



ABSTRACT

The importance of vowel perception has been studied extensively in adults. However, less is known about vowel perception in children. To better understand the importance of vowel discrimination in young children, an easy to administer, pediatric vowel discrimination task is needed. Closed-set, picture pointing paradigms such as the Word Intelligibility by Picture Identification (WIPI; Ross & Lerman, 1970) are effective for pediatric word discrimination tasks (ASHA, 2012). Most WIPI word sets share a vowel but vary by initial and/or final consonant, such that discrimination relies on consonant information. The goal of the current project was to develop a companion test to the WIPI that relies on vowel information. The task includes monosyllabic words arranged in sets of three. The words within each set vary only by central vowel and are within the lexicon of a typically developing young child. Words are separated into three lists balanced for vowel articulation (i.e., position of tongue and degree of lip rounding), word frequency, and imageability difficulty. Preschool children easily identified the images and audio recordings that were created to depict the words.

BACKGROUND & RATIONALE

- The importance of **vowel perception** to intelligibility has been studied extensively in **adult populations**.
- Less is known** about **vowel discrimination** in **young children**.
- Testing** speech intelligibility with **young children** is more **complicated** than testing adult listeners.
 - Tests are sometimes **limited to pictorial representations** of words or same/different paradigms.
 - Closed-set, picture-pointing** paradigms are effective for pediatric word discrimination tasks (ASHA, 2012).

PURPOSE

GOAL 1: Develop a forced-choice, picture-pointing test of vowel discrimination.

- Target words should be easily imaged
- Target words should be within a young child's lexicon
- Sets of target words should phonemically vary only by central vowel

/bæ^{red}t/ /b^{red}ʊt/ /b^{red}oʊt/
bat boot boat

Figure 1: Example word set from the vowel-discrimination task. Central vowel (in red) varies across lists.

GOAL 2: Revise the WIPI to have similar structure as the new vowel-discrimination task.

- Create new images and audio recordings for WIPI in a similar artistic style and using the same talker as new task
- Reduce WIPI word sets from four to three that do not vary in central vowel

/br^{red}ʊm/ /m^{red}ʊn/ /sp^{red}ʊn/
broom moon spoon

Figure 2: Example word set from the revised WIPI. Beginning and/or ending consonants (red) vary, but central vowel (black) does not.

TEST DEVELOPMENT

GOAL 1 : Vowel-discrimination task

Target Words

- Target words are 75 monosyllabic words present in an online database based on child corpora of spoken English (Storkel & Hoover, 2010).
- Selected words included 25 sets of 3 word pairs that varied in central vowel only.

| Set # | List 1 | List 2 | List 3 |
|-------|--------|--------|-----------------------|
| 1 | /baɪk/ | /bæk/ | /bɔk/ |
| 2 | /nʌt/ | /naɪt/ | /nɛt/ |
| ⋮ | ⋮ | ⋮ | ⋮ |
| 25 | /kaɪt/ | /koʊt/ | /kæ ^{red} t/ |

Phonetic & Lexical Balancing

Lists were balanced for phonetic distribution as well as lexical frequency. Median lexical frequency, phonological neighbors, and imageability data are shown below.

| Vowel-Discrimination Task | | | |
|---------------------------|--------|--------|--------|
| | List 1 | List 2 | List 3 |
| Lexical Frequency | 28 | 21 | 29 |
| Phonological Neighbors | 24 | 24 | 23 |
| Imageability (100-700) | 576 | 567 | 551 |

GOAL 2 : Revised-WIPI

Target Words

Original 4-word WIPI sets were narrowed to 3 words using a combination of data from Dengerink et al. (1988), which reported spontaneous identification of original WIPI pictures, and co-authors' judgment.

| Set # | List 1 | List 2 | List 3 |
|-------|---------|--------|---------|
| 1 | /smoʊk/ | /goʊt/ | /koʊt/ |
| 2 | /nɛk/ | /nɛst/ | /drɛs/ |
| ⋮ | ⋮ | ⋮ | ⋮ |
| 25 | /peɪl/ | /teɪl/ | /dʒeɪl/ |

Lists were balanced for phonetic distribution as well as lexical frequency. Median lexical frequency, phonological neighbors, and imageability data are shown below.

| Revised-WIPI | | | |
|------------------------|--------|--------|--------|
| | List 1 | List 2 | List 3 |
| Lexical Frequency | 56 | 29 | 61 |
| Phonological Neighbors | 17 | 18 | 18 |
| Imageability (100-700) | 591 | 593 | 604 |

Target Images

New images were created for each unique target word for the vowel-task and revised-WIPI. Example pictures for the vowel task and revised-WIPI are shown in Figures 3 and 4, respectively.

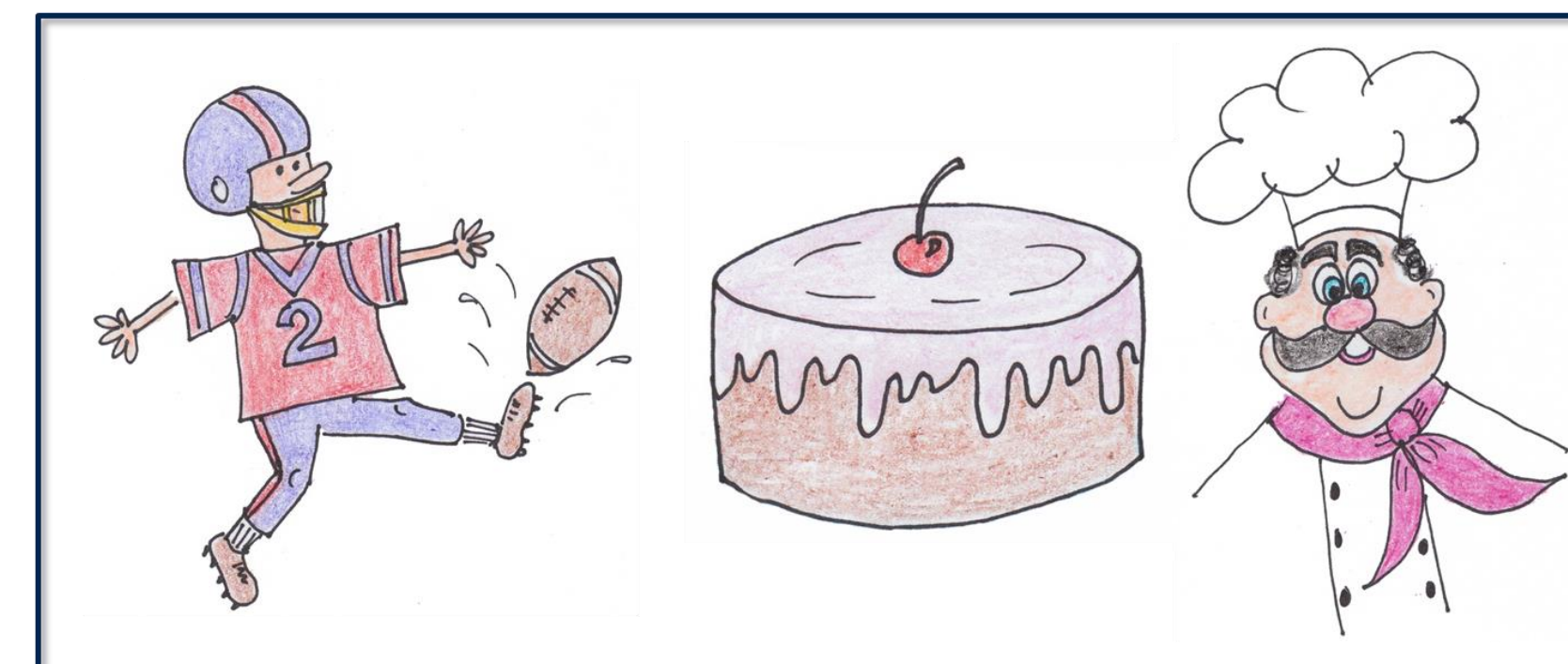


Figure 3: Example images drawn for /kɪk/, /kɛk/, and /kɔk/.

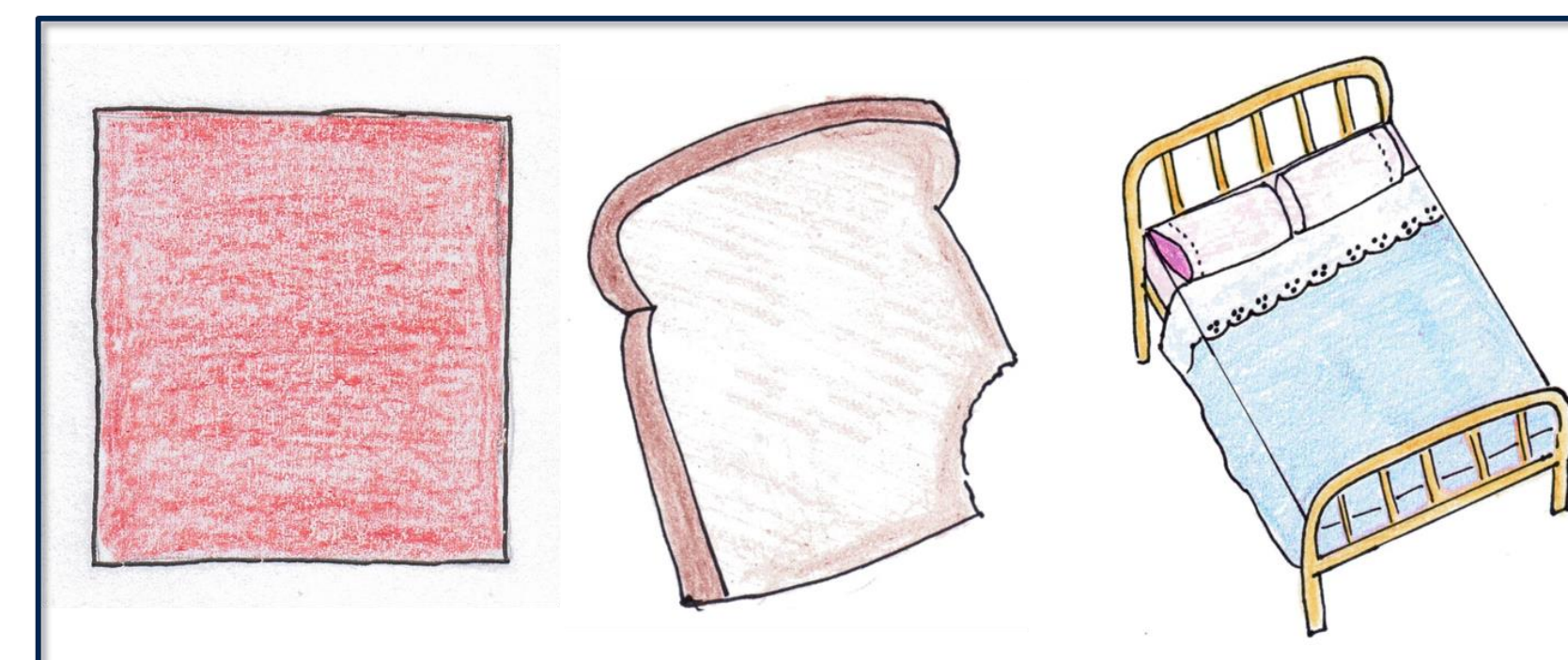
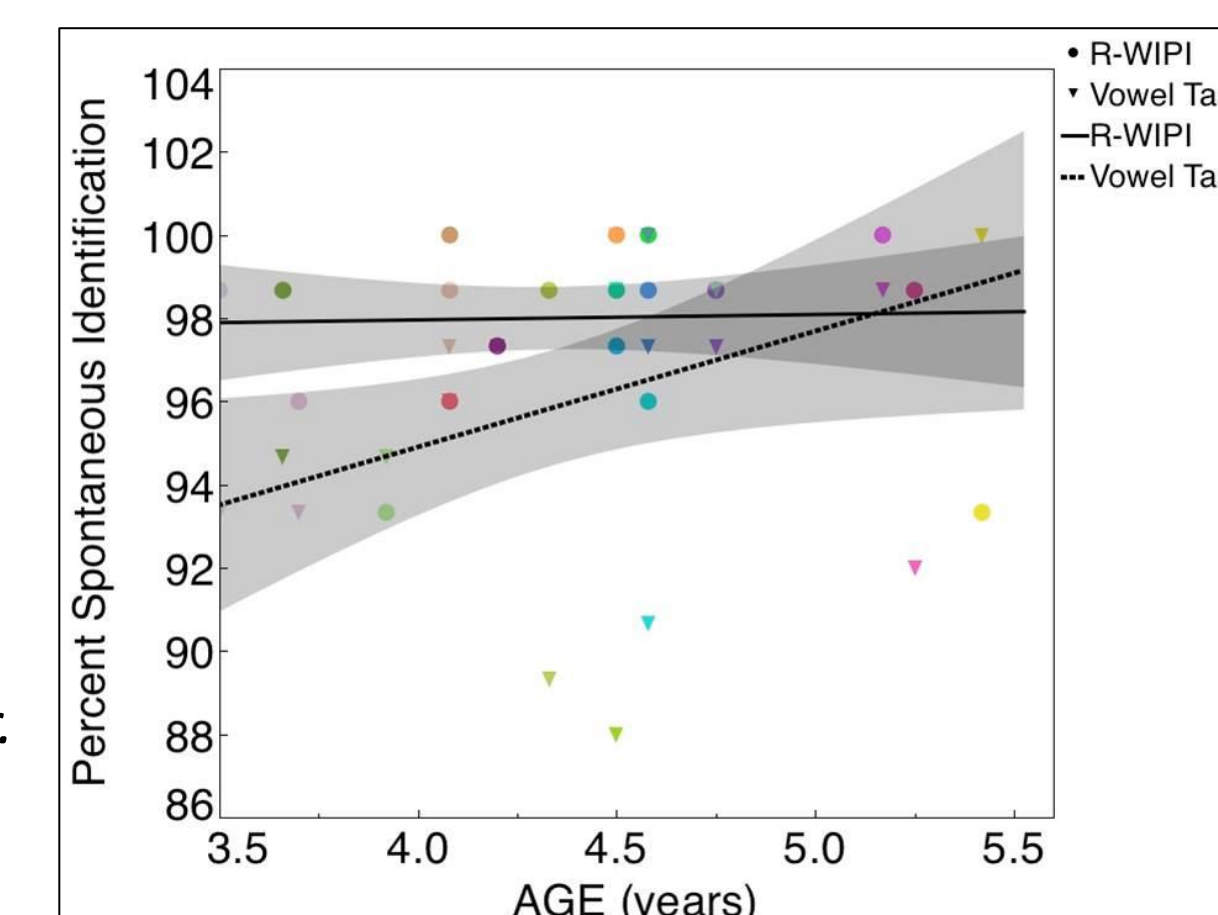


Figure 4: Example pictures drawn for /rɛd/, /brɛd/, and /bɛd/.

Figure 5: Spontaneous identification (n=20) as a function of age (years). Participant is indicated by color. Task is indicated by shape.



Spontaneous Picture-Labeling (Vowel Task)

| | List 1 | List 2 | List 3 |
|-------------------------|--------|--------|--------|
| ID with target word (%) | 79 | 73 | 79 |
| ID with synonym (%) | 17 | 19 | 17 |
| Could not ID (%) | 4 | 8 | 4 |

Spontaneous Picture-Labeling (Revised-WIPI)

| | List 1 | List 2 | List 3 |
|-------------------------|--------|--------|--------|
| ID with target word (%) | 88 | 85 | 95 |
| ID with synonym (%) | 10 | 8 | 4 |
| Could not ID (%) | 2 | 7 | 1 |

Table 1: Open-set spontaneous identification data for the vowel-discrimination task and revised-WIPI

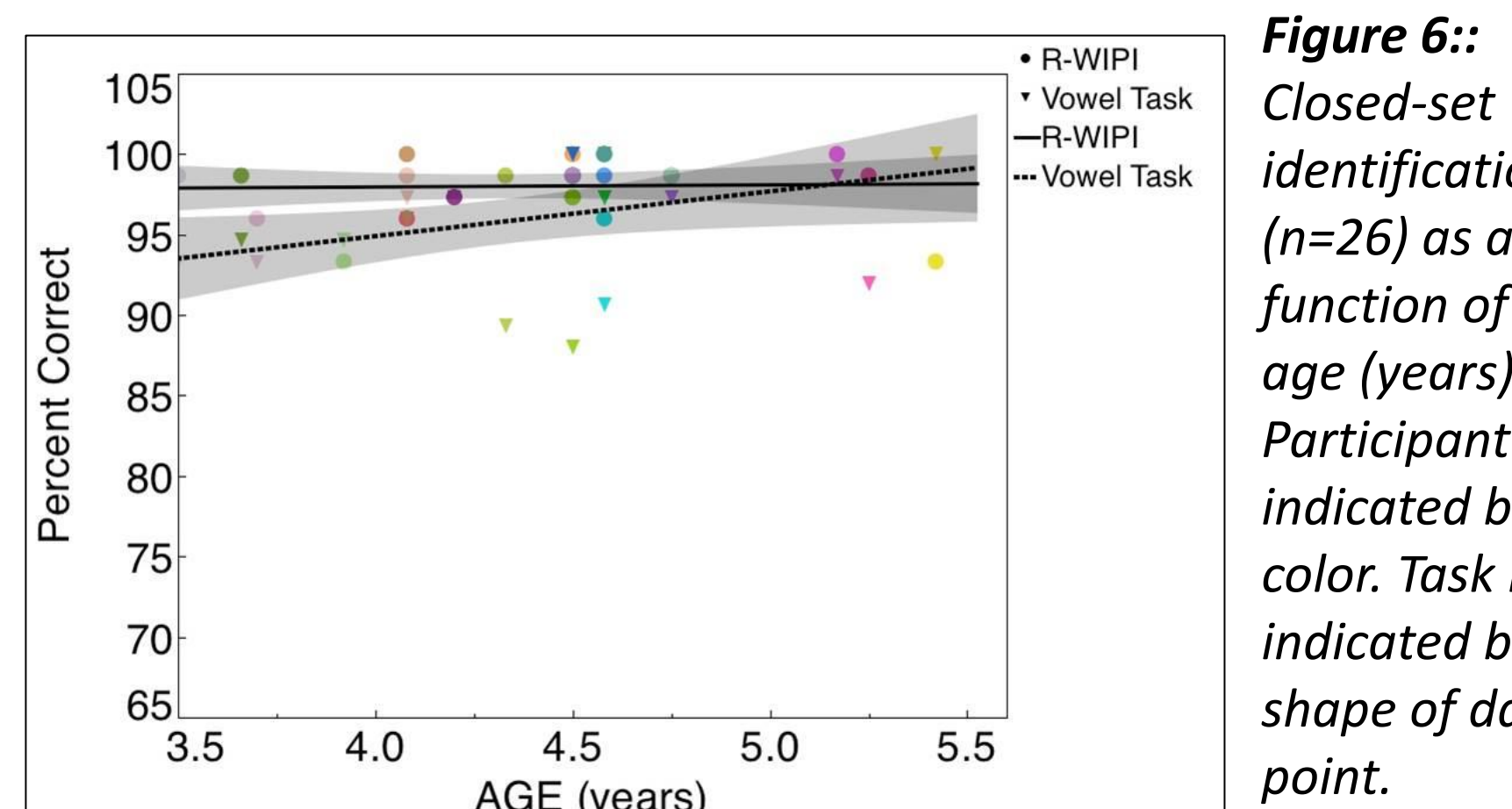


Figure 6: Closed-set identification (n=26) as a function of age (years). Participant is indicated by color. Task is indicated by shape of data point.

TEST DEVELOPMENT CONT'D.

Target Stimuli

Neither peak- nor RMS-equalization resulted in equal loudness across words. Therefore, five adults completed a loudness-balancing task. Each word was played in the context of a carrier phrase and adjusted in 1 dB

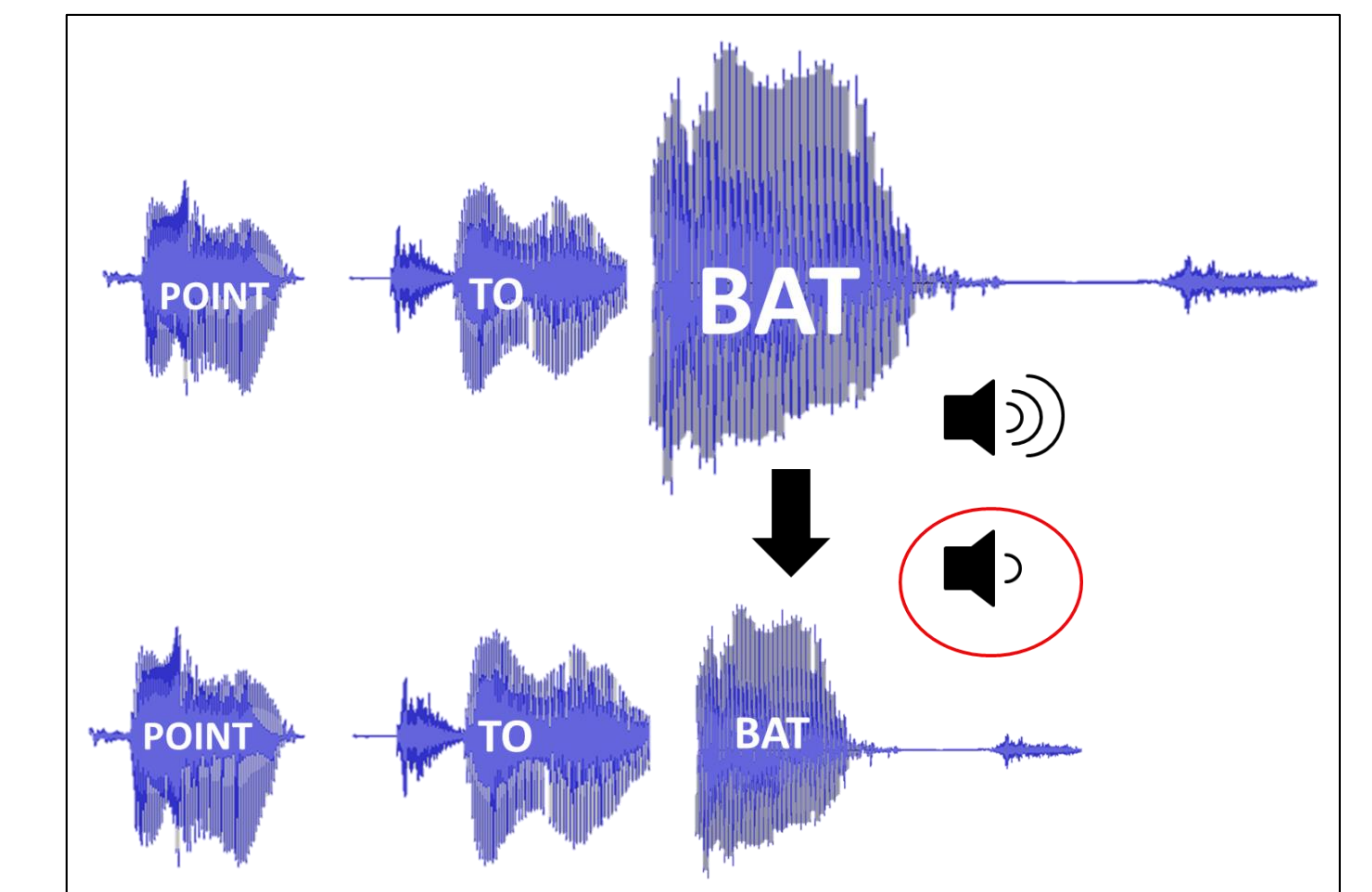


Figure 7: Subjective loudness scaling task

steps until equal loudness was achieved. Starting level was randomly roved by +/- 6 dB for each trial and listener. The range of level matches varied by a median of 3dB across listeners.

CONCLUSIONS

Selected words and images created for the vowel-discrimination task were easily identified by a pediatric population. Results from the open- and closed-set identification tasks indicate that the new task is more difficult than the revised-WIPI. This result is not surprising due to limitations in target word options (i.e. sets of three words that varied only by central vowel and could be imaged within a child's lexicon). It is intended that this task be used to further our understanding of auditory development with respect to vowel discrimination.

FUTURE DIRECTIONS

- Collection of perceptual data in normal-hearing listeners is forthcoming.
- Vowel-discrimination testing will be evaluated in children in competing noise (including steady state and modulated maskers).

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