapping + speaking*”, then 8 attempts “*speaking without tapping*”) before moving to a new phrase, with a goal of practicing 12 different phrases each day. The same set of 12 phrases was practiced for 1 week, and at the end of each week, participants were provided a set of 12 new phrases. More difficult phrases with two and three syllable words were gradually introduced over the 4-week period. After completing all 12 phrases in a given day, participants were free to practice any previous phrases. Participants returned for follow-up evaluation after 4 weeks.

## **Results and Statistical Analysis**

Ten individuals with aphasia in the chronic stage of stroke were recruited. Data from two individuals was not considered in analysis as one was deemed ineligible due to global aphasia diagnosis and the other withdrew from the study shortly after baseline assessment. Our primary outcome measure for this study was patient adherence (measured as hours of app use during the study period), which was extracted directly from the tablet at the follow-up assessment. Over the 4-week intervention, 7 out of 8 participants completed the target dose of home therapy (at least 10 total hours) with three individuals completing over 20 hours of therapy. No safety concerns or adverse events were reported. No additional statistical analyses were performed due to the small sample size of the study

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