2aSC18. Relationship between articulation and mispronunciation detection in children with speech delay: Perception of unfamiliar speech vs. their own speech

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We examined the relationship between speech production and mispronunciation detection ability in children with speech delay (SD). Thirty-three SD children aged between 6;0 and 10;0 participated in a mispronunciation detection test using three types of stimuli: words pronounced correctly by other unfamiliar children (OTHERS); words mispronounced by OTHERS; and the participant’s own speech (SELF) pronounced either correctly or incorrectly. The participant’s articulation was assessed by the standardized GFTA-2 scores. Results indicated that SD children made significantly more errors when judging SELF speech than when judging OTHERS speech. Multiple regression analyses revealed that accuracy of detecting OTHERS mispronounced words was a significant predictor of GFTA-2 scores in these SD children. Interestingly, in the regression model, accuracy for detecting SELF mispronunciations made a significant independent contribution in addition to accuracy at detecting OTHERS mispronunciations. Overall these two measures accounted for a significant proportion of the variance in GFTA-2 scores (R-squared = 0.45). These findings suggest that children with SD may have more coarse phonological representations of their own speech than the speech of other children.
INTRODUCTION

Speech Perception in Children with Speech Delay

Speech delay (SD) is a common communication disorder in children that is characterized by a difficulty producing the speech sounds necessary for adult language relative to peers. Many studies have shown that children with SD also have deficits in speech perception when compared to typically developing (TD) peers [1-4]. However, other studies have shown that there is a subgroup of affected children who show no relationship between production and perception errors [2-4]. The poorer performance on speech perception measures that is often observed in SD children is thought to be indicative of deficits in phonological representations for SD children [5,6].

One method of assessing speech perception in children is the mispronunciation detection task [7, 8]. In this task, children are presented a speech stimulus and an accompanying picture of the object said. They must then judge whether the speech stimulus was pronounced correctly or not. Carroll and Snowling [9] have found that SD children have more difficulty with a mispronunciation detection task than TD peers. In their study, 17 participants (aged between 3;11 and 6;3) identified as having significantly delayed speech were tested on various perceptual measures, including mispronunciation detection, and compared to participants who were at risk for dyslexia and normal controls. The mispronounced stimuli used in [9] were created by substituting a single consonant phoneme. Results from this data revealed that SD children performed worse on mispronunciation detection than controls, but performed similarly to children who were at risk for developing dyslexia.

Often, the speech stimuli that are used in mispronunciation detection tasks are recorded by adult speakers unfamiliar to the participants. As far as we know, there have not been any studies on how SD children perform on a mispronunciation detection task when using their own speech as stimuli. Bunnell et al. [11] reported the preliminary results on the mispronunciation detection performance by children with SD using their own speech and their sibling’s speech. They found that the SD children performed more poorly than their non-SD siblings on mispronunciation detection task, and that errors in mispronunciation detection were more likely when using their own speech as stimuli.

Purpose

The current study examined the mispronunciation detection data collected as a part of the Nemours Genetics of Speech Delay Project [see 12]. More specifically, we examined whether these children had a greater difficulty in detecting mispronunciations in their own speech when compared to the speech of other, unfamiliar children. Furthermore, to see the relationship between speech production and perception, we examined how well these perceptual measures account for the variance in standardized scores of articulation. Consistent with the findings in [11], it is expected that SD children will have more difficulty when making judgments on their own speech.

METHOD

Participants

Data was collected from thirty-three children (aged between 6;0 and 10;0) identified as having delayed speech development. These children were recruited as part of a study at Nemours/Alfred I. duPont Hospital for Children, Wilmington DE.

Stimuli

Speech stimuli consisted of six words presented in three conditions: the participant’s own speech (SELF) pronounced either correctly or incorrectly; words pronounced correctly by other children (OTHERS); and words mispronounced by OTHERS. Each of the six stimuli mispronounced by OTHERS contains a substitution error on a single consonant phoneme (see Table 1). Stimuli within each condition were presented twice during the perception experiment, yielding a total of 36 responses for the mispronunciation detection task.
TABLE 1. Word list and phoneme mispronounced by OTHERS

<table>
<thead>
<tr>
<th>Words</th>
<th>Misarticulated Phoneme</th>
</tr>
</thead>
<tbody>
<tr>
<td>barrel</td>
<td>/r/</td>
</tr>
<tr>
<td>fish</td>
<td>/ʃ/</td>
</tr>
<tr>
<td>locker</td>
<td>/o/</td>
</tr>
<tr>
<td>run</td>
<td>/r/</td>
</tr>
<tr>
<td>tooth</td>
<td>/θ/</td>
</tr>
<tr>
<td>trash</td>
<td>/ʃ/</td>
</tr>
</tbody>
</table>

Procedure

The perception task was completed in a sound-attenuated chamber using the Alvin, an experimental control software [13]. Children were seated in front of a PT1701MU touch screen display, from which response data was collected. During the mispronunciation detection task, children were presented each speech stimulus while a picture of the item was displayed on screen. They were asked to listen carefully to each of the stimuli and decide whether it was pronounced correctly by tapping on icons with a smiley-face (for correct pronunciations) or frowny-face (for incorrect pronunciations). Participants were able to replay each sound as many times as they wished before making a judgment.

Data Analysis

Mispronunciation detection performance was measured by calculating the proportion of errors made in each condition. A within-subjects t-test was used to assess differences in the mispronunciation detection when participants were judging their own speech or unfamiliar speech. A linear multiple regression model was then run to predict participants’ standardized GFTA-2 score. This model contained three predictors: errors on OTHERS well-articulated speech, errors on OTHERS misarticulated speech, and errors on SELF stimuli of all types.

RESULTS

Overall, participants in this study had an average standardized GFTA-2 score of 75.91 (SD = 15.56) and an average error rate of 0.24 (SD = .20) on the mispronunciation detection task. Analyses revealed that the SD children were more likely to make an error when judging their own speech (M = 0.33, SD = 0.17) than when judging the speech of unfamiliar children (M = 0.19, SD = 0.20), t (32) = -4.95, p < 0.001 (see Figure 1). Multiple regression analyses showed that data from the mispronunciation detection task accounted for a significant amount of variance in standardized GFTA-2 scores, $R^2 = 0.45$, $F (3, 29) = 7.79, p < .001$. Specifically, accuracy in detecting OTHERS ($\beta = -.40, p = 0.013$) and SELF ($\beta = -.44, p = 0.009$) mispronunciations were significant predictors, while accuracy in detecting OTHERS well-articulated speech was not significant (see Figure 2).
FIGURE 1. Boxplots of errors SD children made when judging their own speech (SELF) versus the speech of others (OTHERS).

FIGURE 2. Plot of participants’ standardized GFTA-2 score versus the score predicted by the multiple regression model.
DISCUSSION

Consistent with the results found in [11], the SD children made significantly more errors when judging their own speech than when judging the speech of other unfamiliar children. This discrepancy was found to be quite large as SD children made nearly 15% more errors on their own speech. Also as expected, and consistent with other research, there was a significant relationship between participants’ articulation and perception scores. The average number of errors children made when detecting the mispronunciations of others was found to have a negative impact on their GFTA-2 score. The ability of participants to label OTHERS well-articulated stimuli as correct was not found to be a significant predictor, but this is believed to be attributed to a floor effect in the average number of errors for this condition.

Interestingly, the number of errors a child made when judging SELF speech made a significant, independent contribution to the regression model in addition to accuracy at detecting OTHERS mispronunciations. This finding indicates that SD children’s ability to detect SELF mispronunciations is distinct from their ability to identify mispronunciations in OTHERS and may have a critical negative impact on their articulation ability.

While no control group was used for comparison in this study, the overall mispronunciation detection results are very consistent with those obtained in [9]. In that study, SD children had an average error rate of about 25% while we found an average of 24%. This finding is striking when considering the fact that the participants in [9] were a great deal younger (aged between 3;11 and 6;3) than the participants used in our study (aged between 6;0 and 10;0). The poor performance on mispronunciation detection observed in these two groups suggests that the underlying perceptual deficit can persist at least until age 10.

[5] and [6] have proposed that children with SD demonstrate poorer speech perception compared to typically developing peers because of deficits in their phonological representations. We propose that the findings described here are indicative of SD children having a more coarse phonological representation of phonemes in their own speech than the speech of others. Further study on SD children’s perception of their own speech is clearly needed. Future studies may aim at evaluating mispronunciation detection on more varied stimuli to verify whether the coarse phonological representations proposed here extend to phonemes not covered in this experiment.

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REFERENCES