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Comparison of Functional Benefit of Unilateral versus Bilateral Hearing Aid Fitting in Elderly Population Using Hindi Transadaptation of Speech, Spatial, and Qualities of Hearing Scale

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Abstract: *The aim of the study was to transadapt speech, spatial and qualities of hearing scale in Hindi language and to compare the performance of native Hindi speaking elderly hearing impaired across the unaided, aided monoaural and aided binaural hearing conditions using the Hindi transadapted speech, spatial and qualities of hearing scale. A total of sixty native Hindi speaking elderly hearing impaired individuals within the age range of 50–65 years participated in the study. Group 1 comprised of 30 participants using behind the ear hearing aid fitted in one ear and Group 2 comprised of 30 participants using behind the ear hearing aids fitted in both ears. All the participants were asked to rate items on the Hindi transadapted speech, spatial and qualities of hearing scale. Significant difference ($p<0.05$) was observed between the monoaural and binaural fitting conditions. Comparison of the overall mean indicated a significant difference with greater binaural condition scores across the speech hearing, spatial hearing, and quality of hearing sub categories. The results of this study show that two hearing aids work more effectively at the basic level of function (direction, distance, movement), removes the need for strategic positioning and re-positioning and enhances binaural processing.*

Keywords: *hearing impairment, hearing aid, geriatric, monoaural and binaural.*

I. Introduction

Hearing aid benefit can be defined as the difference between unaided and aided performance measured either objectively or subjectively. Hearing aid benefit can be measured objectively by comparing aided and unaided measures of speech recognition ability, as well as subjectively through the use of self-report measures. Self-report measures of outcome such as Speech, Spatial, and Qualities of Hearing scale (Gatehouse & Noble, 2004) are mostly used for predicting real-world benefits of hearing aid performance. A number of studies have reported the benefits of bilateral fitting of hearing aids compared to unilateral fitting on account of improved binaural summation, binaural masking level differences and spatial localization. However, no reliable psychometrically verified clinical field evidence exists to support the contention that bilateral fitting reduce disability in comparison to unilateral fitting.

A lot of documented studies have indicated differences in SSQ performance scores in asymmetrical hearing losses compared to symmetrical hearing losses. Kochkin and Trak (2005) have further reported 93% of all hearing aid users to have experienced improvement in their quality of life as a result of hearing aids. Hence, it was imperative to study the effect and benefit of bilateral versus unilateral hearing aid fitting as perceived by hearing aid wearers using SSQ. However, as items of SSQ scale originally constructed in English may have differed in terms of culture and context in a multicultural and multilingual geographical domain like India, it was critical to transadapt the SSQ scale in Indian languages for maintaining validity and cultural equivalency. With Hindi being the most widely spoken and understandable language in the Indian subcontinent, the SSQ scale was transadapted in Hindi to investigate the performance of native Hindi speaking elderly hearing aid users across items of the transadapted SSQ scale and compare their performance in the unaided versus monaurally and binaurally aided conditions.

It was hypothesized that there will be a significant difference in SSQ scores between pre and post monoaural hearing aid fitting, pre and post binaural hearing aid fitting and between monoaural and binaural hearing aid fitting conditions.

II. Methodology

Participants

A total of 60 native Hindi speaking hearing impaired individuals within the age range of 50 – 65 years (mean age = 44.8 years; SD = 18.26) participated in the study. The participants were studied under two groups across three clinical conditions (unaided hearing, aided monoaural hearing aid fitting, and binaural hearing aid fitting). Group 1 consisted of 30 hearing impaired participants fitted with behind the ear hearing aid in one ear and Group 2 consisted of 30 hearing impaired participants fitted with behind the ear hearing aids in both ears. The participants were drawn from the population of hearing impaired clients who reported for aural rehabilitation services at Ali Yavar Jung National Institute for the Hearing Handicapped, Eastern Regional Centre Kolkata and other speech and hearing clinics in and around Kolkata.

Inclusion Criteria

1. All the participants had an acquired (post lingual) moderate to severe degree of sensorineural hearing loss.
2. All the participants were recommended to be fitted with behind the ear hearing aids in one or both the ears.
3. All the participants were native speakers of Hindi with ability to read Hindi.
4. All the participants were willing to wear hearing aids in one or both ears.

Exclusion criteria

1. Participants having cognitive deficits.
2. Participants having prior listening experience with hearing aids.
3. Participants having associated disabilities such as arthritis, blood pressure, tinnitus, vertigo.
4. Participants having any visual deficits which interfere in reading with or without glasses.

II. Material

The English version of Speech, Spatial, and Qualities of Hearing Scale (SSQ) developed by Gatehouse & Noble (2004) was transadaptated in Hindi and was utilized to assess the benefit of binaural over monoaural hearing aid fitting in native Hindi speaking elderly hearing aid users. The speech, spatial and qualities of hearing scale (SSQ) is a self–assessment inventory. It consists of 49 items with a 10 point rating scale ranging from '0' with the description "Not at all" or "Minimum" to '10' for "perfectly" or "Maximum". The SSQ scale includes three sets of subscales namely speech hearing, spatial hearing and qualities of hearing.

a) Speech hearing: Consist of 14 items. It assesses communication effectiveness in wide range of (speech) hearing contexts.
b) Spatial hearing: Consists of 17 items concerned with the direction or distance of audible occurrence that may be stationary and are important for the listener.
c) Qualities of hearing: Consists of 18 items. It assesses the issues related to segregation of sounds, recognition, clarity / naturalness and listening effort.

Procedure

A three stage experimental research design was devised for the purpose of the study.

Stage 1: Development and validation of the tool

Development of the tool began by transadaptation of 49 items of the Speech, Spatial and Qualities of Hearing Scale (SSQ) developed by Gatehouse & Noble, 2004 in Hindi with the help of native speakers having sufficient knowledge in both English and Hindi language. The transadapted questionnaires were further retranslated in to English with the help of a literary expert having sufficient knowledge in both English and Hindi language.

The transadapted items were given to 30 individuals having sufficient knowledge in both English and Hindi to rate for similarity. A two point rating scale was used to rate the translated items of the Hindi version of SSQ scale as similar (1) and dissimilar (0). The items rated as similar were selected for further analysis and the items rated as unfamiliar were corrected and again given to 30 individuals till no differences were obtained for similarity. Finally**,** the transadapted Hindi SSQ scale was given to a psychologist and an audiologist to be rated on content validity and face validity so as to be approved as valid for the purpose of the present study.

Stage 2: Administration of the developed tool

The participants were explained regarding the purpose of the study and a written consent was also being taken stating that the participants had willed fully participated in the study. Then, the transadapted Hindi SSQ scale was given to the participants for rating in the unaided condition. The following instructions were being given to each participant before administration of the transadapted Hindi SSQ scale in the unaided hearing condition:

"For each question, put a mark, such as a cross(x), anywhere on the scale shown against each question that runs from 0 through 10. Putting a mark at 10 means that you would be perfectly able to do or experience what is described in the question. Putting a mark at 0 means you would be quite unable to do or experience what is described. The transadapted SSQ scale was again re administered on the participants but after two months of hearing aid usage.

The participants were asked to rate the items on the transadapted Hindi SSQ scale as instructed and to submit the response sheets after one week. After one week, the submitted response sheets were cross verified in a one to one setting by again verbally questioning the participants on the items of the developed scale. The participants were asked to rejudge and again mark the correct response across the items where difference in ratings existed.

The same participants were again tested on the same scale but after 2 month of hearing aid usage in one ear/both ears. The submitted response sheets for the aided monoaural condition and binaural condition were cross verified in a one to one setting by again verbally questioning the participants on the items of the transadapted Hindi SSQ scale. The participants were asked to rejudge and again mark the correct response across the items where difference in ratings existed.

After the administration of the scale in the aided monoaural condition, the participants who were fitted with hearing aids in both the ears and were asked to report after 2 month. The scale was given for rating to the participants and was asked to submit the response sheet after marking the responses. The submitted response sheets for the aided binaural condition were cross verified in a one to one setting by again verbally questioning the participants on the items of the transadapted Hindi SSQ scale. The participants were asked to rejudge and again mark the correct response across the items where difference in ratings existed.

Stage 3: Statistical Analysis

The obtained scores across items on the scale were tabulated under the following categories: Speech perception, Spatial Hearing and Quality of Hearing.

The data obtained for both groups from the three conditions (unaided, monoaural and binaural condition) were analysed through SPSS statistical software for windows. Descriptive statistics was used to estimate the mean age of the participants and the mean and percentage occurrence of scores on the items across the three experimental conditions. Paired Sample "t" test and GLM method was used to estimate significant differences if any between the scores on items of the scale across the three experimental conditions.

III. Results And Discussion

The transadapted Hindi SSQ scale was given to all the participants before fitting of hearing aids either monoaurally or binaurally as well as after 2 months of hearing aid use. The mean and SD of the performance scores of the participants across items of the Hindi transadapted SSQ scale has been shown in Table 1

	Unaided mono total score	Mean	S.D	Aided mono total score	Mean	S.D	No. Of participants
1.Speech hearing	1182	39.4	24.095	2576	85.6	25.687	30
2.Spatial hearing	1147	38.2	23.57	3388	112.9	26.109	30
3.Qualities of hearing	1438	47.9	18.136	3552	111.7	14.237	30
	Unaided binaural total score	mean	S.D	Aided binaural score	Mean	S.D	
1.Speech hearing	1269	42.3	24.26	3286	109.5	20.242	30
2.spatial hearing	1224.5	40.8	24.218	4015	133.8	13.907	30
3.Qualities of hearing	1477	49.2	19.076	4333	144.4	18.648	30
	Aided mono total score	mean	S.D	Aided binaural total score	Mean	S.D	
1.speech hearing	2576	85.6	25.678	3286	109.5	20.242	30
2.spatial hearing	3388	112.9	26.189	4015	133.8	13.907	30
3.Qualities of hearing	3552	111.7	14.237	4333	144.4	18.648	30

Table 1: Mean scores of all participants across items of the SSQ scale studied under unaided, monoaural / binaural, aided monoaural / binaural condition.

SSQ Hindi version was administered to all participants before fitting of hearing monoaural / binaural hearing aids as well as after 2 months of use of either monoaural / binaural hearing aids. The comparison of significant difference, "t" value and Least square mean of speech hearing are shown in Table 2, 3 and 4 respectively.

T-Tests			
Difference	DF	t-Value	Pr>|t|
Post fitting- Pre fitting	29	13.16	<.0001

Table 2: The paired t-test of speech hearing between pre and post monoaural hearing aid fitting.

T-Tests			
Difference	DF	t-Value	Pr>|t|
Post fitting- Pre fitting	29	16.45	<.0001

Table 3: The paired t-test of speech hearing between pre and post binaural hearing aid fitting.

The GLM Procedure Least Squares Means

Group	LSMEAN of post fitting	H0:LS Mean1=LS Mean2 Pr>|t|
Binaural	109.054687	<.0001
Monaural	86.345313	

Table 4: Comparison of significant difference in Hindi version SSQ scores for speech hearing between monoaural and binaural hearing aid fitting

The comparison of significant difference, "t" value and Least square mean of spatial hearing are shown in Table 5, 6 and 7 respectively.

T-Tests			
Difference	DF	t-Value	Pr>|t|
Post fitting- Pre fitting	29	21.80	<.0001

Table 5: The paired t-test of spatial hearing between pre and post monaural hearing aid fitting.

T-Tests			
Difference	DF	t-Value	Pr>|t|
Post fitting- Pre fitting	29	20.76	<.0001

Table 6: The paired t-test of spatial hearing between pre and post binaural hearing aid fitting.

The GLM Procedure Least Squares Means

Group	LSMEAN of post fitting	H0:LS Mean1=LS Mean2 Pr>|t|
Binaural	133.2722	<.0001
Monaural	113.494437	

Table 7: Comparison of significant difference in Hindi version SSQ scores for spatial hearing between monoaural and binaural hearing aid fitting

The comparison of significant difference, "t" value and Least square mean of qualities of hearing are shown in Table 8, 9 and 10 respectively.

T-Tests			
Difference	DF	t-Value	Pr>|t|
Post fitting- Pre fitting	29	23.76	<.0001

Table 8: The paired t-test of qualities of hearing between pre and post monaural hearing aid fitting.

T-Tests			
Difference	DF	t-Value	Pr>|t|

Post fitting- Pre fitting	29	18.17	<.0001

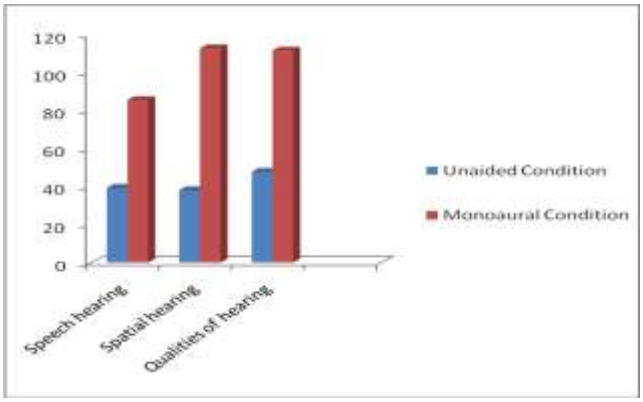
Table 9: The paired t-test of qualities of hearing between pre and post binaural hearing aid fitting.

The GLM Procedure Least Squares Means

Group	LSMEAN of post fitting	H0:LS Mean1=LS Mean2 Pr>|t|
Binaural	144.194192	<.0001
Monaural	118.639141	

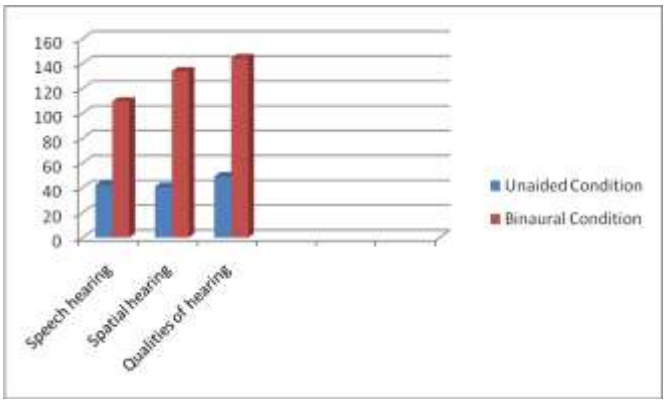
Table 10: Comparison of significant difference in Hindi version SSQ scores for qualities of hearing between monoaural and binaural hearing aid fitting

Comparing means scores of speech hearing, spatial hearing, and qualities of hearing for monoaural fitting of hearing aid as shown in figure 1. It is observed that monoaural hearing aid provide least benefits.



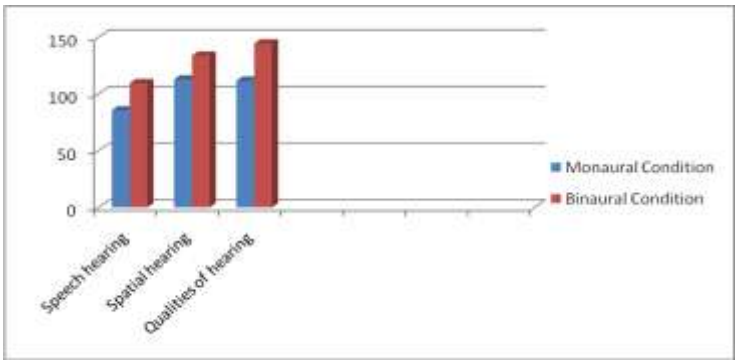
The Figure 1 denotes the speech hearing for monoaural condition is > than the unaided condition.

Comparing means scores of speech hearing, spatial hearing, and qualities of hearing for binaural fitting of hearing aid as shown in figure 2



Graphical representation shows mean score obtained in different category of Hindi version speech, spatial and qualities of hearing scale between unaided and binaural condition.

Graphical representation shows mean score obtained in different category of Hindi version speech, spatial and qualities of hearing scale between monoaural and binaural condition.



Findings of this study are similar to Gatehouse & Nobel, (2004), who respectively reported benefit with one aid and further benefit with two. In the spatial domain, directional hearing showed some benefit with one hearing aid, and particular further benefit in distance and movement discrimination with two. Bilateral fitting added benefit with respect to listening effort.

IV. Summary And Conclusion

The results of this study show that the areas influenced by the fitting of two hearing aids are not in the domains traditionally assumed to be the province of such aiding, namely, hearing for speech, and especially hearing for speech in noisy conditions. Consistent with findings from symmetrical versus asymmetrical hearing loss, it is in domains of dynamic spatial hearing (distance, movement), rapidly switching and divided attention, and listening effort, that two aids do their work. Two aids, in effect, deliver more effectively at the basic level of function (direction, distance, movement), and remove the need for strategic positioning and re-positioning; two aids may also support higher order functionalities through improvements in binaural processing.

It is hoped that research in this area will delineate new insights regarding the benefit of bilateral hearing aid fitting over monoaural hearing aid fitting as self assessed by the hearing aid user. In addition, this line of research may help us to determine whether benefits of bilateral hearing aid fitting over monoaural hearing aid fitting vary across cultural and language boundaries.

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