Perceptual evaluations of children with language impairment and deviant Voice Onset Time

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Abstract

This study investigated how naïve listeners assess words with initial plosives and deviant voice onset time produced by children with language impairment. Thirty-four adults (19 ♂ and 15 ♀) aged 22–60 years assessed 102 words with deviant VOT produced by children (4;2–11;6 y) recorded at SLP-clinics and language pre-school and school units. The participants identified 79% of the words correctly. Words with deviant short VOT had a slightly higher rate of error responses in comparison to words produced with a deviant long VOT. Most participants perceived the words with deviant long VOT as produced with voiceless plosives and words produced with deviant short VOT as having a voiced plosive. The results indicate that other factors than VOT must be taken into consideration for perceptual discrimination of the plosives.

Introduction

Children with speech and language deficits form a large but heterogeneous group. In many cases the causation is obvious. However, there is a large subgroup with articulatory problems without identifiable aetiology.

Within the field of speech and language disorders there is an on-going debate whether the problems of these children are caused by insufficient linguistic knowledge, processing deficits or limitations of motor speech control (Marinis, 2008; Alcock, 2006). Regarding the aspect of motor speech control, different speech sounds require different degree of motor coordination and control. Plosives are among the sounds that place high demands on motoric skills with requirement of a close co-ordination between the larynx and the lips, tongue and jaws (Auzou et al., 2000).

Auditory perceptual evaluations form the basis for the routine assessment of speech and language in clinical speech and language pathologist practice. However, by using acoustic analysis further insights of error patterns can be provided (Ballard & Robin, 2002).

Voice onset time is regarded to be a reliable acoustic cue for the distinction between voiceless and voiced plosives (Helgason & Ringen, 2008), and is considered to reflect the co-ordination between articulatory gestures and phonation (Hoit-Dalgaard, Murray & Kopp, 1983). It is defined as the time between the release of the oral closure and the onset of voicing and is measured in milliseconds. For the voiceless plosives typical Swedish adult values range between 49 and and 78 milliseconds and the corresponding range for the voiced plosives is –91 and –61 milliseconds (Lundeborg et al., 2012).

The perceptual boundary for correctly identifying a plosive as voiced or unvoiced is between +20 and +40 ms (Zlatin & Koenigsknecht, 1976). In two studies of typically developing Swedish children, a clear developmental trend was found both regarding length of VOT for the voiceless plosives and the occurrence of prevoicing in their voiced counterpats.

Adult-like values were established somewhere between 9 and 10 years of age (Larsson, & Wiman, 2010; Lundeborg et al., 2012). In children with phonological impairment atypical VOT-patterns are found and the variability is greater compared to normative data (Bond & Wilson, 1980; Lundeborg et al., submitted).

The aim of the present study is to investigate how productions with atypical VOT-values by children with speech and language impairment are perceived by adult naïve listeners.

Material and methods

A total of 34 mono-lingual Swedish speaking adults (19 ♂ and 15 ♀, 22–60 years, median age 31.5 years) with normal hearing and no specific knowledge of speech and language development participated in the study. The

participants listened to a sound file consisting of recordings of 102 plosive words with deviant VOT produced by 38 children with speech and language impairment.

The material was collected in a previous study (Lundeborg et al., submitted). VOT-values above or below one standard deviation from the mean values for the typically developed children in Larsson and Wiman (2010) and Lundeborg et al. (submitted) were defined as deviant. The participant's task was to select which one out of two words within a minimal pair they heard and also indicate if they were secure or insecure when choosing. A random selection of ten productions was duplicated into the sound file to check for intra-rater agreement.

Statistical analysis

Data were expressed with descriptive statistics for the occurrence of wrong answers. Comparisons between the genders and between words with VOT deviation above and below 1 SD from norm values were made by the use of MannWhitney U-test and a $p < 0.05$ was considered statistically significant.

Results

The participants identified 79% of the words correctly. Words with deviant short VOT-values (below 1SD from norm value) were harder to identify than words with deviant long VOT-values ($p < 0.001$). No gender difference was found. The greatest number of indications for unsecure choices was for the words with deviant long VOT. The intra-rater agreement was .89.

Discussion

Despite listening to productions with deviant VOT values between 1 and 3 SD form norm values the proportion of correct identifications was considerably high (79%). This could be interpreted as that the listeners used other cues in the word identification process. One such factor could be the fortis-lenis distinction, namely that the voiceless plosives are produced with a higher burst intensity than their voiced counterparts. Another relevant factor could be that the voiceless plosives in Swedish in a stressed syllable have a prominent aspiration (Lindblom, 2008). Speech rate is also reported to have influence on perception of syllables with initial plosives (Kessinger & Blumstein, 1998). Further research is needed regarding which cues listeners use when identifying words.

Conclusions

Despite deviances in VOT in the production of plosive-initial words the perceptual assessments of the productions were fairly adequate. Further research is needed of which cues listeners use in the identification process when assessing words with initial plosives.

Notes

The study was carried out in accordance with the etical principles for medical research of the Helsinki declaration as revised in 2008 (World Medical Association, 2008).

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