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About the staRt project

Errors in speech sound production can negatively impact children’s development across academic, social, and psycho-emotional domains (Hitchcock, Harel, & McAllister Byun, 2015). Of particular concern are atypical speech patterns that persist past the age of 9, termed residual speech errors (RSE; Shriberg, 2010). Recent evidence suggests that some cases of RSE that do not respond to conventional methods may be eliminated through treatment enhanced with visual biofeedback technologies (e.g., McAllister Byun et al., 2015; Preston et al., 2014).

Despite the growing evidence base, multiple factors have severely limited the number of clinicians adopting biofeedback methods for speech treatment. A major barrier is the cost of the required equipment, which significantly exceeds the operating budget of a typical speech-language pathologist (SLP). A second barrier is the fact that previous studies of biofeedback intervention for RSE have been small in scope; which limits the strength of the conclusions that can be drawn regarding the efficacy of biofeedback.

Speech Therapist’s App for /r/ Treatment (staRt) is an iOS app currently in development at New York University that aims to increase the number of SLPs using visual-acoustic biofeedback to augment treatment for residual rhotic errors. The staRt project also aims to obtain higher-quality evidence on the efficacy of biofeedback intervention by inviting SLPs and clients who use the app to act as data collection partners in a novel clinician-research collaboration.
Getting staRted

0. Informational video

For an overview of how the staRt app works, please watch our informational video (4 min).

1. Hardware requirements

At the present time, the staRt app has been developed only for use on an iPad.

*Please use a microphone* while using the staRt app with a client. An in-line microphone that is integrated into a set of earbuds is perfectly adequate. The microphone can be clipped onto a stationary object a few inches in front of user's mouth, or the user can wear one earbud and let the microphone hang in front of their chin. It is preferable not to have the user hold the microphone by hand while using the app, because this may lead to variable intensity as the user moves around.

Can the app be used on an iPhone?
No, iPhone is not supported for the current version of the app.

Can the app be used on a Windows tablet or Android device?
No, the app is only available for iOS at this time.
2. Creating a profile

1. Select "Profiles"
2. Create a separate profile for each client who will be using the app.
3. If you are participating in a research study, please use a pseudonym or initials. If you will not be uploading data to our team, you may choose to use the client’s real name or use initials/pseudonym.
4. It is important to provide accurate information about the client (e.g. age and height). This information is used to make an educated guess about the acoustic settings that will be the best fit for the user.

3. Viewing the tutorial

The tutorial is intended for the clinician and client to view together. The "wave" we use for biofeedback (real-time LPC spectrum) is not entirely intuitive to understand and manipulate, especially for young users. The clinician should walk the client through the tutorial and check their comprehension at each step.

4. Adjusting the settings

4.1 Adjusting the resolution of the wave (LPC filter order)

Select a user profile, then choose “Settings” on the profile card.

- The slider that you see controls LPC filter order; that is, how many peaks/resonant frequencies the program tries to find in a given frequency range.
- When you are signed in to a profile in the staRt app, the filter order will be set to a value that we regard as our best guess for the speaker based on age, gender, and height.
- However, this is only our best guess. If you find that a speaker's waves look very different from the model waves in the tutorial--if peaks are missing or if you see extra peaks, for example--you can try changing the filter order using the slider under Resources.
- In our testing, we have observed optimal performance for most speakers with filter order values between 35 and 45.
• The shorter/smaller/younger the speaker, the lower the filter order should be. The taller/older the speaker, the higher the filter order should be. Females generally have lower optimal filter orders than males.

**A good way to tell if you have the right filter order:** When the speaker (or a model speaker of similar size/age) is producing a perceptually accurate /r/, you will ideally see peaks to the left of the slider representing the automatically generated target (see “Sample image A” below). If the filter order is low, the second and third peaks (which are very close together) will tend to merge (see “Sample image B” below). If this happens, raise the filter order and see if distinct peaks become visible.

If you're using a high filter order and still don't see a third peak during your perceptually accurate /r/, **that's not necessarily a problem**. For some adults, a strongly rhotic /r/ won't show separation between the 2nd and 3rd peaks. In such cases, your goal will be to get the merged peak at or below the starfish slider instead of targeting two peaks below that frequency. The more important question is whether a child who misarticulates /r/ will see a third peak somewhere higher up. If you imitate a child's distorted "euhh" for syllabic /r/, do you see three peaks, one of which is higher than the starfish slider? If you then transition into a correct /r/ sound (as illustrated in this video), do you see the third peak move toward the second peak and then merge with it? (See video example [here](#)).

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**Sample image A:** Filter order is optimal
Sample image B: Filter order may be too low

4.2 Adjusting the target frequency

A second setting that you can adjust is the target frequency, which is represented by the vertical line extending up from the starfish on the beach.

- When you are logged in to a profile, the starfish is automatically moved to a location representing our best guess of an appropriate target frequency, based on the information reported in the profile.
- If you do not see the starfish target, try tapping the wave or tapping "Reset Target."
- You may want to experiment with target frequencies other than the default setting.
  - If the client produces accurate /r/ sounds, you may have a chance to observe whether the automatically determined target is appropriate or not. If the client's accurate /r/ sounds feature an F3 peak that is much lower than the automatically determined location of the slider, you can choose a lower frequency to use as that speaker's target. However, we suggest that you not place the slider any lower than around 1550 Hz.
  - If the client produces perceptually accurate /r/ sounds with an F3 peak that is much higher than the automatically determined target, you can move the slider up.
- *In the current version of the app, it is not possible to save a custom setting for a client's target location. Please write down the adjusted target that you want to use and move the slider to that point at the start of each session.*
Using staRt

1. Administering Word Quiz measures

The purpose of the Word Quiz is to record the client producing a range of /r/ words. The Long Word Quiz measure should be administered before the start of treatment (baseline) and again after the end of each phase of treatment (maintenance). The Short Word Quiz should be administered at the start and end of each treatment session, to provide a record of the client's progress within that session.

1) Select "Quiz" from the menu bar
2) Select "Long Word Quiz" or “Short Word Quiz.”
3) The app will present 50 (Long) or 25 (Short) words containing /r/ in various contexts, randomly ordered.
4) Instruct the client to produce the words as clearly as possible. Score each production using the buttons on the screen. (See "Scoring" section on page 10)

*Note: Verbal models and qualitative feedback should NOT be provided during word quiz administration.

2. Administering the Syllable Quiz measure

1) Select "Quiz" from the menu bar
2) Select "Syllable Quiz"

The app will present syllables from Miccio's (2002) stimulability probe measure. The Miccio probe elicits /r/ in onset, medial, and postvocalic position in /i/, /a/, and /u/ vowel contexts. Each syllable target is elicited three times each in blocked order.

3) Cue the client to "listen, watch, and repeat after me while trying to make your very best /r/ sound," as instructed by the app.
4) Pronounce a clear model of each syllable.
5) Score each production using the buttons on the screen. (See "Scoring" section on p. 10)

Why is the Word Quiz ordered before the Syllable Quiz, even though syllables are a simpler level of production? Because our Syllable Quiz is actually a stimulability task involving models and prompting, whereas the Word Quiz assesses production in the absence of a model. We order the stimulability task second so it doesn’t have a carryover effect on word production.
3. Free play (manipulating the wave)

1) Select "Free Play" from the menu bar
2) If you do not see the target slider, tap "Reset Target."

During Free Play practice, you are encouraged to give the client any cues that you think would facilitate improved /r/ production. These can be articulator placement cues, perceptual models, or references to the biofeedback display.

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/r/ categories for practice: In the Syllable and Word Quest modes, staRt gives you the option to target one or more specific subset of /r/ variants in practice. Use your clinical judgment to choose the categories that you regard as most beneficial for your client. Categories are as follows:

- Syllabic /r/, as in word, sir, herd
- Consonantal (onset) /r/ in a front vowel context, as in reef, red, rat
- Consonantal (onset) /r/ in a back vowel context, as in rock, rude, rope
- Vocalic (coda) /r/ in a front vowel context, as in ear, fair, fire
- Vocalic (coda) /r/ in a back vowel context, as in door, far, star

4. Syllable Quest (practice at the syllable level)

1) Select "Quest" from the menu bar, then select “Syllable Quest.”
2) Select between 1 and 5 categories that you want to target in practice (see above).
3) Select the number of trials that you want to elicit. If you are participating in the formal pilot study, you should choose “100 trials.”
4) Tap the circle next to “Wave Hidden” if you want to complete traditional rather than biofeedback practice.
5) Tap "Begin Syllable Quest."
6) If you do not see the target slider, tap "Reset Target."

The app will present your desired number of trials of syllables containing the selected /r/ targets, randomly ordered.

7) Score each production using the guidelines described in the "Scoring" section (page 10).
8) After every 10 trials, a pop-up box will display the message "Pausing for feedback."

During the pause for feedback, you are encouraged to provide the client with qualitative information about his/her performance in the last block of 10 trials. You can also provide one or
more cues for the learner to focus on during the next block of trials. These cues can be articulator placement cues, perceptual models, or references to the biofeedback display.

9) After 100 trials are completed (or the user terminates the practice session by tapping “Stop practice”*), a pop-up will ask you "Would you like to upload this syllable quest session?"
10) Choose "OK" if you would like to upload the session to our research team.

*Note to pilot testers: If you have to discontinue a session before completing 100 trials, remember that we would prefer to have even partial data. We encourage you to choose "OK" to upload even if the session has not been completed.

5. Word quest (practice at the word level)

1) Select "Quest" from the menu bar, then select “Word Quest.”
2) Select between 1 and 5 categories that you want to target in practice (see above).
3) Select the number of trials that you want to elicit. If you are participating in the formal pilot study, you should choose “100 trials.”
4) Tap the circle next to “Wave Hidden” if you want to complete traditional rather than biofeedback practice.
5) Tap "Begin Word Quest."
6) If you do not see the target slider, tap "Reset Target."

The app will present your desired number of trials of words containing the selected /r/ targets, randomly ordered.

7) Score each production using the guidelines described in the "Scoring" section (page 10).
8) Remember to click "Next Word" after you choose a rating.
9) After every 10 trials, a pop-up box will display the message "Pausing for feedback."

During the pause for feedback, you are encouraged to provide the client with qualitative information about his/her performance in the last block of 10 trials. You can also provide one or more cues for the learner to focus on during the next block of trials. These cues can be articulator placement cues, perceptual models, or references to the biofeedback display.

1) After 100 trials are completed (or the user terminates the practice session by tapping “Stop practice”*), a pop-up will ask you "Would you like to upload this syllable quest session?"
2) Choose "OK" if you would like to upload the session to our research team.

*Note to pilot testers: If you have to discontinue a session before completing 100 trials, remember that we would prefer to have even partial data. We encourage you to choose "OK" to upload even if the session has not been completed.
Scoring

The following categories are available to rate a speaker’s /r/ productions during probe or practice sessions.

- **Try again:** Use this rating for productions that represent a different phoneme (e.g. /w/ or /u/) or for severe distortions that lack rhotic quality.

- **Good:** Use this rating for productions that approximate a correct rhotic quality but feature a mild to moderate degree of distortion.

- **Great:** Use this rating for strongly rhotic productions.

*Note: Please attempt to rate the characteristics of the /r/ sound in each word, independent of speech errors elsewhere in the word or other deviations such as nasality or hoarse vocal quality.

Troubleshooting

The staRt app is still in development. We encourage you to report any bugs, suggestions, or questions by emailing nyuchildspeech@gmail.com.