ASSIMILATION OF VOICE IN SPEECH DEVELOPMENT

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ABSTRACT

In Dutch, assimilation of voice is a common phenomenon. In adult speech many factors influence the assimilation process. In the present study we report on assimilation of voice in children. The data show that speech development is a factor which strongly influences the assimilation process. The data are interpreted within a phonetic and a phonological framework.

INTROCUCTION

Assimilation of voice in Dutch has been investigated in several phonetic and phonological studies. With respect to phonology, the assimilation process can be described by an ordered set of rules (see [1]). Summarizing, it may be said that, in a two-obstruent cluster, the first phonemically voiceless obstruent becomes voiced if followed by a voiced stop (e.g. 'klapdeur' /pd/->/bd/, and 'stofdoek' /fd/->/vd/). This process is called *regressive* assimilation. When the second phonemically voiced fricative becomes voiceless if preceded by a voiceless obstruent (e.g. 'potvis' /tv/->/tf/) it is called *progressive* assimilation. Zonneveld [2] argues that progressive assimilation is fed by the rule of final devoicing (e.g.'rondvaart /tv/ -> /tf/) and that the voicelessness of the cluster could be generalized lexically in Dutch.

From a phonetic point of view the assimilation process is characterized by an overlap of articulatory gestures; an inherent feature in a sound segment is altered under the influence of a neighbouring segment, and, since this accomodation occurs systematically, it is incorporated in the phonology of the language. In a phonetic empirical study by Slis [3] assimilation of voice is described in terms of laryngeal adaptation in which several articulatory parameters are involved. Slis assumes that the assimilation process is a form of coarticulation based on the mechanical and aerodynamic properties of the vocal cords.

Many factors influence the assimilation process [4], such as 'sex of the speaker', 'speaking rate', 'phonological composition of the cluster', 'word stress', and 'linguistic boundary'. In a recent study by Menert [5] it is argued that voice assimilation is a gradual and optional process; a discrete classification on the basis of articulatory features is arbitrary. Thefore, she assumes that, primarily, assimilation of voice is part of the grammar of the language user and originates in the internalized phonological rules.

So far, all findings on assimilation of voice in speech production were deduced from adult speech utterances. Actually, assimilation of voice in child speech has never been examined, although it will be most instructive with respect to both the phonetic and phonological explanation of voice assimilation. The research questions in this production study are: Do young children assimilate to the same extent as adult speakers? How are progressive and regressive assimilation distributed across age groups? Do children also assimilate more frequently within compound words than across a word boundary (influence of a Inguistic boundary)?

METHOD

Participants

Three age groups participated in the experiment; 6-year-olds (mean age 6;4), 12-year-olds, (mean age 12;2), and adults (between 25-30). In each group there were three male and three female speakers. On the basis of a pilot experiment we excluded a group of four-year-old children because of problems with both the word material and the recordings.

Material

In total 21 items were selected; 8 two-syllabic compound words, and 13 two-word items (all adjective-noun combinations). In each item the first syllable was stressed. The items contained heteroganic stop-stop, fricative-stop, stop-fricative, and fricative-fricative (C1C2) clusters (see Table 1). All words were known by 6-year-olds, and they were represented by pictures.

Table 1. Illustration of the words with word-medial two-obstruent clusters (for instance, (stropdas= 'tie', knapdier= 'clever animal')

cluster	compound	two-word item
stop-stop	stropdas	knap dier
fric-stop	leesboek	zes ballen
stop-fric	broekzak	leuk vest
fric-fric	grasveld	zes vogels

Task

In all groups the words were elicited by picture cards in a sentence completion task, e.g. 'A book for reading is a ... reading book' (leesboek). In this way the segmental characteristics of the item would not be disturbed. In the two-word items the adjective was always stressed by asking the opposite qualification, e.g. 'These are not five balls but ... six balls' (zes ballen).

Recordings

Recordings were made of both the microphone signal and the electrolaryngograph signal on separate channels of an audiotape (recorder Revox A77). Exact timing of the glottal activity was registered simultaneously with the output of the microphone. All subjects were recorded twice and both recordings were used for further analysis. Besides, no problems occurred during the recordings.

Measurements

Both signals were stored on a microVAX II computer. For actual measurements both visual and auditory information were available. For the adult speakers we maintained the standard criteria of Slis (see [3], [6]). Since the laryngeal configuration of children differs from adults we normalized the adult criteria for the children's realizations. The normalization was done on the basis of voice continuation (voice tail) in intervocalic voiceless stops. In child speech we considered the first obtruent of the cluster to be voiced if the voice tail exceeds 31.5 ms. For the adults the standard 50 ms criterion was used. All other parameters were identical in the children and the adults.

RESULTS

Phonological composition

With respect to the clusters with final fricative (C2) both children and adults display 100% progressive assimilation. This corresponds to the phonological rules [1]. With respect to the clusters with final stop, voice assimilation is either absent, progressive, or regressive. The latter group of items are analysed further for the different age groups.

Age groups

The assimilation categories are distributed differently across age groups (chi^2= 36.54; $p<0.001$; data pooled across words). Both groups of children pronounced the C1C2 clusters with predominantly *progressive* assimilation (see also Figure 1). The adults show mostly *regressive* assimilation. Assimilation does not differ significantly between younger and older children, but it does differ between both groups of children and adults (chi^2= 29.45; $p<0.001$) . The number of words without assimilation do not

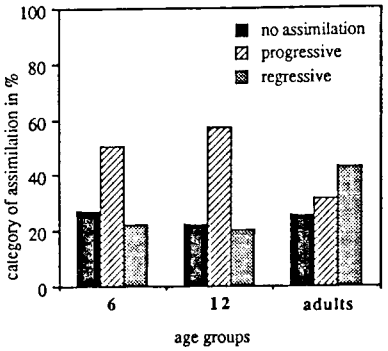

Figure 1. Frequency of occurrence of assimilation (in %) in the age groups.

deviate largely between groups. In none of the age groups a significant difference was found between male and female speakers.

Stop-stop and fricative-stop

In a log-linear analysis possible interactions were tested between the variables 'age', 'manner of articulation of C1' (i.e. stop/fricative), and 'assimilation category'. A significant difference was found for the interactions 'age' by 'category' and 'age' by 'C1' (chi^2=54.52; p<0.001 for fric-stop, and chi^2=10.81; p<0.01 for stop-stop). In the fricative-stop clusters regressive assimilation increases systematically with age, while in the stop-stop clusters a less regular pattern is present.

Linguistic boundary

So far, we did not take into account the linguistic boundary. In one part of the corpus the two-obstruent clusters were situated within a compound word, in the other part they were situated across a word boundary. In the (adult) literature it was found that regressive assimilation occurs more frequently in compound words than across a word boundary. In the present study the adults maniested the same tendency; a significant difference was found for the interaction 'assimilation category' by 'linguistic boundary' (chi^2=28.89; p<0.001). No significant difference was found for the interaction 'age' by 'linguistic boundary'. However, a significant difference was found between children (age 6 plus 12) and adults for the clusters within words (chi^2=18.10; p<0.001) and across a word boundary (chi^2=18.70; p<0.001). The data are indicated in Figure 2. Briefly, children use predominantly progressive assimilation irrespective of the linguistic boundary.

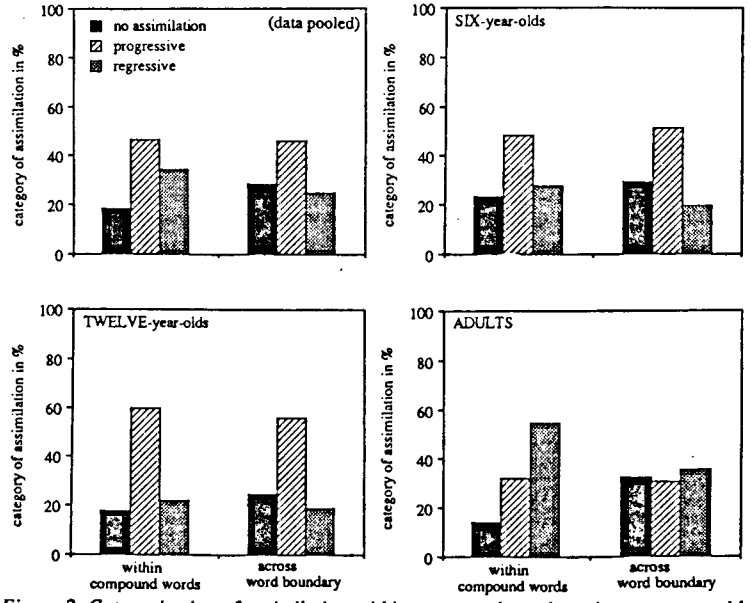

Figure 2. Categorization of assimilation within compound words and across a word boundary for data pooled across age groups, and for the four age groups.

DISCUSSION

We have seen that two-obstruent clusters with a rightmost phonemically voiced fricative, are always assimilated progressively in all age groups. The voiced character of the fricative (closing gesture of the glottis) is overruled by the voiceless character of the preceding obstruent (opening gesture of the glottis). Devoicing of the obstruent-fricative clusters seems to be internalized in the phonological system of the speaker. The data of the young children affirm this claim.

With respect to the obstruent-stop clusters the results lead to the following answers to the research questions. The 6- and 12-year-old children do not assimilate less than adults, but they assimilate differently. While adults show more regressive than progressive assimilation (43% *vs.* 31%), 6- and 12-year-old children display more progressive than regressive assimilation (50% (6) and 57% (12) *vs.* 23% (6) and 20% (12). Furthermore, voice assimilation in children is not influenced by the linguistic context. In adult speakers regressive assimilation occurs more often within words than across a word boundary, whereas in children progressive assimilation dominates irrespective of the strength of the linguistic boundary.

From a phonetic point of view, the predominance of progressive assimilation in children can be explained by the fact that children have more difficulty in maintaining voicing during an obstruction than adults. The articulation-based persistence of voicelessness is easier, and will also be stronger than the influence of the linguistic boundary.

From a phonological point of view, the children's data can be interpreted within a phonological framework. First, they have a general rule deleting voice, fed by the final devoicing. The learning process consists of recognizing that rightmost fricatives cause a voiceless cluster but stops don't. Later on, the interaction between voice assimilation and strenght of the linguistic boundary will be incorporated into their phonological system.

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REFERENCES

[1] Booij, G.E. (1981). *Generatieve fonologie van het Nederlands.* Utrecht-Antwerpen: Spectrum.

[2] Zonneveld, W. (1983). "Lexical and phonological properties of Dutch voicing assimilation". In: M. van den Broecke, V. van Heuven & W. Zonneveld (Eds.). *Sound Structures: Studies for Antonie Cohen.* Dordrecht: Foris Publications, pp. 297-312.

[3] Slis, I.H. (1981). "The effect of speaking rate on assimilation of voice". *Proceedings of the Institute of Phonetics of Nijmegen* 5, pp. 160-176.

[4] Slis, I.H. (1986). "Assimilation of voice in Dutch as a function of stress, word boundaries, and sex of the speaker and listener". *Journal of Phonetics* **14**, 311-326.

[5] Menert, L. (1994) *Experiments on voice assimilation in Dutch: Prosodic structures and tempo.* Utrecht: OTS dissertation series.

[6] Kuijpers, C.T.L. (1993). *Temporal coordination in speech development: A study on voicing contrast and assimilation of voice.* Unpublished Ph.D. Thesis, University of Amsterdam, The Netherlands.