

Annals of Otology, Rhinology & Laryngology

<http://aor.sagepub.com/>

Effectiveness of Domain-Based Intervention for Language Development in Japanese Hearing-Impaired Children: A Multicenter Study

Akiko Sugaya, Kunihiro Fukushima, Norio Kasai, Toshiyuki Ojima, Goro Takahashi, Takashi Nakagawa, Seiko Murai, Yasoichi Nakajima and Kazunori Nishizaki

Ann Otol Rhinol Laryngol published online 13 March 2014

DOI: 10.1177/0003489414525023

The online version of this article can be found at:

<http://aor.sagepub.com/content/early/2014/03/13/0003489414525023>

Published by:



<http://www.sagepublications.com>

Additional services and information for *Annals of Otology, Rhinology & Laryngology* can be found at:

Email Alerts: <http://aor.sagepub.com/cgi/alerts>

Subscriptions: <http://aor.sagepub.com/subscriptions>

Reprints: <http://www.sagepub.com/journalsReprints.nav>

Permissions: <http://www.sagepub.com/journalsPermissions.nav>

>> OnlineFirst Version of Record - Mar 13, 2014

What is This?

Effectiveness of Domain-Based Intervention for Language Development in Japanese Hearing-Impaired Children: A Multicenter Study

Annals of Otolaryngology & Laryngology
1–9

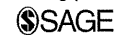
© The Author(s) 2014

Reprints and permissions:

sagepub.com/journalsPermissions.nav

DOI: 10.1177/0003489414525023

aor.sagepub.com



Akiko Sugaya, MD¹, Kunihiro Fukushima, MD, PhD¹,
Norio Kasai, MD, PhD^{1,2}, Toshiyuki Ojima, MD, PhD³,
Goro Takahashi, MD⁴, Takashi Nakagawa, MD, PhD⁵, Seiko Murai, MD⁶,
Yasoichi Nakajima, MD, PhD⁷, and Kazunori Nishizaki, MD, PhD¹

Abstract

Objective: Decreasing language delay in hearing-impaired children is a key issue in the maintenance of their quality of life. Language training has been presented mainly by experience-based training; effective intervention programs are crucially important for their future. The aim of this study was to confirm the efficacy of 6-month domain-based language training of school-age, severe-to-profound hearing-impaired children.

Methods: We conducted a controlled before–after study involving 728 severe-to-profound prelingual hearing-impaired children, including an intervention group (n = 60), control group (n = 30), and baseline study group (n = 638). Language scores of the participants and questionnaires to the caregivers/therapists were compared before and after the intervention. Average monthly increase in each language score of the control group and baseline study group were compared with those of the intervention group.

Results: Language scores and the results of the questionnaire of the intervention group showed a significant improvement ($P < .05$). The average monthly language growth of the intervention group was twice that of the control group and 3 to 4 times that of the baseline study group ($P < .05$). The effect size was largest in communication (1.914), followed by syntax (0.931).

Conclusion: Domain-based language training improved the language development and daily communication of hearing-impaired children without any adverse effects.

Keywords

before–after study, hearing impairment, language development, language intervention

Introduction

Prelingual severe-to-profound hearing impairment is 1 of the most frequent neurological deficits, affecting 1 infant per 1000 live births. Hearing impairment results in language delay and has a lifelong effect, which begins with a lack of fluent communication with preschool friends or unsatisfactory academic performance in school and expands to limited career opportunities in adulthood. Therefore, minimizing language delay is a key issue in addressing the socioeconomic problems in hearing-impaired children. Early hearing detection and intervention (EHDI) has been reported to be 1 of the most effective strategies for improving language development in hearing-impaired children.¹ There have been many clinical efforts to promote EHDI, and new technologies, including digitally processed hearing aids (HA) and cochlear implants (CI), have dramatically improved the audiological experiences in children with hearing impairment. However, many reports suggest that language development in hearing-impaired children continues to lag behind compared with that in their normal-hearing peers.^{2,3} We had

¹Department of Otolaryngology Head and Neck Surgery, Okayama University Graduate School of Medicine, Dentistry, and Pharmaceutical Science, Okayama, Japan

²Department of Otolaryngology, National Sanatorium Oku-Komyo-En, Okayama, Japan

³Department of Community Health and Preventive Medicine, Hamamatsu University School of Medicine, Sizuoka, Japan

⁴Department of Otolaryngology Head and Neck Surgery, Hamamatsu University School of Medicine, Sizuoka, Japan

⁵Department of Otolaryngology, Fukuoka University School of Medicine, Fukuoka, Japan

⁶Department of Otolaryngology, Morioka Municipal Hospital, Iwate, Japan

⁷National Rehabilitation Center for Persons with Disabilities, Saitama, Japan

Corresponding Author:

Kunihiro Fukushima, MD, PhD, Department of Otolaryngology Head and Neck Surgery, Okayama University Graduate School of Medicine, Dentistry, and Pharmaceutical Science, 2-5-1 Shikata-cho, Kita-ku, Okayama-shi, Okayama, 700-8558, Japan.
Email: kuni@cc.okayama-u.ac.jp

previously performed domain-based language assessment as part of the baseline study of the Research on Sensory and Communicative Disorders (RSCD)⁴⁻⁸ to evaluate the characteristics of language development in Japanese hearing-impaired children.

The RSCD, a nationwide, multi-institutional epidemiological study, was conducted from April 2009 to March 2010 and supported by the Ministry of Health, Labour and Welfare of Japan. After open recruitment, we collected data on 4- to 12-year-old hearing-impaired children, with an average hearing level of >70 dB, with the impairment developing ≤ 4 years of age. The study included 638 children from 124 institutions across Japan, including 66 hospitals and clinics, 24 schools for the deaf, 9 preschool training centers, 7 universities, and 5 mainstream schools. A set of language tests (Assessment Package for Language Development in Japanese Hearing-impaired Children [ALADJIN]) was administered to measure communication ability, productive/comprehensive vocabulary, productive/comprehensive syntax, and academic achievements in spoken or sign language, with the children using their usual hearing devices.⁴

The major findings of this study were that early intervention, defined as the use of HAs before 6 months of age, was associated with better communication ability in school-age children and that participation in newborn hearing screening (NHS) was strongly correlated with early intervention.⁵ Many other findings of RSCD, however, revealed that school-age, hearing-impaired children continue to have many language development problems. For example, in comparisons of Japanese syntactic development by normal-hearing and hearing-impaired children, an apparent delay in grammatical skills was observed among hearing-impaired children, especially in the grammatical structures developed during school age.⁶ Although normal-hearing children acquired all basic grammatical structures before the age of 8, the hearing-impaired children appeared to acquire them at 12 years of age or older. It is assumed that this developmental delay in grammar acquisition may readily affect academic achievement.

Another important finding of RSCD was the distribution of language development among hearing-impaired children. Histogram-based analysis of the Test of Question-Answer Interaction Development (TQAID)⁹ revealed that the communication abilities in hearing-impaired children can be clustered into 3 groups: higher scoring (43.7%), intermediate scoring (45.9%), and lower scoring (10.4%). Although the scores of the intermediate-scoring group in both productive/comprehensive basic vocabulary and productive/comprehensive syntax were in the midrange of the 3 groups, their comprehensive abstract vocabulary and academic achievement were equivalent to those of the lower-scoring group.⁷ These results suggested both the importance and difficulties in evaluating language development in

hearing-impaired children. Thus, real problems in comprehensive language skills can be easily obscured without detailed language testing since not a few children may superficially appear to speak well.

The comprehensive RSCD results appear to suggest delays in language development among some portion of hearing-impaired children. Because these delays can be diagnosed by domain-based language evaluations, the establishment of intervention protocols to minimize language delay could affect academic performance in school-age, hearing-impaired children. Although many practical efforts have been directed to achieve this goal, most have used experience-based training programs without domain-based language assessments or prescribed programs. In this era of evidence-based practice, the effectiveness of language training for decreasing language delays in hearing-impaired children requires serious attention.

The study of receptive/expressive language impairments has facilitated the development and availability of well-designed clinical trials of language training.¹⁰⁻¹⁵ On the basis of these studies in areas other than hearing impairment and the results of our RSCD, we developed a before-after clinical trial using domain-based language training that focused on the weaknesses in spoken Japanese language domains. The aim of our study was to demonstrate the effectiveness of this language training in school-age, hearing-impaired children.

Patients and Methods

Intervention Study Design and Participants

We used a controlled, prospective before-after study design to demonstrate the effectiveness of domain-based language training for prelingual hearing impairment in both ears of >70 dB on average. The parents of the children in the intervention study ($n = 72$) agreed to allow the children to receive language training. The inclusion criteria were as follows: (1) 6 to 12 years of age and (2) language delay of greater than -2 standard deviations (SD) in vocabulary, syntax, or communication/discourse compared with hearing peers of the same age, as determined by ALADJIN. The children were recruited from the registered institutions of this study project and subjected to pre-intervention analysis to reveal poorly developed domains/regions. Language training was performed by therapists according to the domain-based language training guideline (hereinafter referred to as the guideline) developed for this study, and video recordings were used to monitor for biases or inconsistencies among examiners. Questionnaires were distributed to both caregivers and therapists before and after the intervention to assess changes/improvements in communication ability and behavior in daily life. The language scores and results of the questionnaires were compared before and

after the intervention. A second questionnaire was distributed to caregivers for the purpose of obtaining medical and educational background information on the children as supplemental data, available online.

In addition to the pre- and post-intervention study, average monthly growth in language scores and socioeconomic backgrounds were compared between the intervention group and the control group (I/C study) and the baseline study group (I/B study).

This study was conducted from August 2010 to December 2011. Central review board approvals from the Ethics Committee of the Associations for Technical Aids and Okayama University Hospital were obtained before the initiation of this study, and written informed consent was obtained from the caregivers of the participants. All investigations have been conducted according to the principles expressed in the Declaration of Helsinki. This trial was registered to the Japanese clinical trial registry: UMIN000005562.

I/C Study: Intervention Group Versus Control Group

The control group ($n = 34$) consisted primarily of children awaiting intervention, who were receiving locally supplied special education at their mainstream schools or schools for the deaf. Children who had participated in the RSCD baseline study⁴ and received a follow-up language assessment at least 6 months after the baseline study were enrolled in this group. The other inclusion criteria were the same as for the intervention group.

I/B Study: Intervention Group Versus Baseline Study Group

Children participating in the RSCD baseline study ($n = 638$) constituted the baseline study group. The inclusion criteria for the baseline study group were as follows: (1) 4 to 12 years of age and (2) the ability to participate in several language tests.⁴

Language Assessments and Questionnaires

Audiological assessments, including pure tone audiometry and a speech discrimination test, and several language tests were administered to the participants by an experienced therapist in a sound-attenuated chamber of their institutions in a face-to-face setting. Children underwent the language tests wearing their usual hearing devices. They received a series of ALADJIN language tests⁴ including the TQAID⁹, which measures communication ability/discourse; the Word Fluency Test¹⁶ (WFT), which measures productive vocabulary; the Picture Vocabulary Test–Revised¹⁷ (PVT-R), which measures comprehensive vocabulary; and the Syntactic

Processing Test for Aphasia¹⁸ (STA), which measures productive and comprehensive syntax. In addition, Raven's Coloured Progressive Matrices¹⁹ (RCPM) test was performed to screen for the presence of nonverbal intellectual delay, and the Pervasive Developmental Disorders Autism Society of Japan Rating Scale²⁰ (PARS) was distributed to the caregivers to screen for pervasive developmental disorder-like behavior characteristics.

The questionnaires for the intervention group were distributed to both the caregivers and the trainers before and after the intervention, separately. This questionnaire included questions about descriptive skills and conversational skills, friendships, and the caregiver's and trainer's impressions regarding the child, such as, "Does he/she respond appropriately to the questions?" and "Does he/she recognize irony?" Caregivers were asked to select 1 of the following 4 scores for each question: almost always (score 3), mostly (score 2), rarely (score 1), or never (score 0). The trainers were asked to select 1 of the following 5 scores for each question: almost always (score 4), mostly (score 3), sometimes (score 2), rarely (score 1), or never (score 0). The scores for each item and the total scores were used in the analysis.

Another questionnaire was distributed to the caregivers of all 3 groups, asking for the following information: birth date, birth weight, sex, participation in NHS, age at first use of a HA and/or preschool language training, type of hearing device, mode of communication, family structure, family annual income, family size, familial involvement in education, and parental education levels. The 15 questions used to assess familial involvement included the following: (1) Do you play with your child? (2) Do you talk with your child about his/her future? (3) Do you talk with your child about social concerns? and (4) Do you participate in parent-teacher association activities? Caregivers were asked to select 1 of 4 scores for each question: almost always (score 1), sometimes (score 2), rarely (score 3), or almost never (score 4). Parental educational levels were measured by asking for the final academic background of the caregivers as follows: junior high school (score 1), high school (score 2), professional training college (score 3), junior college (score 4), university (score 5), or graduate school (score 6). The total scores were used in the analysis.

Intervention

The goals of the intervention were to improve the poorly developed spoken Japanese language domains of vocabulary, syntax, and communication/discourse, as identified in the pre-intervention ALADJIN analysis. Cooperating institutions were recruited for this intervention program, and therapists were required to complete a course in the comprehension and practice of domain-based language analysis and training. The guideline was based on Boyle et al,¹⁰

Table 1. Language Tests and Domains Comprising the Outcome Measures.^a

Language Domain	Communication/ Discourse	Vocabulary		Syntax	
	TQAID	PVT-R (Comprehension)	WFT (Production)	STA (Comprehension)	STA (Production)
Mean	210.253	25.380	21.560	20.740	31.270
SD	75.262	19.710	10.666	10.872	17.458
TLD score	—	○	○	○	○
V score	—	○	○	—	—
S score	—	—	—	○	○
C score	○	—	—	—	—

Abbreviations: C, communication; PVT-R, Picture Vocabulary Test–Revised; S, syntax; SD, standard deviation; SS, standard score; STA, Syntactic Processing Test for Aphasia; TLD, total language development; TQAID, Test of Question–Answer Interaction Development; V, vocabulary; WFT, Word Fluency Test; ○, the language test consisting each score.

^aMeans and standard deviations were referenced data from the baseline study of the Research on Sensory and Communicative Disorders project. Each score was calculated as follows:

TLD score = [PVT-R (SS) + WFT (SS) + STA comprehension (SS) + STA production (SS)] / 4.

V score = [PVT-R (SS) + WFT (SS)] / 2.

S score = [STA comprehension (SS) + STA production (SS)] / 2.

C score = TQAID (SS).

modified for Japanese hearing-impaired children. It described the interpretation of language analysis and practical training methods on the basis of the language analysis results and introduced the use of training materials including cards and books. Before beginning intervention, the results of pre-intervention analyses were discussed by the therapists and the review board of this study project, which was composed of experienced speech–language–hearing therapists, teachers at schools for the deaf, and otolaryngologists, and an appropriate training program for each participant was selected from the guideline. The intervention was performed according to the guideline with a top-down approach.

The criteria for the intervention were as follows.

Vocabulary training: Children who met the following criteria were eligible to undergo vocabulary training: those with more than 1 year delay on the subscales of the TQAID entitled Riddle or Explanation of the meaning of words; those in whom a language delay of greater than -2 SD was recorded in the results of vocabulary testing using the PVT-R and WFT; and those in whom less use of nouns and more use of onomatopoeia or mimetic words was observed in daily communication.

Syntactic training: Children who met the following criteria were eligible to undergo syntactic training: those with more than 1 year delay on the subscales of the TQAID entitled Supposition, Reason, or Explanation; those in whom a language delay of greater than -2 SD was recorded in the results of syntactic testing using the STA; those in whom syntax had developed disproportionately (according to STA score) compared with vocabulary (as indicated by PVT-R and WFT scores); and those in whom grammatical errors, including misuse

of the grammatical particles, were frequently observed in daily conversation.

Training of communication/discourse: Children who met the following criteria were eligible to undergo syntactic training: those in whom a language delay of greater than -2 SD was recorded in the results of the TQAID.

Participants received 40 minutes of individual language training for 12 sessions over 6 months at their affiliated institutions in a face-to-face setting by speech–language–hearing therapists and teachers. Repeated monitoring and discussions between the review board and the therapists were carried out, in compliance with the training program.

Data Preparation

Standard scores, configured for the baseline study group ($n = 638$) as the parent population, were used to analyze the results of the language tests. The means and standard deviations of TQAID, WFT, PVT-R, and STA scores were then calculated (Table 1). The standard scores [$SS = 50 + 10 \times <z \text{ score}>$, $z \text{ score} = (\text{score of the language test of each child} - \text{mean score of the language test}) / \text{SD}$] for the intervention and control groups were calculated using these parameters and designated TQAID(SS), WFT(SS), PVT-R(SS), and STA(SS).

We prepared 4 outcome measures to assess language development: the total language development (TLD) score, the vocabulary (V) score, the syntax (S) score, and the communication (C) score. Each score was calculated as described in Table 1. The monthly improvements in these 4 outcome measures were calculated by dividing the increase of the language scores with the test–retest

Table 2. Regression Equations for the Outcome Measures Calculated From the Baseline Study.

Outcome Measure	Regression Equation	R ²	P Value ^a
TLD score	$y = 0.216x + 29.190$	0.448	<.001
V score	$y = 0.237x + 27.237$	0.501	<.001
S score	$y = 0.200x + 30.611$	0.335	<.001
C score	$y = 0.232x + 26.970$	0.392	<.001

Abbreviations: C, communication; S, syntax; TLD, total language development; V, vocabulary; x, age in months; y, score.

^aSignificant P values (< .05) are in bold.

intervals. Regression lines were drawn using the data from the baseline study, and the coefficient values were calculated. These values represented the average growth in language scores of hearing-impaired children, as shown in Table 2.

Statistical Analysis

Intervention study. The 4 outcome measures, that is, the TLD, V, S, and C scores, were compared by paired *t* tests before and after intervention. In addition, the 4 outcome measures in the preintervention analysis of the dropped out participants were compared to the intervention group with a 2-sample *t* test.

We also used paired *t* tests to separately compare the items and total questionnaire scores obtained from the caregivers and language therapists before and after intervention.

I/C and I/B studies. For the intervention group versus control group (I/C study), the average monthly improvements in the 4 outcomes for both groups were compared with 2-sample *t* tests. The effect sizes of the intervention were also calculated.

For the intervention group versus baseline study group (I/B study), the same scores between the intervention and baseline study groups were compared using *z* tests.

As supplemental data, background information on the children in the intervention group was compared with those of the control and baseline study groups. Pearson's chi-square tests were performed for sex, participation in NHS, age at first wearing a HA (≤ 6 or ≥ 7 months), use of CI or use of sign language, and familial income (< 5 million yen or ≥ 5 million yen). Two-sample *t* tests were performed for age, birth weight, standard score on RCPM, PARS score, age at beginning preschool language training, aided hearing level on pure tone audiometry, best score on speech discrimination test, familial participation, parents' education levels, and the number in the family.

The significance (*P*) level was set at .05. Analyses were performed with SPSS version 19 (IBM Corporation, Armonk, New York, USA) on a Windows 7 computer.

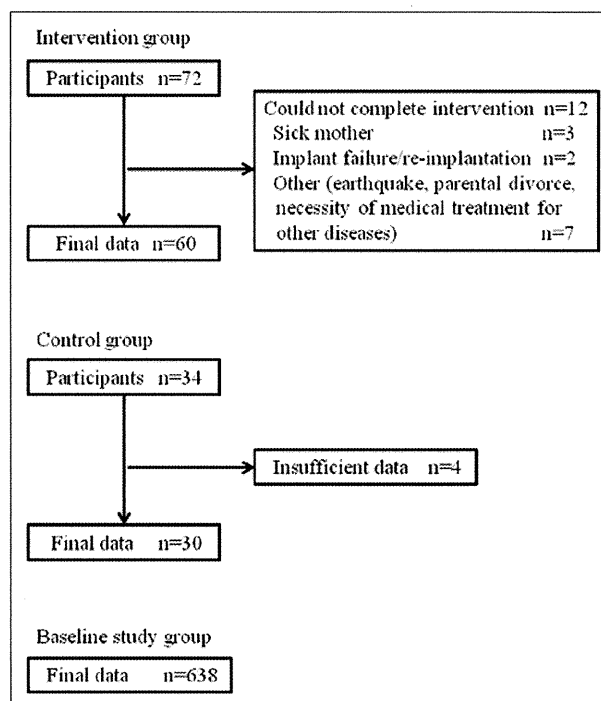


Figure 1. Flowchart of the numbers of participants in the intervention group, the control group, and the baseline study group.

Results. A total of 744 hearing-impaired children were enrolled in this study (Figure 1)

In the intervention group, 12 children failed to complete the intervention for various reasons including caregiver illness ($n = 3$), implant failure or re-implantation ($n = 2$), earthquake disaster, divorce of the parents, or the need for treatment of another disease. Thus, 60 children completed the intervention and were included in the final analysis. There were 7 males and 5 females in the dropped out group (mean [SD] age = 119.9 [28.929] months). There were no significant differences in the baseline data of the dropped out group and the intervention group (Table 3).

Among the 34 control group participants, 4 cases were eliminated because of insufficient data, resulting in a final total of 30 children in the control group. The natural language growth of the control group is shown in Table 3.

Intervention Study

Intervention was performed by 24 speech–language–hearing therapists at 15 registered institutions across Japan, including 10 medical institutions, 4 training centers, and 1 school for the deaf, from August 2010 to December 2011. Each of the standard language scores improved significantly ($P < .01$) by approximately 5 points after 6 months of language training (Table 3). All items on the caregiver and

Table 3. Changes of the Language Scores of the Intervention Group and the Control Group.^a

Language Outcome	Dropped Out Group, Mean (SD)	Before Intervention, Mean (SD)	After Intervention, Mean (SD)
TLD score	55.73 (6.12)	54.30 (5.23)	59.47 (4.70)
P value		.413	.001
V score	53.62 (7.53)	53.69 (5.12)	58.60 (5.88)
P value		.997	<.001
S score	56.98 (6.59)	54.30 (7.31)	59.81 (5.61)
P value		.323	<.001
C score	56.29 (4.00)	52.96 (7.62)	57.03 (6.08)
P value		.207	<.001

Language Outcome	RSCD Baseline Study, Mean (SD)	Follow-Up Assessment, Mean (SD)
TLD score	48.45 (7.26)	53.12 (6.88)
V score	48.91 (7.83)	53.32 (7.76)
S score	48.12 (7.27)	53.14 (7.27)
C score	54.31 (5.11)	56.56 (3.86)

Abbreviations: C, communication; RSCD, Research on Sensory and Communicative Disorders; S, syntax; TLD, total language development; V, vocabulary.

^aUpper part of table: intervention group; lower part of table: control group. Significant *P* values by 2-sample *t* test and paired *t* tests of the intervention group; significant *P* values (*P* < .05) are in bold.

therapist questionnaires showed significant improvement (*P* < .05) following intervention (Table 4).

There were no protocol deviations from the study as planned, except for the child who failed to complete the intervention, and there were no adverse events related to the intervention.

I/C Study

The mean monthly improvements in language scores for both groups are shown in Table 5.

Language growth in the intervention group was significantly better (almost 2 times higher) than that in the control group (*P* < .05). The effect size of the intervention was highest in the C score (1.914), followed by that in the S score (0.931).

There were no significant differences in any of the background information between the intervention and control groups, as shown in Supplementary Tables S1 and S2.

I/B Study

The mean monthly improvements in the language scores in the intervention group were significantly (3 to 4 times) higher than those in the baseline study group (*P* < .001), as shown in Table 5.

There were no other differences in background factors between the 2 groups, except the NHS participation rate, the use of CI, age, aided hearing level, and the best score on the speech discrimination test (*P* = .013, *P* = .001, *P* = .003, *P* = .007, and *P* = .010, respectively), as shown in Supplementary Tables S1 and S2.

Discussion

Although an appropriate study design ensures relevance for clinical practice, to our knowledge, there have been no previous clinically designed intervention studies of language development in hearing-impaired children.²¹ In this study, we enrolled a large number of school-age children and carefully assessed their language development and demographics. We introduced an original training guideline for the purpose of administering prescribed language training for hearing-impaired children. The conversion of the language development scores into standard scores enabled us to compare children of different ages in the 3 groups.

After 6 months of language training, language development, as measured by 5 standard scores, was significantly improved in the intervention group. On the other hand, the results of the follow-up analysis of the control group showed that there is a natural language growth in 6 months, and comparing the monthly language growth between each group might have been appropriate. The mean monthly language growth in the intervention group was significantly higher than that in the control group (2 times) and in the baseline study group (3 to 4 times). Calculated from these data, the language growth after 6 months of domain-based language training was equivalent to as much as 2 years of language growth without additional interventional services. This indicates that when hearing-impaired children receive well-planned, intensive language training following appropriate language assessment, language delays would be expected to decrease in a relatively short time.

The results of the effect size showed that the effect of the intervention was largest in communication (C score, 1.914), followed by syntax (S score, 0.931). In contrast, the effect of the intervention on vocabulary was relatively small (V score, 0.458), although it was still significant. Because our training protocol was primarily based on conversational interactions between the child and the therapist, communication skills may be improved at a relatively early stage of intervention. In contrast, the intervention protocol for vocabulary development included lessons in methods for guessing the meaning of the words; thus, the effects may become apparent at a later stage or even after the intervention program. Long-term outcomes assessed by follow-up study may reveal the more accurate effect sizes of this intervention.

The questionnaire results also demonstrated significant improvements after 6 months of training, as observed by both caregivers and therapists. This suggests that the effects

Table 4. Caregiver and Therapist Questionnaire Scores Before and After Intervention.

	Before Intervention, Mean (SD)	After Intervention, Mean (SD)	P Value ^a
Caregivers			
General impression	8.07 (1.582)	8.48 (1.621)	.021
Descriptive skills	13.62 (4.570)	16.05 (4.077)	<.001
Conversational skills	26.57 (8.259)	31.12 (7.603)	<.001
Friendship	22.72 (5.909)	26.32 (5.537)	<.001
Other	11.87 (2.825)	13.27 (3.209)	<.001
Impression regarding the child	30.83 (5.831)	33.72 (5.645)	<.001
Total	113.67 (24.477)	128.95 (23.892)	<.001
Therapists			
General impression	21.03 (4.614)	22.67 (3.847)	<.001
Descriptive skills	17.13 (5.697)	20.67 (5.470)	<.001
Conversational skills	48.27 (13.619)	57.45 (11.661)	<.001
Total	86.43 (22.447)	100.78 (19.980)	<.001

^aSignificant *P* values (< .05) by paired *t* tests are in bold.

on language development are not limited to the testing conditions but extend to daily communications.

Limitations

Our study has limitations. The first limitation of this study was that there may have been several selection biases because it was not a randomized controlled study. The children who participated in the intervention may have come from families with more concern for education, and familial communication⁵ and parental education^{22,23} are important factors for better language development. However, there were no significant differences in socioeconomic data between the intervention and control groups, suggesting that any possible biases were relatively small. Nevertheless, more children in the intervention group had undergone NHS and CI and eventually exhibited better aided-hearing levels and speech discrimination when compared with the baseline study group. Although the percentages of children who received NHS or CI did not differ between the intervention and control groups, it is possible that in the I/B study, the groups were not fully comparable in this regard.

Second, although approximately half the children in all 3 groups used both spoken and sign language, the preferred communication in daily life may have differed among the children in each group. Because our training guideline was based on a study of receptive/productive language impairment using assessments of spoken Japanese, the intervention group might have included more users of daily spoken language. Therefore, there is a need for the development of Japanese sign language assessments and a corresponding intervention protocol.

Table 5. Comparison of Mean Monthly Language Growth in I/C Study (*t* Test) and I/B Study (*z* Test) and Effect Size in I/C Study.

Language Outcome	I/C Study		I/B Study
	Control Group, Mean (SD)	Intervention Group, Mean (SD)	Baseline Study Group, Mean (SD)
TLD score	0.428 (0.504)	0.792 (0.511)	0.216 (0.240)
P value ^a	.003		<.001
Effect size	0.722		
V score	0.423 (0.721)	0.753 (0.644)	0.273 (0.243)
P value ^a	.036		<.001
Effect size	0.458		
S score	0.437 (0.467)	0.872 (0.739)	0.200 (0.293)
P value ^a	.002		<.001
Effect size	0.931		
C score	0.183 (0.256)	0.673 (0.706)	0.232 (0.283)
P value ^a	<.001		<.001
Effect size	1.914		

Abbreviations: C, communication; I/B study, intervention group versus baseline study group; I/C study, intervention group versus control group; S, syntax; TLD, total language development; V, vocabulary.

^aSignificant *P* values (< .05) are in bold.

Third, because the language assessment was not always performed by the same therapists, there might have been observer bias. We used video recordings to minimize this.

Fourth, since the intervention period was limited to 6 months, the changes in language development and communication in daily life were assessed over a relatively short period. The long-term merit of this 6-month intervention should be evaluated to determine whether language ability continues to improve. All of the participants are now being followed to evaluate the long-term efficacy of this intervention.

The fifth limitation of this study was that the outcome measures were limited to growth in specific aspects of language, such as vocabulary, syntax, and communication/discourse. Thus, it remains to be determined whether these improvements in domain-based tests are associated with improved quality of life, including academic performance, job opportunities, or other aspects of daily life.

Clinical Implications and Future Directions

Because we consider the ultimate goal of language intervention to be improvements in the welfare of hearing-impaired children, further study is needed to measure long-term outcomes, perhaps with the inclusion of more participants. According to the RSCD study, the most reliable prognostic factors for academic achievement are comprehensive vocabulary and comprehensive syntax.⁸ Although our study had several limitations, the improvements in these aspects appear to be promising for the

improved academic achievement of hearing-impaired children. In summary, domain-based language training may contribute to the language development of school-age, hearing-impaired children without adverse effects.

Conclusion

Domain-based, well-designed language therapy was shown to promote better language development for hearing-impaired children, and their language growth after 6 months was equivalent to 2 years of language growth in children who did not receive additional interventional services. The questionnaire results indicated a high level of satisfaction among the caregivers and language therapists. There were no adverse events related to the intervention.

Acknowledgments

We would like to express our deepest appreciation to all of the participants in this study, especially the children and their caregivers. We thank all of the cooperative institutions including Tomo ENT Clinic, Akita Prefectural Schools for the Deaf, the centers for hearing-impaired children "Kanariya-Gakuen" (Okayama) and "Olive-En" (Akita), Tokyo Gakugei University, International University of Health and Welfare, Isawa Kyoritsu Hospital, Shinsyu University Hospital, Nihon Fukushi University Chuo College of Social Services "Sakura," Arao ENT Clinic, National Mie Hospital, Nonohana ENT Clinic, Fukuoka University Hospital, Kanda ENT Clinic Nagasaki Bell Hearing Center, Miyazaki University Hospital, and Okayama University Hospital. We also thank our collaborators, Tomoko Shintani, Misao Nakazawa, Hitomi Inoue, Yukihiko Kanda, Tetsuya Tono, Akie Fujiyoshi, Tomoko Taguchi, and Kana Omori.

Supplementary Material

Supplementary material for this article is available on the AOR website at <http://aor.sagepub.com/supplemental>.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was supported by the RSCD project, funded by the Ministry of Health, Labour and Welfare of Japan.

References

- Pimperton H, Kennedy CR. The impact of early identification of permanent childhood hearing impairment on speech and language outcomes. *Arch Dis Child*. 2012;97:648-653.
- Baudonck N, Van Lierde K, D'haeseleer E, Dhooge I. A comparison of the perceptual evaluation of speech production between bilaterally implanted children, unilaterally implanted children, children using hearing aids, and normal-hearing children. *Int J Audiol*. 2011;50:912-919.
- Fitzpatrick EM, Crawford L, Ni A, Durieux-Smith A. A descriptive analysis of language and speech skills in 4- to 5-yr-old children with hearing loss. *Ear Hear*. 2011;32:605-616.
- Fukushima K, Kasai N, Omori K, et al. Assessment Package for Language Development in Japanese Hearing-Impaired Children (ALADJIN) as a test battery for the development of practical communication. *Ann Otol Rhinol Laryngol Suppl*. 2012;202:3-15.
- Kasai N, Fukushima K, Omori K, Sugaya A, Ojima T. Effects of early identification and intervention on language development in Japanese children with prelingual severe to profound hearing impairment. *Ann Otol Rhinol Laryngol Suppl*. 2012;202:16-20.
- Fujiyoshi A, Fukushima K, Taguchi T, et al. Syntactic development in Japanese hearing-impaired children. *Ann Otol Rhinol Laryngol Suppl*. 2012;202:28-34.
- Sugaya A, Fukushima K, Kasai N, et al. Language ability in the intermediate-scoring group of hearing-impaired children. *Ann Otol Rhinol Laryngol Suppl*. 2012;202:21-27.
- Sugishita S, Fukushima K, Kasai N, et al. Language development, interpersonal communication, and academic achievement among Japanese children assessed by the ALADJIN. *Ann Otol Rhinol Laryngol Suppl*. 2012;202:35-39.
- Satake T, Higachie H, Chinen H. *Manual for Test of Query-Answering Relationship* [in Japanese]. Tokyo, Japan: Escor Co. Ltd.; 1996.
- Boyle J, McCartney E, Forbes J, O'Hare A. A randomised controlled trial and economic evaluation of direct versus indirect and individual versus group modes of speech and language therapy for children with primary language impairment. *Health Technol Assess*. 2007;11:1-139.
- Ebbels SH, van der Lely HK, Dockrell JE. Intervention for verb argument structure in children with persistent SLI: a randomized control trial. *J Speech Lang Hear Res*. 2007;50:1330-1349.
- Cohen W, Hodson A, O'Hare A, et al. Effects of computer-based intervention through acoustically modified speech (Fast ForWord) in severe mixed receptive-expressive language impairment: outcomes from a randomized controlled trial. *J Speech Lang Hear Res*. 2005;48:715-729.
- Gillam RB, Loeb DF, Hoffman LM, et al. The efficacy of Fast ForWord language intervention in school-age children with language impairment: a randomized controlled trial. *J Speech Lang Hear Res*. 2008;51:97-119.
- Bishop DVM, Adams CV, Rosen S. Resistance of grammatical impairment to computerized comprehension training in children with specific and non-specific language impairments. *Int J Lang Disord*. 2006;41:19-40.
- Camarata S, Nelson KE, Gillum H, Camarata M. Incidental receptive language growth associated with expressive grammar intervention in SLI. *First Lang*. 2009;29:51-63.
- Koren R, Kofman O, Berger A. Analysis of word clustering in verbal fluency of school-aged children. *Arch Clin Neuropsychol*. 2005;20:267-284.
- Ueno K, Nagoshi S, Konuki S. *Picture Vocabulary Test-Revised* [in Japanese]. Tokyo, Japan: Interuna Publishers, Inc.; 2002.

18. Nakajima R, Horai T, Sugata T, Tatsumi H, Hamanaka T. Syntactic and communication abilities of aphasics as assessed by CADL, STA, and CADL family questionnaire. *Jpn J Logopedics Phoniater*. 1997;38:161-168.
19. Uno A, Shinya N, Haruhara N, Kaneko M. Raven's Coloured Progressive Matrices in Japanese Children as a screening intelligence test for children with learning disorder and acquired childhood aphasia. *Jpn J Logopedics Phoniater*. 2005;46:185-189.
20. Yamada A, Suzuki M, Kato M, et al. Emotional distress and its correlates among parents of children with pervasive developmental disorders. *Psychiatry Clin Neurosci*. 2007;61:651-657.
21. Tomblin B, Heber K. Current state of knowledge: outcomes research in children with mild to severe hearing impairment—approaches and methodological considerations. *Ear Hear*. 2007;28:715-728.
22. Sininger YS, Grimes A, Christensen E. Auditory development in early amplified children: factors influencing auditory-based communication outcomes in children with hearing loss. *Ear Hear*. 2010;31:166-185.
23. Fitzpatrick E, Coyle DE, Durieux-Smith A, Graham ID, Angus DE, Gaboury I. Parents' preferences for services for children with hearing loss: a conjoint analysis study. *Ear Hear*. 2007;28:842-849.

