A STUDY ON VISUAL DEPENDENCY IN HEARING IMPAIRED CHILDREN FOR PERCEPTION OF SPEECH

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Abstract

Visual speech perception is also known as lip reading and speech-reading. Visual speech is used by hearing impaired individuals, as well as individuals with normal hearing. The dependency of auditory performance on visual cues can be accounted to the concept of sensory integration. The aims of the study are : To assess the performance of children with hearing impairment in visual only and combined audio-visual tasks and to derive the implications of visual dependency in auditory performance based on their respective age and gender and also complexity of speech stimuli(words and sentences). Method included two groups of severe to profound sensorineural hearing impaired subjects. Each Group consists of 25 hearing impaired individuals. The stimuli were divided into visual (lip-read), auditory and picture stimuli presented in three conditions auditory only, audio and visual and audio-visual accompanied with the picture. The total combined Mean scores for words and sentences were slightly higher for the audio-visual with picture presentation when compared with the visual only presentation. Standard deviation scores of audio visual with picture presentation is lesser than visual only condition. Overall condition which was associated with picture presentation was more likely to receive higher scores than visual alone condition.

Introduction

It was proposed by Immanuel Kant (1760) that modes of perception determine our knowledge about the outside world. Perception through senses can be of five types: Sight, Smell, taste, touch and hearing. Each of these senses have receptor cells which is linked to the nervous system and thus to the brain. At primary levels of the cells sensing is initiated and further integrated in to sensations at the level of the nervous system. Hearing is the second sense to be developed in humans, first being sight. Different type of environment energy is transduced by the nervous system. As light energy is transuded by the retina similarly sound energy is transduced by the cochlea. When neurological processing of these two energies is combined which results in a unified perception of the object or event occurred. Speech reading is important for both hearing impaired individuals and individuals with normal hearing. Individuals with Hearing impairment perceive speech through watching the face of the talker while listening through the amplification system. Also Normal hearing persons tend to rely on visual cues in difficult situations such as communication in noisy or reverberant environment.

According to the Bernstein (2005) integration of auditory and visual speech is achieved by the neurological networks in the cortex, which have lead to the predictable associations between the two modalities.

As individuals with hearing impairment can't rely completely on auditory cues with amplification for perception of speech. Comprehension of the message increases with the integrated cues of both audition and vision. To improve the perception of the speech signal this technique of integration can be used by hearing impaired listeners along with the amplification.

Speech perception requires decision to be made both about the trends and also about the speaker's language pattern. It has been commonly observed that addition of even small amount of auditory input to the visual stimulus greatly enhances perception of a speech signal. As stated earlier by Erber (1979) this enhancement effect usually found in Profound Hearing loss subjects, In whom the available auditory evidence from the acoustic speech signal is limited due to cochlear pathology. Barbara Dodd (2009) reported that as soon as birth and four months of age infants are aware that lip movements match the speech sound and they also have language specific speech-reading skills.

In another study by Bernstien et al., (2000) explains the importance of perceiver's hearing history as a factor while determining conducive environment for enhanced speech-reading skills. In subjects where hearing loss have an early-onset of Severe to Profound hearing degree, only minimal auditory cues are available, Therefore increasing the speech-reading skills for communication.

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An extensive research has been conducted to address effectiveness of speech reading when paired with amplification. Ross (1998) estimated that about 30 to 40% of speech is recognized only through visual cues.

Persons with hearing impairment are known to maximally use their other senses including vision. Their daily performance in all aspect including audition can be supplemented by visual information. Hence a protocol that would act as a prognostic indicator with regard to person's auditory performance in daily living situations and also aids in decision making regarding appropriate rehabilitation measures should be incorporated. Since previous studies have incorporated visual and audio-visual conditions to assess speech perception most of the language used is English and other native languages. Very few materials are available to asses Kannada speaking hearing impaired individuals. Most of the studies conducted have used vowel or consonant perception (Erber, 1972) and also words, but there are very limited studies on using sentences for visual speech perception which suggest as a useful measure for daily consequences and challenges encountered by the hearing impaired individuals.

The aims of the study are: To assess performance of the hearing impaired individuals in visual only and combined Audio-Visual tasks and to derive the implications of visual dependency on auditory performance. To investigate the difficulty in perception of speech as the complexity of the stimuli increases and to notice if there is any altering in the modality of speech perception due to complex stimuli. To derive affect of age of the hearing impaired children on speech perception mode. Also to see if there is any difference between genders of hearing impaired children in mode of perception of speech.

Method

Subject: Two groups of sensorineural hearing impaired subjects were included in the current study. Participants attended a special school for hearing impaired incorporating total communication as the mode of communication and all participants had Kannada language as their medium of instruction. Group I consists of 25 hearing impaired individuals with bilateral severe to profound hearing loss within the age range of 8 to 13 years studying in primary level. Group II includes 25 subjects with the similar type and degree of loss within the age range of 13 to 18 years studying in secondary level. In both the groups, subjects had normal visual acuity and were using Kannada as their first language.

Table 1: Shows distribution of subjects into groups and also includes Mean and Range of Pure tone average of male and female subjects in each group.

GROUPS	GROUP I		GROUP II	
Number of subjects	25		25	
	Male	Female	Male	Female
	13	12	13	12
Pure tone average (Mean)	91.61	88.29	92.01	95.83
Pure tone average (Range)	28	35	35	30

Material Development: The stimuli were divided into visual (lip-read), auditory and picture stimuli. Eighty high frequency words were identified on the basis of participant's vocabulary which were distributed among five special educators from the special school (Hearing impaired children school) for familiarity testing of the participants. The final 50 words, 10 phrases and 5 sentences were selected on the basis of special educator's responses.

All the stimuli were recorded through Cannon Power shot digital camera with high resolution (with 8 megapixels) and recordings were done in double walled sound booth. Recording were loaded into Compaq CQ60 laptop and presented through a VLC media player on 17 inch monitor display. Five recordings of stimuli were obtained from five different female speakers and evaluated by 10 individuals whose mother tongue was Kannada.

Five individuals who were not aware of the aim of the study and not from speech and hearing background and whose mother tongue was Kannada were asked to evaluate the recordings. Each individual had to rate all the five stimulus recordings. They were asked to rate for naturalness of speech using a rating scale from 0 to 5 where 0 was rated as poor natural speech and 5 as natural speech. The five individuals rating for five different stimulus recordings were averaged and the recording which received best average rating was selected for the study. Pictures representing all the stimuli (words and sentences) were selected and the special educators of the participants were asked to evaluate them based on picture clarity and comprehension. Those pictures which were difficult to comprehend and contained more distractions were replaced by better pictures.

Instrumentation: Recorded stimuli were presented through Compaq CQ60 laptop and Sound-Level-Meter (SLM) was used to determine output dB SPL for each word and sentence. Bruel & Krjaer SLM type 2231 connected to half inch microphone type 4155 using the adaptor ZC002

were used and measurement was done in the sound proof booth. SLM settings was kept at 'A' weighting, fast network was used for each sentence and word. SLM was held at patient's ear level 3 feet away from the monitor and measured output at each word level when volume of laptop was 100% and VLC media player volume was 50% . Stimulus was presented using VLC media player 0.9.2 through widescreen 17 inches Compaq CQ 60 laptop. Stimulus was presented in a double walled sound proof booth with adequate lighting. Output dBSPL of words and sentences was obtained individually and the Average output ranged from 60 to 70dBSPL.

Test procedure: Stimulus was presented in three conditions:

Condition 1: Visual presentation**:** The recorded visual stimuli were presented by muting the speakers of the laptop and the participants could visualize the speaker's face at 0 degree azimuth.

Condition 2: Visual +Auditory Presentation: Both recorded auditory and visual stimuli were given together.

Condition 3: An Audio-Visual stimulus was presented simultaneously with the corresponding picture.

The speaker`s view was frontal from the head to the shoulders and approximately 3 feet distance from the seating of the participant. Response sheets were provided to the participants to write down the words and sentences. Three response sheets were used for three respective conditions: Response sheet 1 (Visual only); Response sheet 2 (Visual+Auditory only); Response sheet 3 (Visual+Auditory+Pictures only): participants were asked to write down words and sentences perceived in all the three conditions.

Pictures were presented in a closed set. Four alternative choices were provided, one among them was target picture stimulus which corresponds to the word stimuli presented Audio-Visually. The participant should identify the picture depicting the word and sentence, presented audio-visually. The pictures were randomly selected and shuffled for alternative choices.

Session starts with the presentation of visual stimulus which had a time interval of 10 sec between each word and 20 sec between each sentence and also a pause is provided for the participant to write down the responses.

Participants who fail to perceive stimulus in visual only condition was subjected to the audio-visual condition for the same word or sentences. If participants fail to pass in the first two conditions, then they were provided with third condition (auditory + visual + picture). Participants were encouraged to guess the word and write down the responses for all the stimuli.

Scoring: Scoring was done separately for three conditions and total number of correct words under each condition was calculated. The correct written word was scored as 1. Phrase and Sentence scoring depended on the number of correct content words and functional words exist among them. If the words in the phrases and sentences were completely correct then the subject was given a score of 3. If there are all content words and few functional words then it was scored as 2, few correct content words without any functional words then it was scored as 1, if there was no response the subject gets the score of 0.

The data was tabulated using Microsoft Excel and statistical analysis was done by SPSS software. Comparison of between groups and within groups were done using Four way Analysis of covariant for investigating difference between groups (group 1 v/s group2), gender(Male v/s Female), types of stimuli(words v/s sentences) and modes of presentation (visual v/s visual+audition v/s visual+audition+picture).

Results and Discussion

Participants were compared for age, gender, mode of presentation and types of stimuli presented.

1) Visual only presentation **(**For words and sentences):

Table 2: Shows the mean and standard deviation (Sd) values for words and sentences in visual mode of presentation for group I and group II males and females.

Visual for words		Males	Females	Total
Group I	Mean	9.9167	15.0000	12.4583
	SD	4.44069	0.00000	4.02146
Group II	Mean	18.0000	20.1667	19.0833
	SD	7.07107	4.62863	5.94845
Visual for sentences				
Group I	Mean	Mean	1.4167	3.0000
	SD	1.4167	3.0000	2.2083
Group II	Mean	2.06522	3.69274	3.03572
	SD	10.2500	8.5000	9.3750

2) *Audio-visual presentation* (For words and sentences):

Table 3: Depicts the mean and standard deviation values for words and sentences in Audio visual mode of presentation for group I and group II males and females.

Audio visual for words		Males	Females	Total
Group I	Mean	7.2500	9.9167	8.5833
	SD	2.37888	5.74390	4.51005
Group II	Mean	10.5833	7.5000	9.0417
	SD	5.96137	3.06001	4.89435
Audio visual for Sentences				
Group I	Mean	5.4167	3.8333	4.6250
	SD	3.67939	2.69118	3.25460
Group II	Mean	6.5833	7.1667	6.8750
	SD	5.35059	3.53768	4.44593

3) *Audio-visual and pictures presentation* (For words and sentences):

Table 4: Represents the mean and standard deviation values for words and sentences in Audio visual with pictures mode of presentation for group I and group II males and females.

Audio visual and picture for words		Males	Females	Total
Group I	Mean	18.0000	17.0000	17.5000
	SD	3.27525	5.89299	4. 69042
Group II	Mean	17.0833	18.0833	17.5833
	SD	4.07784	3.11764	3.58641
Audio visual and picture for sentences		Males	Females	Total
Group I	Mean	18.0000	17.0000	17.5000
	SD	3.27525	5.89299	4. 69042
Group II	Mean	17.0833	18.0833	17.5833
	SD	4.07784	3.11764	3.58641

4) *Comparison of overall response for type of stimuli and mode of presentation:*

a) Total scores for words:

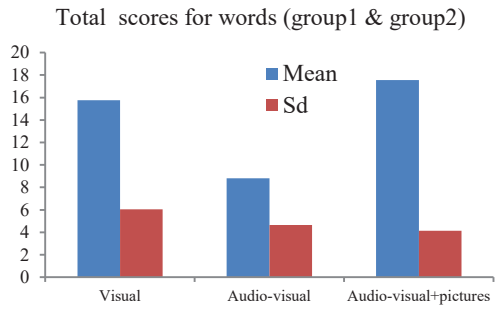

Figure 5: Shows the total score of Mean and standard deviation values for words for group1 and group2 males and females.

The Mean and standard deviation scores for words were slightly higher for the audio-visual with picture presentation when compared with the visual only presentation. Whereas Audio-visual only condition had lower scores when compared to other two conditions.

b) Total scores for sentences:

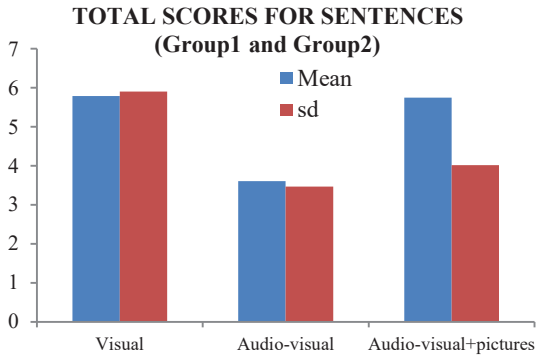

Figure 6: shows the total Mean and standard deviation values for sentences of group1 and group2 males and females.

The Mean and standard deviation scores for sentences were greater for the visual only presentation when compared with the audio-visual only presentation. Whereas Audio-visual only condition had lower scores when compared to other two conditions.

c) Total scores for words and sentences

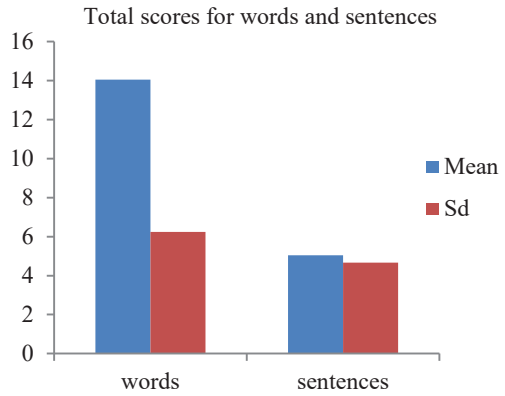

Figure7: Shows the total scores of Mean and standard deviation values for words and sentences for males and females of group1 and group2.

The total Mean and standard deviation scores were higher for words than for sentences in all three modes of presentation for both males and females of group1 and group2.

d) Total combined scores for words and sentences

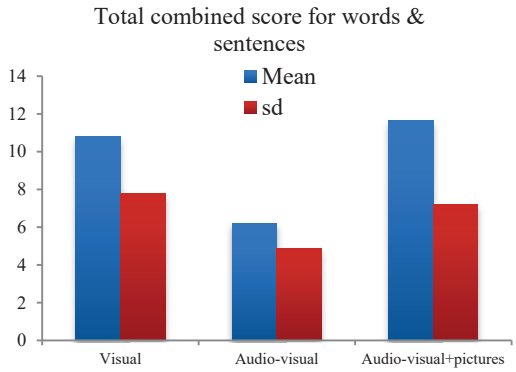

Figure 8: Shows overall total combined Mean and standard deviation values for words and sentences for modes of stimulus presentation for males and females of both group1 and group2.

The total combined Mean scores for words and sentences were slightly higher for the audio-visual with picture presentation when compared with the visual only presentation. Standard deviation scores of audio visual with picture presentation is lesser than visual only condition. Whereas Audio-visual only condition had lower Mean and standard deviation scores when compared to other two conditions.

Summary and Conclusion

The study aimed at assessing dependency of children with hearing impairment on visual cues for perception of speech using words and sentences in Kannada as the stimuli. The constructed test material was administered for 50 hearing impaired children of Severe to Profound degree containing both male and female subjects from two age groups. Group I consisted of 25 subjects with an age range of 8 to 13 years and Group II which consisted of 25 subjects with an age range of 13 to 18 years. Words and Sentences selected for the study checked for similarity and matched the vocabulary of the subjects participated. All the stimuli were recorded and presented through a wide screen laptop.

The test stimuli were presented in three conditions: visual only (V) presentation in which only speaker's face and lip movements were visible with no additional cues. Second, Audio-visual (AV) mode in which visible face and lip movements simultaneously accompanied with auditory signal. Third mode included, Audio-visual with picture (AVP) presented simultaneously, where the picture depicted the word or sentence presented Audio-visually.

All the words and sentences used in the test were presented to all the participants in when subject failed to perceive word or sentence in visual only condition then he/she was subjected to the second condition where the stimuli was presented Audio-visually, if the difficulty still persist then the third mode of presentation Audio-visual with picture was administered. Responses were in written form of perceived word or sentence from the subjects.
The statistical analysis revealed that best performance of the subjects was for Audio-visual with picture condition followed by visual only condition. The Audio-visual only presentation received least scores among the other two conditions. Group II male and female subjects outperformed Group I male and female subjects in all three visual tasks.

The results revealed the Group II subjects performed better when compared to Group I subjects because of experiential influence. Condition which was associated with picture presentation was more likely to receive higher scores than visual alone condition. Performance of both group I and group II were least for Audio-visual only presentation because of limited benefit from hearing aid.

Limitations of the study

1. Only limited number of subjects could be taken for the study and was not compared with control group
2. Study could be extended to cochlear implant group to assess difference in modality of perception.

Future directions

The stimulus used in this study can be used as a test in Kannada for assessing visual dependency in hearing impaired children for perception of speech.

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