Syllable Repetition in Children with Speech Sound Disorder and Typically Developing Children: Task Performance and Neural Basis

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PURPOSE

Gain insight on neural networks related to speech in children during a syllable repetition task to better understand and treat Speech Sound Disorders (SSDs).

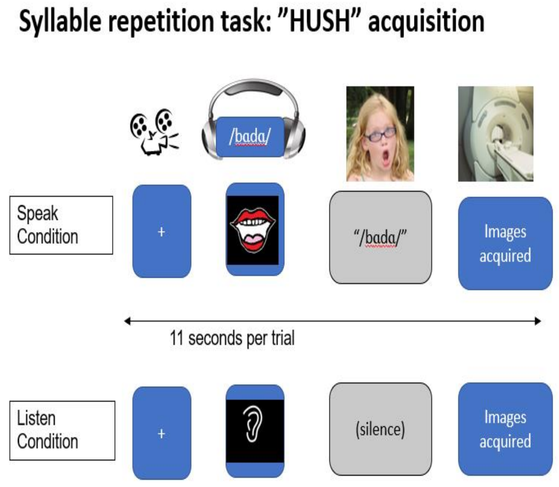
BACKGROUND

- Most typically developing children acquire their language's speech sounds by 5 or 6 years, but 8-9 years can be considered the hard cap.
- Speech Sound Disorders feature persistent speech perception and or production errors.
- As many as 24.6% of children could have speech sound disorders. Statistics are admittedly murky on this subject in part due to how broad the classification of SSDs is and inter-clinician differences.
- SSDs are particularly common in preschoolers, the age-range studied.
- Difficulty with using the muscles associated with speech, hearing and processing speech sounds, and mental representations of speech sounds can all mutually or exclusively contribute to a speech sound disorder.
- However, the neural basis of speech sound disorders could be better understood.
- More could be known about how children's brains with SSD differ from their typically developing peers, so researching the subtle differences in speech processing and generation could shed light on the causes and neural differences in SSD.

PARTICIPANTS

- 5 children (4F) with SSDs ages 4:0-5:11 [year:months].
- Control: 25 typically developing children ages 4:0-5:11.
- Participants had normal hearing, normal oromotor function according to oral mechanism exam, and no family history of speech, language, or neuro-developmental disorders. The preschoolers all spoke English natively with typical receptive language skills.

SYLLABLE REPETITION TASK



- Participants would enter a magnetic resonance imaging (MRI) machine to perform the task.
- A movie would play for about 10 minutes while structural MRI data is collected, also serving to ease the preschooler's anxieties. Syllable repetition tasks involved non-words made up of "early-sounds" such as /b, d, m, n, a/. These sounds should be easy to reproduce for the participants.
- In the listening condition, participants were tasked to listen to the syllables when presented with a picture of an ear and repeat the syllables when presented with an image of lips
- The number of syllables increases from 2 to 4, and thus complexity of the task progressively increased over each trial.
- The task allows for studying both the neural function when producing speech unaffected by speech production errors and neural function when speech errors are made.
- Responses were recorded from within the machine with an MRI-compatible microphone.
- Participants' responses would be scored and transcribed.

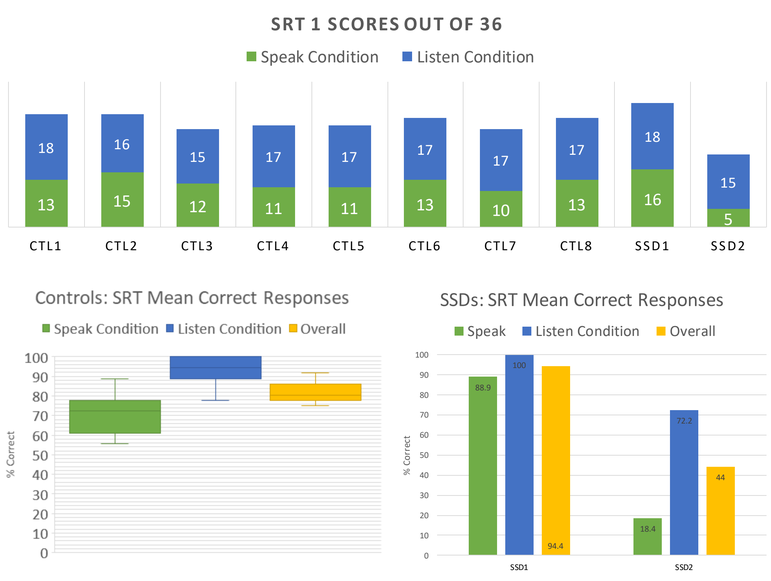
TRANSCRIPTION

- Syllable repetition task responses would be transcribed and then scored to see if they matched the condition's prompt.
- To use the neural imaging data across participants, we would need to identify when participants were on task and responding correctly and when they were distracted.
- Transcribed responses can be used to provide insight on when neural imaging data will and will not be comparable to other participants. This was most clear when a preschooler's response is a full word or sentence, showing that they are not participating in the task rather than simply responding incorrectly.

ERRORS

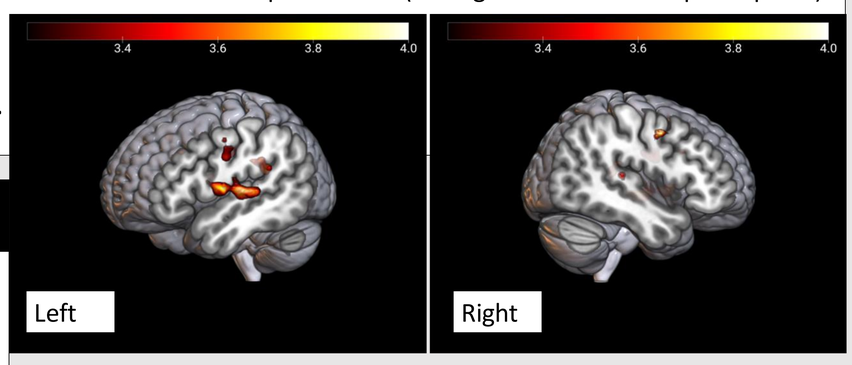
- Following the task design proved inconsistent even for children with typical speech.
- Common Errors: Speaking during listening condition, silence during speaking condition, substitutions, and consonant and full syllable deletion in longer words.
- Potential sources of error in controls:
  - fMRI can be challenging for young children sometimes enough to stop the trial entirely.
  - Mixing up speaking and listening condition.
  - Boredom with the design being too simple.
  - Failing to recall the entire string of syllables.

RESULTS



- 8 controls and 2 participants with SSDs completed the first SRT without interruption or complication. Transcribed and scored responses for those 10 trials are summarized in the combined bar chart to the left.
- The other 20 SRTs are excluded due to participants' noncompliance or microphone failures.
- The two figures below display mean percentage of correct responses across 15 control trials with acceptable levels of compliance, including participants' second and third trials when available. SSD1 completed 1 trial. SSD2 completed 2 trials.
- For participants with unavailable recordings, general compliance with the task was noted at the time of data collection so their neural imaging data could still be used.
- 24 control participants completed at least 1 "run" of the task; 16 completed a second run.
- 3 participants were excluded from neuroimaging data for task noncompliance; error trials were not excluded if task compliance was overall appropriate.
- Motion threshold framewise displacement (FWD)>2mm; excluded 2 additional participants.
- N in group analysis = 19
- Threshold at p<.001 uncorrected.

FMRI activation for speak>listen (average over 19 control participants)



LIMITATIONS

- Low number of participants with SSDs. Recruitment from speech clinics was challenging during and post-COVID
- Challenges of scanning young children using MRI
- Technical limitations with MRI-compatible microphone led to missing recordings

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