

The role of hearing aids use on reading ability in deaf students

Bambang Udji Djoko Rianto

Department of Otolaryngology Head Neck Surgery
Faculty of Medicine, Gadjah Mada University/ Dr. Sardjito Hospital,
Yogyakarta

ABSTRACT

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Introduction: Reading is a very complex process, which includes the cognitive process, initialized by visual analysis and letter transformation into vocabulary form, word identification by letter sound mapping, correlating words and interpretation. Deafness causes difficulties in acquiring language information via hearing process thus inhibiting a successful conversation process. Hearing aids can amplify sound information to the auditory organs.

Objective: To know the effect of hearing aids on deaf students.

Methods: A historical cohort design was done. The reading ability of 35 deaf students with hearing aids who received early education were compared to those without hearing aids. The variables measured included age, age of school enrollment, length of studies, degree of deafness, sex, parental educational level.

Results: Regression analysis showed that hearing aids plays a role to significantly increase reading ability statistically (p: 0.006; OR: 10.197; 95% CI: 1.939-53.628) compared to students without hearing aids, besides the length of studies variable (p: 0.002; OR: 38.250; 95% CI: 3.739-391.361).

Conclusion: This study concluded that the use of hearing aids significantly play a role to increase reading ability in deaf students who receive early education.

Key words: hearing aids - deaf student - reading ability.

ABSTRAK

Bambang Udji Djoko Riyanto – *Peran pemakaian hearing aids dalam kemampuan membaca pada murid yang tuli.*

Latar Belakang: Membaca adalah proses yang sangat kompleks, yang meliputi proses kognitif, dimulai dengan analisis visual dan transformasi huruf ke dalam bentuk kosa kata, identifikasi kata dengan pemetaan suara berdasar huruf, menghubungkan kata-kata dan interpretasi. Tuli menyebabkan kesulitan dalam mendapatkan informasi bahasa lewat proses pendengaran, jadi menghambat keberhasilan proses percakapan. *Hearing aids* dapat memperkeras informasi suara pada alat pendengaran.

Tujuan: Untuk mengetahui efek dari *hearing aids* pada murid tuli.

Metode: Penelitian kohort historikal dilakukan pada murid tuli. Kemampuan baca 35 murid dengan *hearing aids* pada pendidikan awal dibandingkan dengan murid yang tidak memakai *hearing aids*. Variabel yang diukur meliputi umur, umur masuk sekolah, lama belajar, jenis kelamin, derajat tuli, tingkat pendidikan orang tua.

Hasil: Analisis regresi menunjukkan bahwa *hearing aids* memainkan peran dalam hal menaikkan kemampuan baca murid yang memakai alat tersebut dibanding yang tidak memakainya, secara statistik signifikan (p: 0,006; OR: 10,197; 95% CI: 1,939-53,628), demikian pula dalam hal lama belajar (p: 0,002; OR: 38,250; 95% CI: 3,739-391,361).

Simpulan: Disimpulkan bahwa pemakaian *hearing aids* secara bermakna mempunyai peran menaikkan kemampuan baca murid tuli pada pendidikan awal.

INTRODUCTION

Reading is an activity which is needed in almost every aspect of life. Reading is one of the human brain highest levels of function, as a form of interaction between thought and language. Reading is an important learning activity which is involved in the comprehension of other forms of knowledge. Only with a satisfactory ability to read human can search, find, and implement information, data, research results, knowledge and science for various necessities in their lives.²

A cognitive mode explains that reading is a complex process which involves the cognitive process, a process which is initialized with visual analysis by transforming visual letters to the form of speech, identifying words with letter-sound mapping, connecting words with its meaning (alphabetical stage) and abstract visualization to receive a more accurate representation of a word (orthographic stage). The processes will lead to the formation of accurate reading ability.³

In a person's life, education is important for self development and the sustainability of life, this is also implied for deaf students where education is important to develop their abilities thus sustaining a suitable life. There are several important goals in the education of deaf students, which are to reach adequate language ability and sustaining sound mental health i.e. the ability of comprehensible speech and the effortlessness to communicate with other people. If those goals are met thus it is possible to be successful in their lives.^{4,5}

The Conference of Executive of American School for the Deaf defines the word deaf as the loss of hearing of 70 dBHL or more, whereas hard hearing as the loss of hearing of 35 – 69 dB. The perception of deaf child in this research was based on the limitations of the word deaf, that is a child with severe hearing handicap that inhibits the speech process thus experiencing difficulties in receiving language information through hearing with or without amplification (hearing aids).⁶

It is estimated that approximately 1 to 2 babies born per 1000 births throughout the world, suffer from hearing impairment which are congenital or acquired during the perinatal period. The prevalence of hearing impairment in neonatal is reported to increase 10 to 50 times higher in babies at risk. Severe or moderate unilateral and bilateral sensorineural hearing loss of

babies in the neonatal intensive care unit has a prevalence of 2% to 4%, whereas babies in the normal nursery rooms have an estimated prevalence of 0.05% to 0.1% or 1/40 of the prevalence in the neonatal intensive care unit.⁷

The prevalence of deafness in Indonesian specifically is unknown. The Hearing Sense Health Survey in 7 provinces in Indonesia in 1994 – 1996 reported that the prevalence of deaf children was 0.1%.⁸ This number did not specify risk factors such as age, gender, type and degree of deafness, measuring method, and other risk factors.

Reading for children is an important skill and supports the ability to receive new materials. Recently, the progress of deaf children educational technology has reached monumental development; early education can be done due to objective diagnostic equipment which is accurate to detect hearing impairment even for newborns. The use of modern hearing technology such as digital hearing aids or cochlear implant allows deaf children to receive early maximal acoustic impulses.⁹

The importance of early identification of hearing impairment in infants correlates with the effects of hearing impairment to the ability of speech and language, academic achievements, and social and emotional development. The first three years of life is an optimal period of hearing and speech development, thus if a child with hearing impairment or deafness at birth or suffered from deafness in infancy, this child will not receive adequate sound, language, and social stimulation required to develop speech, language, social and emotional learning.¹⁰

The relation between sound perception, sound production and language development is very close, furthermore, strong basic language abilities is an important key to the development of reading ability.¹¹ In the students with normal hearing, mostly do not have difficulty in learning speech and language, but not all have the ability to read properly. Approximately 20% of elementary school students have low reading abilities.¹² Students with hearing impairment which do not have verbal language abilities (speech) will experience weakness in the phonologic process i.e. to map letters into sounds. The low level of reading – writing ability in deaf students compared to normal students is mostly caused by the difference between imperfect languages systems with the need to read based on a speech system.¹³

Generally, there is an internal factor that is cognitive ability and non cognitive internal factors which are psychological and physiological factors playing a large role in a student's ability to read. Furthermore, the ability to read is also influenced by external factors which form an environment that supports or inhibits the ability to read.¹⁴

In deaf children who have normal cognitive abilities, the delay of speech, language and learning process development is generally affected by the limited sensory stimulation during the first years of life which can cause permanent neural changes, perception impairment and difficulties in adapting to the environment. These factors can be avoided by early introduction and intervention with an adequate educational process. Other factors that are involved, other than environmental factors of education and family, are the degree of hearing loss, age during diagnosis, time of hearing aids use or cochlear implant.^{11,12}

METHODS

The research design implemented was historical cohort. Group I are deaf students which receive early education in special education schools B (SLB B), whereas group II (control) are deaf children which receive early education in special education schools B with a conventional educational system.

Inclusion criteria: complete school data recorded including age, age admitted to school, length of study, degree of deafness, sex, use of hearing aids, parental educational level, and has entered the reading study phase. Exclusion criteria: suffered from other impairments which can influence cognition (mental retardation), the subject or family refused to cooperate with the research and unilateral deafness.

Reading ability test was done using a validated reading list (TABLE 1).

TABLE 1. Items in the reading skills test

Reading Material	Competence		Amount
	Knowledge	Understanding	
1. Water Buffalo	1.2	3.4	4
2. Planting corn	1.2	-	2
3. Planting rice	1.2	3	3
4. Our village	1.2	3.4	4
5. Fishing	1.3	2	3
Total			16

Understanding the percentage of correct answers from the questions was related to the reading materials, the higher the percentage achieved by the subject the higher understanding of the reading materials. The understanding to read was calculated with the following formula: the ability to read well if the reading ability score > 50% of the total score whereas the ability to read bad if the reading ability reading score < 50% of the total score.

The statistical analysis employed was t-test to calculate the characteristic differences between both groups, a χ^2 test was used to compare the sample distribution based on gender, length of study difference, degree of deafness, the use of hearing

aids and the parent educational level, as well as the logistic regression.

RESULTS AND DISCUSSION

Subjects in the group I were deaf students who have attended early education (enrolled in school under the age of 6 years old) whereas group II were deaf students who have attended standard education (enrolled in school during the age of 6 and above) which are located in the Yogyakarta area (TABLE 2). The total amount of subjects for this study was 70 children, comprised of 35 children from the early education group and 35 children from the standard education group.

TABLE 2. Data of average of school enrollment.

	Average age of school enrolment	Standard Deviation	<i>p</i>
Group I	3.929 years old	1.1829	0.001
Group II	6.771 years old	0.4260	

In this study, the proportion of the amount of boys and girls in both groups were quite equal, where from 35 children in the early education group consisted of 18 boys (51.4%) and 17 girls (48.6%), whereas for the 35 children in the standard education group consisted of 15 boys (42.8%) and 20 girls (57.2%). Statistically the difference between the gender in both groups was not significant with $p=0.473$ (TABLE 2). This proportion is similar to the reports of the two previous studies, Setiajit acquired the proportion of 32 deaf boys (45.72%) and 38 deaf girls (54.28) whereas Mashari acquired a proportion of 40 deaf boys (48.78%) and 42 deaf girls (51.22%).^{5,15}

A factor which was suspected to play a role in the ability to read was the length of study at school, the longer a student underwent formal education the easier the reading process achieved. In this study the length of study between both groups was not significant different ($p = 0.060$). Other factors such as degree of deafness and the use of hearing aids in both groups show insignificant differences with $p = 0.550$ for degree of deafness and $p = 0.303$ for hearing aids use. The family environment factor which showed significant difference in both groups was the level of parent's education, this can be explained statistically with the level of parent's education which was higher in group I compared to group II (TABLE 3).

TABLE 3. Data of the general characteristics of the research subject.

Subject characteristics		Group I (%)	Group II (%)	<i>p</i>
Number	70	35 (50)	35 (50)	1
Age	Mean	8.74	11.34	0.001
Sex	Male	18 (51.4)	15 (42.8)	0.473
	Female	17 (48.6)	20 (57.2)	
Length of study	≤ 3 years	6 (17.14)	13 (37.14)	0.060
	> 3 years	29 (82.86)	22 (62.86)	
Degree of deafness	Severe	27 (77.14)	29 (82.86)	0.550
	Moderate	8 (22.86)	6 (17.14)	
Hearing aids use	No	22 (62.86)	26 (74.29)	0.303
	Yes	13 (37.14)	9 (25.71)	
Father's educational level	Basic	23 (65.71)	31 (88.57)	0.023
	Higher	12 (34.29)	4 (11.43)	
Mother's educational level	Basic	22 (62.86)	33 (94.29)	0.001
	Higher	13 (37.14)	2 (5.71)	

The cognitive factor was not assessed in this study because every deaf student in this study had been assessed during their orientation period and if the results were abnormal the child would be

attending a double handicap class; thus, every child in the B Special Education class had only hearing impairments. This was different compared to the results of Mashari who reported that 10.98% of

deaf children have an IQ of 66 – 79, 15.85% of deaf children had IQ of 80 - 90, 50% of deaf children had IQ of 91 – 110, 17.07% of deaf children had IQ of 111 – 120 and 6.10% of deaf children had IQ of 121 – 127.

From TABLE 2 can seen that the average age during school enrollment in group I is 3.929 years old (standard deviation 1.1829) whereas the average age of school enrollment in group II was 6.771 years old (standard deviation 0.4260). Both groups can be compared because based on the t-test the average age difference during enrollment was statistically significant ($p = 0.001$).

Ideally confirmation of the basis of early education is before 3 years old according to the language development theory where it is the golden age for children’s language development, but the amount of deaf children undergoing education since 2 years old are limited and most are in play groups or kindergartens which do not have reading competences. In the developed countries the education for deaf children is more optimal as reported by Moeller, where 6 months after detection every deaf child can enroll in daily preschool

programs with the average age of enrolment of 15 months.¹⁶

Reading Ability Test

The reading ability test is devised to assess the speed and ability to comprehend reading for students in the reading competence phase. The form of this test is a passage which consists of 3 – 5 declarative statements which are followed by several questions. Inferential questions are presented in the form of multiple choice questions with three alternative choices. The reading ability test was devised by Widiana and the validity of the test has been done in several elementary schools in the Yogyakarta area.²

The reading ability test was given individually to each subject and 20 minutes were allocated to complete it. The reading ability test scores were grouped into excellent and poor based on previous research results by Wiguna where a score of 8 or above was considered excellent and < 8 was considered poor.¹²

The results of the reading ability test of both groups can be seen in TABLE 4.

TABLE 4. Reading ability test scores in deaf children.

	Average reading ability score	Standard Deviation	<i>p</i>
Group I	9.7143	4.68145	0.001
Group II	5.2286	4.79636	

The reading ability score was higher in group I compared to group II which was significant statistically 0.001 ($p < 0.05$). This is unlike studies in developed countries where there were more advance deafness screening technology for infants thus resulting in early deafness detection and early intervention can be done consequently reading abilities for deaf children compared to children with normal hearing in the same age group are similar.¹⁷

The correlation between early education with the ability to read.

The correlation between early education prognosis factors with the ability to read in a cohort study can be assessed by calculating the relative risk. The relative risk is also known as the risk ratio which can be

calculated by comparing the incidence of reading ability in subjects without prognostic factors (standard education) with the incidence of reading ability in the group with prognostic factors of early education. Thus the correlation between early education with reading ability can be assessed (TABLE 5).

A significant correlation can be seen in TABLE 5 between the educational group with the ability to read ($p < 0.05$). Group I with standard education had a risk to receive poor reading abilities 3 times more compared to group II with early education.

The results of this study was similar to the study by Moeller where there was a significantly higher reading ability for deaf children aged 5 who underwent early intervention (age 11 months) even though there were other factors influencing which were the role of

TABLE 5. Reading ability in deaf children based on group.

Group	Reading category		RR	p	95% CI
	poor (%)	excellent (%)			
Group I	23 (65.7%)	2 (34.3%)	3.674	0.009	1.369 – 9.858
Group II	12 (34.3%)	23 (65.7%)			

the family. Furthermore, Geers calculated the reading ability in 181 deaf children aged 8 – 10 who had been underwent cochlear implants before the age of 5, it was showed in a plot diagram results of 50% of the children with reading abilities excellent in average compared to the reading abilities of children with normal hearing.^{16,17}

The correlation between other variables with the ability to read.

Language is a symbolic system for storage or information exchange, whereas speech is a mechanic aspect from voice production. Expressive language represents the ability to produce symbolic output which are visual (writing, signing) or auditory (speech).¹⁸ Receptive language signifies the ability to read other individual output language code

consisting of visual (reading) and auditory (conversation listening) abilities. Based on above, reading skills in children is a part of language abilities which is influenced by social environment, input system, speech and language central system, and output system. In deaf children the use of hearing aids plays a role in the input system.

In this study the environmental factor assessed were familial factors such as parent’s educational level and child’s early education, but parent’s educational level can not be concluded concerning its role in reading skills because its distribution was significantly different since the child’s enrollment to special education schools. Other factors which can be analyzed showed significant differences in reading skills with $p < 0.05$ other than early education as well as the factor of length of study and hearing aids use (TABLE 6).

TABLE 6. Correlation between variables and reading abilities

Factor		Reading ability		p
		Poor N (%)	Excellent N (%)	
Hearing aids use	No	31 (64.6)	17 (35.4)	0.001
	Yes	4 (18.2)	18 (81.8)	
Sex	Female	16 (43.2)	21 (56.8)	0.231
	Male	19 (57.6)	14 (42.4)	
Length of study	≤ 3 years	18 (94.7)	1 (5.3)	0.001
	> 3 years	17 (33.3)	34 (66.7)	
Degree of deafness	Severe	30 (53.6)	26 (46.4)	0.232
	Moderate	5 (35.7)	9 (64.3)	
Education	Standard	12 (34.3)	23 (65.7)	0.009
	Early	23 (65.7)	12 (34.3)	

Other factors assessed are sex; in this study the ability to read was not affected by gender which was shown with $p > 0.05$, this was unlike the study by Kelly who stated that the pattern of brain function development for language correlates with sex, where the myelinization of nerve cells are affected

by estrogen hormones, thus brain development in females are much faster than in males. An MRI can reveal central nerve system activation in females that occurs diffusely compared to males during the phonologic process. In males the brain activity is more dominant on the left inferior frontal

gyrus whereas in females the right and left region has the same activity.

The results of this study showed that the factor of the degree of deafness did not influence the ability to read significantly, this was supposed due to the condition that the deaf children were homogeny with deafness, similar to the study by Pramujianta. It was from BERA results in children experiencing developmental delays at Sardjito General Hospital

since September 2005 until July 2006, the results showed abnormality of 72% with total or severe peripheral neural hearing loss.

The results of logistic regression analysis of all the calculated variables revealed that the variables which significantly contributd to reading skills other that the use of hearing aids were the length of study and early education (TABLE 7).

TABLE 7. Results of logistic regression analysis between variables with the ability to read.

Variable	Exp β	p	95% CI	
Hearing aids use	2.322	10.197	0.006	1.939- 53.628
Length of study	3.644	38.250	0.002	3.739- 391.361

The use of hearing aids can stimulate sound according to the residual hearing or certain frequency which can be responded. Furthermore, in developed countries the development of cochlear implant application, thus hearing stimulation, results in more optimal for deaf children educational process. It will be more perfect if a detailed study on using hearing aids or the type of hearing aids used could be done, thus the analysis can be more specific.

CONCLUSION

The use of hearing aids significantly plays effect to increase reading ability in deaf students who receive early education.

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