

# Assessing Voice Familiarity in Normal-Hearing Adults: Behavioral and Electrophysiological Approaches

Maddie R. Porter<sup>1</sup>, Fuh-Cherng Jeng<sup>1,2</sup>, Molly G. Taylor<sup>1</sup>, Chao-Yang Lee<sup>1,2</sup>, Sydney W. Bauer<sup>1</sup>, Amanda E. Carriero<sup>1</sup>, Kalyn McDonald<sup>1</sup>

<sup>1</sup>Communication Sciences and Disorders, Ohio University, Athens, Ohio, USA; <sup>2</sup>Communication Sciences and Disorders, Asia University, Taichung, Taiwan



## INTRODUCTION

- Voice pitch is an important auditory perception in the individual's ability to identify the different pitch contours. This serves as an important role in the identification of familiar voices. The ability to identify familiar voices is important for speaker identification in everyday interactions (Gainotti, 2018).
- Previous studies have explored similar ideas surrounding voice familiarity and brain activity but differ in the age of participants (Turnure, 1971; Beauchemin et al., 2011) and how electroencephalographic (EEG) measurements are compared (Tanaka & Kudo, 2012)
- The electrophysiological assessment utilizes Frequency-Following Response (FFR), which is a form of electroencephalographic (EEG) measurement through electrodes on the scalp that can be used to evaluate how the human brain processes acoustic features of an incoming speech signal (Krizman & Kraus, 2019; Skoe & Kraus, 2010). Electrophysiological research has shown FFRs in normal hearing adults to accurately preserve pitch information of speech sounds (Krishnan et al., 2004)
- We hypothesize (1) behavioral responses and EEG will accurately reflect to how the participants can distinguish between their mother's voice from a stranger's voice, (2) shorter reaction times when disyllables are presented versus monosyllables, and (3) a correlation between behavioral responses and EEG measurements.

## METHODS

### Participants

- 11 adult students (10 females, 1 males; 23.4 ± 1.4 years old)
- 18-40 years old with normal hearing thresholds
- Mothers of participants must be native to English and willing to have a virtual meeting to record the voice tokens

### Stimulus

- 8 monosyllabic words: "seed", "sock", "suit", "say", and "deed", "dock", "dude", "day"
- 8 disyllable words: "toothbrush", "doormat", "popcorn", "bluebird", and "baseball", "inkwell", "ice cream", "mousetrap"
- Due to time constraints, only "day" was utilized to elicit FFRs
- The duration and root-mean-square (RMS) amplitude of each voice token was equalized to the mean duration and RMS amplitude of the same word across all 11 mothers, respectively.

### Behavioral Response accuracy and reaction time

- Familiarization: Mother 16 voices
- Practice: Mother + 1 stranger voices
- Test: Mother + 3 strangers voices

### EEG Recording

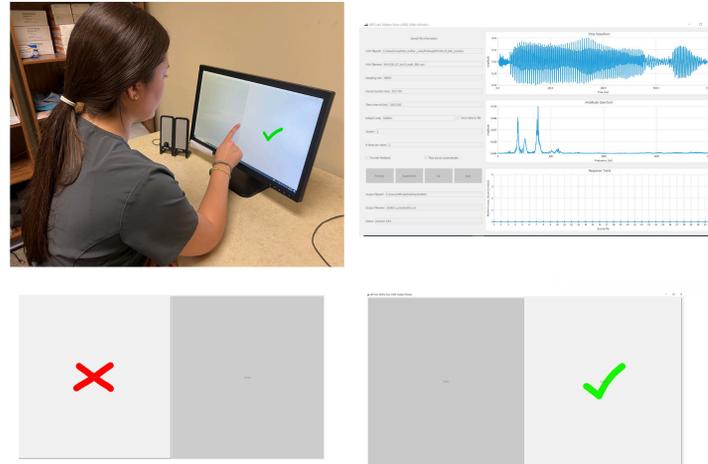
- 3 gold-plated surface recording electrodes
- 4000 accepted sweeps for mother and stranger's "day" voice

### Statistical Analysis

- Behavioral response: Generalized linear mixed model (GLMM)
  - Fixed-effect factors:
    - Stimulus types: Mother vs. stranger
    - Tokens (or Token types): 16 tokens (or monosyllables/disyllables)
  - Random-effect factor: Participant
- EEG: Paired-samples t-tests
- Behavioral and EEG: Pearson's correlation

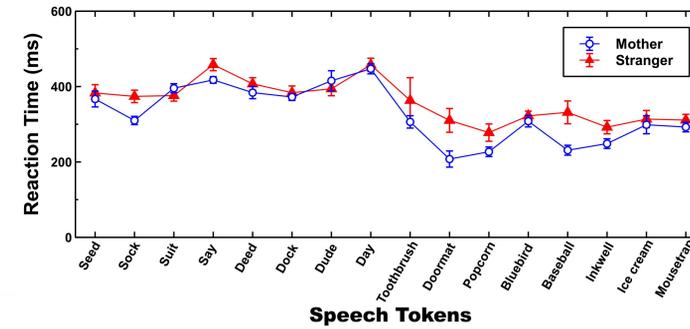
## Behavioral Measurements

### Behavioral Experiments

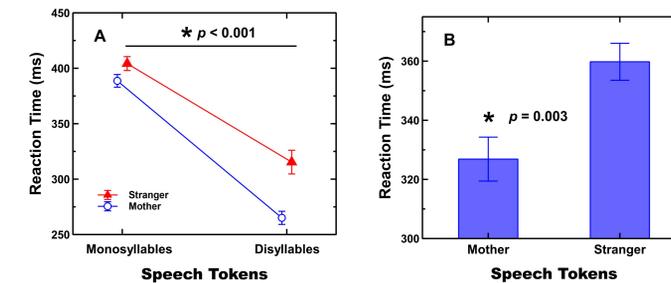


**Figure 1.** Behavioral reactions times were obtained from each participant (top left) by using custom-built software (top right). During the practice round of the behavioral portion, adult child participants are instructed to select whether they believe the randomized speech stimuli was their mother or a stranger. Incorrect responses produced an 'X' (bottom left) while correct responses produced a check mark (bottom right).

### Shorter Reaction Times to Mother Voice and Disyllables



**Figure 2.** Behavioral responses are plotted for each of the 16 tokens for mother and stranger speech token stimuli and compared to reaction time.



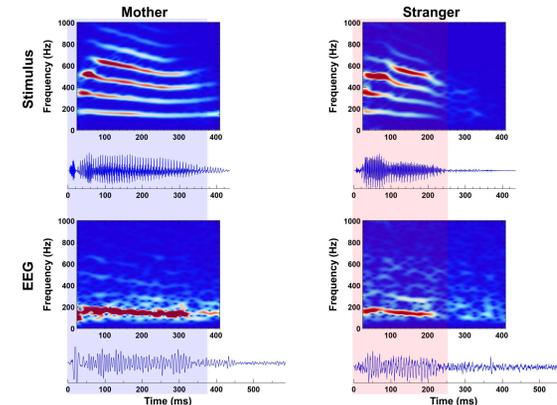
**Figure 3.** Speech stimuli were then broken down further into monosyllables and disyllables (left) and furthermore into mother versus stranger (right).

## Electrophysiological Assessment



### Electrode Placement

**Figure 4.** Gold plate electrodes were placed on the high forehead, right mastoid, and low forehead to pick up neural activity elicited from hearing a speech stimuli through an insert ear tip placed in the right ear. Participants were encouraged to remain relaxed and still throughout testing.



### Electrophysiological Response Results

**Figure 5.** The spectrogram and time waveform on the left indicates results from the mother while the stranger is on the right. The effective regions of the "day" stimuli produced by the mother and stranger are highlighted.

Paired Samples T-Test					
	Measure 1	Measure 2	t	df	p
fe	fe.mother	fe.stranger	0.081	10	0.937
se	se.mother	se.stranger	0.843	10	0.209
ta	ta.mother	ta.stranger	0.48	10	0.641
sa	sa.mother	sa.stranger	0.762	10	0.464
ps	ps.mother	ps.stranger	-1.405	10	0.19
rms	rms.mother	rms.stranger	0.956	10	0.361

### Non-Significant Findings

**Figure 6.** Each of the EEG indices were found to be non-significant ( $p > 0.05$ ): frequency error (fe), slope error (se), tracking accuracy (ta), spectral amplitude (sa), pitch strength (ps), and root mean square (rms) amplitude.

## DISCUSSION

- A significant difference ( $p < 0.05$ ) was observed when comparing mothers' voices to female stranger voices. These findings show a cognitive advantage to processing familiar female, specifically maternal, voices.
- Additionally, disyllables show an improved behavioral response (e.g. shorter reaction time) to speaker identification.
- Our overall findings provide additional insight on how the brain is more efficient at processing familiar speech versus unfamiliar speech stimuli.
- There was no significance found in the electrophysiological assessment testing. A paired samples t-test was conducted for each of the six indices. When comparing the mother and stranger voice data for each index, the p value indicated non-significance for all findings.
- FFR findings and the behavioral mean reaction time were correlated using Pearson's r, but no significant correlation was found.
- Limitations of this study and future directions
  - A sample size of eleven college students limited generalizability of findings. With a larger sample size, findings could be further explored in subdivisions such as gender, age, etc.
  - While our study focused primarily on monosyllabic and disyllabic words, future studies could incorporate words of varying linguistic complexities.
  - We found significance between mother and female stranger voices, but excluded other familiar voices such as fathers, siblings, and other family members.

## ACKNOWLEDGMENTS

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