Does fluctuating conductive hearing loss affect children's phonological development in the early ages?

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Keywords

acute otitis media, fluctuating hearing loss, phonological development

Introduction

It is well established that a child's communicative development, cognitive development, and academic achievements can all be seen as directly linked to his/her language development. Therefore, it is of vital importance to identify each individual child who is at risk of delayed language development. Children with hearing loss constitute a high-risk group for delayed language and speech development. Acute otitis media is one of the etiological factors of hearing loss.

Children with recurrent episodes of acute otitis media, 3 or more episodes during a 6 months period, are said to be otitis prone (Swedish consensus conference on otitis media, 2000). Retracted tympanic membrane or effusion in the middle ear can emerge following each episode, leading to fluctuating hearing loss (Rovers et al, 2004). This hearing loss spans 0-40 dBHL and can vary in its configuration, although it is traditionally said to affect all frequencies (Northern and Downs, 2002). Thus, during a number of episodes of retracted tympanic membrane or effusion in the middle ear, fluctuating and degraded acoustic signals are presented to the cochlea, limiting children's ability to discriminate, store and reproduce appropriate acoustic contrasts between speech sounds (Shriberg et al, 2003). As Shriberg and his co-workers point out, the numerous studies on otitis prone children's language development do not present an unequivocal answer as to whether there is a clear impact of recurrent episodes of acute otitis media on language development. This lack of consistency can partly be explained by methodological differences between investigations, and partly by different authors using different approaches to language.

A reliable way of examining a child's developmental level of receptive and expressive language is to focus on a detailed description of the child's phonology. This includes an autonomous description of the child's own phonological system, containing word structure, syllable structure and segment structure (i.e. Bernhardt and Holdgrafer, 2001), and a description of the child's developmental phonological processes. These processes, established by Ingram (1976), include syntagmatic and paradigmatic processes, describing the relationship between the child's production and the target word.

This pilot study, as the first stage of an extended, longitudinal study, aims to present a complete description of otitis prone children's autonomous phonological systems, and the distribution of their developmental phonological processes.

Method

Eight children were included in this study; 4 otitis prone children (+OPC), and 4 non otitis prone children (–OPC) with matching age and gender. The +OPC group consisted of 2 males, age 30 months, and 2 females, age 42 months. The study has undergone an ethical review.

A Swedish picture naming test, *Stora Fonemtestet*, (Hellquist, 1984), including 103 pictures, was used. The full test situations were recorded using a portable digital recorder, Micro Track 24/96. Each recording was transferred and stored as a data file, and narrowly transcribed.

First, the child's autonomous phonological system was examined: 1) the distribution of the words according to their length, expressed as number of syllables, 2) the distribution of the syllables according to their structure, and 3). the distribution of consonant phonemes, with respect to manner and place of articulation. Thereafter, the occurrence of the developmental processes was examined, according to the method presented by Yavaş (1998). Due to the small number of participants, no statistical analyses were undertaken.

Results

Autonomous phonological system

Figure 1 illustrates the proportion of mono- (S), di- (SS), and polysyllabic (Others) words. Data for the age groups are collapsed. It appears, that +OPC produced a slightly lower proportion of disyllabic words than did –OPC.

Figure 2 shows the proportion of CV-, CVC-syllables, and syllables containing pre- and/or postvocalic consonant clusters (Others). An inverse effect seems to be present between the proportion of CVC-syllables, and

syllables containing consonant clusters. As can be seen in Figure 2, +OPC produced a slightly higher proportion of CVC-syllables, and a lower proportion of syllables including consonant clusters, than did –OPC.

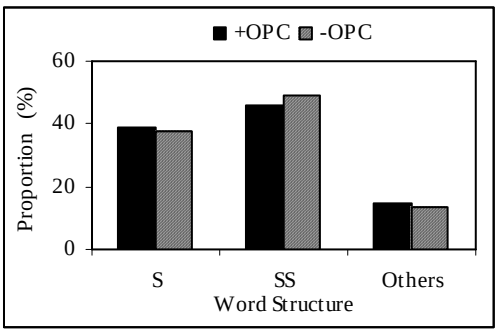

Figure 1. Distribution of word structures

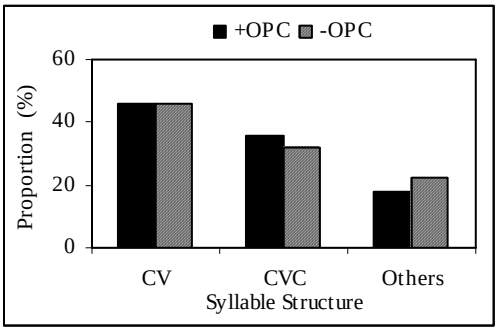

Figure 2. Distribution of syllable structures

In Figure 3, the distributions of consonant phonemes are presented, based on their manner of articulation. An inverse effect seems to appear between the distribution of fricatives and trills. The +OPC group produced a slightly higher proportion of fricatives and lower proportion of trills, than did the –OPC group.

The distributions of consonant phonemes, based on their place of articulation, are presented in Figure 4. The bar label "Others" refers to two articulation places: 1) simultaneous labial-palatal, and 2) glottal. As illustrated in Figure 4, an inverse effect appears to be present between the distribution of dentals and palatals. The +OPC group produced a higher proportion of palatals and velars, and a lower proportion of dentals, than did the –OPC group.

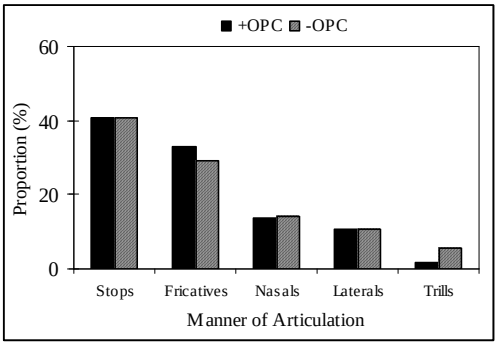

Figure 3. Distribution of consonant phonemes – manner of articulation

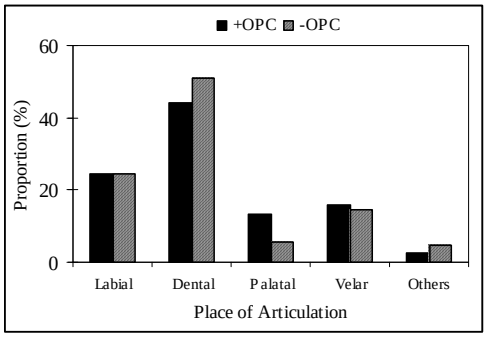

Figure 4. Distribution of consonant phonemes – place of articulation

Process description

The percentages of possible occurrences of the syntagmatic processes that are realized can be seen in Figure 5. The bar label "Others" includes processes like assimilation and vowel neutralisation. As Figure 5 demonstrates, +OPC appeared to realize weak syllable deletion and consonant cluster simplification to a considerably greater extent than did –OPC.

Figure 6 presents the distributions of the paradigmatic processes. The bar label "Others" includes processes like nasalisation, de/voicing and backing. According to Figure 6, also other processes seemed to occur slightly more often in +OPC than in –OPC.

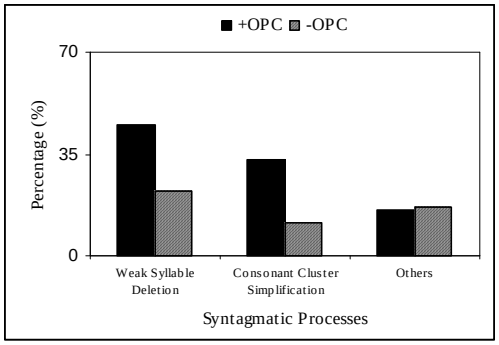

Figure 5. Percentages of possible occurrences of the syntagmatic processes that are realized

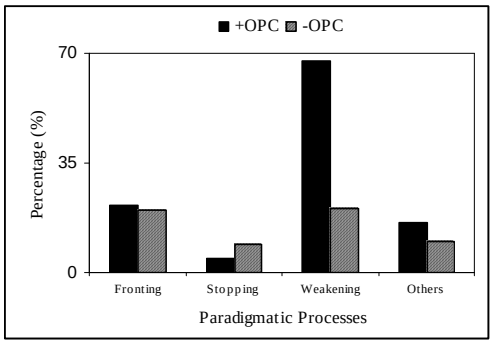

Figure 6. Percentages of possible occurrences of the paradigmatic processes that are realized

Discussion

The findings clearly show a strong relationship between the autonomous description and the process description: 1) Word Structure and Weak Syllable Deletion, 2) Syllable Structure and Consonant Cluster Simplification, and, 3) Segment Structure and Fronting, Stopping or Weakening.

First, a clear connection between shortening of words with respect to the number of syllables and the syntagmatic process of weak syllable deletion would be expected. However, the present pilot study did not show this effect. In spite of the relatively higher occurrence of weak syllable deletion (Figure 5) in +OPC, only small differences were found between the +OPC and –OPC on the word structure level (Figure 1). A possible explanation for this is that it has been observed that, when children name the pictures, they alternate between a noun's definite and indefinite forms, although they could be expected to use the indefinite form. In Swedish, using the definite form of a noun often involves an additional syllable (for example: Swe: ett hus – huset, Eng: a house - the house). Nevertheless, weak syllable deletion would still be seen as a characteristic phonological process in the speech of otitis prone children. According to the authors' own observations, unstressed syllables are usually 6 dB weaker than stressed syllables. Considering +OPC's fluctuating hearing loss, unstressed syllables, being only half as loud as stressed syllables, might not be perceived, and therefore deleted.

Second, at the syllable level, +OPC were found to produce a higher proportion of CVC-syllables, and a lower proportion of syllables containing a consonant cluster (Figure 2). This tendency can be explained by the fact that +OPC use the developmental phonological process of consonant cluster deletion to a greater extent than –OPC (Figure 5). When pre- and/or postvocalic consonant clusters are reduced to singletons, the complexity of syllables becomes simpler. The acoustic events correlated with consonant clusters might be too complex for the children with fluctuating hearing loss to perceive and produce.

Third, at the segment level, considering manner of articulation, +OPC seems to use a higher proportion of fricatives at the expense of trills (Figure 3). The corresponding phonological process is weakening, meaning that the trill /r/-sound is substituted by the fricative /j/-sound (Figure 6). Acoustically, the apical r-phoneme is usually seen as being acquired relatively late. From this investigation, it appears that +OPC might have more difficulties with this sound than –OPC. Considering place of articulation, the correspondence between the consonant phoneme distribution (Figure 4) and the underlying paradigmatic processes (Figure 6) needs to be analyzed further. However, it was observed, that +OPC often replaced the dental s-sound with a palatal fricative. The acoustical energy for this substitute concentrates on lower frequencies than that of the s-sound, and thus, this backing might reflect the effects of the fluctuating hearing loss.

Conclusion

Summarising, this pilot study tentatively supports the point of view that fluctuating hearing loss affects phonological development.

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