Trends in Performance Using Early Speech Perception Test in Typically Developing Tamil-Speaking Children

Gladys Prathiba Dawson[1], Ravikumar Arunachalam[2],
Prakash Boominathan[1], and Asha Yathiraj[3]

[1]Department of Speech Language and Hearing Sciences, Sri Ramachandra Institute of Higher Education and Research (D.U), Chennai, Tamil Nadu, India
[2]SRM Medical College Hospital and Research Centre, Kattankalathur, Tamil Nadu, India
[3]JSS Institute of Speech and Hearing, Mysuru, Karnataka, India

Background and Objectives: The study attempted to trace age-related changes in speech perception in typically developing children (≥3 to ≤6 years) using the "Early Speech Perception (ESP)" in Tamil. The test was developed in line with the original English version of ESP but adapted to suit the linguistic requirement of the Tamil language. **Subjects and Methods**: Using a cross-sectional design, the test was administered to 205 children with normal hearing who were classified into three age groups (≥3 to ≤4, >4 to ≤5, and >5 to ≤6 years). The developed test had three subtests (syllable categorization, bisyllable word identification, and trisyllable word identification). **Results**: All three age groups obtained perfect or near-perfect scores on the three subtests of ESP. There was no significant difference observed between the two adjacent age groups (≥3 to ≤4 vs. >4 to ≤5 years, >4 to ≤5 vs. >5 to ≤6 years) for all three subtests. However, significant differences were seen only between the youngest and the oldest age groups for the three subtests (≥3 to ≤4 vs. >5 to ≤6 years). **Conclusions**: The results indicated that ESP in Tamil can be performed effectively in all the three age groups studied.

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Introduction

Audition plays a major role in the development of spoken language and communication in children. However, children with hearing loss have speech perception deficits that vary with the degree of hearing loss [1]. To restore access to hearing, suitable technology is provided to deliver appropriate listening levels to children with hearing loss.

The assessment of speech perception is clinically relevant for various reasons. First, it helps to identify the specific listening deficits due to hearing loss. Second, it is useful to monitor the performance of a child with an amplification device, thus indirectly measuring the benefits of the device [2]. Third,

it aids in deciding the candidacy for cochlear implantation and monitoring progress with the device [3]. Most importantly, the assessment provides perceptual information that is vital to plan appropriate long-term management strategies for intervention for those with hearing impairment.

In English, there are many standard hierarchical tests to document developmental changes in children with hearing impairment [4]. The Early Speech Perception (ESP) test is one of the first tests that tap the pattern perception, spondaic word identification, and monosyllable word identification in a closed set for children who use hearing devices [4-6]. Using this test, individuals with hearing loss can be classified based on their perceptual abilities. The outcome obtained by evaluating children with hearing impairment using ESP has been critical for hearing professionals to plan interventional options beyond conventional hearing aids [7]. The ESP is different from other speech perception tests as it incorporates the hierarchical ac-

quisition of perceptual capabilities of a child. The ESP has been adapted to Mandarin [4], Hebrew [5], and Jordanian Arabic [8] to culturally suit the target population. Indian adaptations of the ESP tests have also been done in languages such as Marathi [9], Malayalam [6], Hindi [10,11], Kannada [12], and Indian-English [13]. However, it has not been adapted to Tamil, a language spoken in southern part of India in the state of Tamilnadu. Therefore, it was essential to establish performance changes in typically developing children as a function of age with ESP in Tamil. The data obtained from typically developing children would serve as reference while evaluating children with hearing impairment.

The need to develop ESP test in Tamil was felt necessary due to several reasons besides the nature of the test. Due to the initiation of the government funded cochlear implant program in the state of Tamil Nadu in 2013, more than 3,500 children have been implanted in the state that has a rural population of 40 million [14]. With the growing numbers of cochlear implant recipients, the need to evaluate the progress with appropriate tests becomes essential. However, one of the major challenges in adaptation of the test in Tamil was the construction of subtests as its language structures are different from English. The selection of test stimuli was slightly modified to suit the linguistic construction of Tamil language. Tamil is a diglossic language with a standard form and a spoken regional dialect and it differs based on the geographical location of the state. The spoken form or the colloquial form of the language was used for the test stimuli and the phonemes that were represented in the words were those used by the target group. The words included low, mid, and high frequency sounds. The colloquial form of the language was selected as the target age group for whom the test is meant will not be exposed to the standard forms of the language until they commence formal schooling [15].

Most studies of speech perception outcomes reported in Tamil speaking population have only used parental perspectives and rating scales to document perceptual abilities in children with hearing loss [16-18]. To evaluate the initial speech perceptual abilities in children with hearing loss, there is a need to develop a speech perception test in Tamil for young children and to validate the same on typically developing children. Thus, the study aimed to develop an ESP test in Tamil and to determine age-related changes in typically developing children aged ≥3 to ≤6 years. The data can serve as a normative value for speech perception abilities of typically developing children in the above mentioned age group.

Subjects and Methods

Participants

The study was conducted using a cross-sectional design and was approved by the Institutional Ethics Committee of Sri Ramachandra Institute of Higher Education and Research (Ref: IEC-NI/15/FEB/45/10). Initially, the standard version of ESP in Tamil was developed, after which it was validated on children aged ≥3 to ≤6 years.

The participants included 205 children with normal hearing in the age range of ≥3 to ≤6 years (118 boys and 87 girls). The children were divided into three age groups: group I (≥3 to ≤4 years, n=63), group II (>4 to ≤5 years, n=25), and group III (>5 to ≤6 years, n=117). Children with Tamil as a primary language were recruited from local schools and district schools of Tamil Nadu. Children diagnosed with obvious sensory, cognitive, or behavioural additional needs, as per-school records, were excluded from the study, after consultation with schoolteachers. Otoscopy was carried out on all children to rule out any problem in the external ear canal and middle ear. The children were selected only if their pure-tone average for the frequencies 500, 1,000, and 2,000 Hz was below 15 dB HL.

Development of ESP test material in Tamil

The test was adapted from the original ESP in English [19]. The test stimuli were modified to suit the linguistic construction of Tamil, a diglossic language with a standard form, and a spoken regional dialect. The spoken form of the language was used for the test stimuli as the participants were not exposed to the standard form, which is learnt only after entry to formal school curriculum.

The ESP in Tamil was developed for children aged ≥3 to ≤6 years to have three subtests (syllable categorization, bisyllable word identification, and trisyllable word identification). The words for the subtest were chosen from picture books, story books, and school textbooks appropriate for the target age group. Only words that were picturable were selected. Initially, 35 words for syllable categorization subtest, 15 words for bisyllable word identification subtest, and 12 words for trisyllable word identification subtest were selected. The words were validated by two parents and two primary school teachers to confirm whether the words were in the vocabulary of the youngest age group. Additionally, the teachers rated the word on a three-point rating scale as being very familiar, familiar, or unfamiliar. Only words that were rated as being very familiar and were used across different dialects of Tamil were selected for the test.

Further, the pictures for the corresponding words were selected and purchased from an online website. The pictures were

loaded on to a tablet (Samsung Galaxy 12-inch Tab; Seoul, Korea). The pictures for each subtest were grouped and displayed on separate pages. To confirm if the words were in the vocabulary of the youngest age group as well as the appropriateness of the pictures, five children aged ≥3 to ≤4 years were asked to name each picture. The children were asked to point to the pictures when the examiner named them. The stimuli were selected only if 90% of the children could carry out the tasks. From the words that were familiar to the children, for the syllable categorization subtest 12 words that included four bisyllabic, four trisyllabic, and four polysyllabic words were selected (Supplementary Material in the online-only Data Supplement). The phonemes used in the stimuli were those typically utilized by the target population. In syllable categorization subtest, only the number of syllables were scored and not the word identification. For the bisyllable and trisyllable word recognition subtests, 10 words each were selected (Supplementary Material in the online-only Data Supplement). The scoring for syllable categorization subtest was based on the correct identification of number of syllables (bisyllable, trisyllable, and polysyllable categorization). For the bisyllable and trisyllable word identification subtests, scoring was given only for correct word identification.

The words selected for the test were recorded by a native female Tamil speaker in sound recording studio using professional voice recording and editing software Nuendo (Version 6.0; Steinberg, Hamburg, Germany), using a 44,000 Hz sampling rate and 16-bit resolution. The stimuli were edited using Adobe Audition (Version 3.0, Adobe Inc., San Jose, CA, USA) software to normalize the intensity across the words. A calibration tone of 1 kHz was added in the beginning of the word list. The word list was subjected to a goodness test on 10 adults who were native speakers of Tamil, to ensure that all the recorded words could be identified. The recorded material was loaded on to the tablet that contained the pictures.

A pilot study was carried out using the final test material on 15 typically developing children, five from each of the three age groups. The children were instructed to point to the appropriate picture on the tablet. The pilot study was carried out to ensure that children were able to perform the test and to rectify any challenges during test administration. As all the children were able to perform the tasks, no further changes were incorporated in test material.

Procedure

The test was administered in a sound-treated room with minimal distraction. The stimuli were presented at 50 dB HL through a diagnostic audiometer (Piano-Inventis, Padova, Italy) to a loudspeaker placed 1 m from the head of the children at 0° azimuth. The children were initially familiarized with the test material and were instructed to respond to the words heard by them by touching the appropriate picture on the tablet. Short breaks were provided if the children showed signs of fatigue or restlessness.

The scoring for syllable categorization and word identification subtests were calculated separately. For syllable categorization, a score of 1 was given for each correct identification within the category. The response was scored correct as long as the word identified had the same number of syllables as the test stimulus. For the word identification subtests, a correct response was given a score of 1 and incorrect response was scored 0. The total score for the syllable categorization subtest was 12, bisyllabic word identification subtest was 10, and trisyllabic word identification subtest was 10. The overall total score was 32.

Statistical analyses

The collected data were analysed with SPSS statistics software (23.0 Version; IBM Corp., Armonk, NY, USA). Both descriptive and inferential statistics were done. A Shapiro-Wilks test indicated that the data were not normally distributed, hence non-parametric tests were used. To find the significant difference among the age groups Kruskal-Wallis test was used followed by the Mann-Whitney U test. Freidman test was used to compare the performance across all age groups for each subtest of ESP, followed by Wilcoxon signed rank test for pair-wise comparison.

Results

The findings of the study are provided in terms of the variation in scores for each of the subtests across the three age groups as well as variation in performance across the subtests within each of the age groups. The median and interquartile range (IQR) of the three age groups of the three subtests are given in Table 1.

Performance across age for each of the subtests of ESP in Tamil

To establish the overall difference in performance across the three age groups Kruskal-Wallis test was used. The results indicated that there was a significant difference ($p < 0.001$) in performance across the three age groups (Fig. 1). Mann-Whitney U test was used for pair-wise comparison between the age groups (Table 2). No significant difference in scores was present between the younger two age group (≥3 to ≤4 years, >4 to ≤5 years) for all three subtests. Likewise, the scores of all three subtests had negligible variation across the older two

Table 1. Performances with the Early Speech Perception test in Tamil across age groups for syllable categorization, bisyllable word identification, and trisyllable word identification

Subtests	Group I (n=63)		Group II (n=25)		Group III (n=117)		Total (n=205)
	Median (%*)	IQR	Median (%*)	IQR	Median (%*)	IQR	Median for all age groups combined (%*)
Syllable categorization	12 (100)	0.00	12 (100)	0.00	12 (100)	0.00	12 (100)
Bisyllable word identification	10 (100)	0.00	10 (100)	0.00	10 (100)	0.00	10 (100)
Trisyllable word identification	9 (90)	1.00	10 (100)	1.00	10 (100)	1.00	9.6 (97)

*Percentage scores. Age group: Group I, ≥ 3 to ≤ 4 years; Group II, >4 to ≤ 5 years; Group III, >5 to ≤ 6 years. Maximum possible scores for syllable categorization subtest=12; maximum possible scores for the bisyllable word identification subtest=10; maximum possible scores for the trisyllable word identification subtest=10. IQR, interquatile range
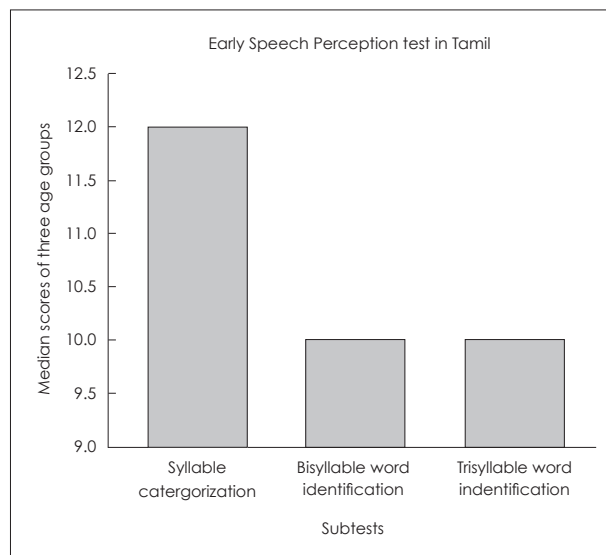

Fig. 1. Median scores of syllable categorization, bisyllable and trisyllable word identification subtests in typically developing children, with the three age groups combined.

age groups (>4 to ≤ 5 years, >5 to ≤ 6 years). However, a significant difference in scores ($p<0.001$) with a low effect size was observed between the youngest and the oldest age groups (≥ 3 to ≤ 4 years, >5 to ≤ 6 years), with the latter group obtaining higher scores. The low effect size calculated using Cohen's d indicates that the magnitude of difference between the groups were low. Hence, further analysis was carried out with the groups combined.

Performance across the three subtests of ESP in Tamil with the age groups combined

Freidman test was used to evaluate the overall difference in performance in the three subtests of ESP in Tamil (syllable categorization, bisyllable word identification, and trisyllable word identification). As the maximum possible score for the three subtests were different, the comparison was done with the percentage scores. The Friedman test indicated the presence of a significant main effect [$\chi^2(3)=374.35$, $p<0.0005$], hence pair-wise comparison was done using Wilcoxon singed rank

test. The scores differed significantly between the subtests syllable categorization and bisyllable word identification (Z= -3.181, $p<0.01$; d=0.190); bisyllable and trisyllable word identification (Z=-6.089, $p<0.01$; d=0.605); as well as syllable categorization and trisyllable word identification (Z=-7.547, $p<0.01$; d=0.754).

Discussion

The findings of the age-related changes in typically developing children on the adapted ESP test in Tamil and the difference in scores across the subtests (syllable categorization, bisyllable word identification, and trisyllable word identification) are discussed. No significant difference was seen between the adjacent age groups (Group I vs. Group II, Group II vs. Group III) for all three subtests. However, significant differences were seen only between the youngest and the oldest age groups for the three subtests (Group I vs. Group III). The relatively low-effect size for majority of the subtests indicated that this difference between the youngest and oldest age groups probably occurred due to some covariables. The near-perfect scores obtained by the three age groups (Table 1) also substantiate that they did not differ. Similar results were reported by Zheng, et al., [4] wherein the subtests were compared within age groups and the results were statistically not significant. Whereas, Begum [13], Jijo and Yathiraj [6], and Priya [12] did not carry out within age group comparison in the standard version of the ESP test unlike the within group age comparison performed in the present study. Thus, it can be construed that typically developing children as young as three-to-four years can carry out all three subtests of the ESP in Tamil as effectively as the children aged five-to-six years. The similarity in performance across the three age groups probably occurred as the stimuli selected for the test was familiar to the youngest age group. The findings of the present study also indicated that there was a significant difference in performance across the three subtests when the three age groups were combined. The effect size between the scores of the bisyllable

Table 2. Pair-wise comparison of the age groups for each of the subtests of the Early Speech Perception test in Tamil, measured using Mann-Whitney U test

Subtests	Group I vs. Group II			Group I vs. Group III			Group II vs. Group III		
	U	p	d	U	p	d	U	p	d
Syllable categorization	776.0	0.853	0.11	3312.0	0.007	0.15	1327.5	0.038	0.42
Bisyllable word identification	661.0	0.088	0.20	3059.0	0.001	0.58	1446.5	0.847	0.01
Trisyllable word identification	608.5	0.068	0.51	2749.0	0.001	0.45	1383.5	0.595	0.003

Age group: Group I, ≥3 to ≤4 years; Group II, >4 to ≤5 years; Group III, >5 to ≤6 years. Effect size measured using Cohen's d

word identification and trisyllable word identification subtest as well as between the syllable categorization and trisyllable word identification subtests were moderate. Thus, it can be inferred that these subtests measure different levels of perceptual difficulties. However, the effect size between syllable categorization and bisyllable word identification subtests was low, indicating that the significant difference between these subtests was caused by other covariables. Hence, it can be inferred that these two subtests assess similar levels of difficulty in speech perception in typically developing children. It is however possible that children with hearing loss may find the difficulty levels of these two subtests to be different. Thus, it is recommended that all three subtests of the ESP in Tamil be administered on children with hearing impairment until it is confirmed that they have similar performance across the subtests. It has been noted by Begum [13], Jijo and Yathiraj [6], Zheng, et al. [4], and Priya [12] that performance varies across the subtests of ESP in children with hearing loss. They also reported that children with hearing loss performed better with the syllable categorization subtests compared to word identification subtests. This difference in performance between the subtests may be inferred to the better perception of spectral information by individuals with hearing impairment [12].

Further, as the stimuli selected for the ESP in Tamil were similar across various dialects of the language, the test can be administered on different regions where the language is spoken. Although dialectal analysis was not carried out in the present study, the near-perfect scores obtained by children across the three subtests indicate that dialect had a minimal effect of the test performance. This may be due to the selection of the stimuli that was familiar across the different regions of the state. These findings are in agreement with the results reported by Zheng, et al. [4] that dialectal exposure had negligible effect on the test.

In conclusion, the findings of the study demonstrate that ESP in Tamil can be performed by typically developing children between the age range of ≥3 to ≤6 years. It is recommended that all three subtests of the test be administered as significant differences occurred between them. The test can be used in evaluating young children with hearing loss who have limited vocabulary to make judgements about their speech perception in comparison to typically developing children. The test can be used to select the type of device to be used by young children with hearing impairment. Additionally, it can be used to evaluate the progress made by these children subsequent to any form of listening training.

Supplementary Materials
The online-only Data Supplement is available with this article at https://doi.org/10.7874/jao.2021.00703.

Conflicts of Interest
The authors have no financial conflicts of interest.

Author Contributions
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ORCID iDs
Dawson Gladys Prathiba   https://orcid.org/0000-0002-5096-521X
Ravikumar Arunachalam   https://orcid.org/0000-0001-9668-9444
Prakash Boominathan   https://orcid.org/0000-0002-6994-1584
Asha Yathiraj   https://orcid.org/0000-0003-2825-3256

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