Development of High And Low Predictable English Sentence Test (EHLPS)

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Abstract

In an everyday situation there is a combination of high and low predictable sentences. The present study aimed at developing an English High Predictable-Low Predictable Sentence test for Non-Native English speakers (EHLPS). The test was administered on twenty normal hearing and eleven individuals with mild-to-moderate sensorineural hearing loss. The responses were scored in terms of high and low predictable target words and key words in the sentences. The statistical analysis of the data revealed that there was a significant difference between the normal group and individuals with hearing impairment on the EHLPS for both key word and target word scoring. The developed test has been found to be useful in determining the perceptual problems in individuals having hearing loss. Hence it may be used as a part of diagnostic test battery and for pre and post therapy evaluations in individuals having auditory perceptual problems.

Key words: speech identification, perceptual problems, sensorineural hearing loss

Introduction

Speech is highly redundant because the information in it is conveyed in several ways simultaneously (Martin, 1994). A hearing loss involving only part of the auditory frequency range may go undetected in a speech test which is not carefully controlled. It has been noted by Martin (1994) that it was not possible in a single test to sample all types of speech events that might occur in practice. This is because everyday speech communication covers a wide range of spoken material and takes place in a variety of contexts.

Denes and Pinson (1963) reported that basically two kinds of operations were involved in the understanding of sentences. One was the reception and initial processing of acoustic information through the auditory system and the other was the utilization of linguistic information that is stored in memory. A test of a listener's ability to understand everyday speech therefore must assess both the acoustic-phonetic and the linguistic-situational components of the process.

The goal of most speech perception tests is to provide a measure of an individual's performance in everyday listening situations. Although there are many meaningful word and nonsense syllable tests available that provides analytic information regarding a patient's speech perception abilities, sentence tests offer additional insight about the individual's performance in

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more realistic communication situations. Sentences are considered more valid indicators of intelligibility and a better representation of spoken communication. The use of single words, especially single syllable words, imposes severe limitations on the capacity to manipulate certain patterns like intonation and co-articulation effects on the ongoing speech. Sentences have face validity as 'natural' and 'meaningful' stimuli for assessing auditory function (Miller, Heise & Lichten, 1951).

Different forms of sentence tests have been developed over the years. Certain sentence tests have been developed with the aim of tapping the perceptual difficulties of those with hearing loss (Mendel & Danhauer, 1997). Other sentence tests have been constructed to determine difficulties in the perception of high predictable or low predictable sentences. High predictable sentences are those in which the target test words can be guessed from the context whereas in low predictable sentences the final word cannot be guessed from the sentence context (Kalikow, Stevens & Elliot, 1977). In our day-to-day life situation there is a combination of high and low predictable sentences.

The present study aimed to develop a test having low and high predictability sentences and administer it on a group of normal hearing individuals and a group having mild-to-moderate hearing loss. It would be determined whether the test can differentiate the perceptual problems of individuals with a hearing loss.

Method

Participants: The study was done in the three stages. The participants in each stage were different. In stage I, ten normal hearing children in the age range of 12 years to 17 years 11 months were used to check for the familiarity of words used in the sentence test. In addition to classify the sentences as high predictable and low predictable 10 normal hearing adults (18 to 30 years) were used. For stage II of the study two groups of normal hearing individuals were used each consisting of 20 members. One group was in the age range of 12 years to 17 years 11 months and the other in the age range of 18 years to 30 years. In stage III ten individuals having mild-to-moderate sensorineural hearing loss were taken to check the utility of the material.

Each participant for stages I and II had English as a medium of instruction for at least 5 years. They had normal hearing (i.e. air conduction and bone conduction thresholds within 15 dB HL with an air-bone gap of less than 10 dB in the frequency range of 250 Hz to 8 KHz and 250 Hz to 4 KHz respectively). The participants had normal speech and language with no history of hearing loss and any report of neurological problems. The participant inclusion criterion for stage III was the same as that of stages I and II except that they had a mild-to-moderate sensorineural hearing loss. Their age ranged from 20 to 55 years (mean age of 40 years).

Instrumentation: A dual channel calibrated diagnostic audiometer (Madsen OB 922) was used for establishing hearing thresholds and for administering the developed test material. To rule out middle ear problems an immittance audiometer (GSI-Tymstar) was utilized. A Pentium IV

computer with the WavePad software was used to record the material and normalization of the speech material was done using the Adobe Audition software.

Test development: Seventy-five sentences were constructed with each sentence containing 5 to 7 words. A pilot study was done to check for the familiarity of the developed material and to classify them as high and low predictable sentences. Ten normal hearing children aged 12 years were used to check the familiarity of words. The participants were instructed to classify the words on a three point scale as 'highly familiar', 'familiar' or 'not familiar'. The familiarity of words was decided based on their frequency of occurrence in regular communication.

To classify the sentences in terms of predictability ten adults were used. The adults were instructed to categorize the sentences as high predictable or low predictable sentences based on their ability to guess the final word. Each participant was given the set of sentences with the target word not provided and they had to guess it. They were instructed to give as many options as possible for the target word. The sentences in which only one option was given that matched the test stimuli were classified as highly predictable sentences. In contrast, sentences with more than one target word were considered as low predictable sentences. Using the above material five lists of sentences was developed. Each of them consisted of 10 sentences. The sentences were such that they contained equal number of high and low predictable sentences (Appendix A). The developed test was titled 'High predictable and low predictable English sentence test for non-native English speakers (EHLPS).

A female speaker was used for recording the material onto a computer. The 'WavePad' software was used for the recording. The recording was done in a quiet room using a sampling rate of 16 KHz. Scaling of the signals were done using 'Adobe Audition' software to ensure that the intensity of all the sounds were equal. A 1 KHz calibration tone was recorded prior to each list.

Procedure: Administration of the developed sentence test was done on normal hearing individuals in stage II in a sound treated double suite. Prior to the administration of the test the pure tone thresholds of the participants were obtained. The speech recognition threshold (SRT) was established using the English paired words developed by Chandrashekara (1972). The recorded version of the EHLPS test was played on a Pentium IV computer using the WavePad software. The output of the computer was routed to the tape input of the audiometer. The output from the audiometer was played at 40 dB SL with reference to the participant's SRT. The calibration tone was used to adjust the VU meter deflection of the audiometer to zero. The participants heard the recorded material through headphones. Half the participants were tested in the left ear and half in the right ear to avoid any ear effect. The participants were asked to write down as well as verbally repeat what they heard.The verbal responses were noted by the experimenter. The procedure for stage III was similar to that of stage II. Instead of evaluating normal hearing individuals the test was administered on ten adults with a mild-to-moderate hearing loss. They were tested in their better ear.

The responses from the participants were scored in two different ways. While the first way involved scoring the high predictable or low predicable target words (final words) the second way involved scoring the key words in the sentences. Every correct score was awarded a score of one and every incorrect response got a score of zero. The maximum score for target words was ten for each list with five being awarded for the high predictable sentences and the other five for the low predictable sentences. In contrast the scores for the key words varied across each list. List 1 had 28 key words while lists 2, 3, 4 and 5 had 29, 27, 30 and 27 key words respectively. The raw scores for target words and key words of the participants were statistically analyzed separately using the computer software SPSS (version 10.0).

Results and Discussion

The data obtained on the group having normal hearing and the group having hearing loss were analysed separately. For each of the groups the analyses were done within lists and across lists.

Analyses of data from Nnormal hearing individuals

To compare the scores of high and low predictable sentences within each list descriptive statistics was initially done where the mean, standard deviation (SD) and 95% confidence interval were calculated. This was done separately for each of the lists (Table 1). It can be observed from the table that for both high predictable (HP) and low predictable (LP) sentences the mean scores were either equal to the maximum scores or were just slightly less than the maximum scores. The variability in scores was almost nil or minimal as evident from the SD values.

Table 1: Mean, SD and 95% confidence interval values for High predictable (HP) and Low predictable (LP) sentence scores

List no	Sentence type	Mean (Max score=5)	SD	Lower bound	Upper bound	Significance
List 1	HP	4.85	.37	4.68	5.00	NS
	LP	5.00	.00	-	-	
List 2	HP	5.00	.00	-	-	NS
	LP	4.85	.49	4.62	5.00	
List 3	HP	4.95	.22	4.85	5.00	NS
	LP	5.00	.00	-	-	
List 4	HP	5.00	.00	-	-	NS
	LP	4.85	.37	4.68	5.00	
List 5	HP	5.00	.00	-	-	NS
	LP	4.9	.45	4.69	5.00	

Note. NS = Not significant

Further to check for the variation between the high and low predictable sentences within each list paired sample t-test was done. The t values obtained showed no significant difference at the 0.05 level (Table 1). The findings of the present study are not in agreement with that of

Kallikow, Stevens and Elliot (1977). They reported that better performance was noted for HP sentences than the LP sentences. This lack of agreement in finding can be attributed to the difference in testing procedure. The study by Kallikow et al. was done in presence of various signal-to-noise ratios (SNR) whereas the EHLPS was done in a quiet condition. Individuals with normal hearing depended more on the contextual cues in adverse listening conditions such as noise and not in a quiet condition. Had the present study been conducted in the presence of noise a similar result would have been probably obtained as that of Kallikow et al.

To check the difference between high predictable and low predictable sentence scores across lists a one-way repeated measure ANOVA was carried out. It showed no significant difference across the lists between the high predictable sentences [$F(4, 76) = 2.259$, $p > 0.05$] and low predictable sentences [$F(4, 76) = 1.048$, $p > 0.05$]. The above findings indicate that all five lists are similar in terms of HP and LP sentences. Since normal hearing individuals performed equally well on all five tests, any one of them can be used while evaluating the speech identification ability of clients when HP-LP scoring is done. Repeated measures ANOVA was also calculated for key word scores across sentences and it showed a significant difference [$F(4, 76) = 3.009$, $p < 0.05$]. This was unlike that seen for the HP-LP target word scores (Table 1) where there was no significant difference across lists. This highlights that the lists are equal when they are valued in terms of HP and LP scores but are unequal when they are scored on the basis of key words. The mean values for both the target HP-LP scoring and key word scoring is given in Table 2. Within each list the scores for HP-LP words and key words are comparable.

Table 2: Mean values for HP-LP target word scores and key-word scores

List no	**HP-LP Target word score**	**Key word score**
List 1	9.85 (98.5%)	27.6(97.6%)
List 2	9.85 (98.5%)	28.6 (98.7%)
List 3	9.95 (99.5%)	26.9 (99.6%)
List 4	9.85 (98.5%)	29.7 (99.3%)
List 5	9.9 (99%)	26.6 (98.7%)

Note: Value given in bracket refers to the percentage score. Maximum HP-LP target word scores was ten and maximum key word score ranged between 27-30.

From the Bonferroni's multiple comparison test it was evident that List 1 and List 3 showed a significant difference while the other pairs of lists did not. The participants obtained significantly lower scores on List 3 when compared to List 1.

A possible reason as to why List 1 and List 3 are not equal could be due to the method used in the construction of the lists. While constructing the test care was taken to equate the target HP-LP words in each sentence in terms of frequency of occurrence of various phonemes.

This was not done for the key words as the main aim of the study was to develop and evaluate HP-LP sentences. Further it is possible that the HP-LP target words were easier to predict in the sentence compared to the other key words in the sentences. Also the words occurring toward the end of a sentence tend to be more predictable and more likely to be restored and recalled quickly than the rest of the words in the sentence.

Thus, it is recommended that when key words are being used to score the responses of participants the combination of List 1 and 3 should not be used for comparing perceptual outcomes. However, other list combinations can be used for perceptual evaluation of individuals. These combinations include Lists 1, 2, 4 and 5 or Lists 2, 3, 4 and 5.

Analyses of data collected from the group with hearing impairment

Table 3: Mean, Standard deviation and 95% confidence interval values for HP and LP sentence scores in individuals with hearing impairment

List no		Mean (Max score = 5)	SD	Lower bound	Upper bound	Level of Sig.
List 1	HP	3.55	1.21	2.73	4.36	0.831
	LP	3.45	.93	2.83	4.08	
List 2	HP	4.55	.69	4.08	5.00	0.006**
	LP	3.45	.93	2.83	4.08	
List 3	HP	4.64	.50	4.30	4.98	0.019*
	LP	3.55	1.29	2.68	4.41	
List 4	HP	4.55	.52	4.19	4.90	0.000**
	LP	3.18	.75	2.65	3.69	
List 5	HP	4.64	.50	4.30	4.98	0.038*
	LP	3.91	1.14	3.15	4.67	

Note. * Significant at .05 level; ** Significant at .01 level

High and low predictable sentence scores within each list were compared in the individuals with hearing impairment. The mean scores varied only minimally depending on whether the sentence was a high predictable one or a low predictable one. For all five lists, the scores obtained on the LP sentences were lower. The t-test revealed a significant difference between the HP and LP sentences for all but List 1 either at the 0.05 level or the 0.01 level (Table 3). Also, the variability in scores was comparatively more in LP sentences compared to the HP sentences as seen from the SD values.

The findings of the present study reveal that the individuals with hearing impairment did depend more on the contextual cues rather than the audibility cues. The contextual cues were limited in the LP sentences and hence they obtained comparatively less scores in these sentences.

One-way repeated measure ANOVA was done to compare the difference between high predictable and low predictable sentence scores across lists. The scores obtained from the individuals with hearing impairment showed a significant difference between the lists for the high predictable sentences [$F(4, 40) = 4.518$, $p < 0.05$]. The Bonferroni's multiple comparisons

test revealed that List 1 and List 2 had a significant difference and the other pairs of lists did not show a significant difference. The results were not similar for the low predictable sentences across lists. Here there was no significant difference seen [F (4, 40 = 0.974, p > 0.05] indicating that individuals with hearing impairment performed similarly on the LP sentence across lists. Probably with the HP sentences the individuals were able to guess the target word in certain lists and not so in certain other lists. However, this was not the case with the LP sentences.

The mean scores obtained for HP-LP target words and key words, expressed in terms of raw scores as well as percentage, are depicted in Table 4. When the key words were scored in individuals with hearing impairment it showed a significant difference across lists [F (4, 40) = 4.905, p < 0.05]. This is similar to what was observed for the LP sentence scores in the group with hearing impairment. It was seen from the Bonferroni's multiple comparison test that for the key word scores, List 2 and 5 showed a significant difference. Likewise Lists 3 and 5 had a significant difference while the other lists did not have a significant difference between them.

Table 4**:** Mean and SD for HP-LP target word scores and key word scores in individuals with a HI

List no	Target HP-LP word score	Key word score
List 1	7 (70%)	20.09 (71.7%)
List 2	8 (80%)	21.81 (75.1%)
List 3	8.19 (81.9%)	20.36 (74.7%)
List 4	7.73 (77.3%)	23.36 (79.3%)
List 5	8.55 (85.5%)	22.81 (85.1%)

Note: Value given in bracket refers to the percentage score; Maximum HP-LP word scores was ten and Maximum key word score ranged between 27-30

Scores were comparable within a list when HP-LP target words and key words scores were used. The similarity in scores was more pronounced in List 1, 4 and 5. Both scoring procedures seem to detect the perceptual problems of individuals with hearing impairment.

Comparison between Normal Group and the Deviant Group

The high and low predictability sentence scores were compared between groups. The mean HP-LP scores for the two groups are depicted in Table 5. The mean scores obtained by the individuals with hearing impairment were lower when compared to the normal hearing group. An independent t-test was performed and it was found that there was a significant difference at the 0.01 level between the two groups for all the Lists for both HP and LP sentences. Only the HP sentences in List 3 were significantly different at the 0.05 level. The findings of the present study are in agreement with that reported in literature. Olsen, Noffsinger and Kurdziel (1975) have documented that speech discrimination scores were comparatively worse in individuals

with hearing impairment in quiet. Similarly, Pekkarinen, Salmivalli and Suonpaa (1990) reported that word recognition scores were poorer in their participants with hearing impairment compared to the normal hearing group in a quiet situation. Thus it can be inferred that HP-LP target word scores are sensitive in assessing perceptual problems in individuals with hearing impairment. Both high predictable sentences as well as low predictable sentences are equally sensitive.

Table 5: Mean and t values for HP-LP target words across normal and individuals with HI

List	Sentence type	Groups	Mean (Max score = 5)	T values
List 1	HP	Normal	4.85	4.50**
		HI	3.55	
	LP	Normal	5.00	7.50**
		HI	3.45	
List 2	HP	Normal	5.00	2.99**
		HI	4.55	
	LP	Normal	4.85	5.49**
		HI	3,45	
List 3	HP	Normal	4.95	2.40*
		HI	4.64	
	LP	Normal	5.00	5.10**
		HI	3.55	
List 4	HP	Normal	5.00	3.94**
		HI	4.55	
	LP	Normal	4.85	8.36**
		HI	3.18	
List 5	HP	Normal	5.00	3.27**
		HI	4.64	
	LP	Normal	4.90	3.47**
		HI	3.91	

One-way repeated measure ANOVA was calculated for the key words in the normal and deviant group and it showed a significance difference [$F(4, 116) = 9.067$, $p < 0.05$]. Along with ANOVA independent t-test was also done to check for difference between key word scoring across both the groups. The t values showed a significant difference at the 0.01 level (Table 6). This shows that key word scoring is also an equally sensitive test procedure to detect perceptual deficits in the hearing impaired population.

Table 6: Mean and t values for key words across normal and HI group

List no	Groups	Mean	T values
List 1	Normal	97.66	9.90**
	HI	71.75	
List 2	Normal	98.78	8.52**
	HI	75.19	
List 3	Normal	99.63	9.36**
	HI	74.74	
List 4	Normal	99.33	6.80**
	HI	79.36	
List 5	Normal	98.70	6.41**
	HI	85.10	

Note. ** Significant at .01 level

Conclusion

Thus from the present study it can be concluded that there is no significant difference between the high predictable and low predictable sentence scores in the normal population. It is seen that all the five lists containing high predictable and low predictable sentences were equal but the lists are unequal when key words are scored in normal hearing individuals. In individuals with hearing impairment the LP sentences yielded significantly lower scores than the HP sentences for most of the lists. Overall there was a significant difference between the normal hearing group and individuals with hearing impairment on the EHLPS for both key word and target word scoring. Thus EHLPS is a sensitive test for the assessment of auditory perceptual difficulty in individuals having a hearing problem. The test would provide information about the auditory perceptual problems present in individuals having a hearing loss.

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Appendix – A

English High Predictable Low Predictable Sentence test for Non-native English speakers (EHLPS)

List 1

1. A **year** has **twelve <u>months.</u>**
2. I **hit** the **ball** with a **<u>bat.</u>**
3. The **sport shirt** has **short <u>sleeves.</u>**
4. I was made to **lift** my **<u>bag.</u>**

5. The **baby slept** with **closed eyes.**
6. She **baked** his **birthday cake**.
7. The **room** is always kept **neat.**
8. Put a **battery** in the **clock.**
9. **February** has **28 days.**
10. He looks **different** with a **beard.**

List 2

1. She just **heard** a **loud scream.**
2. The **peacock** is our **national bird.**
3. He had a **bath** with **hot water.**
4. The **heavy rains** caused a **flood.**
5. The **baby** has **chubby cheeks.**
6. I have got a **new dress.**
7. He **wiped** the **mirror** with a **sponge.**
8. He **eats** using his **right hand.**
9. A **day** has 24 **hours.**
10. **Give** her a few **slices** of **bread.**

List 3

1. The **dogs** were **tied** to the **gate.**
2. She has to **pay** the **tuition fees.**
3. We got **drenched** in the **rain.**
4. I need to **fill ink** in my **pen.**
5. He **prefers** to have **tea.**
6. I got **stuck** in the **lift**
7. **Lotus** is our **national flower**
8. The **bomb exploded** with a **blast.**
9. The **barber cut** his **hair.**
10. She **opened** the **room** with a **key.**

List 4

1. The **cricket match** ended in a **draw.**
2. The **bomb exploded** with a **blast.**
3. He **stuck** the **paper** with **glue.**
4. In **autumn**, the **trees** shed their **leaves.**
5. **Sunday** is a **holiday.**
6. Every morning I brush my **teeth.**
7. There are 7 days in a **week.**
8. She hit the water with a **splash.**
9. He was asked to unlock the **door.**
10. We could consider the **request.**

List 5

1. A **dog** has four **legs.**
2. He was **assigned** the **task.**
3. A **rainbow** has **seven colours.**
4. I **met** with a **car accident.**
5. The **sun rises** in the **east.**
6. The **door** was **wide open.**
7. I made the **call** from a **booth.**
8. **Stop playing** with your **hands.**
9. **Help** me in **arranging** the **books.**
10. We should have **considered** the **matter.**

Note: Words in bold are the key words and words underlined are the HP-LP target words.