Time-Compressed Speech Test in Kannada for Children

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Abstract

The study aimed at developing a time-compressed speech test in Kannada for children and establishes norms on a group of children. The developed test consisted of four lists. Each list had 25 CVC words that were phonemically balanced. These word lists were compressed at four different levels 0%, 40%, 50% and 60%. The developed test material was administered on 60 normal hearing children in the age range of 7 to 12 years. It was found that with increase in compression level the scores generally dropped. There was significant decrease in performance seen with increase in the level of compression in all age groups except the oldest group. Generally the results indicated that as the age increased performance on the time-compressed speech test also increased. However there was no significant difference between the lists and gender.

Introduction

The ability to attend to spoken conversation, to comprehend, remember and respond appropriately to speech has been noted to involve a series of intricate processes that occur automatically in most individuals. Central auditory processing involves various processes such as auditory closure (decoding), binaural integration, binaural separation, temporal patterning, binaural interaction, neuro-maturation and inter-hemispheric transfer (Bellis, 1996). Deficits in the central auditory mechanism and processes have been found to affect non-verbal as well as verbal signals and influence various higher functions including language and learning (Phillips, 1993, 1995; ASHA, 1996).

According to Jerger and Musiek (2000) the assessment of central auditory processing should begin with careful observation of the child with particular attention to the auditory behavior patterns. When possible, an in-depth history from the child's parent or guardians should be taken. Hearing evaluation to rule out peripheral hearing loss was also considered essential. An auditory processing disorder (APD) has been found to be characterized by poor speech understanding despite normal hearing.

To evaluate different processes specific tests have been developed. To test a single process more than one test is available. To evaluate temporal processing, the tests developed are Frequency patterns or Pitch Pattern Sequence Test (PPST) by Pinheiro and Ptacek (1971); Duration Pattern Test (DPT) by Pinheiro and Musiek (1985); Gap Detection Test (GDT) by Williams and Perrott (1972); and time-compressed speech test by Beasley, Schwimmer, and Rintelmann (1972b). While the time-compressed speech test has been considered mainly as a test for auditory closure (Bellis, 1996), it may also be used to evaluate temporal processing. The

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original test made use of time compression along with reverberation, which was probably the reason that it was mainly considered a test for auditory closure.

The use of time-altered speech materials has gained recognition as a simple, sensitive and valid clinical tool. Time-compressed speech has been employed in investigations of central auditory abilities in children with normal peripheral hearing (Beasley, Maki & Orchik, 1976), normal hearing adults (Beasley, Schwinner & Rintelmann, 1972b) and adults with sensori-neural hearing loss (Sticht & Gray, 1969; Kurdziel, Rintelmann & Beasley, 1975). In addition, it has been used to assess auditory processing in adults with temporal lobe lesions (Kurdziel, Noffsinger & Olsen, 1976), aphasics (Orchik, Walker & Larson, 1977) and the elderly (Konkle, Beasley & Bess, 1977).

In the pediatric population research accelerated in the 1980s. Several tests have been developed for children to help identify if the auditory system is functioning normally (Keith & Jerger, 1991). More commonly central auditory testing in children is used to determine the functional auditory ability.

The monaural low redundancy speech tests available to evaluate children in India are the Speech-In-Noise (SPIN) test and time-compressed speech perception test in English (Sujitha, 2005). Mueller and Bright (1994) have suggested that SPIN test is a misused test of central auditory function. The SPIN test is found to have a low sensitivity to brainstem and cortical lesions. The time-compressed speech perception test is considered to be a more sensitive test for central auditory dysfunction evaluation (Kurdziel, Noffsinger & Olsen, 1976). For the western population norms for this test have been reported by Beasley, Schwimmer and Rintelmann, (1972a) and Beasely, Forman and Rintelmann (1972b). In India, norms for this test were developed in English for Indian children by Sujitha (2005). No such study has been developed in Indian languages. Therefore, the present study has been taken up to develop and establish normative data for a time-compressed test in Kannada.

The average intelligibility scores as measured by time-compressed monosyllables have been found to increase as a function of age in normal children (Beasley, Maki & Orchik, 1976; Nagafuchi, 1976). However, no significant difference has been found between males and females (Nagafuchi, 1976). It needs to be investigated as to whether such a phenomenon occurs in tests developed in India also.

Thus, the present study aimed at developing a time-compressed speech perception test in Kannada for native speaker of the language and obtaining norms. The study also planned at investigating the effect of ear of testing, gender and ages. Further, the effect of level of compression was also studied.

Method

Participants: The participants for the study were a group a 60 normal hearing children (30 boys and 30 girls) in the age range of 7 years to 12 years. These participants were divided into five age groups with each group having 6 boys and 6 girls (7 - 7;11 years, 8 - 8;11 years, 9 - 9;11 years, 10 - 10;11 years and 11 - 11;11 years). All the participants were speakers of Kannada and were exposed to the language from early childhood. They had no history of otological, neurological,

speech or hearing problems. Their pure tone thresholds were within the normal range (AC and BC thresholds were less than 15 dB HL) and their speech identification scores were more than or equal to 90%. Besides having a normal IQ they demonstrated good academic performance. The participants had no illness on the day of evaluation. Further they did not have symptoms of an auditory processing disorder which was determined using the screening checklist for auditory processing (SCAP) developed by Yathiraj and Mascarenhas (2003).

Development of the test: The stimuli from the 'Bisyllabic Phonemically Balanced Words in Kannada for Children' developed by Yathiraj and Vijyalakshmi (2005) was used to prepare the compressed material. Four compression levels were used i.e. 0%, 40%, 50% and 60%. List 1 was compressed to 0%, list 2 to 40%, list 3 to 50% and list 4 to 60%. A 1 KHz calibration tone was recorded before each list for adjusting the VU meter of the audiometer.

Instrumentation: A Pentium IV computer with the Praat software was used for preparing the compressed speech material. A two channel clinical audiometer Madsen OB 922 was employed for the preliminary test as well as for presenting the time compressed signal. The output of the audiometer was presented through TDH-39 earphones housed in MX- 41/AR ear cushions. An immittance audiometer, GSI Tympstar was utilized to ruling out the presence of any middle ear pathology.

Test Environment: The test was carried out in an air-conditioned sound treated double room suite. The ambient noise levels in the room were within permissible levels (re: ANSI, 1991, cited in Wilber, 1994).

Procedure: The participants who met all the participant selection criteria were administered the developed time-compressed speech test. The stimulus was presented at 40 dB SL monaurally. Each participant heard all four lists at 0% compression (no compression) as well as at 40 %, 50% and 60% compression.

Scoring: Each correct response was assigned a score of one while, a wrong response was given a score of zero. The scoring was done separately for the different levels of compression. The raw scores were statistically analyzed.

Results and Discussion

The data obtained were analyzed using SPSS version-10.1 software. The effects on time-compression scores by the ear of evaluation, gender and level of compression with reference to age (effect within an age group and across age groups) were determined. These effects were analyzed using descriptive statistics as well as a three-way MANOVA. Post hoc analyses were carried out using the Duncan's test and Bonferroni's multiple comparison tests when required.

1. Ear Effect

The mean and standard deviation of the right ear and left ear was determined at each compression level for each age group (Table 1). The MANOVA results indicated that there was

no significant difference between the right and the left ear at different compression levels. This finding was seen across all the age groups.

Table 1: Mean, SD for right and left ears, males and females, across age groups for different levels of compression

Level of compression	Age	Ear	Mean		S.D	
			Male	Female	Male	Female
0%	7 - 7.11	Right	23.67	24.33	1.15	.58
		Left	23.33	24.00	2.89	1.00
	8 - 8.11	Right	24.33	22.00	.58	2.00
		Left	24.33	23.67	1.15	.58
	9 - 9.11	Right	24.33	24.67	.58	.58
		Left	24.33	23.67	1.15	1.15
	10 -10.11	Right	24.67	24.33	.58	.58
		Left	24.33	24.00	.58	1.00
	11 -11.11	Right	25.00	25.00	.00	.00
		Left	24.67	23.33	.58	1.53
40%	7 - 7.11	Right	21.67	22.67	2.89	2.31
		Left	22.00	22.33	3.00	2.52
	8 - 8.11	Right	24.00	23.67	1.00	.58
		Left	23.33	22.33	1.53	.58
	9 - 9.11	Right	23.00	23.00	1.73	1.73
		Left	23.00	24.00	1.00	1.00
	10 -10.11	Right	24.33	24.00	1.15	1.73
		Left	24.00	24.33	.00	1.15
	11 -11.11	Right	25.00	24.00	.00	1.73
		Left	24.33	24.33	.58	1.15
50%	7 - 7.11	Right	21.67	21.33	2.08	.58
		Left	21.67	21.00	2.08	1.73
	8 - 8.11	Right	22.67	21.67	.58	2.52
		Left	22.00	21.00	1.00	1.00
	9 - 9.11	Right	22.33	22.33	.58	2.08
		Left	21.33	21.33	2.31	1.15
	10 -10.11	Right	22.67	23.33	2.52	1.15
		Left	22.67	23.67	1.53	1.15
	11 -11.11	Right	24.67	23.33	.58	2.08
		Left	22.67	23.67	2.31	1.15
60%	7 - 7.11	Right	21.33	22.67	3.06	2.52
		Left	22.67	22.00	2.08	3.00
	8 - 8.11	Right	23.67	21.67	1.15	.58
		Left	22.33	20.67	2.31	.58
	9 - 9.11	Right	22.33	23.33	3.06	2.08
		Left	23.33	23.00	.58	.00
	10 -10.11	Right	22.33	22.00	2.08	2.00
		Left	22.67	23.33	1.15	.58
	11 -11.11	Right	24.33	24.67	.58	.58
		Left	23.33	22.67	.58	2.52

The results obtained from the present study are in agreement with the results of study conducted on the western population by Beasley, Schwimmer and Rintelmann (1972b) and on Indian non-native English speakers by Sujitha (2005). They reported that there existed no difference between the right and left ear scores at different levels of time-compression.

2. Gender Effect

The difference in the scores between males and females was determined at each compression level by calculating the mean and standard deviation (Table 1). The gender effect was further analyzed using a three-way MANOVA. The results indicated that there was no significant difference between males and females at different compression levels. Similar finding have been reported by Konkle, Beasley and Bess (1977). Sujitha (2005) also reported that there was no difference in gender at different compression levels in children aged 7-12 years.

3. Effect of Level of Compression within an age group

As there was no difference between genders as well as between ears, the whole data was combined. Further analyses regarding effect of different compression levels and different ages were done with data obtained for gender and ear combined.

Table 2: Mean, SD, Confidence Interval, Maximum and Minimum scores for all age groups at different levels of compression.

AGE		Mean	95% Confidence Interval for Mean		Std. Deviation	Minimum	Maximum
			Lower Bound	Upper Bound			
7 - 7.11	0%	23.6	22.52	24.68	1.51	20	25
	40%	21.6	20.08	23.12	2.12	19	25
	50%	21.1	20.12	22.08	1.37	19	24
	60%	21.6	20.05	23.15	2.17	18	25
8 - 8.11	0%	23.6	22.58	24.62	1.43	20	25
	40%	23.4	22.56	24.24	1.17	22	25
	50%	21.7	20.63	22.77	1.49	19	24
	60%	21.8	20.74	22.86	1.48	20	25
9 - 9.11	0%	24.1	23.47	24.73	.88	23	25
	40%	23.1	22.12	24.08	1.37	21	25
	50%	21.4	20.50	22.30	1.26	20	23
	60%	22.8	21.59	24.01	1.69	19	25
10 - 10.11	0%	24.2	23.75	24.65	.63	23	25
	40%	24.1	23.31	24.89	1.10	22	25
	50%	23.0	21.83	24.17	1.63	20	25
	60%	22.3	21.29	23.31	1.42	20	24
11 - 11.11	0%	24.4	23.63	25.17	1.07	22	25
	40%	24.3	23.54	25.06	1.06	22	25
	50%	23.3	22.13	24.47	1.64	20	25
	60%	23.6	22.52	24.68	1.51	20	25

Examination of the raw data indicated that a few participants showed no change in scores with increase in compression level. Hence, further analyses were done after deleting the scores of these participants who continued to perform well in spite of the compression. This was done to avoid the scores skewing the results. Thus from each age group the scores of two participants were dropped and the data were analyzed for 50 participants. The mean, SD and confidence interval for the 50 subjects is given in Table 2.

From the information in Table 2 it can be seen that the performance for time-compressed words reduced with increase in the level of compression for all the age groups. In order to find out if there was a significant difference for different level of compression in a particular age group repeated measure ANOVA was done. At all the ages except 11-11;11 years age group there was a significant difference ($p < 0.001$) across the compression levels.

To check whether this significant difference was present across all compression levels for each age group, the Boneferroni multiple comparisons test was done to see the pair-wise differences. The level of significance for the different pairs is given in Table 3.

Table 3: Significance difference between different compression levels across age groups

Tested pair	**7- 7;11**	**8-8;11**	**9-9;11**	**10-10;11**
0% & 40%	< 0.05	NS	NS	NS
0% & 50%	< 0.001	< 0.05	< 0.01	NS
0% & 60%	NS	NS	NS	< 0.05

The above finding brings to light that there is an overlap in scores at each of the ages, with increase in compression level. It is also evident that the effect of compression is not uniform in each of the age groups.

The raw data indicated that for individual clients there was generally a decrease in scores with an increase in compression level. Thus it is recommended that for each client the scores should be compared at different compression levels rather than compare the scores with norms obtained at one compression level. This would provide more diagnostic information.

Research by Beasley, Bratt and Rintelmann (1980) has shown that in young adults with increase in compression levels the scores varied very marginally up to 60% compression. The compression level had to be increased to 70% before the scores dropped significantly.

Thus it can be construed that compressions up to 60% do not result in significant variation in scores in individuals who have normal hearing. It needs to be investigated whether individuals with a temporal processing problem show marked differences across compression levels unlike that reported in normal hearing subjects in the study by Beasley et al. (1980) and in the present study.

4. Effect of level of compression across age groups

MANOVA was done to find out the effect of the level of compression across ages. The results indicated that there was no significant age effect at 0% and 60% compression levels. However, there was a significant age effect at the 40% and 50% compression levels. From this it can be inferred that when the task is very easy (0% compression level) or very difficult (60% compression level) the subjects across different ages perform in a similar manner. However,

when the task was of moderate difficulty (40% and 50% compression levels) the effect of maturation was evident. This occurred when the scores of all 60 subjects were analyzed. The analysis was also done after deleting the scores of ten subjects with very high scores at higher levels of compression. When this was done the scores varied across ages for the 60% compression also {F (4, 45) = 2.327, p > 0.1}.

The Duncan's Post-hoc test was done for the 50 subjects in order to find out the effect of each compression level across age levels. At 40% compression level, the youngest age group (7-7;11 years) performed significantly poorer than all the older age groups (8-11;11 years). However there was no maturational change from 8 years onwards at this compression level. At 50% compression level the youngest group (7-7;11 years) performed significantly poorer than the older two groups (10-11;11 years). However, they did not differ from the adjacent two age groups (8-8;11 years and 9-9;11 years). At 60% compression level the trend was little different from that seen at the 40% and 50% compression levels. Here the youngest age group (7-7;11 years) performed significantly poorly than the oldest age group (11-11;11 years). The 8-8;11 years old children also had scores that were significantly different from the oldest group. There was no significant difference between the other age groups.

The finding reveals that when there was no compression (0%) there is no difference in the scores at different ages. However, when compression was introduced a developmental trend was observed. The developmental trend varied depending on the level of compression (Figure 1).

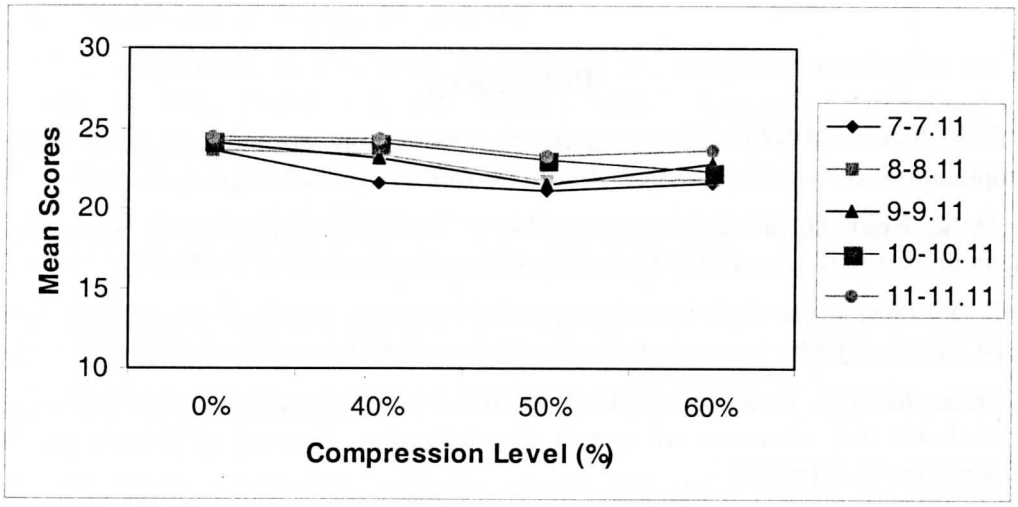

Figure 1: Mean scores for different age groups across compression levels

It has also been reported by Sujitha (2005) that scores on a compression test does vary across ages in children. The developmental trend observed by her was not similar to what was observed in the present study. This variation could be due to the material used. While she used CVC monosyllables, CVCV bisyllables were used in the present study. Hence there was a higher chance of consonantal information being deleted from the stimulus in her study than in the present study. It was also observed in her study that the mean scores across ages were lower than that seen in the present study. This too could be accounted for by the greater reduction in consonantal information in her study when compared to the present study.

De Chicchis, Orchik and Tecca (1981) also noted that significant variations in scores were obtained in time-compression tests depending on the material used. They noticed the variation at 30% and 60% compression levels.

Summary and Conclusion

The results of the study revealed that there was no significant difference in the right and left ear scores for the monotically presented time-compressed Kannada speech stimuli. Likewise, there was no difference in the performance of males and females across ages at different levels of compression. With an increase in compression level the scores generally dropped. However, the effect of compression at each of the age groups was not identical. There was a significant decrease in performance seen with increase in the level of compression in all age groups except the oldest group.

The results of the present study support the findings of previous studies by Beasley et al. (1972b), Nagafuchi (1976), De Chicchis et al. (1981) and Sujitha (2005). Thus, the findings of the present study on the Indian population are consistent with the finding obtained on the western population and similar to the non-native English speakers. The present study also reveals that the time compressed speech test can be administered in any ear and in both males and females without adversely affecting the results.

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