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The impact of speech material on speech judgement in children with and without cleft palate

Abstract

Background: The chosen method of speech assessment, including type of speech material, may affect speech judgement in children with cleft palate.

Aim: To assess the effect of different speech materials on speech judgement in 5-year-old children born with or without cleft palate, as well as the reliability of materials by means of intra- and inter-transcriber agreement of consonant transcriptions.

Methods & Procedures: Altogether 40 children were studied, 20 born with cleft palate, 20 without. The children were audio recorded at 5 years of age. Speech materials used were: single word naming, sentence repetition (both developed for cleft palate speech assessment), retelling of a narrative and conversational speech. The samples were phonetically transcribed and inter- and intra-transcriber agreement was calculated. Percentage correct consonants (PCC), percentage correct places (PCP), percentage correct manners (PCM), and percentage active cleft speech characteristics (CSC) were assessed. In addition an analysis of phonological simplification processes (PSP)was performed.

Outcome & Results: The PCC and CSC results were significantly more accurate in word naming than in all other speech materials in the children with cleft palate, who also achieved more accurate PCP results in word naming than in sentence repetition and conversational speech. Regarding PCM and PSP, performance was significantly more accurate in word naming than in conversational speech. Children without cleft palate did better, irrespective of the speech material. The medians of intra- and inter-transcriber agreement were good in both

groups and all speech materials. The closest agreement in the cleft palate group was seen in word naming and the weakest in the retelling task.

Conclusion & Implications: The results indicate that word naming is the most reliable speech material when the purpose is to assess the best speech performance of a child with cleft palate. If the purpose is to assess connected speech, sentence repetition is a reliable and also valid speech material, with good transcriber agreement and equally good articulation accuracy as in retelling and conversational speech. For typically developing children without a cleft palate, the chosen speech material appears not to affect speech judgement.

What this paper adds

What is already known on this subject

Several factors can influence the results when evaluating cleft palate speech. Standardized methods for collecting and analysing speech in a valid and reliable way are required.

The impact of speech material on phonetic transcription when assessing cleft palate speech has not been studied previously.

What this study adds

The impact of four different speech materials on judgement of speech in 5-year-old children with and without cleft palate was investigated. The speech materials assessed were word naming, sentence repetition, retelling and conversational speech. Word naming, combined with sentence repetition, appears to be a reliable and valid sampling mode for evaluating cleft palate speech, when best performance and performance in connected speech are aimed for.

Introduction

A diversity of surgical methods and ancillary interventions regarding cleft palate are available. Continuing scientific analysis of treatment results is essential to improve intervention procedures. However, several factors complicate the evaluation of intervention in cleft palate in general, such as multidimensionality of outcome, duration of follow-up, reproducibility and validity of outcome measures, diversity of management, and small sample size (Roberts *et al*. 1991). The possibility of comparing different treatment procedures has also been limited by lack of standardized methods for collection and analysis of speech data (Lohmander and Olsson 2004, Sell 2005). Several researchers have advocated standardized methods in order to collect and analyse speech in a valid and reliable way, and emphasized the need for more detailed reports on methodologies in speech assessment (for example, Kuehn and Moller 2000, Gooch *et al*. 2001, Lohmander and Olsson 2004, and Sell 2005). In their critical review of literature on perceptual speech assessment of patients with cleft palate, Lohmander and Olsson (2004) noticed that the different speech materials used in different studies make the interpretation of clinical data difficult and detain the development of cleft palate intervention. In altogether 88 articles published in three relevant journals, between 1980 and 2000, no information about the speech material was found in 11%. In 38% was one type of speech material used, spontaneous speech being the most common and in 18%, two types of speech material were used, the most common combination being spontaneous speech and single words.

Impact of speech material on speech judgement

Conversational speech sampling has been claimed important as it may provide information about consistency or deterioration of articulation proficiency and changes in resonance characteristics, and is also regarded to have the greatest face validity as it reflects the individual's natural speech (Kuehn and Moller 2000). However, as early as 1964, Van Demark reported a high correlation between sentence repetition and conversational speech. Information about an individual's best speech performance can also be important for the clinician as well as for the researcher, since it may elucidate the primary features of the speech problem.

In a study by Morrison and Shriberg (1992) regarding different speech materials in children with "speech delay", speech sounds appearing early in their development were better produced in conversational speech, while developmentally later sounds were better produced in response to articulation test stimuli. In their review of the literature, continuous speech rather than formal articulation testing generally seemed to be associated with frequent omission errors, especially of consonants in word-final position, and errors involving consonant clusters and unstressed syllables.

The impact of speech material on speech accuracy in children with "speech delay" and phonological impairment has been investigated in some studies by analysing percentage correct consonants (PCC) (Morrison and Shriberg 1992, Wolk and Meisler 1998, Johnson *et al.* 2004, Masteron *et al.* 2005). A larger proportion of correct consonants was observed in conversational speech than in word naming, in a study by Masterson *et al*. (2005). They used a computer-based phonological test consisting of a single word list partly tailored to each individual's phonological system, and suggested that this test would provide sufficient and representative information for treatment planning. A higher PCC score in conversational

samples than in picture naming was also reported in a study by Wolk and Meisler (1998) on phonologically impaired children. They suggested that "severity of phonological impairment may be determined more by complexity of the task than by its nature" (p. 303) and further that it is "essential to examine a child's disability at the level where the difficulty arises" (p. 305). When comparing sentence repetition and conversational samples in children with "speech delay", Johnson *et al*. (2004) did not observe any significant differences in PCC. A weakness in their study was the order of transcribing of the samples, where by for each child the conversational sample was recorded and transcribed directly after the imitation task; consequently, sentence transcription might have influenced the transcription of the conversational sample.

The impact of speech material on PCC scorings in children with cleft palate has not been studied previously. However, in a study of five children with cleft palate, a high correlation of intelligibility measures between a task consisting of imitated words and a conversational speech sample was indicated (Hodge and Gotzke 2007).

Methods for analysing deviancies in cleft palate consonant articulation

Rating has been a commonly used method to assess cleft palate speech (Lohmander and Olsson 2004), but in recent years phonetic transcription has become more common (Chapman and Hardin 1992, Morris and Ozanne 2003, Chapman *et al*. 2008, Lohmander and Persson 2008). Phonetic transcription makes it possible to analyse the separate units of speech in a linear sequence, and in later stages of analysis to identify and prioritize which aspects of speech need to be focused on (Heselwood and Howard 2008). The measure PCC was originally developed by Shriberg and Kwiatkowski (1982) to measure the proportion of

correctly articulated consonants in transcriptions of conversational speech, in order to assess "severity of involvement".

Two PCC modifications, percentage correct places (PCP) and percentage correct manners (PCM), were used in addition to PCC, by Lohmander and Persson (2008) when assessing cleft palate speech. PCP determines the number of correct articulatory places, that is, if the consonant is produced in the correct place in the oral cavity. PCM measures the total number of correct articulatory manners. PCC in cleft palate speech has also been calculated based on different types of articulatory manners, such as stops, fricatives, nasals, affricates, liquids and glides (Morris and Ozanne 2003, Chapman *et al*. 2008).

Percentage compensatory articulation has been used as a measure by Chapman *et al*. (2008). Compensatory articulation, that is, if the patient compensates for a deficiency related to the cleft palate condition by using some other articulatory place or manner, is an overall term for articulation errors associated with cleft palate (Trost 1981). For example an anterior articulation place such as /t/, in Swedish normally dentally produced, can be articulated posteriorly and be produced as a palatal stop /c/ or a velar stop /k/. It can also be produced at vocal cord level as a glottal stop, as a compensatory strategy for the inability to produce sufficient intra-oral pressure needed to produce high-pressure consonants. In other words, if a child has a coupling between the oral and the nasal cavities, consonants normally produced in a place anterior to the nasal air leakage may be retracted to a place behind the oro-nasal coupling (Henningsson and Isberg 1990). Other described compensatory articulations are for example, the pharyngeal fricative and the posterior nasal fricative. Cleft speech characteristics may be categorized as active or passive (Brøndsted and Hutters 1987, Harding and Grunwell 1998). Compensatory articulation is then regarded as an active strategy, whereas speech

characteristics directly caused by limited structure or function, such as hypernasality, nasal emission, weak articulation and in most cases nasal realization, are passive.

The importance of a combined articulatory and phonological approach, when treating cleft palate patients, has been emphasized by Grunwell and Russell (1988) and phonological analysis when assessing cleft palate speech has been included in some studies (Grunwell and Russell 1998, Chapman and Hardin 1992, Morris and Ozanne 2003). An articulatory or phonetic analysis describes the articulation of speech sounds, whereas a phonological analysis describes a child's systematic organization of motor patterns and perception of speech sounds and the phonological simplification processes used (Salameh *et al*. 2003). In the present study both articulatory and phonological approaches will be used.

Issue of reliability

The issue of intra- and inter-transcriber agreement when evaluating speech as an outcome of treatment is fundamental since it gives confidence in the usefulness of the results. Severe speech disorders are often associated with low transcriber agreement, where broad phonetic transcription is more reliable than narrow (Shriberg and Lof 1991, Brøndsted *et al.* 1994). In clinical contexts, however, narrow transcription is currently to be preferred (Heselwood and Howard 2008). In a study by Gooch *et al*. (2001) on transcriber agreement in compensatory articulation the lowest agreement occurred concerning glottal and pharyngeal stops, whereas the highest concerned pharyngeal affricates and posterior nasal fricatives. Surprisingly the judges felt most confident in transcribing glottal and pharyngeal stops. The difficulty of identifying phonemic categories that do not exist in the listener's native language has also been documented in other studies (Brøndsted *et al.* 1994, Santelmann *et al*. 1999).

Recent studies on cleft palate speech based on phonetic transcriptions usually report a transcriber agreement of about 80-90 % (Chapman and Hardin 1992, Morris and Ozanne 2003, Willadsen and Albrechtsen 2006, Chapman *et al.* 2008, Lohmander and Persson 2008). Although a generally low reliability in perceptual assessment of cleft palate speech has been highlighted (Santelmann *et al*. 1999, Gooch *et al*. 2001, Sell 2005, Brunnegård and Lohmander 2007) reliability of perceptual evaluation of disordered speech seems to be improved by training (Sell *et al.* 2009).

Studies comparing transcriber agreement in different speech materials in children with "speech delay" or phonological impairment have produced varying results, though the differences are small. In a study by Shriberg and Lof (1991), transcription agreement based on continuous speech samples was slightly better than that based on articulation test responses, whereas in a study by Masterson *et al*. (2005) there were no significant differences in reliability when using a single word task compared with a conversational sample. Johnson *et al*. (2004) calculated percentage agreement of modified PCC scores and showed that the inter-judge agreement was good for both imitated sentences and conversational speech, but better for the former. Differences in transcriber agreement related to different speech materials have not been studied in individuals with cleft palate.

In addition to differences regarding agreement associated with severity of speech disorder and the transcribers phonetic and phonological background, differences might be related to different sampling modes including the formation of the speech material, for example how the tests are designed and which elicitation strategies for conversational speech are used (Shriberg and Lof 1991, Johnson *et al.* 2004, Masterson *et al.* 2005, Henningsson *et al.* 2008). Furthermore, methods of calculation and the criteria of agreement have varied in

different studies, as has the quantity of material re-transcribed and the time elapsed between the original transcription and the re-transcription (Shriberg and Lof 1991, Johnson *et al.* 2004, Masterson *et al.* 2005).

Although the question, whether different speech materials can lead to different speech judgements is very important in the evaluation of treatment in cleft palate, the impact of speech material on phonetic transcription of cleft palate speech have not been studied previously.

If different speech materials result in comparable speech judgements, then the choice of speech material when evaluating cleft palate speech could be decided on which tasks are the easiest for both the clinician/researcher and the child.

Aims

The overall aim of the present study was to assess the effectiveness of four different speech materials in 5-year-old children born with and without cleft palate. This was evaluated by:

- analysing differences in percentage speech accuracy;

  and

- comparing the reliability of speech materials by means of intra- and inter-transcriber agreement of consonant transcriptions.

Methods

Participants

Altogether 40 children from the western region of Sweden were included; a consecutive series of 20 children born with unilateral cleft lip and palate and 20 children without cleft lip and palate. The children without cleft palate were recruited through child welfare centres and were,

according to a parent questionnaire, generally developing typically, including language. All 40 children were native Swedish speaking and had no known additional malformations or syndromes. The median age at the time of recording in the cleft palate group was 5 years (range = 4;8 to 5;2), as it was in those without cleft palate (range = 4;6 to 5;4). The group born with cleft palate consisted of nine girls and eleven boys, and the group without cleft palate, eleven girls and nine boys.

Speech samples

Four types of speech materials were used:

- Word naming: the test was developed in the Scandcleft Project to assess cleft palate speech. It was loaded with phonemes known to be vulnerable in speakers with cleft palate, and consisted of 33 pictures with the purpose of eliciting the naming of single words (Lohmander *et al.* 2009). The child was asked to name the picture. In the case where a child could not name the target word and semantic prompting failed, imitation of the target word was used. In most cases two to four words were imitated, the maximum number being seven. No phonetic prompting was used. Fifteen of the children with cleft palate required imitation, and of the group without cleft only two. Each word consisted of one or two syllables and most words contained only one pressure consonant (that is, a stop or the fricatives /s/, /f/, /v /), which was the target and always placed in a linguistically stressed position. However, a few words with two pressure consonants were included to obtain a sufficient number of words that young children could name. No nasal consonants or consonant clusters were included among these words. In addition, three words with the nasal /n/ as target consonant

were also included. The Swedish consonant sound system was not represented in its entirety in the test (International Phonetic Association (IPA) 1999). As the test was developed in order to capture stability and to detect possible variations in production within the children, all target consonants were realized three times in three different words.

- Sentence repetition: 13 short sentences were repeated after the test leader. In recordings made in 2002 and 2003 the material consisted of seven sentences with stops and fricatives with high intra-oral pressure, one sentence with low pressure, one with nasals and four with mixed consonants (see appendix A). Eight children born with cleft palate (but none without cleft palate) were recorded using this material. From 2004, sentences from the SVANTE test (Lohmander *et al*. 2005) were used, where each sentence was loaded with the same consonant. All sentences contained different high-pressure consonants, two sentences contained low pressure consonants, one sentence nasal consonants, and finally two contained transitions from nasals to stops (see appendix A).
- Retelling: a narrative task, the Bus Story Test (BST), was used (Renfrew 1997, translated into Swedish by Svensson and Tuominen-Eriksson 2002), where the children were asked to retell the story with the aid of 12 pictures.
- Conversational speech: about 2 min of conversational speech were recorded, where the test leader asked the children about their daily life or talked about pictures or a jig-saw puzzle.

Speech recordings

Speech was documented with digital audio recordings (Sony Walkman TCD-D8; Sony Corp., New York, NY, USA) using a condenser microphone (Sony ECM-MS957) in a quiet room. In addition, simultaneously video recordings were made using a high quality video camcorder with external microphone (Sony ECM-MS957). The microphones were placed centrally on a table in front of the child.

Editing

The audio recordings were randomly mixed and coded with a number between one and 40, which meant that the transcriber did not know which samples came from children with cleft palate and which from children without cleft palate. The recordings were transferred to .wav-files in a computer (Sony Vaio VGN-SZ3XP/C), for editing in Adobe Audition 2.0. Four recordings were of poor quality and were replaced by the audio files from the simultaneous video recordings. A noise reduction process was used to reduce background noise and, when needed, the recordings were amplified. One .wav-file for each sample type and child (word naming, sentence repetition, re-telling of The Bus Story, conversational speech) was created. The children's names, silent pauses, instructions, encouragement, and other communication were deleted from the naming sequence and the sentence repetition. In the word sequences the child's production of the target word was followed by the test leader's repetition of the word and then five seconds of silence before the next production. The sentence produced by the test leader was directly followed by the child's repetition. The interval between the different sentences was five seconds. The word naming files of all the children were randomly presented on a CD. In addition the word naming files of seven children with cleft palate and seven

without cleft palate were randomly selected, duplicated and randomly mixed on the CD, for evaluation of intra-transcriber agreement. Another CD was produced with the same selected material from these 14 children for independent transcription by an external transcriber, for inter-transcriber agreement analysis. The other speech materials were presented in exactly the same way on other CDs, which resulted in two CDs per speech material, one for the main transcriber and one for the external transcriber.

Phonetic transcription

Transcription of the whole material was performed by the first author (main transcriber), with more than 5 years' experience in the area of cleft palate speech. The second listener, who transcribed the material of seven children with cleft palate and seven without, has had about 20 years' experience as a speech and language pathologist but not particularly with cleft palate speech. None of the raters had treated the children, who were recruited from a different cleft palate centre. First, 15 h of transcription calibration took place, when the two listeners transcribed recordings of about ten other 5-year-old children with cleft palate speech characteristics and discussed the use of different phonetic symbols and diacritics. Then the transcriptions of the study cohort were performed independently, by the first rater during a period of 3 weeks and by the second rater during 6 weeks. First the word samples were transcribed, then the sentence samples, followed by the retelling samples and the conversational speech. Narrow transcription according to the transcription used for cleft palate speech in Sweden based on the IPA and extIPA conventions (extIPA 1997, IPA 1999, 2005) was used. A computer with Windows Media Player and Sony headphones MDR-CD580 and MDR-V700 were used. Every target sequence could be listened to repeatedly.

Description of the transcriptions used for analysis

Most of the transcribed word samples comprised 33 words, but five children named only 32. The median number of words in the sentence samples was 42 (range = 23-43). The first author chose which parts of the transcriptions of the retelling task and the conversational speech to be analysed. Sampling rules for the transcriptions of the retelling task and conversational speech are described in appendix B. Samples of retelling The Bus Story with fewer than 50 words were excluded. The median number in the included samples of the retelling task was 84 (range = 54-136). For conversational speech a sequence with 50-150 words was chosen for analysis. Samples with fewer than 50 words were excluded. This resulted in a median of 105.5 words (range = 52-148). The numbers of participants in the different speech materials differed (tables 1 and 3).

Analysis of the transcriptions

The first author analysed the samples using five different measures: PCC, PCM, PCP, percentage of active cleft speech characteristics (CSC) and percentage of phonological simplification processes (PSP). Vowel errors were few and hence not analysed. All transcribed samples were analysed in exactly the same way, on the same premises, without knowing if the sample was of a child with a cleft or not. No analysis of the sample's overall pattern was performed. The scoring rules are described in appendix B.

In the present article the term "nasal realization" is used when an oral target phoneme is changed to a nasal phoneme, irrespective of if it is deemed an articulatory or phonological process. The term "a slightly nasalized oral consonant" is used when an oral target phoneme is

slightly nasalized or if nasal emission is present, but the phoneme is unchanged. Nasalization refers to the underlying phonological process and this term is only used when scoring PSP (Salameh *et al.* 2003).

In general, passive deviations such as weak articulation, nasal air leakage, and slightly nasalized oral consonants were deemed as correct articulation, provided that the target phoneme was unchanged. Deviancies, that merely resulted in an added diacritic sign, such as de-voicing or inter-dental production, were scored as correct. Deviancies that changed the target phoneme into another phoneme were deemed as incorrect. Retracted oral articulation, glottal stops/fricatives, actively produced nasal fricatives and nasal realization of other oral consonants, such as voiced stops, were regarded as active cleft speech characteristics. According to Harding and Grunwell (1998) nasal realization and the use of /h/ for voiceless stops usually is regarded as passive deviations due to impaired structure and function, but these processes may in some cases also be internalized in the child's phonology and remain after the velopharyngeal inadequacy has been treated, and occur as active ones. Consequently they were included among the active cleft speech characteristics assessed. Analysis of phonological simplification processes was performed according to Salameh *et al.* (2003). The PSP quotient of each sample was calculated by dividing the number of phonological simplification processes by the total number of consonants of the sample and multiplying it by 100. The PCC, PCP, PCM, CSC and PSP for each speech material, for the group with cleft palate and for those without cleft palate, were calculated.

Statistical methods

Not all children produced samples that fulfilled the criteria for all the four different speech materials. Therefore, a comparison of two speech materials at a time was performed, with the

individual child serving as its own reference. For this purpose the Wilcoxon matched-pairs signed rank test was performed using SPSS (Statistical Package for Social Sciences, version 14). $p < 0.05$ was considered to indicate a significant difference between the speech materials.

Reliability testing

Inter- and intra-transcriber reliability of consonant transcriptions was tested by means of percentage agreement, point-by-point. The consonants compared had to be identically transcribed for place, manner and voicing in order to be considered as agreed. The four categories used for place were: bilabial/labiodental; inter-dental/dental/alveolar/postalveolar/retroflex (common variations of dental consonants in Swedish); palatal/velar/uvular (common variations of velars in co-articulation in Swedish); and glottal. The six categories used for manner were: stops; fricatives (lateral realization of /s/ included); nasals, realizations of /r/; the lateral /l/; and other approximants. Transcription agreement of consonants in word-final position is known to be weak (Shriberg and Lof 1991) and deletion of consonants in word-final position is fairly common in spoken Swedish. Both inter- and intra-transcriber agreement were consequently calculated once more, with the exclusion of disagreements of deletions in word-final position.

Results

Children with cleft palate

Results from the group with cleft palate are presented in table 1, including all usable samples. Better performance on word naming compared with the other speech materials is evident for all measures.

Table 1. Median (range) values of percentage consonants correct (PCC), percentage correct places (PCP), percentage correct manners (PCM), percentage active cleft speech characteristics (CSC), and percentage of phonological simplification processes (PSP), for the different speech materials in the group of children with cleft palate

	WN	SR	BST	CS
Number	20	18	11	14
PCC				
Median	86.4	81.5	74.4	80.7
Minimum	38.5	18.8	37.2	34.6
Maximum	100	99.0	97.9	97.7
PCP				
Median	89.9	81.9	82.4	84.8
Minimum	46.2	22.9	39.4	39.7
Maximum	100	99.0	98.7	99.4
PCM				
Median	93.5	87.5	88.8	86.1
Minimum	64.1	70.8	72.5	65.4
Maximum	100	99.0	98.6	97.7
CSC				
Median	5.7	15.2	10.8	7.3
Minimum	0.0	0.0	0.0	0.3
Maximum	44.9	72.9	52.2	55.1
PSP				

Median	5.3	14.7	17.0	15.7
Minimum	0.0	1.0	2.1	1.9
Maximum	50.6	51.9	62.9	52.5

Note: WN, word naming; SR, sentence repetition; BST, retelling of The Bus Story; CS, conversational speech.

The differences between medians in the different speech materials and measures, when compared in pairs, are presented in table 2. When measuring the PCC and CSC, the children with cleft palate performed significantly better in word naming than in all other speech materials. They also performed better in word naming than in sentence repetition and conversational speech for PCP. For PSP and PCM, their performance was significantly better in word naming than in conversational speech.

Table 2. Differences between medians (range) in the cleft palate group when comparing speech materials two at a time using Wilcoxon signed-rank test

	WN-SR	WN-BST	WN-CS	SR-BST	SR-CS	BST-CS
Number	18	11	14	10	12	10
PCC						
medians	85.4-81.5	84.4-74.4	86.4-80.7	81.5-73.4	76.7-80.7	69.4-80.5
z	-2.591*	-2.090*	-3.140**	-1.070	-1.098	-0.663
PCP						
medians	81.9-89,6	82.4-89.9	84.8-92.1	78.1-84.6	84.5-83.8	84.8-78.6
z	-2.505*	-1.824	-2.970**	-1.376	-1.490	-0.816
PCM						
medians	87.5-93.5	88.8-87.7	86.1-93.6	89.4-89.1	86.1-88.9	85.0-84.2
z	-0.240	-0.089	-2.122*	-0.561	-1.962	-0.296
CSC						
medians	6.3-15.2	6.2-10,8	6.3-7.3	11.6-10.1	15.6-9.9	11.1-6.5
z	-3.338**	-2.395*	-2.386*	-1.244	-0.078	-0.459
PSP						
medians	11.3-14.7	11.4-17.3	3.9-15.7	13.0-18.5	13.0-15.7	17.0-16.7
z	-1.633	-1.580	-2.731**	-0.770	-1.805	-0.652

Notes: WN, word naming; SR, sentence repetition; BST, retelling of The Bus Story; CS, conversational speech.

* $p < 0.05$; and ** $p < 0.01$

Comparison group

Results from the comparison group, whose performance was good in all speech materials and measures, are presented in table 3. No statistical analysis was conducted, since accuracy was high for all samples.

Table 3. Median (range) values of percentage consonants correct (PCC), percentage correct places (PCP), percentage correct manners (PCM), percentage active cleft speech characteristics (CSC), and percentage of phonological simplification processes (PSP), for the different speech materials in the group of children without cleft palate (comparison group)

	WN	SR	BST	CS
Number	20	19	18	19
CSC				
Median	98.8	95.7	93.7	96.1
Minimum	83.3	87.6	80.3	81.7
Maximum	100	100	99.6	99.7
PCP				
Median	98.9	98.9	95.7	97.6
Minimum	83.3	87.6	83.9	83.8
Maximum	100	100	99.6	99.7
PCM				
Median	98.8	95.9	94.8	96.9

Minimum	83.3	87.9	84.7	90.2
Maximum	100	100	99.6	99.7
CSC				
Median	0.0	0.0	0.0	0.0
Minimum	0.0	0.0	0.0	0.0
Maximum	3.8	1.0	2.9	3.1
PSP				
Median	1.5	2.1	5.1	3.0
Minimum	0.0	0.0	0.4	0.3
Maximum	16.7	12.4	20.4	17.5

Note: WN, word naming; SR, sentence repetition; BST, retelling of The Bus Story; CS, conversational speech.

Intra- and inter-transcriber agreement

For the cleft palate group the median values of intra-transcriber agreement of the main transcriber were good (>80-90%) for retelling of the BST (table 4) and for the three other speech materials, very good (>90-95%) or excellent (>95-100%). The median of intra-transcriber agreement for the group without cleft palate was excellent (>95-100%) for all speech materials.

Median values of inter-transcriber agreement for the children with cleft palate were also good (>80-90%), for word naming, sentence repetition and conversational speech, and acceptable (79.5%) in the retelling task of the BST (table 4), though for one child with cleft palate agreement was below 70% for all speech materials. For another child with cleft palate, the corresponding agreement in the BST was below 70%. This child produced less than 50 words in conversational speech, and was therefore excluded from the analysis of conversational speech. When disparities of omissions in word-final position were excluded, median agreement for the cleft palate group in all speech materials exceeded 80%, although the inter-transcriber agreement for some individual samples was still below 70%. Median inter-transcriber agreement for the group without cleft palate was good (>80-90%) for retelling in the BST. For the other three speech materials, the medians were very good (>90-95%).

Table 4. Median (range) of intra- and inter-reliability by means of agreement of the consonant transcriptions, point by point, in the different speech materials

Agreement	WN		SR		BST		CS	
	Median	Range	Median	Range	Median	Range	Median	Range
With cleft palate								
Intra	97.5	91.0-98.8	94.9	93.5-100	88.3	70.6-99.4	93.7	85.7-97.3
Inter	89.7	47.0-95.2	86.0	69.0-98.9	79.5	52.9-94.2	86.2	50.3-93.9
Without cleft palate								
Intra	98.8	94.7-100	98.9	94.2-100	96.7	86.9-98.0	97.4	93.9-97.8

Inter	91.0	84.0-98.8	94.7	88.4-98.0	86.4	75.9-96.0	93.0	83.6-96.6

Note: WN, word naming; SR, sentence repetition; BST, retelling of The Bus Story; CS, conversational speech; Intra, intra-transcriber agreement; and Inter, inter-transcriber agreement.

Discussion

Results in relation to previous studies

The purpose of the present study was to establish whether or not speech material had any impact on speech accuracy when evaluating speech of children with cleft palate, and to assess reliability demonstrated by intra- and inter-transcriber agreement of consonant transcriptions in the different speech materials. The main focus was to study the effectiveness of the speech materials and determine whether word naming, sentence repetition, retelling and conversational speech are comparable speech materials for evaluating cleft palate speech.

The percentage speech accuracy of the children with cleft palate was significantly higher for word naming than for all the other speech materials in percentage correct consonants (PCC) and cleft speech characteristics (CSC), and higher for word naming than for sentence repetition and conversational speech in percentage correct places (PCP). Regarding percentage correct manners (PCM) and phonological simplification processes (PSP), a significant difference was noted between word naming and conversational speech, with better performance for word naming. This is interesting, since in cleft palate speech evaluation both information about best speech performance and habitual speech is useful. Word naming can then be used if one wants to examine the best performance of a child. Since there were no

significant differences in percentage speech accuracy in the other materials, this indicates that they can be regarded as comparable.

As expected the children without cleft palate performed well, irrespective of speech material. Nevertheless, the inclusion of typically developing children without cleft palate was important. By presenting the samples of both groups randomly mixed, the samples from the children with cleft palate could be judged impartially.

Previous research has reached varying conclusions regarding the effect of speech material on the appraisal of speech in “speech-delayed” or phonologically impaired children. According to Morrison and Shriberg (1992), continuous speech by ”speech-delayed” children seemed to be more closely associated with frequent deletion errors, errors involving consonant clusters and unstressed syllables, than word naming. However, their study did not indicate better performance in the articulation test, as was seen in the present study. Results contradicting those of the present study, with better performance in conversational speech than in word naming, have been reported in at least two studies. Wolk and Meisler (1998) found a higher PCC in children with phonological impairment in conversational speech than in a picture naming task for phonological analysis, although the error patterns were similar in both speech materials. Higher PCC in conversational speech than in word naming was also reported in the study by Masterson *et al.* (2005). Regarding sentence repetition and conversational samples in children with “speech delay”, Johnson *et al*. (2004) observed no significant differences in PCC, which tallies with the results of the present study.

One reason for the differing results may be the different perspectives and methods used (Masterson *et al*. 2005, Wolk and Meisler 1998). The design and structure of word-naming tests as well as the conditions for sampling of continuous speech appear to be crucial for the

outcome (Morrison and Shriberg 1992, Wolk and Meisler 1998, Johnson *et al*. 2004, Masterson *et al*. 2005). These studies have assessed children with "speech delay" or phonological impairment and consequently used naming tasks designed for phonological analysis. Phonological tests usually embrace the whole phonology of a language, the consonants are presented in varying word positions, the words contain varying number of syllables and they also include different consonant clusters. The word-naming test and sentence repetition test used in the present study were designed to capture deviances frequently seen in cleft palate speech, that is, difficulties with high-pressure consonants; both passive and active cleft speech characteristics (Lohmander *et al*. 2009). However, the phonological system is represented incompletely in the word-naming test and the word structure is rather simple, with only one or two syllables and no consonant clusters. This may have affected the results positively in word naming, compared with the other speech materials. A word-naming test designed to capture both cleft speech characteristics and phonological simplification processes might have given other results. The sampling conditions of conversational speech also differ. Shriberg *et al*. (1997), for example, calculated PCC of conversational samples containing 80-270 words. The target consonants of words that recurred were not scored, unless articulation changed (Shriberg and Kwiatkowski 1982). By contrast, several participants in the present study uttered few words, and consequently 50 words was chosen as a minimum for the retelling and the conversational samples. To avoid too great a variance in sample size a maximum of 150 words was set. The samples were therefore on average slightly smaller than in the study by Shriberg and Kwiatkowski (1982). As instability of the phonological system is one known cleft palate characteristic (Harding and Grunwell 1998), recurring words were not excluded from the samples. These factors may have influenced the results.

In this study inter- and intra-transcriber agreement were satisfactory and higher in word naming, sentence repetition and conversational speech than in retelling of The Bus Story. On the other hand the intra- and inter-transcriber agreement was rather better in conversational speech than in word naming in the study by Shriberg and Lof (1991). The study by Masterson *et al.* (2005) showed no significant difference of transcriber agreement in these two speech materials. In the study by Johnson *et al.* (2004), inter-judge agreement of modified PCC scorings was better in sentence repetition than in conversational speech, in comparison with the present study where no noticeable difference was evident in agreement between the two speech materials. Methodological variations may accentuate the differences seen in different studies (Shriberg and Lof 1991, Johnson *et al.* 2004, Masterson *et al* 2005), such as the design of word-naming tests used, methods for transcription, if transcription calibration between transcribers is performed before the actual transcription takes place or not, and how transcriber agreement is defined.

The generally better performance in word naming in this study might have influenced the agreement rates in a positive direction. The lower transcriber agreement in the retelling task may be related to the general lower percentage accuracy in retelling, although not verified by statistical analysis. One can speculate if this is caused by the fact that the vocabulary when retelling a story is restrained by the story itself, and that in conversational speech the children are freer to choose what words to use. Close transcriber agreement seems to some degree to correlate with good performance, although Shriberg and Lof (1991) only noticed weak to moderately positive association between transcriber agreement and severity of disorder, indexed by PCC and intelligibility. Another fact that might have had a positive effect on agreement in word naming, was that the target phonemes were known to the transcriber. On the

other hand they were known in sentence repetition too, but not in conversational speech, and in these speech materials the agreement was equally close. The poor agreement in the samples of two of the children with cleft palate may be attributed to frequent occurrence of glottal articulation in these samples and that the speech was mostly unintelligible (Gooch *et al*. 2001, Shriberg and Lof 1991). One can not ignore that other co-occurring speech problems in the cleft palate group, such us nasality, nasal airflow, or voice problems not studied in the present work, may have had an impact on the results.

Practical issues

Most children in the present study took part in the word-naming task and even the sentence-repetition task. Unfortunately, several children with cleft palate had to be excluded from the analysis of the retelling task and conversational speech because of the paucity of words. This may be because some children were tired as they had undergone several other assessments the same day, and also were unwilling to speak because of their unintelligible speech (Schwartz and Leonard 1982). In some of the retelling and conversational speech samples the speech was unintelligible; the target phonemes consequently unknown to the transcriber, and the children had to be excluded. To carry out the measurement methods used in the present study, the target phonemes have to be known, which is so in both word naming and sentence repetition.

Another practical issue is that the analysis of a sample cannot be too extensive for the clinician. Generally collection and analysis of continuous speech are more time-consuming than articulation tests (Johnson *et al*. 2004) and sometimes difficult to administer (Wolk and Meisler 1998). In this study, transcription of words was quicker than the sentences while the

most time-consuming was transcription of the retelling task and conversational speech, due to the amount to be transcribed.

Further research

When using PCC scoring, there are only two possible options for every consonant: correct or incorrect. The risk of chance agreement is obvious when calculating agreement of PCC scorings (Cucchiarini 1996). Consequently, agreement of phonetic transcriptions was chosen to be calculated in this study. However, the disadvantage of the traditional calculation of percentage transcription agreement is that disagreement is not graded. For example, two phonemes that differ in place, manner, and voicing produce the same degree of disagreement as two phonemes that differ merely in voicing. Cucchiarini (1996) has developed a method where by experimentally derived phonetic feature matrices are used as input into a computer-based program that aligns transcription pairs automatically. Strings of transcriptions are then inserted into the computer, each symbol in string A being matched with a corresponding symbol in string B. The degree of agreement for each transcription pair is then calculated as an average distance from the phonetic feature matrices. In this way the disagreements can be graded. Feature matrices in Swedish for use as input in the program have not yet been developed; consequently the method could not be used in this study, but it would be interesting in future research.

Conclusion

The results of the present study indicate that word naming is the most reliable method for the evaluation of cleft palate speech when assessing a child's best performance. If the purpose is

to assess connected speech, then sentence repetition is a valid and reliable speech material, with good transcriber agreement and equally good articulation skill as in retelling and in conversational speech. Other advantages of word naming and sentence repetition, compared with the retelling task and spontaneous speech, are a lower drop-out rate, and less demanding and quicker administration. Consequently, if only two speech materials have to be chosen when analysing cleft palate speech, a combination of word naming and sentence repetition is to be recommended.

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Appendix A

Swedish	Broad phonetic transcription	Translation
2002 -2003		
Pippis apa hoppar	pɪpɪs ɑ:pa hɔpaɹ	Pippi’s monkey is jumping
Bibbi bakar bullar	bɪbɪ bɑkar bəlaɹ	Bibbi is baking
Titta på TV	tɪta po: te:və	Watch TV
Idag är det tisdag	ɪdɑ ɛ dɛ tisdɑ	Today is Tuesday
Kicki kokar ägg	kɪkɪ ku:kaɹ kɔɹv	Kicki is boiling eggs
Giggi lagar tåget	gɪgɪ lɑ:gaɹ to:gɛt	Giggi is repairing the train
Sissi sover	sɪsɪ so:vɛɹ	Sissi is asleep
Solen lyser	su:lɛn ly:sɛɹ	The sun is shining
En kopp kaffe	ɛn kɔp kafɛ	A cup of coffee
Hämta inte mina vantar	hɛmta ɪntɛ mi:na vantaɹ	Don´t fetch my gloves
Mamma å Mimmi e hemma	mama ɔ mɪmɪ ɛ hɛma	Mum and Mimmi are at home
Ville å Valle	vɪlɛ ɔ valɛ	Ville and Valle
Snipp snapp snut	snɪp snap snʉ:t	(a rhyme that ends stories)
2004 – 2008		
Pippis apa piper	pɪpɪs ɑ:pa pi:pɛɹ	Pippi’s monkey is whining
Bibbi bara jobbar	bɪbɪ bɑra jɔbar	Bibbi is just working
Titti tittar på TV	tɪtɪ tɪtaɹ po: te:və	Titti is watching TV
David å du leder	dɑ:vɪd ɔ dʉ: le:dɛɹ	David and you is leading
Kicki kokar korv	kɪkɪ ku:kaɹ kɔɹv	Kicki is boiling sausage
Giggi vill väga guld	gɪgɪ vɪl væ:ga gəld	Giggi wants to weigh gold
Sissi å Lasse sover	sɪsɪ ɔ lasɛ so:vɛɹ	Sissi and Lasse are asleep
Fiffi får kaffe	fɪfɪ fo:ɹ kafɛ	Fiffi gets coffee

Vivvi vevar	vɪvɪ ve:vaɹ	Vivvi is turning the handle
Lollo lurar Ella	lʊlʊ lʉ:ɹaɹ ɛla	Lollo is deluding Ella
Svante vill inte ha vantar	svantɛ vɪl ɪntɛ hɑ: vantaɹ	Svante doesn’t want gloves
Anki hämtar hinken	ankɪ hɛmtaɹ hɪnkɛn	Anki is fetching the bucket
Mimmi å mamma e hemma	mɪmɪ ɔ mama ɛ hɛma	Mimmi and mum are at home

Appendix B

Sampling rules

For conversational speech, a sequence with 50 -150 words has been chosen

The following where excluded:

• Samples of conversational speech or BST with fewer than 50 words

• Non-word rhymes

• Singing

• Utterances as: ja, a (*eng.* yes) nej, nä (*eng.* no), eh, oh

• Utterances simultaneous with those of the SLP

• Iterations

• Unintelligible utterances

• The error-sequence, if the child corrects itself

PCC scoring

• Diacritic signs, such as for laminal/lateral/inter-dental production, de-voicing (with exception of aphonic speech), voicing, aspiration, nasal escape, slightly nasalized oral consonants, weak articulation, are scored as correct, as long as the target phoneme does not completely change into another phoneme

• Certain deletions (e.g. deletion of final /r/) and co-articulations common in spoken Swedish (e.g. /n/ in connection with /k/ changes to /ŋ/) are scored as correct

Scored as incorrect:

• Changed place or manner of articulation

• Glottal reinforcement and double articulation

- In sequences with numerous glottal stops and where it is not possible to hear where one glottal stop ends and the next starts, each audible glottal stop is counted as just one error, although sometimes it may replace more than one target consonant
- Additions, such as when /f/ becomes /vf/, if not self-corrected in the subsequent utterance. If it is not obvious to which of the closest consonants the added phoneme is related, it is excluded
- Deletions, except for deletion of a word ending, if it is a common deletion in spoken language
- In metatheses, every consonant that does not match the right place in the target word is scored as incorrect

PCP scoring

- Diacritic signs, such as for laminal/lateral/ interdental production, are scored as correct, as long as the target phoneme does not completely change into another phoneme

Scored as incorrect:

- Changed place of articulation
- Additions/deletions of consonants (see PCC)
- Glottal reinforcement

PCM scoring

- Diacritic signs, such as de-voicing, voicing, aspiration, nasal escape, slightly nasalized oral consonants, weak articulation, are scored as correct, as long as the target phoneme does not completely change into another phoneme

Scored as incorrect:

- Changed manner of articulation
- Additions/deletions of consonants (see PCC)
- Voicing and devoicing (with exception of aphonic speech)

CSC scoring

Scored as cleft palate speech characteristics:

- Retracted oral articulation
- Glottal stops and glottal reinforcement

PSP scoring

Scored as phonological simplification processes:

- Fronting
- Backing

- /h/ used for oral consonants
- Nasal realization of oral consonants

- Stopping
- Frication
- Nasalization
- Lateralization
- Weakening/gliding
- H-zation
- Voicing and devoicing
- Insertion of consonants
- Reduplication of syllables
- Assimilations
- Metatheses
- Reduction of syllables and consonants