

THE ACQUISITION OF VERBAL MORPHOLOGY IN GERMAN CHILDREN WITH HEARING IMPAIRMENT - A FOLLOW UP STUDY AT AGE 7

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ABSTRACT

The acquisition of verbal morphology may be affected in children with hearing impairment (HI). In a recent study on the acquisition of subject-verb agreement (SVA) in German children with a mild-to-moderate HI (age 3-4), these children show a delay of about one year compared to age-matched controls (Penke et al. 2014). This delay is more pronounced in the production of the verbal inflections *-st* and *-t* (i.e. 2nd and 3rd sg. markers) than in the production of *-n* (3rd pl.). This result has been interpreted as a consequence of the reduced perception of high-pitched sounds which affects /s/ and /t/ in particular, but not /n/ (Hennies et al. 2012; Penke et al. 2014). The question arises whether children with HI are able to catch up within this domain, or whether the delay leads to a stable deficit.

11 children from the previous studies by Hennies et al. (2012) and Penke et al. (2014) were re-tested at age 7 using the same experiments. The 7-year-old children significantly improved their performances in perceiving and producing word final /s/ and /t/. Furthermore, all children (but one) show a relevant progress in the area of SVA at age 7. We conclude that while hearing-impaired children show selective difficulties in the production of SVA at the age of 4, the majority catches up in this domain up to age 7, based on improvements in perceiving and producing the relevant phonemes.

INTRODUCTION

Recent studies indicate that young children with a sensorineural HI show deficits with inflectional morphology (e.g. Norbury et al. 2001; McGuckian & Henry 2007; Moeller et al. 2010; Koehlinger et al. 2013). Sensorineural hearing deficits particularly affect the perception of phonemes that fall into higher frequency ranges of 2000-8000 Hz.

Hence, the majority of children with HI has difficulties hearing high-pitched sounds even if provided with modern hearing aids (Pittman & Stelmachowicz 2003; Eisenberg 2007; Müller-Deile 2009). The speech spectrum ('speech banana') (see Fig. 1) illustrates the distribution of phonemes across the relevant frequency ranges, highlighting the high-pitched sounds /s/ and /t/ and the low-pitched nasal sounds. All three phonemes function as inflections in the SVA paradigm in German.

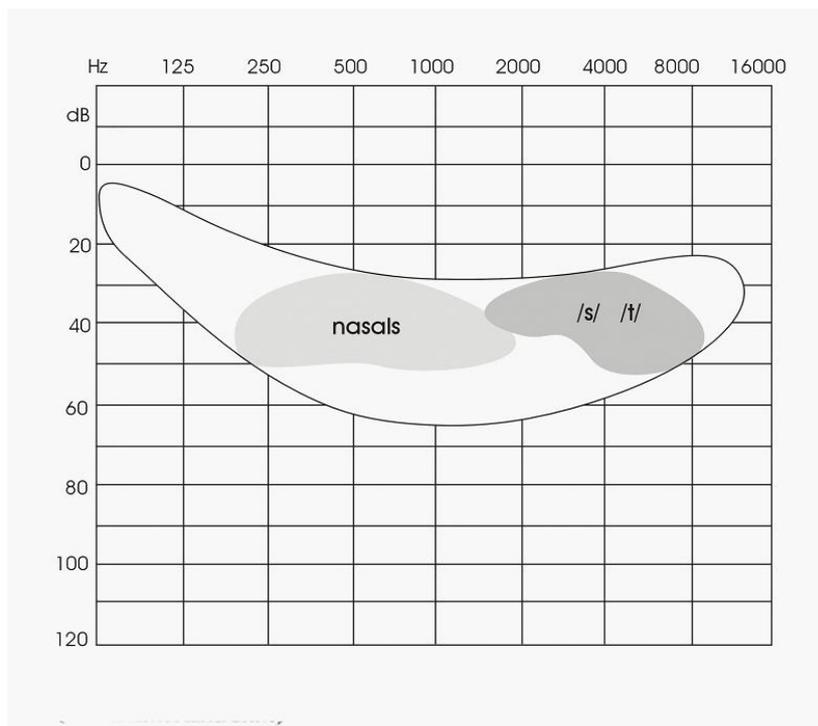


Figure 1: 'speech banana': distribution of /s/, /t/ and nasals in different frequency ranges (based on Fant (2004))

German subject-verb agreement inflection

German SVA inflection marks the morphosyntactic dimensions person and number. Here, we will focus on the 2nd singular marker *-st*, the 3rd singular marker *-t*, and the 3rd plural marker *-n* that are expressed by the coronal consonants /s/, /t/ and /n/. Most verbal stems end in one or two consonants. Inflecting a verb with the suffix *-st* or *-t*, hence, leads to an accumulation of word-final consonants (e.g. *trink + st* -> *du trink-st* 'you are drinking'). The syllable structure in German allows up to three obstruents to follow the nucleus of the syllable.

The investigation of SVA inflection in German sensorineural hearing-impaired children is particularly interesting due to at least two reasons. First, of the three coronal consonants /s/, /t/ and /n/ that serve to express SVA in German, the voiceless consonants /s/ and /t/ are more difficult to perceive than the nasal /n/ in HI. This results from the fact that the former obstruents have a higher pitch compared to

nasal consonants such as /n/ (cf. Fig. 1). Second, the acquisition of the SVA paradigm constitutes an important milestone in the acquisition of the German language (Clahsen & Penke 1992) and is severely affected in children with SLI (Clahsen et al. 1996; Rothweiler et al. 2012), suggesting that this grammatical domain might be particularly vulnerable for language disorders (Penke 2008).

Results of previous research

In previous studies we investigated whether and how the system of SVA inflection is affected in children with sensorineural HI aged 3 to 4. Specifically, we explored if difficulties in perceiving specific phonemes in HI relate to problems in producing and/or acquiring inflectional suffixes expressed by these phonemes (Hennies et al. 2012; Penke et al. 2014). We used three experiments: Elicited production of SVA inflections, production of the relevant phonemes in word-final position (no inflections) and discrimination of word-final high-pitched obstruents (for details see METHODS). Our results have shown that hearing-impaired children have particular problems in identifying and producing coronal consonants in syllabic offsets, especially in complex offsets. In all three experiments, the group of children with HI scored significantly below the age-matched control group. We also observed that the discrimination and production of phonemes /s/ and /t/ is more difficult than the nasal /n/ for hearing-impaired children. This may be explained by the fact that /s/ and /t/ are located in a higher frequency range and are thus less perceivable for children with HI (Hennies et al. 2012). These problems are responsible for a delay in the acquisition of SVA by hearing-impaired children (Penke et al. 2014).

Aim of the present study

The question arises whether children with HI are able to catch up on the domain of SVA, or whether the delay results in a stable deficit. We addressed this issue by investigating the acquisition of verbal agreement morphology in a follow-up group of German children with sensorineural HI at age 7 using the same experiments as in the previous studies by Hennies et al. (2012) and Penke et al. (2014).

PARTICIPANTS

Eleven children with a bilateral HI as a result of congenital sensorineural hearing loss with an average of 54dB (range 32-75 dB) in the better ear (unaided) were tested. All

were fitted with bilateral hearing aids. They were recruited from intervention centres, (pre-)schools, medical centres and paediatric audiologists, were monolingual German and showed no other physical or cognitive impairments. At the first point of examination (p1) the children were 3 to 4 years old. They achieved an average IQ-score of 101 (range 78-118) (cognitive structures of the SON-R). The same children were tested again four years later at the age of 7 to 8 (p2).

MATERIALS AND METHODS

During the experimental session the children wore their hearing aids. The sessions were videotaped and phonetically transcribed.

Elicitation task: description of video scenes

We conducted a production task during which the children were asked to describe an action depicted in 30 short silently presented video scenes.

The videos show actions that were either performed by a single child (1st singular), two children (3rd plural), or by the investigator (2nd singular). One scene shows e.g. the experimenter laughing (2nd singular *du lach-st* 'you laugh'). The presented actions can be described by main verbs that are part of the vocabulary of preschool children.

The videos were presented on a computer screen. Each video runs about 10 seconds. The 30 videos (10 per grammatical context tested) were presented in two blocks of 15 trials in a randomized order. After presenting the video the experimenter asked the child 'What is happening there?' to elicit the production of an utterance containing a finite verb.

Picture-naming task

To investigate whether omissions of /s/ and /t/ occur independently of the morphosyntactic content of these phonemes, we examined the ability of hearing-impaired children to produce the relevant phonemes in syllabic offset positions of simplex nouns where these phonemes are part of the noun stem.

We used 18 picture cards (plus one practice card) that illustrate six nouns whose stems end in /s/ (e.g. *Eis* 'ice'), six ending in /t/ (e.g. *Hut* 'hat') and six nouns ending in /n/ (e.g. *Bahn* 'train'). All target nouns are monomorphemic and are part of the vocabulary of preschool children.

The investigator presented the picture to the child and asked the child to name the object.

Discrimination of final consonants (FinKon-Test)

We developed a new perception test (FinKon-Test = *Finale-Konsonanten-Test* 'test for final consonants') in which the consonants /s/, /t/ and /n/ have to be discriminated at the end of a word.

The test design is similar to usual speech-audiometric-tests and is constructed as a picture-word-matching-task. There are 14 minimal or quasi-minimal pairs (28 nouns, e.g. *Ei* 'egg' - *Eis* 'ice'; unrelated distractor - *Eimer* 'bucket'). One of the three words is the actual test item (*Eis*), one is the phonological distractor (*Ei*).

There were two test blocks, each consisting of 14 items. Testing took place in a quiet room. The items were presented by two loudspeakers with a level of loudness of 65 dB. The instructor asked the child to point at the picture referring to the word the child hears. After the first test block the child was involved in a playing activity in order to minimize a possible memory effect. In the second test block, the phonological distractors were presented as test items, whereas the test items of the first block became phonological distractors.

DATA ANALYSIS

On the basis of all analysable reactions, we calculated percentages for each individual subject as well as group averages for each of the critical test conditions. In the following, we present the group-results of the first testing at age 3 to 4 (p1) and of the follow-up testing at age 7 to 8 (p2).

Results

Results of the video experiment

First, all reactions were categorised in analysable and not analysable reactions with regard to SVA. To count as analysable, the reaction had to be clearly based on the video and had to contain both a main verb and a subject. We identified 532 reactions as analysable (p1: 226, p2: 306).

Figure 2 summarizes the results of the video experiment. At p1 the children produced 80% correct reactions over all contexts on average. At p2, the mean correctness score was 96%. This difference was significant (t test: $t = -2.24$, $p = 0.015$).

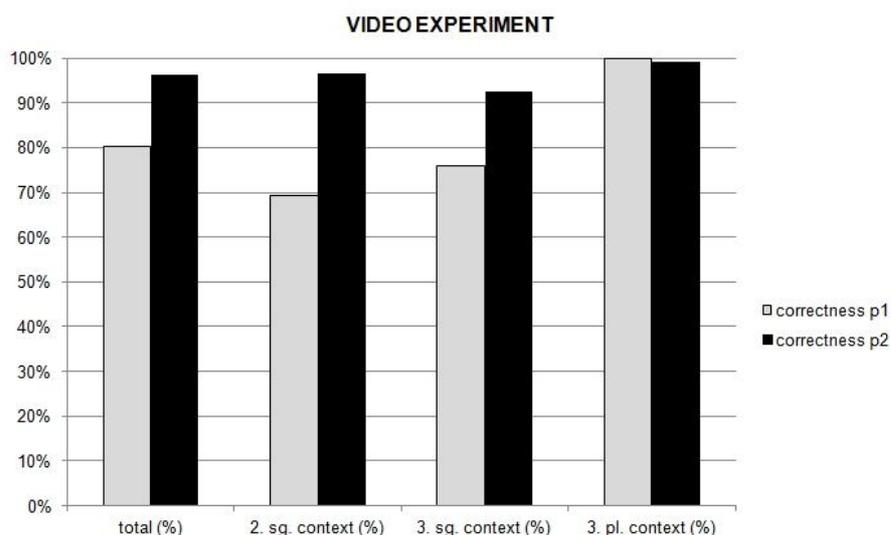


Figure 2: Correctness scores in the video experiment at p1 and p2

While in contexts for 2nd and 3rd singular the children produced the inflectional markers *-t* and *-st* less than 80% correct at p1, they produced over 90% correct inflections in 3rd plural contexts that are marked with *-n*. At p2, the same children achieved accuracy scores of over 90% for the affixes *-st* and *-t* in 2nd and 3rd singular contexts. The difference between p1 and p2 is significant for the two contexts (*-st/-t*: *t* test: $t = -2,766$, $p = 0.02$). Furthermore, the results show a clear difference between the production of *-t* and *-st* in the relevant contexts on the one hand, and *-n* in 3rd plural contexts on the other for the first testing (p1), but not for the second (p2).

Results of the picture-naming task

The utterances of the hearing-impaired children were categorised in analysable and not analysable. We classified lexically wrong designations, unspecific reactions (as 'I don't know.') as well as strong mispronunciations as not analysable. 412 (p1: 197; p2: 215) utterances were identified to be analysable. For all analysable reactions it was then counted whether or not the critical stem-final phonemes /s/, /t/, /n/, and /m/ were produced. Production scores increased from 78% at p1 to 96% at p2 (see Fig. 3). The difference between p1 and p2 is significant (*t* test: $t = -3,040$, $p = 0.012$).

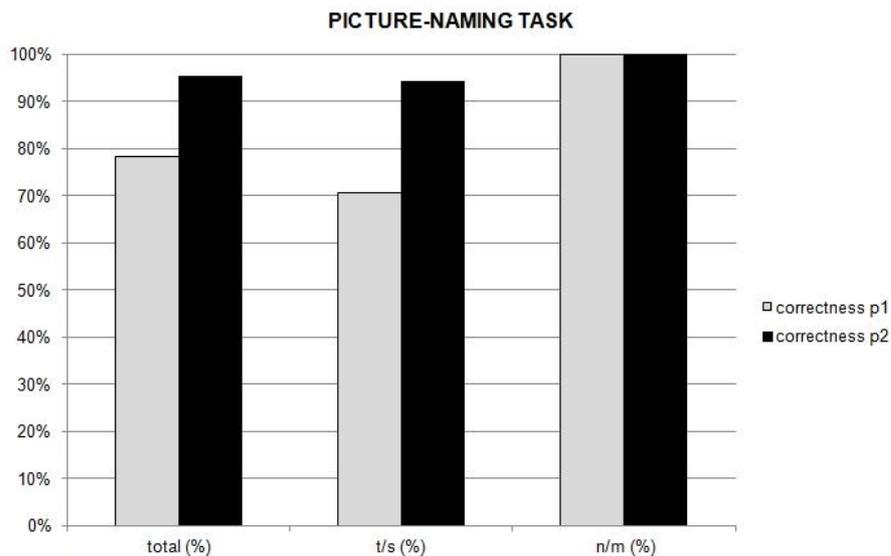


Figure 3: Correctness scores in the picture naming task at p1 and p2

Figure 3 also differentiates between the correct words ending with /t/ or /s/ and words ending with /n/ or /m/. For words ending on /t/ or /s/ we found a significant increase in production scores from p1 to p2 (71% at p1, 94% at p2; t test: $t=-3,240$, $p=0.009$). For words with /n/ or /m/ as offsets, the children already reached a correctness score of 100% in p1.

Again, the results confirm a clear difference between the production of /t/ and /s/ on the one hand, and nasal consonants on the other hand for the first testing (p1). Four years later, at p2, the children succeeded in producing the correct stem final consonant for all tested consonants.

Results of the discrimination-test of final consonants

In this experiment, we categorised a reaction as analysable if the child pointed at one of the three presented pictures. 483 reactions were identified as analysable (p1: 242; p2: 241). Taken together, there were 63% correct reactions at p1 and 95% at p2 (see Fig. 4), resulting in a significant difference between p1 and p2 (t test: $t=-5,897$, $p<0.001$).

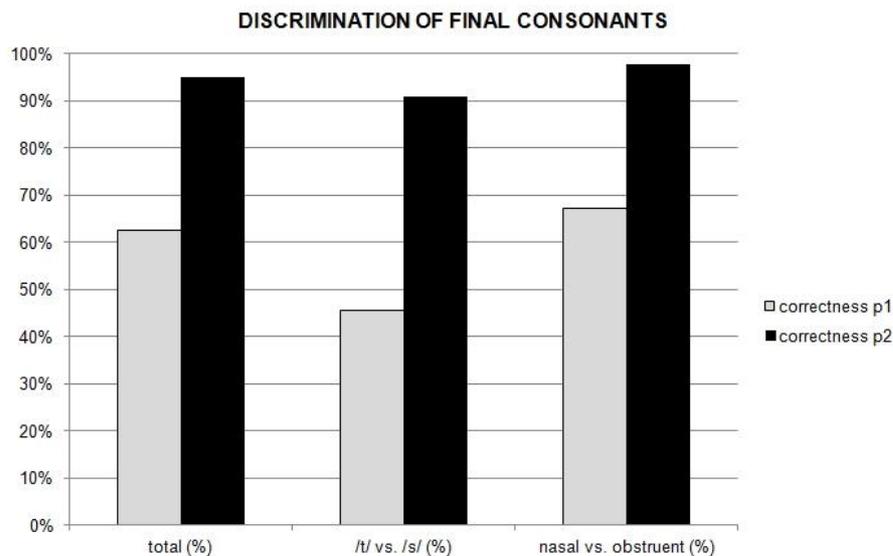


Figure 4: Correctness scores in the discrimination task at p1 and p2

Examining the items in which children have to distinguish a nasal from an obstruent consonant in the final word position, the level of correctness (68% at p1) increased significantly to 98% at p2 (t test: $t=-3,849$, $p=0.003$). For words differing in /t/ and /s/ in the final position of the word-stem, we also found a significant increase of correct reactions (45% at p1, 91% at p2; t test: $t=-5,590$, $p<0.001$).

In addition to the production tests, the perception test confirms a clear difference in the perception of /t/ vs. /s/ on the one hand and nasal consonants on the other hand for the first testing (p1). Four years later, at p2, the children were able to discriminate all tested phonemes.

DISCUSSION AND CONCLUSION

A bilateral sensorineural hearing loss in childhood affects speech and language acquisition. Especially the perception and production of the high-pitched, voiceless obstruents /s/ and /t/ are restricted in 3 to 4 year olds with HI (Penke et al. 2014). This deficit affects a child's ability to mark the morphological information of person and number on a verb. The aim of this paper was to examine whether this deficit still persists up to school age or whether the children manage to catch up and display unimpaired performance with respect to verbal agreement marking. To pursue this question we collected data from a group of 7 to 8 year old hearing-impaired children, previously tested at age 3 to 4, with a picture naming task, a test on the discrimination of final consonants, and a video description task that were already conducted by Penke et al. (2014) and Hennies et al. (2012)

The picture-naming task and the FinKon-Test aimed at revealing the children's ability

to produce and perceive final consonants, in particular high-pitched coronals. The children's performance at the age of 3 to 4 gave rise to concern. Problems in the production as well as in the discrimination of the coronal consonants /s/ and /t/ in word-final position were observed. Four years later the picture had changed. The children reached correctness scores of more than 90% in production and perception of word-final /s/ and /t/. By age 7 the children, thus, have achieved the ability to discriminate and produce the word-final consonants that are relevant for German verb morphology.

These results match with the outcomes of the video experiment on SVA. While the 3 to 4 year olds have selective deficits in producing the correct person and number markings in 2nd and 3rd singular contexts, i.e. *-st* and *-t*, the same children have overcome this problem by the age of 7 to 8. This progress was observed in 10 of the 11 tested children. Only one child showed no development after four years, in all three tests.

We conclude that the majority of children with a mild-to-moderate HI show a delay in the acquisition of SVA compared to hearing age mates and that most of them overcome this delay by school age. Specific speech and language support aiming at training perception and production of the relevant phonemes should accelerate this development.

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