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Original Paper

Hearing Impairment in Children

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Abstract

This paper surveys the speech therapy methods used with hearing-impaired children. Several problems in the development of hearing-impaired children are explained, including speech therapy by auditory training to alleviate the problems. The validity of Mori's check-list and Mori's language ability test were demonstrated using four sample cases. Finally, the important points of speech therapy in hearing-impaired children are discussed.

Introduction

Education of hearing-impaired children has been conducted since before the 15th century. Various methods have been used to educate these children. The concept of auditory training, which involves education of hearing - impaired children by scientific methods, using hearing aids, etc., to facilitate acquisition of verbal language ability, was introduced in Western countries in the 1920s, and in Japan in the 1960s. The following findings were learned from the experiences of children with impaired hearing (about 100dB or less) before the 1970s[7].

1. Auditory training promotes the development of the brain itself, and is useful as a means of establishing the left half of the brain as the dominant speech center.
2. In order for auditory training to become effective, it is essential that the training be started during the optimal age range (between 2 months and 3 years, the period when the cerebral structures, including the auditory cortex, grow rapidly) and continued until they begin school.
3. If children with residual hearing (to about 100 dB)receive auditory training, it is possible for these children to attain verbal language ability comparable to that of normal children. Integrated education is also possible for these children.

To date, however, the following questions have not yet been resolved:

1. What developmental problems do children with severe hearing impairment (over 100 dB)

have?

2. How can auditory training help to prevent problems related to severe hearing impairment?

3. How should language learning conditions during infancy and early childhood be optimized so that auditory training can be most effective?

4. How can the language ability of children be used as an indicator of the effectiveness of auditory training?

5. What is the prognosis for children's language ability after auditory training? Is it possible for children with severe hearing impairment (over 101 dB) to overcome the stagnation of development at age 9, when children usually begin abstract thinking?

On the basis of our findings obtained between April 1970 and January 1995, and referring to the literature, this paper will attempt to resolve the five questions mentioned above, and summarize the essential points which medical speech therapists should consider when providing auditory training to children with impaired hearing.

What developmental problems are seen in children with severe hearing impairment (over 100 dB)

Arayama et al. (1970)[2] reported that children with hearing impairment more severe than 80 dB cannot acquire verbal language ability without language training.Failure to acquire verbal skills due to hearing impairment is said to cause the following problems:

1. delay in intellectual (language-related) development (Oleron, 1977)[16]

2. poor scholastic ability, i.e., the stagnation of development at age 9 (Hine, 1970)[3]

3. problems of personality and ego development (Altsuler, 1974)[1]

4. interpersonal and social difficulties (Nakano, 1972)[14].

How can auditory training help to prevent problems related to severe hearing impairment?

We analyzed the clinical data obtained from 391 children with hearing impairment (216 boys and 175 girls) who were at our department between 1970 and 1985. They had received language training (primarily auditory training) before starting school, and their verbal IQ and ability to learn Japanese in school had been followed until at least age 9. This analysis yielded the following findings (Mori, 1992a)[7]:

1. Several conditions must be met in order for hearing-impaired children to acquire verbal language ability. Medical speech therapists should arrange for the children to experience these conditions as early as possible. A feedback system, which is required for language learning, must be established in children before the age of about 3. In the case of severe hearing impairment, the sense of touch also must be utilized as a component of the feedback system. However, principal roles are played by both the auditory-voice and the visual-motor circuits in this system (Kirk et al., 1961)[4]. The more severe the hearing impairment, the more difficult it is to utilize the auditory-voice circuit without training.

2. For children with severe hearing impairment, training, which makes use of the auditory function, must be started early (by the age of 1, or at most 2). Unless this training is started early, it is difficult or impossible for these children to acquire verbal language ability. In cases where such training was provided adequately at age 1 or 2 and visual cues (e.g., letters) were used after age 3 to make up for lack of information via the auditory channel, acquisition of verbal language skills was greatly enhanced by the combined effects.

3. Our data supported the view that the acqui-

sition of verbal ability is determined by the processes of biological maturation of the brain (Lennenberg, 1974)[6]. The development of verbal ability was found to be stratified. Medical speech therapists need to bear this in mind when preparing a language training program and they should assure that the children acquire verbal language ability corresponding to their chronological age before they begin school. If such training is successfully provided, it is possible for even children with severe hearing impairment (over 101 dB) to overcome the stagnation of development at age 9, which has long been a major impediment to the education of hearing-impaired children. In other words, whether or not hearing-impaired children encounter the stagnation of development at age 9, is determined by their verbal language ability at about age 6.

4. Objective assessment is needed to determine whether or not the training program used was valid and whether or not children had acquired language ability corresponding to their chronological age with the training. For this assessment, a language test (designed for preschool age children) was needed. Normal development of language-related abilities, corresponding to the norm of one's chronological age, before starting school entrance seemed to be very important for preventing poor performance or learning delay in school.

How should language learning conditions during infancy and early childhood be optimized so that auditory training can be most effective? — Introduction of Mori's check list —

1. History of the development of Mori's check list of optimal language learning conditions for the prediction of language abilities after auditory training.

Our experience supported the view, reported by Hirota et al. (1988)[5], that severity of hearing impairment is the single best predictor of language learning level attainment by hearing - impaired children. Taking into account the work of Sumi et al. (1966)[18] and Ohwada (1978)[15], the following 9 factors also seem to affect language learning by hearing-impaired children: (1) age at the start of training (the age at which language training by the auditory training method is started), (2) length of systematic language training (the length of language training, especially those using auditory training methods, provided training is continuous during preschool age), (3) use of hearing aids (on one ear or both ears), (4) effects of hearing aids (i.e., whether or not hearing is aided by more than 21 dB on average), (5) performance IQ (i.e., whether or not the performance IQ is "upper middle" range or higher), (6) presence or absence of problems other than hearing impairment (e.g., hyperkinesis and impaired coordinated movement), (7) presence or absence of problems involving the environment and parents (i.e., problems which can hamper training), (8) participation in integrated preschool education (at what age does the child begin receiving preschool education together with normal children?), and (9) presence or absence of a systematic language training program, especially those involving auditory training (i.e., whether or not the trainer uses a systematic language training program).

The author has prepared a check list (Mori's check list of language learning conditions), as shown in Table 1 (Mori, 1992b[8], 1993[10]; Mori et al., 1993a[11], 1993b[12], 1993c[13]; Seo et al., 1993[17]; Yoshioka et al., 1993[19]). With this check list, the degree of difficulty of language learning for each level of severity of hearing impairment is scored. This provides an indicator for pinpointing optimal language learning conditions before the age of about 3,

and for eliminating as soon as possible, factors which may hamper language learning. Using the check list, 9 factors, which are thought to be related to language learning, are evaluated to yield an aggregate score for each level of hearing impairment.

2. Application of the check list to 4 cases

The check list was applied to 4 deaf children (over 101 dB for both ears) at age 3 (Table 2).

Table 3 summarizes problems detected (the underlined) and guidance provided.

Table 4 shows the application of the same check list to the same children at age 6. In this table, the data for Case 2 was obtained at age 4 years and 7 months, because this child was younger.

Table 5 shows the current verbal language ability of these 4 children. This table was prepared to compare prediction with outcome.

In Cases 1, 2 and 4, prediction on the basis of the check list scores agreed with the actual verbal language ability acquired in school. In Case 3, however,the prediction did not agree with the outcome, indicating the necessity of revising the check list. It is possible that problems such as hyperkinesis, as seen in Cases 1 and 3, can be dealt with by appropriate education. Therefore, it seems inappropriate to attempt to predict the outcome of children with such problems at a very early age (e.g., at age 3). We are now reviewing the validity of the factors and the scoring system used in this check list, on the basis of data

Table 1 Revised Mori's Check List (excerpts) — Prognosis after Auditory Training —

Severity of hearing impairment			Moderate (41-70 dB)		Severe (71-100 dB)		Profound deafness (Over 101 dB)	
1. Age upon start of training	4 and over	0	3	1	2	2	1	3
2. Length of systematic speech training	Less than 3 years	0	Over 3 years	1	Over 4 years	2	Over 5 years	3
3. Hearing aid	Not used	0	Used	1	Used	2	Used	3
4. Effect of hearing aid	Less than 21 dB on average, as compared with the open ear hearing level	0	Over 21 dB on average, as compared with the open ear hearing level	1	Over 21 dB on average, as compared with the open ear hearing level	2	Over 21 dB on average, as compared with the open ear hearing level	3
5. Children with "higher middle" or higher performance IQ	Absent	0	Present	1	Present	1	Present	1
6. Problems other than hearing	Present	0	Absent	1	Absest	1	Absent	1
7. Problems related to environment or parents	Present	0	Absent	1	Absent	1	Absent	1
8. Participation in integrated education	Absent	0	Present	1	Present	1	Present	1
9. Practice in systematic speech training program, with emphasis on auditory training	Absent	0	Present	1	Present	1	Present	1
Total score						Points		

* The minimum score, which allows the child to overcome the stagnation of development at age 9, is 9 in the case of moderate hearing impairment, 13 in the case of severe hearing impairment and 17 in the case of profuond deafness. Children with scores lower than these limits are judged to have problems.

Table 2 Application of the Mori's Check List to Four Deaf Children at Age 3
— Prognosis after Auditory Training —

Severity of hearing impairment			Moderate (41-70 dB)		Severe (71-100 dB)		Profound deafness (Over 101 dB)	
1. Age upon start of training	4 and over	0	3	1	2	2	1	3
2. Length of systematic speech training	Less than 3 years	0	Over 3 years	1	Over 4 years	2	Over 5 years	3
3. Hearing aid	Not used	0	Used	1	Used	2	Used	3
4. Effect of hearing aid	Less than 21 dB on average, as compared with the open ear hearing level	0	Over 21 dB on average, as compared with the open ear hearing level	1	Over 21 dB on average, as compared with the open ear hearing level	2	Over 21 dB on average, as compared with the open ear hearing level	3
5. Children with "higher middle" or higher performance IQ	Absent	0	Present	1	Present	1	Present	1
6. Problems other than hearing	Present	0	Absent	1	Absest	1	Absent	1
7. Problems related to environment or parents	Present	0	Absent	1	Absent	1	Absent	1
8. Participation in integrated education	Absent	0	Present	1	Present	1	Present	1
9. Practice in systematic speech training program, with emphasis on auditory training	Absent	0	Present	1	Present	1	Present	1
Total score								Points

Patient 1 (DK) 2 points — Patient 2 (HO) 5 points — Auditory training not provided

Patient 3 (TY) 13 points — Patient 4 (NT) 17 points — Auditory training provided

Remark: When evaluated at age 3, it was predicted that Patients 1, 2 and 3 would have difficulties in overcoming the stagnation of development at age 9. These three children were thought to require individual guidance. It was predicted that Patient 4, on the other hand, would be able to overcome the stagnation at age 9 if training were to be continued until strating school. Patients 1 and 2 were therefore admitted to the kindergarten section of a school for the deaf at age 3. Patient 3 received auditory trainging for 1 year and 7 months after the above evaluation, but the child's score did not improve during this period. For this reason, this child was admitted to a school for the deaf at age 4 years and 7 months and then received training both at that school (training using cues) and at our department (auditory training and language training using letters). This child was able to make use of his residual hearing upon entering the school for the deaf.

from a larger number of cases. In our experience, it appears that of the 9 factors used in the check list, the impact of 2 factors (age at the start of training and length of systematic training) are decisive and cannot be changed by other interventions. The impact of four factors (use of hearing aids, effect of hearing aid, presence or absence of problems other than hearing impairment, and participation in integrated preschool education) can be affected with proper guidance. Therefore, if appropriate guidance is provided in cases where these 4 factors are unfavorable, it is possible to achieve normal language ability. In practice, however, it is difficult to achieve 21 dB or greater hearing aids in children with severe hearing impairment (120-130 dB). At the same time, it is known that a few children

Table 3 Problems detected in 4 children at age 4 and guidance provided

Problems / Patient	Problems detected using the check list and guidance provided
Patient 1 (boy): DK born December 22, 1989 Right ear: over 130 dB Left ear: 111 dB	The patient had bilateral neural hearing loss probably caused by rubella. First examined at our department at age 3. It was therefore impossible for him to receive 5 years or more of training before starting shool. No hearing aid was used (hence, no hearing aid effects). Hyperkinesis was noted. Performance IQ could not be measured. His parents had been very indifferent; they had neither sent the child to a nursery school nor received any guidance, even though the child had not spoken a word by age 3. Considering the child's state at age 3, we believed it would be difficult to achieve improvement through auditory training. We advised that this child should be fitted with hearing aids (Othicon Ear-Hung Type E39PL) on both ears, and he was admitted to the Kindergarten section of a school for the deaf at age 3. Subsequently, the boy has been followed yearly at our department.
Patient 2 (boy): HO born April 3, 1990 Both ears: over 110dB	The patient was suspected of having familial hearing loss, because his paternal grandfather and older brother also had hearing loss. The boy had received a hearing test immediately after birth and had been diagnosed as being deaf. Hearing aids had been used on both ears since age 3 months, but the aids had not been adequately effective. Performance IQ was relatively low (lower middle range). Hearing loss was the only physical problem of this boy. He was the older brother of a pair of twin boys. In addition, he had an older brother (2 years older, who had severe hearing loss. The parents were planning to divorce, and the family's financial situation was a problem. Thus this child had problems in family environment and on account of his parents. In addition, his home was far from a hospital and continued training was difficult, although his hearing loss was detected soon after birth. For these reasons, it appeared to be difficult for this child to be provided with 5 year or longer auditory training. The boy had entered a nursery school. On the basis of our advice, the boy was admitted to a school for the deaf at age 3. Now, he is living in a school dormitory because of his family's difficulties. The boy has been followed up at our department at the end of each school term.
Patient 3 (boy): TY born October 6, 1987 Right ear: 110 dB Left ear: 104 dB	The patient had hearing loss probably caused by rubella. Hearing loss was detected at age 1 year and 2 months. Ear-hung type hearing aids were immediately fitted on both ears (although their effects were insufficient), and training was started. His mother had leadership qualities. The boy entered a nursery school and received continued guidance from us. Hyperkinesis was marked. No dominant hand was established by age 5. Development of motor function of the extremities had been delayed. That is, the boy had some physical problems in addition to hearing loss. His score suggested that this boy would probably face difficulties at age 9. We plan to provide training at a school for deaf, making use of visual media such as cues. If hyperkinesis is reduced by such training, it may be possible for this boy to overcome the stagnation of development at age 9.
Patient 4 (girl): NT born September 3, 1987 Right ear: over 103 dB Left ear: 104 dB	She had unexplained hearing loss. Hearing aids were fitted at age 1 year and 9 months. No problems were detected by an evaluation using the Mori's check list. We estimated that if auditory training were continued untill the time of school entrance, this girl would be able to overcome the stagnation of development at age 9. Thus, we have decided to continue training this girl at our department.

Remark: Underline in Table 3 indicates problems detected using the check list.

do acquire good verbal language ability, even though their hearing aids are insufficient.

It is therefore necessary to clarify the mechanism by which visual information makes up for the deficit of auditory information. The performance IQ of children with hyperkinesis or other problems, measured at age 3, differed from that measured at later ages. This result poses questions, e.g., whether or not performance IQ measured in the presence of hyperkinesis represents the true IQ, and whether or not performance IQ, like language IQ, can also be raised by training until the age of about 6. Data from many cases need to be analyzed to resolve these questions. Regarding the presence or absence

Table 4 Application of the Mori's Check List to Four Deaf Children at Age 6
— After Auditory Training —

Severity of hearing impairment			Moderate (41-70 dB)		Severe (71-100 dB)		Profound deafness (Over 101 dB)	
1. Age upon start of training	4 and over	0	3	1	2	2	1	3
2. Length of systematic speech training	Less than 3 years	0	Over 3 years	1	Over 4 years	2	Over 5 years	3
3. Hearing aid	Not used	0	Used	1	Used	2	Used	3
4. Effect of hearing aid	Less than 21 dB on average, as compared with the open ear hearing level	0	Over 21 dB on average, as compared with the open ear hearing level	1	Over 21 dB on average, as compared with the open ear hearing level	2	Over 21 dB on average, as compared with the open ear hearing level	3
5. Children with "higher middle" or higher performance IQ	Absent	0	Present	1	Present	1	Present	1
6. Problems other than hearing	Present	0	Absent	1	Absest	1	Absent	1
7. Problems related to environment or parents	Present	0	Absent	1	Absent	1	Absent	1
8. Participation in integrated education	Absent	0	Present	1	Present	1	Present	1
9. Practice in systematic speech training program, with emphasis on auditory training	Absent	0	Present	1	Present	1	Present	1
Total score							Points	

Patient 1 (DK)	Patient 2 (HO)	Patient 3 (TY)	Patient 4 (NT)
8 points	5 points	14 points	17 points
Slightly improved	No change from the score at age 3	Improved by 1 point	No change from the score at age 3
Auditory training not provided		Auditory training provided	

Remark 1: The minimum score, which allows the child to overcome the stagnation of development at age 9, is 9 in the case of moderate hearing impairment, 13 in the case of severe hearing impaiment and 17 in the case of profound deafness. Children with scores lower than these limits are judged to have problems.

Remark 2: Patient 2, who has not entered school, was checked at age 4 years and 7 months.

of a systematic language training program, it is difficult to evaluate objectively, differences in training facilities and differences in the length of experience and the abilities of the trainers. These questions need to be examined in more detail. In any event, the check list was very useful for detecting problems early and taking appropriate countermeasures. Between 1992 and early January 1995, we applied it to about 80 children with hearing impairment (moderate to severe congenital, bilateral and neural impairment, between 60 and 100 dB).

The check list is particularly useful for selecting optimal education methods for individual children before and after starting school , for the following reasons:(1) the probability that a given child can acquire verbal language ability corresponding to his/her chronological age following auditory training can be predicted at about age 3 with fairly high reliability,and (2) the check list is a

Table 5 Current verbal speech ability of 4 cases as of December 1994

		Patient 1 (DK; 6 years and 8 months)	Patient 2 (HO; 4 years and 7 months)	Patient 3 (TY; 7 years and 0 months)	Patient 4 (NT; 6 years and 6 months)
Score and prediction at age 3		2 Problems detected	5 Problems detected	13 Problems detected	17 No probrems
Score and prediction at age 6		8 Problems detected	5 Problems detected	14 Problems detected	17 No problems
Verbal speech ability	Language IQ	WISC-R Unmeasurable	WPPSI Unmeasurable	WISC-R 105(Medium)	WISC-R 111(Upper medium)
	Language quotient on language ability evaluation table	63	46	97	100
Verbal speech ability as compared to check list evaluation		Identical	Identical	Not identical	Identical

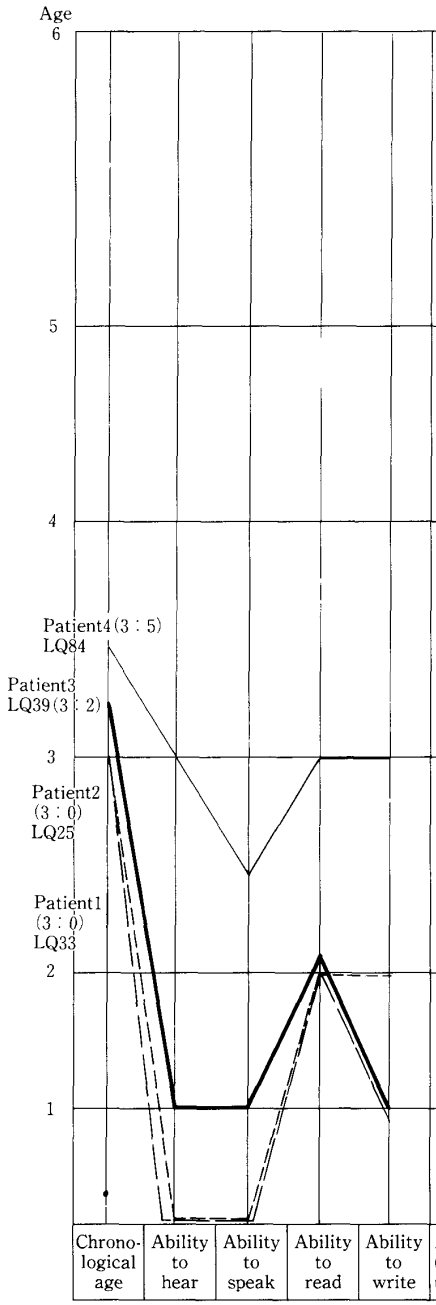
Remark 1: The verbal speech ability of Patient 2 was assessed at age 4 years and 7 months.
Remark 2: Underlining indicates problems.
Remark 3: The agreement rate between verbal speech ability and check list evaluation was 75%.

fairly accurate predictor of the probability that a given child will encounter the stagnation of development at age 9, so that special preschool training can be initiated to mitigate the problem. We, however, have the impression that care is needed in using this check list in the following cases: (1) children who have lost hearing sometime after birth, (2) children with progressive hearing impairment, (3) children with conductive hearing loss caused by congenital anomalies, etc., (4) children with severe neural deafness characterized by a sharp loss in the high frequency range, (5) children with mild to moderate neural deafness (40-60 dB), and (6) children with profound deafness (over 101 dB).

How can the language ability of children be used as an indicator of the effectiveness of auditory training? — Introduction of Mori's age-wise language ability evaluation table —

As the author has previously pointed out (Mori, 1992c)[9], no test is available in Japan which allows us to evaluate four language-related abilities (hearing, speaking, reading and writing) at chronological ages between 0 and 6. To allow normal development of language-related abilities in hearing-impaired children, the author has devised a Mori's age-wise language ability evaluation table (hereafter referred to as "evaluation table"), as shown in Table 6. With this table, the four language-related abilities (hearing, speaking, reading and writing) can be assessed at each age and it is easy to identify the problem or problems in a given case so that proper training can be initiated. The author originally intended to use this table only in hearing-impaired children. However, when it was used in 30 non hearing impaired children with impaired language abilities, it was found that the test was a good predictor of impaired learning in school (Mori et al., 1993a)[11]. Our experience suggests that proper development of all 4 language-related abilities needs to be achieved before entering school so that learning impairment does not occur after beginning school. Children who showed overall retardation in language-related abilities or uneven development of these abilities before

Table 6 Application of the Mori's age-wise verbal speech ability evaluation table (first draft) to 4 deaf children at age 3



Chronological age	Ability to hear	Ability to speak	Ability to read	Ability to write	Ability to hear (auditory language understanding)	Ability to speak	Ability to read (visual cognition)	Ability to write (composition)
6					·Language age at 6 and above ·Understands numbers up to 10 ·Can answer by fingers the day of the week named ·Can point out one's birthday on a calendar	·Language age about 6 ·Can speak about 2100 words ·Can accurately speak more than 80% of the 110 Japanese syllables ·Can use many complex or compound sentences ·Can create sentences including conjunctions ·Can pronounce one's age, address and parents' names ·Can repeat five-word sentences ·Can correctly answer the Enjōji type questions to check understanding	·Has the reading ability of about a six-year old ·Can find a picture illustrating a short sentence one has just read ·Can find a word representing a picture shown	·Can write down short sentences included in the reading ability test ·Can keep a diary
5					·Can accurately indicate 10 colors ·Can play cards ·Can distinguish between a ¥10 and ¥5 coin.	·Language age about 5 years ·Can speak about 1600 words ·Can often use predicative sentences or compound sentences containing complements ·Can use complex sentences composed of 4-5 words ·Can explain the functions of the eyes and ears	·Can recognize all Kana	·Can write down individual letters and numerals ·Can copy drawings of houses, trees, desks, etc. ·Can write one's name in Hiragana
4					·Can distinguish between light and heavy ·Can understand 4 or more of position indicators like up, middle, down, back, front and side	·Language age about 4 years ·Can speak about 1000 words ·Can use most postpositional words ·Can often use simple sentences (subject + predicate) ·Can use compounds sentences composed of about 4 words ·Use declarative and interrogative sentences more often than before ·Can pronounce one's family name ·Can repeat 3-digit numbers	·Picks out numbers and Hiragana from books, etc. ·Understands one's own name	·Can copy drawings of triangles and squares
3					·Language age about 3 years (it is preferable to determine this age using audiory test alone) ·Can understand two or more of position indicators like up, down, front and back	·Language age about 3 years ·Can speak about 500 words ·Can speak sentences with correct syntactic structure, composed of 2 or 3 words ·Can repeat words contained in the PVT ·Can repeat 2 numerals ·Can pronounce verbs	·Can match one picture with a duplicate	·Can copy circles ·Can draw a picture, using the entire paper, and then color it
2					·Can point to a particular named by the examiner in a drawing ·Understands body part names	·Language age about 2 years ·Can speak about 200 words ·Can speak sentences composed of 2 words.	·Looks at picture books	·Can draw lines with a pencil
1					·Responds to others' who say "bye bye" ·Distinguishes sounds produced by toys	·Speaks a word. ·Speaks "babbling"	·Follows a person walking within a room with one's eyes	·Scribbles

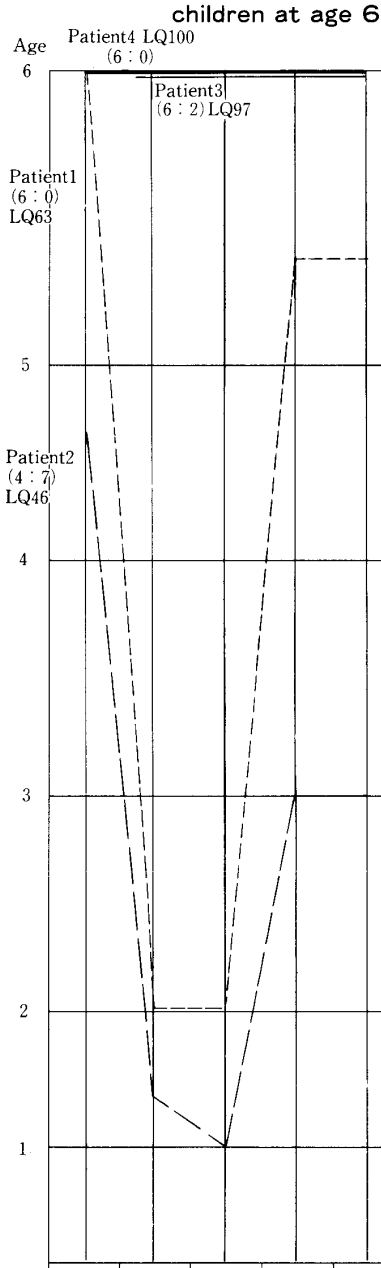
Remark: Evaluation of subsequent courses of language ability of the 4 deaf children is presented in the previous check list.

starting school, often showed poor school performances or delay in learning. The results of assessment using this table are expressed in terms of language age (LA) and language quotient (LQ).

Tables 6 and 7 show the language ability of 4 deaf children at ages 3 and 6, respectively.

In Cases 1 and 2, development of language ability was inadequate, as had been predicted using the check list. Their data at age 6 clearly demonstrated delayed learning and suggests that these children will encounter the stagnation of development at age 9. On the other hand, in Cases 3 and 4, the language ability at age 6 corresponded to their chronological age, suggesting that these children

Table 7 Application of the Mori's age-wise verbal speech ability evaluation table (first draft) to 4 deaf children at age 6



Chronological age	Ability to hear	Ability to speak	Ability to read	Ability to write	Ability to hear (auditory language understanding)	Ability to speak	Ability to read (visual cognition)	Ability to write (composition)
6					·Language age at 6 and above ·Understands numbers up to 10 ·Can answer by fingers the day of the week named ·Can point out one's birthday on a calendar	·Language age about 6 ·Can speak about 2100 words ·Can accurately speak more than 80% of the 110 Japanese syllables ·Can use many complex or compound sentences ·Can create sentences including conjunctions ·Can pronounce one's age, address and parents' names ·Can repeat five-word sentences ·Can correctly answer the Enjoji type questions to check understanding	·Has the reading ability of about a six-year old ·Can find a picture illustrating a short sentence one has just read ·Can find a word representing a picture shown	·Can write down short sentences included in the reading ability test ·Can keep a diary
5					·Can accurately indicate 10 colors ·Can play cards ·Can distinguish between a ¥10 and ¥5 coin.	·Language age about 5 years ·Can speak about 1600 words ·Can often use predicative sentences or compound sentences containing complements ·Can use complex sentences composed of 4-5 words ·Can explain the functions of the eyes and ears	·Can recognize all Kana	·Can write down individual letters and numerals ·Can copy drawings of houses, trees, desks, etc. ·Can write one's name in Hiragana
4					·Can distinguish between light and heavy ·Can understand 4 or more of position indicators like up, middle, down, back, front and side	·Language age about 4 years ·Can speak about 1000 words ·Can use most postpositional words ·Can often use simple sentences (subject + predicate) ·Can use compounds sentences composed of about 4 words ·Use declarative and interrogative sentences more often than before ·Can pronounce one's family name ·Can repeat 3-digit numbers	·Picks out numbers and Hiragana from books, etc. ·Understands one's own name	·Can copy drawings of triangles and squares
3					·Language age about 3 years (it is preferable to determine this age using audiory test alone) ·Can understand two or more of position indicators like up, down, front and back	·Language age about 3 years ·Can speak about 500 words ·Can speak sentences with correct syntactic structure, composed of 2 or 3 words ·Can repeat words contained in the PVT ·Can repeat 2 numerals ·Can pronounce verbs	·Can match one picture with a duplicate	·Can copy circles ·Can draw a picture, using the entire paper, and then color it
2					·Can point to a particular named by the examiner in a drawing ·Understands body part names	·Language age about 2 years ·Can speak about 200 words ·Can speak sentences composed of 2 words.	·Looks at picture books	·Can draw lines with a pencil
1					·Responds to others' who say "bye bye" ·Distinguishes sounds produced by toys	·Speaks a word. ·Speaks "babbling"	·Follows a person walking within a room with one's eyes	·Scribbles

Remark 1: Evaluation of subsequent courses of language ability of the 4 deaf children is presented in the check list.

Remark 2: Patient 1, who is 6 years and 8 month old, is rated at about age 2 in terms of hearing and speaking abilities. Thus, this case shows marked delay in the development of some abilities.

Remark 3: Patient 2, 4 years and 7 months old, also shows marked delay in overall development.

The check score suggests that these children will face difficulties at age 9.
The evaluation table also suggests it.

Remark 4: Patient 3 was found to have no problem in language ability when assessed at age 6.

Remark 5: Patient 3 was rated as having problems when assessed using the check list. Until age 3, this child primarily received auditory training. After the residual auditory function was confirmed, training using cues and finger language was started at age 4 years and 7 months in the school for the deaf, in parallel to the language training at out department. As a result, the child showed favorable development in language ability by the school entrance age as shown in Table 7. At present, this child belonged to a fixed class for children with hearing loss.

Remark 6: Patients 3 and 4 are younger than 9 years. The stagnation of development at age 9 has not yet be checked.

These children are likely to be able to overcome the stagnation of development at age 9

will progress smoothly.

Thus, a combination of the check list and the evaluation table will allow proper training program planning and enforcement, tailored to each individual child. Also, it will be useful in determining whether a given child should enter a school for the deaf, a special class for hearing-impaired children at an ordinary school or a class for normal children.

The validity of this evaluation table is now being assessed. An effort to standardize the table is also under way.

Prognosis after auditory training — the possibility for children with severe hearing impairment (over 101 dB) to overcome the stagnation of development at age 9 —

Between April 1970 and January 1995, we found that a combination of the check list and the evaluation table allows early detection of problems in hearing-impaired children and prompt countermeasures. As a result, children with 100 dB or less severe hearing impairment, in the absence of any other complications, showed favorable development of their language ability. About half of these children overcame the stagnation of development at age 9. Of the children with severe hearing impairment (over 101 dB) but without any other complications, only about 10% could overcome the stagnation of development at age 9, but this percentage should increase if the check list and the evaluation table are used more extensively. Of the children with severe hearing impairment accompanied by other problems, such as hyperkinesis, who were evaluated before 1985, all encountered the stagnation of development at age 9. However, when children who received training after the development of the check list and the evaluation table were analyzed, it was found that early adoption of optimal training methods prevented the stagnation of development at age 9, as seen in Case 3. The training provided for Case 3 did not rely only on auditory training. Instead, after some residual hearing was confirmed in the child, visual training was combined with auditory training (the so-called total communication method). There was close cooperation between our department and the school for the deaf the child was attending in the training program. In this way, the child acquired adequate communicating abilities and psychological development. As a result, hyperkinesis in this child was reduced, and language ability developed. The data concerning this case will be reported in a separate paper. Valid methods for allowing children with severe hearing impairment (over 101 dB) to overcome the stagnation of development at age 9 are thus needed.

Conclusion

— Essential points medical speech therapists should consider when providing auditory training —

Medical speech therapists should try to understand and support hearing-impaired children sufficiently until they grow to adulthood. To achieve this goal, it is important for them to use every possible means in guiding hearing-impaired children. The author would like to emphasize the following two points.

First, medical speech therapists should remember that the first 2 or 3 years after birth is very important for effective training of hearing-impaired children, especially making use of their sensory functions. Whether or not hearing-impaired children are able to utilize their auditory function at later ages, is determined by the treatment or training provided during this short period.

Second, although education based on audi-

tory training is important, introduction of visual cues, is also recommended if children do not respond well to auditory training. In cases where language training using auditory methods does not seem to be effective after it has been provided for some time (usually until the age of 3 or 4), it is necessary to use other methods to help the children acquire verbal language ability corresponding to their chronological age. The brains of children,until about age 6, are highly flexible and have unlimited potential to develop. However, it is essential to use various training methods in an appropriate order. In our experience, it was effective to adopt visual training using letters and finger language after auditory training was provided. It does not appropriate to argue about whether auditory training or finger language training is better. Instead, medical speech therapists should consider how they can best use these methods of training for the benefit of hearing-impaired children at each stage of development. Whether or not children encounter the stagnation of development at age 9 is determined by the verbal language ability they have acquired by the age of about 6. The delay in the development of verbal language ability is difficult to overcome after age 6. Medical speech therapists, working at hospitals, should bear these points in mind and try their best to promote the favorable development of hearing-impaired children.

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