

SPEECH INTELLIGIBILITY IN (3-4 YEARS OLD) TYPICALLY DEVELOPING CHILDREN

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Abstract

Speech intelligibility is an index of overall speech adequacy. It reflects the child's verbal communication competence and is vital in determining the need for intervention. Intelligibility data for young children with typical as well as disordered phonologies are lacking, even though they are critical for clinical decisions. The present study aimed at tracking the developmental progress in speech intelligibility with increasing age in two tasks: spontaneous speech and sentence imitation. The study included 16 kindergarten (3-4 years) typically developing Kannada speaking children as participants who were divided into four age groups: a) 3-3.3years b) 3.3-3.6 years c) 3.6-3.9 years d) 3.9-3.12 years. The speech samples were recorded using a digital recorder. These were played to 12 unfamiliar and untrained adults within 35 years of age who served as the judges for the study. Three judges were assigned to each age group and were played the first hundred utterances of the spontaneous speech and sentence imitation samples for verbatim transcription. The verbatim transcription of each subject was evaluated and percent speech intelligibility was obtained using the key developed by the researcher for each subject's utterances per se. Mean, standard deviation and range of percent intelligibility were obtained for each age group and for the two tasks separately. Appropriate statistical analysis was carried out using SPSS package, the results revealed a statistically significant difference across the age groups for spontaneous speech task and not for the sentence imitation task. However, there was no significant difference across the two tasks. The study indicated a linear progress in intelligibility with increasing age especially in spontaneous speech. The findings show that, by 3.3 years, normal children achieve 85% intelligibility and near 100% intelligibility by four years of age itself. This finding has important clinical significance for assessment of intelligibility in children with communication disorders.

Key Words: Spontaneous speech, Sentence imitation, verbatim transcription

Efficient and effective communication requires the speaker to be well understood by the listener. Communication breakdown usually occurs when the listener finds it difficult to understand the speaker's message which can be attributed to the deviances in the speaker's verbal output. In this context the word speech intelligibility emerges and plays a vital role in oral or verbal communication.

Speech intelligibility which has been defined as the 'word or utterance recognition in natural communication situations' (Smith & Nelson, 1985), has been used as an index of overall speech

adequacy by researchers and clinicians (Bernthal & Bankson, 1998 and Weiss, Gordon & Lillywhite, 1987). It implies what is understood by the listener of the phonetic and phonemic realizations of speech. De Bodt, Hernandez-Diaz and Van De Heying, (2002) defined intelligibility as a product of a series of interactive processes such as phonation, articulation, resonance and prosody. The intelligibility of spontaneous speech is the reflection of the client's verbal communication competence and is a most important factor when determining the need for intervention and for evaluating the effectiveness of intervention strategies. Speech intelligibility is not only

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another consideration regarding the sequence of phonetic development, but is also a true measure of articulatory proficiency i.e., how the child uses the speech sounds or the phonemes acquired in contextual speech.

The speech sounds of the child may be correctly articulated in isolation and the child may have acquired these in his or her verbal repertoire, but these may not be clear to the listeners in conversational speech. When comparing a child's articulation with the developmental norms of speech sounds, one may find articulation on target, yet the speech of the child may be very difficult to understand, suggesting that factors other than the normal phonetic and phonemic development influence intelligibility. Intelligibility metrics are often affected by articulation and phonological aspects including adventitious sounds on one hand and by a number of other factors such as communicative developmental dysfluencies of the child, inflection, juncture, mean length of utterance, morphology, morphophonemics, physical posture, pitch, pronunciation, speaking rate redundancy, resonance, rhythm, semantics, stress, syntactic level of the child, voice quality, vocal loudness, pragmatics (Bernthal & Bankson 1998; Shriberg & Kwaitkowski, 1982; Weiss, 1982) on the other.

The above mentioned factors influence speech intelligibility perception from the perspective of the child's verbal productions. There are also certain factors which can influence speech intelligibility perception which can be attributed to be emerging from the listener's side. Some of these include sophistication of the listener as well as listener familiarity with the stimuli being used to assess speech intelligibility, the type of stimulus material and the context in which the speaker's verbal productions are presented to the listeners.

Unlike the articulatory development, the development of speech intelligibility is less orderly and less systematic due to the influence of many variables affecting it adversely. Linguistic aspects such as the size of the child's vocabulary, length of the utterance and familiarity of the word can influence intelligibility to a large extent. Larger the vocabulary, the longer the child's utterance and longer and less familiar the word, greater are the chances of having poorer intelligibility.

The construct of speech intelligibility has important clinical applications including assessments

and determination of intervention if needed, setting intervention goals and evaluating the effectiveness of intervention (Bernthal & Bankson, 1998). According to parent's reports, normally developing two year old subjects can be understood by a stranger 50 % of the time (Coplan & Gleason, 1988). Vihman and Greenlee, (1987) studied 10 three year old subjects from well educated families and revealed an average of 70 % intelligibility in conversation. Gordon-Brannan (1994) reported a mean intelligibility of 93 % with normally developing 4 year old subjects. Shipley and Mc Afee (1998) reported varied percentages of intelligibility for different age groups which are: 19-24 months: 25-50%; 2-3 years: 50-75; 4-5 years: 75-90 %; 5 years and above: 90-100 %. Chin, Tsai, and Gao (2003) studied 47 normal hearing English speaking children and found that children reached adult like or near adult like intelligibility around the age of 4 years. Baudnock, Buekers, Gillebert, and Van Lierde (2009) reported percent speech intelligibility of 90 % in children between 4-5 years having Flemish as their mother tongue. It is generally recognized that a 3 year old child who is unintelligible is a candidate for treatment.

As per the literature reports, there are three general approaches for measuring intelligibility. They are: open set word identification, closed set word identification and rating scale procedures (Gordon-Brannan, 1994). The first two methods yield intelligibility percentages. Open set methods are based on the listener identification through orthographic or phonetic transcription of words spoken by the participant. Closed set methods involve the listener selecting words from a pool of word choices while rating scales involve equal appearing rating scales and direct magnitude rating scales.

Currently most practicing speech-language pathologists make impressionistic estimates of speech intelligibility. These intelligibility estimates which often turn out to be inaccurate can influence the course of intervention for these subjects (Kent, Miolo & Bloedel, 1992). The method that is considered most valid for measuring intelligibility involves calculating the percentage of words understood from a continuous speech sample (Kent et al., 1992; Kwaitkowski & Shriberg, 1992). The procedure involving determining the percentage of words understood is most objective than estimation.

Need for the study: Most of the research on speech intelligibility has focused on individuals with

hearing loss, or neurological impairments or on adults who are alaryngeal speakers (Yorkston & Buekelman, 1981). Intelligibility data for young children with typical phonologies are lacking, especially in the Indian context, even though critical clinical decisions often are dependent on the normal aspects of speech intelligibility. Hence there is a need for studies to emerge regarding the speech intelligibility scores of typically developing children.

Objectives of the study are

- Primarily to obtain speech intelligibility scores from typically developing young Kannada speaking children.
- Secondly, to verify if any significant difference existed in intelligibility percent across spontaneous speech and sentence imitation tasks.

Method

Subjects: Sixteen normal Kannada speaking kindergarten subjects ranging between 3-4 years of age were considered as subjects for the study. The subjects were divided into 4 trimesters according to their chronological ages (3-3.3 years, 3.4-3.6 years, 3.7-3.9 years, and 3.10-3.12 years). Each group included four subjects respectively. These subjects were selected on the criteria that they had Kannada as their mother tongue and had normal speech, language, hearing and cognitive function with no history of any developmental delay.

Tasks: The subjects were required to perform on two verbal tasks: a) Spontaneous speech and b) Sentence imitation.

Stimulus for spontaneous speech: Attractive pictures of zoo and park were used for picture description. The subjects were encouraged to speak more on these topics through prompts provided by the researchers whenever required.

Stimulus for sentence imitation: Five sentences from Kannada story books appropriate for children of 3-4 years age group were selected. The mean length of utterance of the target sentences were 4-5 words (Appendix A). These sentences were presented auditorily to the subjects one at a time and their responses were recorded in a quiet room with a high signal to noise ratio.

Instrumentation: A digital voice recorder (Olympus W-100) with a sampling frequency of 16 KHz was used to record the speech samples. The samples were then digitized for audio recording using audio editing software (Cool Edit Pro version 2.00).

The edited sample contained only the subject's speech and was completely devoid of the researchers utterances.

Selection of the judges: 12 judges were selected for the purpose of verbatim transcription. They were selected based on the following criteria:

- within the age range of 20 - 35 years
- minimum qualification of Pre University
- Kannada as their mother tongue
- Absence of physical ailments or auditory deviancies
- minimum or limited exposure to children's speech

Perceptual judgment: Three judges were assigned to each group. Judges were presented first with each child's spontaneous speech samples followed by sentence imitation samples. In the spontaneous speech sample the first 100 verbal productions of the child were presented. For verbatim transcription of spontaneous speech, the samples were played as many times as needed and on a basis of three words at a stretch so that the judges had the opportunity to transcribe the perceived words immediately. Later the percentage of intelligibility for each child was calculated by comparing the verbatim transcription of the judges with a key which the researcher had developed for each child separately depending upon the child's actual utterances.

Statistical analysis: Appropriate statistical analysis was carried out using the SPSS (Ver 16) package.

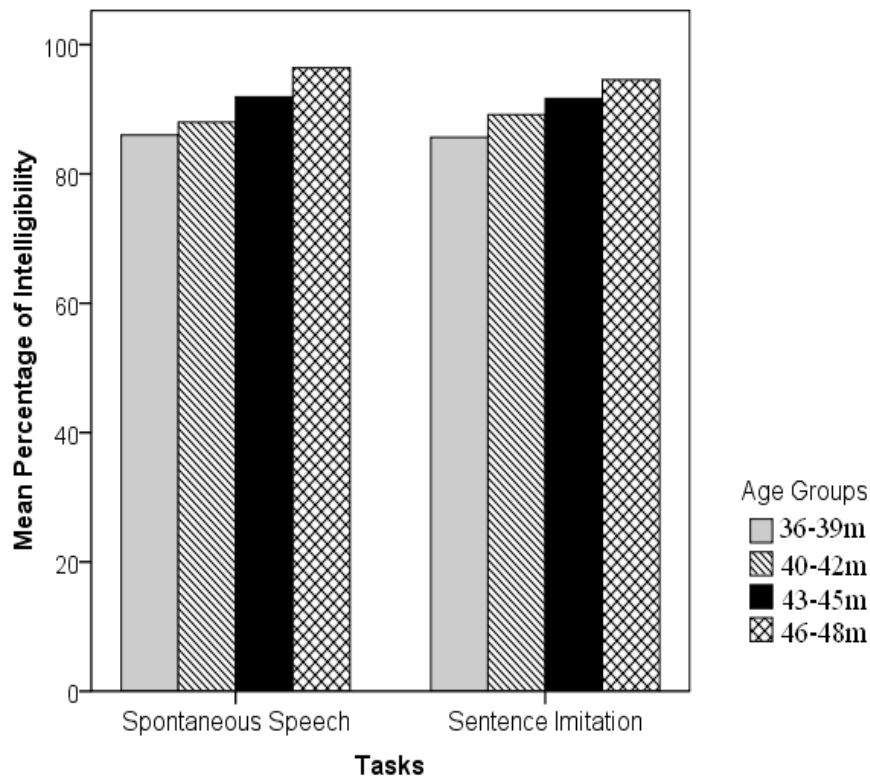
Results and Discussion

The main aim of the study was to track the developmental progress in speech intelligibility in typically developing Kannada speaking toddlers. Various statistical tools were utilized in arriving at the results. The Reliability coefficient alpha test was used to determine the inter judge reliability for each age group. It ranged from 75% to 90% indicating fair interjudge reliability.

Using descriptive statistics mean standard deviation and ranges of intelligibility scores were obtained for each of the four age groups and for the two tasks separately (Table 1). As is evident from Table 1, there is an increment in percent intelligibility in both the speech tasks with increase in age with the youngest age group having 86% and 85% in spontaneous speech and sentence imitation tasks respectively.

Table 1: Mean, Standard deviation and Range of percent intelligibility for the two tasks.

Age (years)	Spontaneous speech			Sentence imitation		
	Mean%	SD	Range	Mean%	SD	Range
3.0 - 3.3	86.00	5.60	82.60-89.60	85.60	3.36	81.60 - 93
3.4 - 3.6	88.00	2.12	86.00-90.00	89.16	8.33	83.30 - 93
3.7 - 3.9	91.91	1.34	90.30-93.30	91.66	5.77	85.00 - 100
3.10 - 3.12	96.41	2.21	93.60-95.60	94.58	3.43	88.3 - 100



Graph 1: Mean % of intelligibility in different age groups across tasks.

The oldest group scored 96 % intelligibility in spontaneous speech task and 94% intelligibility in sentence imitation task. This observation is much in accordance with the results of the previous Western studies which have reported a linear development in intelligibility with increasing age (Bowen, 2002; Shipley & Mc Afee, 1998; Gordon-Brannan, 1994; Baudnock et al; 2009). This is because, as children develop in their phoneme acquisition, they become more intelligible. Recent study by Pratima (2009) indicated that all the phonemes in Kannada are mastered by 3.5 years except phonemes /r/ and /h/ in the initial position. Another interesting fact was that

the children were 85% and above intelligible within 3.3 years itself and nearing 100 % by 4 years whereas some of the previous authors have reported only 75 % intelligibility by 4 years. Graph 1 indicates the linear increase in intelligibility with increase in age.

In this study two comparisons were made:

- Speech intelligibility across the four age groups using the statistical measures Kruskal Wallis and Mann Whitney tests for the two tasks
- Speech intelligibility across the two tasks for each age group using Wilcoxon signed ranks test.

Age wise comparison

The Kruskal-Wallis test revealed that there was an overall significant difference across the age groups in the spontaneous speech task at .05 level of significance (p=.013). Therefore Mann Whitney test was run to detect the presence of significant difference across the age groups. The results revealed that there was a significant difference in intelligibility across some of the groups which are shown in Table 2.

Across age group (years) comparison	'p' value	Significant difference
3-3.3 vs 3.4 - 3.6	.386	-
3-3.3 vs 3.7 - 3.9	.191	-
3-3.3 vs 3.10 - 3.12	.021	+
3.3-3.6 vs 3.7 - 3.9	.043	+
3.3-3.6 vs 3.10 -3.12	.021	+
3.7-3.9 vs 3.10-3.12	.021	+

Table 2: Shows significant difference for across age group comparison for spontaneous speech task. +/-: Significant Difference present/absent

However, as Kruskal-Wallis test did not reveal any significant difference across age for sentence imitation task, Mann-Whitney test was not performed for this task. This lack of significance could be possibly because the subjects received a model from the researcher in the imitation task, which provided visual and auditory cues thereby aiding in their correct production irrespective of their age.

Task-wise comparison

The Wilcoxon Signed Ranks test was run to compare the percent intelligibility difference across the two tasks in each age group. The results revealed that there was no significant difference in the percent intelligibility across the two tasks. The most acceptable explanation for this finding is that despite receiving a model while imitating the target sentences, there could be certain words which are totally new to the child or even when present in the expressive vocabulary, they are sparingly used. This is supported from the earlier reports that familiarity with the words is also a major factor influencing speech intelligibility (Baudnock.et al; 2009). However, it is suggested that the validity of this finding be explored further with more number of subjects.

Conclusions

The present investigation was an attempt to track the developmental progress in speech intelligibility in Kannada speaking toddlers. The study revealed that there is a significant linear progress in intelligibility with age in spontaneous speech task but not in sentence imitation task. The results indicate that by the age of 3.3 years itself, typically developing children attain 85 % intelligibility, and by four years of age near 100 % intelligibility is present even to strangers. This finding has important clinical implications for speech language pathologists in their diagnostic as well as therapeutic procedures.

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Appendix:

Target sentences for the task of sentence imitation.

1. /nʌnɪge aɪs kri:m tʌmbə: ɪftʌ/
2. /nʌm mʌnege nentʃru bʌndɪdru/
3. /bekku bɪsɪjə:dʌ hɑ:lʊ nekkiʃtu/
4. /rɑ:dʒʊvɪnʌ bɪsketʃtu keɪlʌge bɪttʃu/
5. /ɑ:mə mɒlʌkke spʌrde/