

COMPARISON OF INTELLIGIBILITY MEASURES ON SINGLE WORD AND SPONTANEOUS SPEECH TASKS FOR CHILDREN WITH AND WITHOUT CLEFT PALATE

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(Project of the Canadian Language and Literacy Research Network)

1. INTRODUCTION

Assessment of intelligibility is often included as part of the evaluation procedure for children with cleft palate. Therefore, development of a reliable and valid means of assessing intelligibility for this population is essential¹. Furthermore, it is desirable that an intelligibility measure is sensitive to the particular error patterns of the population for which it is intended². The *Speech Intelligibility Probe for Children with Cleft Palate (SIP-CCLP)* was developed to measure single word intelligibility in children with cleft palate³ based on these children's typical error patterns. Examples of these include sibilant distortions, sonorant for stop substitutions and glottal place substitutions for other for obstruents. The *SIP-CCLP* was designed to evaluate the effect of speech error patterns of children with cleft palate on their ability to make their spoken messages understandable to listeners. The *SIP-CCLP* has three components: 1) administration and recording of target test words from children, 2) presentation of a child's test word recordings at a later time to adult listeners for open- and closed-set word identification tasks, and 3) analysis of listeners' responses to determine intelligibility scores and error profiles. Preliminary evaluation of the reliability and content and construct validity of the *SIP-CCLP* indicated that it has the potential to be a reliable and valid clinical tool³. The purpose of this study was to conduct a preliminary evaluation of the criterion validity of a software version of the *SIP-CCLP* using speech samples from young children with and without cleft palate.

The following questions were addressed:

1. What is the relationship between intelligibility scores obtained from *SIP-CCLP* (open-set response task) and a spontaneous speech sample?
2. What is the relationship between speech error patterns obtained from analysis of the children's *SIP-CCLP* productions and a spontaneous speech sample?

2. METHOD

2.1 Participants

Audio recordings from eight children with typical speech and language development (TS) and four children with repaired complete clefts of the lip and palate (CP) were judged by 35 graduate students in speech-language pathology. Table 1 provides descriptive characteristics for the children. All children had receptive

and expressive language skills within normal limits for their chronological age as determined by standardized language testing. The children with typical speech production also had a normal speech mechanism and normal hearing. The children with cleft palate had hearing within normal limits at the time of data recording. Listener judges had normal hearing and English as a first language.

Table 5. Child participant information.

Child	Age (Mos.)		Description of Repaired Cleft
TS1	37	female	n/a
TS2	43	female	n/a
TS3	57	male	n/a
TS4	57	male	n/a
TS5	60	male	n/a
TS6	61	male	n/a
TS7	65	male	n/a
TS8	82	male	n/a
CP1	45	female	Bilateral cleft lip & palate
CP2	47	male	Unilateral cleft lip & palate
CP3	59	male	Unilateral cleft lip & palate
CP4	79	male	Unilateral cleft lip & palate

2.2 Speech Recordings

Recordings were made using a Panasonic AG-196 video camera and a Sony Electret - 150 lapel microphone. Fifteen minute spontaneous speech samples were collected from each child in a sound booth using parallel and interactive play scenarios following procedures described by Shriberg⁴. Item presentation for the *SIP-CCLP* was randomized to create a unique test order for each child. The computer was set up with the monitor and keyboard inside the sound booth and the hard drive outside the sound booth to minimize background noise. Pictures were presented on a 17-inch screen with 800 X 600 resolution. The child was instructed to repeat the name of the picture displayed after the examiner. Four practice words preceded the presentation of the test stimulus words to ensure that the child understood the task. All 123 stimulus words were presented with the examiner modeling the word(s) that went with each stimulus picture.

Digital audio files of the children's spontaneous speech sample utterances and *SIP-CCLP* productions were made using CSpeech⁵ with a sampling rate of 22 kHz and 16 bit quantization. These audio files were then converted to .wav files for playback for the listener identification tasks.

2.3 Intelligibility Scores

Spontaneous Speech Sample. The first author prepared an orthographic transcription of the speech sample⁴ and then randomly selected a section containing 100 consecutive words and few examiner turns⁴ for listener identification. During playback, each of the child's utterances was presented in the order of occurrence in the transcript. The orthographic gloss was used as the key against which the listener judge's responses were compared for scoring. Three judges performed the word identification task independently for each child's sample. Their mean number of words identified correctly served as the child's intelligibility score.

SIP-CCLP. For the open-set response task, the *SIP-CCLP* software presented the child's four practice words followed by the 123 stimulus words for listener identification. Listeners were instructed to type in the word that they perceived the child to say. Three judges performed this word identification task independently for each child's recordings. Their mean number of words identified correctly served as the child's intelligibility score. For the closed-set response task, the *SIP-CCLP* software randomly generated the order of presentation for each target contrast judgment. The listener was presented with four choices for each item: the target word and a minimally contrastive foil (in random order), a box to type in a word that was not one of the first two choices, and a box to indicate "can't identify". A contrast item was scored as correct if at least two of three independent listeners selected the target word.

2.4 Phonetic Analyses

The first author prepared phonetic transcripts of the 123 SIP-CLLP stimulus words and 100-word speech samples for each subject using the conventions of Shriberg⁴. Tallies of percent consonants correct in each of the manner categories for stops, fricatives, affricates, nasals, glides and liquids were made for the spontaneous speech sample and SIP-CCLP transcriptions for each child. Inter-rater agreement with a second, independent transcriber for a random selection of 20% of the utterances was 85%.

3. RESULTS

The group mean intelligibility score for the spontaneous speech sample was 87.3% (SD=6.1%) for the children with typical speech production and 62.7% (SD=20.1%) for the children with cleft palate. Group mean intelligibility scores for the *SIP-CCLP*, based on the open-set response task, were 77.3% (SD=12.8%) for the children with typical speech production and 50.2% (SD=20.2%) for the children with cleft palate. A significant positive correlation between intelligibility scores from the *SIP-CCLP* and those obtained from a spontaneous speech sample ($r = .90$, $p < .01$) was obtained for the combined groups (N=12). Group results for the phonetic analyses of the spontaneous speech sample and *SIP-CCLP*

productions and for the *SIP-CCLP* closed-set response task are shown in Table 1. No significant differences were found between phonetic transcriptions of the *SIP-CCLP* items and the spontaneous speech sample for percent correct stops, fricatives, affricates, nasals or glides. However, a significant difference was found between the two conditions for liquids ($p < .05$). Also there were no significant differences between error analysis of the *SIP-CCLP* closed-set task and phonetic analysis of the spontaneous speech sample for fricatives, affricates, nasals, liquids and glides but there was a significant difference for stops ($p < .05$).

Table 1. Comparison of sound class results (% correct) for phonetic analyses (PA) for the spontaneous speech sample (SSS) and *SIP-CCLP* production and *SIP-CCLP* closed-set (CS) task.

	Stops	Fric.	Affric.	Nasals	Glides	Liquids
PA:						
SSS	85.5	81.8	77.8	93.2	96.5	82.2
PA:						
SIPCCLP	88.6	79.5	83.5	90.4	94.0	68.7
CS:						
SIPCCLP	92.4	83.1	92.2	95.8	98.6	93.7

4. DISCUSSION AND CONCLUSIONS

Initial support for the criterion validity of the *SIP-CCLP* is demonstrated by the strong, significant positive correlation between intelligibility scores on the *SIP-CCLP* and the spontaneous speech sample. Higher intelligibility scores on the spontaneous speech sample were expected, given the positive effect of context on listeners' word identification performance. Evidence for criterion validity is also provided by the findings that: 1) with the exception of liquids, there were no significant differences in percent correct scores for the manner sound classes between phonetic transcription of the speech sample and *SIP-CCLP* productions, and 2) with the exception of stops, there were no significant differences in percent correct scores between the speech sample and error patterns on the *SIP-CCLP* closed-set response task. Possible reasons for differences in liquid and stop scores between the two tasks will be explored further and include transcriber and child factors.

5. REFERENCES

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