SELF-VOICE IDENTIFICATION IN CHILDREN WITH PHONOLOGICAL IMPAIRMENT

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ABSTRACT

We report preliminary data from a study of self-voice identification in children with phonological impairment (PI), where results from 13 children with PI are compared to results from a group of children with typical speech. No difference between the two groups was found, suggesting that a phonological impairment does not affect children's ability to recognize their recorded voices as their own. We conclude that children with PI indeed recognize their own recorded voice and that the use of recordings in therapy can be supported.

Keywords: phonological impairment, speech perception, children

1. INTRODUCTION

Phonological impairment (PI) is a common type of communication impairment in children, affecting around 10% of children in preschool and school-age children [4]. The most apparent feature of PI is deviant speech, but there are often accompanying problems in how the child perceives and categorizes speech sounds. For example, children who substitute [t] for /k/ in their speech often have problems realizing that there is a phonological distinction between the phonemes /k/ and /t/ that they fail to produce in their own speech. Some of these children also have problems perceiving the phonological distinction between /k/ and /t/ as others speak. On the other hand, many researchers have recognized that deviant speech production may also occur in children who do not have problems with auditory perception (e.g. [2]). But although reports on the relation between speech production and perception have been equivocal, it is clear that in order to revise deviant speech, the child must be able to recognize that his/her current speech production is somehow insufficient [6]. Therefore, phonological perception is a crucial aspect of assessment when planning phonological intervention, as well as an important target in the ongoing therapy.

Phonological perception is often assessed (and targeted) in phonological intervention through external discrimination. The child is given the task of discriminating speech sounds in words or word pairs spoken by another person, typically the therapist. For example, a child could be given the task of judging whether two words are "same" or "different". However, many children with PI can perceive a phonological contrast in the speech of others, but still fail to produce the same distinction in their own speech [1, 8]. To assess children's ability to evaluate phonological accuracy in their own speech, tasks of internal discrimination have been suggested [1, 7, 8]. An example of an internal discrimination task is to let the child evaluate if his/her own speech production is correct or incorrect, either immediately after the act of speaking, or when heard in a recording [1]. One might question, however, if discrimination of recordings of one's own speech really is a form of internal discrimination. As we hear our recorded voice through air but our voice as we speak through air and bone conduction simultaneously, the two representations sound quite different [10]. And if the listener does not perceive his/her recorded voice as his/her own, discrimination of one's own recorded speech would in fact just be another example of external discrimination. However, there is evidence that adults rarely fail to recognize recordings of their own voice as their own [11]. Moreover, it has been found that children as young as 4-5 years old in general also recognize their recorded voice as their own, although not quite at adult levels and with large variation in performance among the children [12].

There is a possibility that children with deviant speech production might perform differently from children with typical speech and language development on tasks of self-voice recognition. If, on the one hand, they perceive a phonological contrast that they fail to produce in their own

speech, they might use their speech deviance as a cue to distinguish their own voice from other children's voices, thereby performing better than children with typical speech. If, on the other hand, they do *not* perceive this phonological contrast, they cannot use their speech deviance as a cue, and could thus be expected to perform at the same level as children with typical speech. The third possibility, that children with PI perform worse than other children in general might suggest a more general deficit in perceiving speech.

The answer to the question of whether children with PI perceive their recorded voice as their own or not will have implications for the suggested use of recordings in tasks of internal discrimination in speech intervention, but will also generate new knowledge about the interplay between perception and production in children with PI.

1.1. Purpose

The purpose of the present investigation is to explore whether children with PI are able to recognize their recorded voice as their own at the same level as children with typical speech and language development. Moreover, we will examine whether production accuracy has any effect on the children's ability to recognize their recorded voice.

2. METHOD

13 children diagnosed with PI participated in the study. Only children displaying patterns of either velar fronting (substituting [t], [d] and [n] for /k/, /g/ and /ŋ/, respectively) or dental backing (substituting [k], [g] and [ŋ] for /t/, /d/ and /n/, respectively) were eligible for participation. (Additional phonological deviances were not disqualifying.) The children were between 4 and 6 years old (ranging from 4;3 to 6;6, M = 5;0, SD = 7.7 months). All participating children had Swedish as their mother tongue, and none of them had any hearing problems. All children were recruited through their speech and language therapists in Stockholm. Consent forms were used which complied with Swedish ethical guidelines for subject participation.

51 children with normal speech and language development were used as a control group. These children were between 4 and 8 years old (ranging from 4;2 to 8;9, M = 6;6, SD = 17.6 months), and had Swedish as their mother tongue. All children in the control group had normal hearing and normal speech and language development, as assured by their parents.

For the children with PI, language comprehension was assessed through the Swedish version of TROG-2 [3]. Only children with language comprehension skills adequate for their age were included in the study. Assessment of phonological production in the children with PI was performed using the Swedish Fonemtestet [5], and phonological perception of the /t/-/k/ distinction was evaluated using a computerized version of the Locke's Speech Production Perception Task [9]. This test is based on the child's error production and assesses the child's ability to perceive the contrast between the target sound, the substitution sound and a control sound, as produced by another person. All children except one had adequate external phonological discrimination for the phoneme they produced in error and the substitution phoneme.

2.1. Material

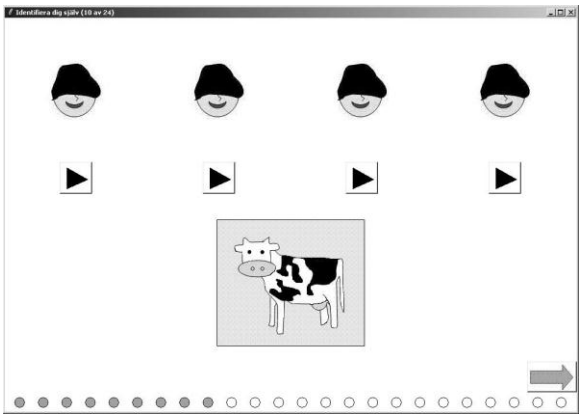
A recording script of 24 words was used (see Appendix). The words all began with /tV/ or /kV/, and all had primary stress on the first syllable.

Three 6-year old children (two girls and one boy with typical speech) were recorded as normal-speaking references. None of the reference children were known to the children in the test groups.

2.2. Recording/identification procedure

The children were fitted with a headset and the experimenter with headphones to supervise the recordings. A computer program was used to present the words in the scripts in random order. For each word, the program first played a reference voice (adult) that read a target word, while displaying a picture that illustrates the word. Then, the child's production of the same word was recorded. Immediately after recording a stimulus, the child's production was presented together with the three reference children's productions of the same word. The four stimuli were randomly mapped onto four identical characters on the screen, letting the child select one of these as his/her own (see Fig. 1), by pointing at the screen. The actual selection was managed by the experimenter by mouse clicking. The children were given two introductory training items, to assure understanding of the task.

Figure 1: The listening/identification setup.



In the first test session, the children performed both the recording and the voice identification task. For the recordings, all children were instructed to speak with their normal voice, and utterances were re-recorded until both child and experimenter were satisfied. In the second test session, after a period of 1-2 weeks, the children performed only the identification task. Apart from general encourage-ment, the experimenter provided no feedback regarding the children's performance during the voice identification task.

Phonological accuracy of the recordings was judged by the experimenter; 186 of the 312 recordings of children with PI were judged as deviant, whereas all 1224 recordings of children with typical speech were judged as normal.

3. RESULTS

Table 1 displays the mean correct own-voice identification for the participating children, as well as the corresponding data for the children in the control group.

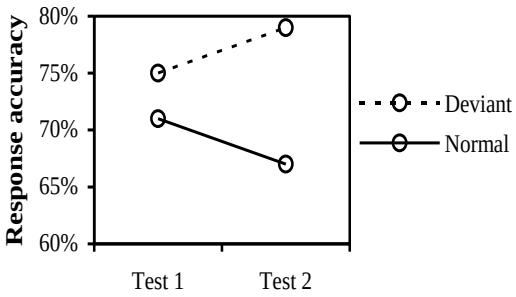
Table 1: Mean correct responses on the first and second test, for the test group and the control group. (Max score/test = 24.)

	Mean test score	
Group	First test	Second test
Children with PI	17.5 (SD: 6.4)	17.7 (SD: 7.5)
Children without PI	19.9 (SD: 4.5)	17.7 (SD: 5.8)

A 2*2 mixed model ANOVA was conducted with language group (with or without PI) as a between subjects factor and test occasion as a within subjects factor. This revealed no difference in performance ($F(1,62) = .55$, $p = .46$) between the groups. The difference between the children's performance on the first and the second test occasion was not significant ($F(1,62) = 1.76$, $p = .19$), and there was no interaction effect of group and performance ($F(1,62) = 3.11$, $p = .08$).

To examine the association between phonological accuracy of the children's speech production (i.e. whether a stimulus was produced correctly or not) and the children's response accuracy (i.e. whether the children were able to identify that stimulus accurately), a Pearson's χ^2–test was conducted within the group of children with PI. This could not show any dependence between these two factors on the first test occasion ($\chi^2(1, N = 312) = 0.45$, $p = 0.45$). However, on the second test occasion, there was a significant dependence between speech production accuracy and self-voice recognition accuracy ($\chi^2(1, N = 312) = 5.98$, $p = 0.02$). Here, the children identified the words that they produced with deviant speech more easily (147/186 = 79% accuracy) than words that they produced with normal speech (84/126 = 67% accuracy). This relation is illustrated in Fig. 2.

Figure 2: Self-voice identification accuracy in relation to the phonological accuracy of the children's speech production (normal or deviant), for the first and second test occasion.



4. DISCUSSION

In this study, no difference in performance on self-voice identification was found between children with PI and children with typical speech. This suggests that a phonological impairment does not affect a child's self-voice recognition ability. A practical interpretation of this finding is that recordings of the child's own speech might well be used in phonological intervention, e.g. in tasks of internal discrimination.

The finding that children with PI identify recordings produced with deviant speech more easily than words produced with normal speech (on the second test occasion) is interesting. This implies that the children iuse their speech deviance as a cue to identifying their own recorded voice, at least when there is a delay between recording and

self-voice identification. However, it is unclear why the difference in identification accuracy between stimuli produced with normal speech and stimuli produced with deviant speech is not as pronounced on the first test occasion. A possible explanation can be found if one again considers that children with deviant speech often have problems perceiving that their own speech is deviant – they hear what they *intended* to say rather than what they actually said. It might be that the intended utterance is still active when the children hear their own voice immediately after recording it, and that it thereby disturbs the perception of any speech production deviance in the actual utterance. When time has passed between recording and identification, on the other hand, the intended utterance is no longer active, and the child can perceive the recorded utterance more objectively.

Although the data presented here is preliminary, the findings so far provide support for the use of recordings in phonological intervention, as children with PI recognize their own recorded voice at the same level as children with typical speech. Furthermore, the results suggest that for children with PI, delayed identification of the recorded voice is more similar to external perception than immediate self-voice identification, as far as perception of speech production deviance is concerned.

5. ACKNOWLEDGEMENTS

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7. APPENDIX

	Orthography	Transcription	In English
1)	k	/’ko:/	*(the letter k)*
2)	kaka	/’kɑ:ka/	*cake*
3)	kam	/’kam/	*comb*
4)	karta	/’kɑ:ʈa/	*map*
5)	katt	/’kat/	*cat*
6)	kavel	/’kɑ:vəl/	*rolling pin*
7)	ko	/’ku:/	*cow*
8)	kopp	/’kɔp/	*cup*
9)	korg	/’kɔrj/	*basket*
10)	kula	/’kʉ:la/	*marble*
11)	kulle	/’kʉlə/	*hill*
12)	kung	/’kʉŋ/	*king*
13)	tåg	/’to:g/	*train*
14)	tak	/’tɑ:k/	*roof*
15)	tant	/’tant/	*lady*
16)	tavla	/’tɑ:vla/	*picture*
17)	tidning	/’ti:nɪŋ/	*newspaper*
18)	tiger	/’ti:gər/	*tiger*
19)	tomte	/’tɔmtə/	*Santa Claus*
20)	topp	/’tɔp/	*top*
21)	tub	/’tʉ:b/	*tube*
22)	tumme	/’tʉmə/	*thumb*
23)	tunga	/’tʉŋa/	*tongue*
24)	tupp	/’tʉp/	*rooster*