PROGRESSIVE AND REGRESSIVE PHONOLOGICAL PROCESSES: AN AUDIOLOGICAL SCREENING OF CHILDREN AGED 3 TO 4

Eduardo D. Faingold
The University of Tulsa, Oklahoma, USA
faingolde@centum.utulsa.edu

ABSTRACT
An audiological and linguistic screening was conducted on 40 three- and four-year old children at an early childhood center. The effect of middle ear infections, flat tympanograms, and thresholds above 25 dB on the production of phonological patterns was examined. Children failing the audiological screening show a lower number of adult words (75%) and a higher number of substitutions (22%) and deletions (3%), while normal children exhibit a higher number of adult words (86%) and a lower number of substitutions (13%) and deletions (1%). These findings have implications for child linguists studying phonological processes in normal children, since it is suggested that children with a delay in the production of phonological processes may go undetected.

1. INTRODUCTION
I discuss two opposite effects in the production of phonological processes: 'progressive' phonology in 'non-refers'--children that failed the audiological screening (i.e. a high number of adult words and a low number of segmental substitutions and deletions) vs. 'regressive' phonology in 'refers'--children that passed the audiological screening (i.e. a low number of adult words, a higher number of segmental substitutions and deletions). The study is concerned with the value of early audiological and linguistic screenings in young children, since it is suggested that children with a delay in the production of phonological processes may go undetected.

2. METHODS
2.1. Subjects
The research subjects were 40 Caucasian middle-class three- to four- year old children at a kindergarten in Tulsa, Oklahoma. The subjects were all tested once in school by a certified audiologist and a graduate student of speech pathology.¹ The subjects are all monolingual speakers of the variety of American English spoken in northeastern Oklahoma.

2.2. Reliability
The phonological transcription was produced for each child by a certified audiologist and a graduate student of speech pathology, both of whom had extensive training in IPA phonetic transcription and are highly reliable transcribers (see note 1.).

2.3. Audiological screening
The audiological screening consisted of three standard audiological tests: otoscopy, tympanometry, and air conduction audiometry; the reason is that more than one test is needed to determine the presence of ear infections, hearing loss, and equalization tubes [4], [5].

2.3.1. Otoscopy
Otoscopy allows us to visualize the tympanic membrane; it is necessary to direct a light, as from an otoscope, into the external auditory canal. Because the tympanic membrane is semitransparent, such a light also allows some of the structures of the middle ear to become visible. In this study, the otoscope employed was the Reister from Germany. Otoscopy allowed the audiologist to detect fluid and a red and bulging ear; it also allowed her to detect the presence of pressure equalization tubes. In order to obtain objective data, children that have been intubated were excluded from this study.

2.3.2. Tympanometry
Tympanometry measures the compliance (i.e. the amplitude of the vibrations in response to a pure sound--a single wave-length sound) of the ear drum as a function of the pressure that is applied to the ear drum. The audiologist employed a portable tympanometer. Subjects who passed the tympanometry test show a bell-shaped curve, indicating a normal middle ear function, while a child who failed the test shows a flat tympanogram (i.e. the ear drum is showing great resistance to sound), indicating the likely presence of fluid in the middle ear or a perforation of the ear drum.

2.3.3. Air conduction audiometry
Air conduction audiometry specifies the amount of the patient's hearing sensitivity and range of hearing in the entire auditory system through the use of controlled amounts of sound. Measurements were made with the air conduction earphones of a portable audiometer at an intensity of 25 dB HL at the frequencies of 500, 1000, 2000, and 4000 Hz. Subjects who passed the air conduction screening can hear all tested frequencies or fail only one or two frequencies, while subjects who failed the air conduction screening cannot hear three, four, five, and six frequencies.

2.4. Speech and language screening
The speech and language screening tool used was the Fluharty Preschool Speech and Language Screening Test, which measures early speech and language performance on children, ages two to six [3]. Non-imitative samples of all fifteen words in the articulatory task of the Fluharty test were obtained for each child. The stimulus items are 'hat', 'bag', 'sock', 'knife', 'teeth', 'pencil', 'window', 'comb', 'ring', 'shoes', 'leaves', 'chair', 'feather', 'jelly', 'yes'; the items are designed to test the acquisition of a wide variety of initial, intermediate, and final consonants. Responses to the test items are elicited to identify children in need of in-depth diagnosis evaluation of speech and language skills. The test requires identifying objects and words, while articulation errors are noted; it also samples the child's level of vocabulary and proficiency of articulation.
3. RESULTS

3.1. Audiological effects

<table>
<thead>
<tr>
<th></th>
<th>Pass screening tests (non-refers)</th>
<th>Fail screening tests (refers)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>22 (55%)</td>
<td>18 (45%)</td>
<td>40 (100%)</td>
</tr>
</tbody>
</table>

Table 1. Audiological screening

In Table 1, eighteen children (45% of the total) failed the audiological screening (i.e. otoscopy revealed fluid and a red and bulging middle ear, and tympanometry revealed flat responses, or the children failed the air conduction screening at three or more frequency levels) and were considered as 'refers'; 22 children (55% of the total) passed the audiological screening and were considered as 'non-refers'.

3.2. Progressive and regressive phonological processes

An analysis and quantification of all phonological processes was conducted for the articulation errors (substitutions and deletions) produced by the subjects in all fifteen words in the Fluharty (see above). The analysis uncovers the percentage of substitutions, deletions, and adult words produced by the subjects, and reveals two opposite phonological results—progressive vs. regressive phonology [1], [2].

Below I discuss the effects of regressive phonology in children who failed the audiological screening; the effects of regressive phonology are compared with the effects of progressive phonology in children who passed the audiological screening. Table 2 shows the breakdown of the 330 words produced by the children who passed the hearing screening.

<table>
<thead>
<tr>
<th></th>
<th>Adult words</th>
<th>Substitutions</th>
<th>Deletions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>284 (86%)</td>
<td>44 (13%)</td>
<td>2 (1%)</td>
</tr>
</tbody>
</table>

Table 2. Progressive phonology: Pass the hearing screening

In Table 2, the children who passed the hearing screening produced a high number of adult words and a lower number of substitutions (e.g. /tif/ 'teeth') and deletions (e.g. /lis/ 'leaves'). Table 2 presents 284 adult words (86% of the total), 44 words with substitution (13% of the total), and two words with deleted segments (1% of the total). Table 3 shows the breakdown of the 270 words produced by the children who failed the hearing screening.

<table>
<thead>
<tr>
<th></th>
<th>Adult words</th>
<th>Substitutions</th>
<th>Deletions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>202 (75%)</td>
<td>60 (22%)</td>
<td>8 (3%)</td>
</tr>
</tbody>
</table>

Table 3. Regressive phonology: Fail the hearing screening

In Table 3, the children who failed the hearing screening produced a lower number of adult words and a higher number of substitutions (e.g. /wail/ 'knife', /lips/ 'leaves'), including stopping (e.g. /feder/ 'feather') and deletions (e.g. /lis/ 'leaves', /pesil/ 'pensil', /bal/ 'bag'). Table 3 presents 202 adult words (75% of the total), 60 words with substitution (22% of the total), and 8 words with deleted segments (3% of the total).

These results seem to support recent claims that reduced hearing acuity during the first years of life is likely to affect the language development of young children [4], [6], [7], [8], [9].

4. CONCLUSION

The results suggest a possible relationship between failure in the audiological screening and the production of a low number of adult words, and a high number of segmental substitutions and deletions (regressive phonology), as well as a relationship between passing the audiological screening and the production of a high number of adult words, and a low number of segmental substitutions and deletions (progressive phonology).

These findings have theoretical implications for linguists studying language acquisition in "normal" children. I suggest that researchers administer audiological tests such as those employed in this study for diagnosing possible hearing loss in "normal" children subjected to psycholinguistic investigation. Since it is suggested that children suffering a delay in the production of phonological processes may go undetected, it is likely that earlier studies in the child language literature may have wrongly classified some of those children as "normal" (i.e. progressive); and child linguists may have increased the variability of what is considered normal behavior.

ACKNOWLEDGMENTS

Analysis of the data was supported by a University of Tulsa Faculty Development Summer Fellowship and Research Support Grant #20-2-1010114 to the author.

NOTE

1. Dr. Parker Haberly conducted the hearing and linguistic evaluations at the University of Tulsa. Dr. Haberly is specially trained to work with children and holds a Ph.D. in audiology and a Certificate of Clinical Competence from ASHA. Ms. Lori Burns, a graduate student in speech pathology, assisted Dr. Haberly with the tests.

REFERENCES