

The Relationship between Deaf and Hard-of-Hearing Students' Japanese Sign Language and Japanese Language Proficiency¹

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Abstract: The present study represents an attempt at investigating the relationship between the Japanese Sign Language proficiency and the Japanese literacy skills of high school students who are deaf and hard-of-hearing (D/HH). A pilot test of Japanese Sign Language was designed and administered to 138 D/HH students. A validation analysis was carried out employing classical test theory methods, and test scores were compared to scores obtained by the same participants on a Japanese language and literacy test. Although the small number and heterogeneity of the items in the Japanese Sign Language Test lowered the test's reliability estimate, the comparison with the Japanese language and literacy test provided useful insights into the relationship between the two languages. In particular, students who performed well on the general narrative comprehension task of the Japanese Sign Language Test, and those who were good at processing sequential information in Japanese Sign Language, also had good overall command of written Japanese. Moreover, there seemed to be a positive correlation between students' metalinguistic awareness of Japanese Sign Language and their knowledge of Japanese grammar.

Keywords: deaf and hard-of-hearing students, Japanese Sign Language test, literacy

1. Introduction

The generally low literacy level of deaf and hard-of-hearing (D/HH) students is a central issue in deaf education and there has been an ongoing debate with regards to the best methods of overcoming it. Recent developments in related fields, such as D/HH children's language acquisition, native and artificial sign languages, bilingualism and language testing, continue to provide new insights into the idiosyncratic nature of deaf literacy. In the meantime, the search for a successful model for teaching reading and writing to D/HH students continues (Mayer & Akamatsu, 2003; Paul, 2003).

It is generally agreed that the low literacy levels of D/HH students are the consequence of their particular linguistic profiles. The academic success of D/HH children largely depends on their age when hearing loss occurred, on whether they have any residual hearing, and on whether they have a fully-fledged language when they enter school. Research has shown that deaf

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children of deaf parents perform at their grade-equivalent on reading tests, and this is assumed to be result of them being able to communicate proficiently in sign language (Mayer & Akamatsu, 2003). However, because around 90% of D/HH children are born in hearing families, most D/HH children enter school without a proper first (or home) language, and without any experience of reading or writing (Knight & Swanwick, 2002). Therefore, they are faced with the daunting task of learning a spoken language at the same time as learning how to read and write. Moreover, because of their sensory limitations, D/HH children cannot benefit from incidental language learning, which plays an important role in hearing children's language acquisition. Moreover, about 30% of D/HH children have a learning disability besides deafness (Knight & Swanwick, 2002). All these characteristics explain why D/HH children make up such a heterogeneous group, and why it has been so difficult to find an effective model for teaching literacy skills.

Deaf bilingual education is a teaching model that has recently been gaining popularity in deaf schools around the world. It is theoretically grounded in the linguistic interdependence principle, which was formulated by Cummins (1991) with regard to hearing bilingualism. Cummins suggested that proficiency in a first language (L1) supports the acquisition of literacy skills in a second language (L2). More precisely, he hypothesized the existence of a common underlying proficiency across languages, which allows for a positive transfer of cognitive-academic or literacy-related skills to occur from L1 to L2, provided that there is adequate exposure to L2. In the case of deaf bilingualism, L1 is considered to be the sign language and L2 the written form of the language spoken by the hearing majority (Padden & Ramsey, 2000). It is considered that high levels of proficiency in a native sign language support the development of literacy in L2. This premise is validated by research findings according to which deaf children of deaf parents perform on a level with their hearing counterparts on reading measures (for a review, see Mayer & Akamatsu, 2003).

Criticism brought to bilingual deaf education pertains to the fact that Cummins' linguistic interdependence model does not apply perfectly to deaf bilinguals (Mayer & Akamatsu, 2003). One reason is the difference of modality between sign language and the spoken language. Other reasons are the lack of a written version of sign language, and the fact that D/HH learners do not have easy access to the face-to-face form of L2 (i.e., the spoken language). According to Cummins (1991), for a positive transfer to occur from L1 to L2, there is a need for good academic-cognitive or literacy-related skills in L1, as well as for a certain level of proficiency in the face-to-face form of L2. Also, because sign language does not have a written form, literacy-related skills cannot be developed in L1 for D/HH learners. However, the proponents of sign-bilingual education emphasize the fact that the development of conceptual and background knowledge in sign language presents an incontestable advantage for the acquisition of literacy and subject matter content (Mayer & Akamatsu, 2003). Using native sign language to teach literacy skills has proven to be beneficial for developing prior knowledge, metacognitive strategies and metalinguistic awareness, as well as knowledge of the organization of connected discourse (Mayer & Akamatsu, 2003; Paul, 2003).

The purpose of the present study was to identify the particular aspects of sign language and written language that make up D/HH students' common underlying proficiency. In line with the above-mentioned research findings, it was hypothesized that there will be a certain overlap between D/HH students' sign language and written Japanese proficiency. Therefore, the present study is aimed at answering the following two questions: (1) Does Japanese Sign Language (JSL) correlate with Japanese proficiency?; and (2) Which particular JSL skills can be employed to support the acquisition of Japanese grammar and reading skills? This was carried out by measuring D/HH learners' proficiency in JSL and Japanese, and identifying the language skills

that correlate across the two languages. Although bilingual education programs are not common in Japan yet, most Japanese D/HH students have certain levels of proficiency in JSL.

2. Method

Participants. A total of 138 D/HH high school students from 14 Japanese deaf schools participated in this study. Their distribution per grades was as follows: 57 were first grade; 38 were second grade; and 43 were third grade students. The group consisted of 57 females and 81 males. None of the students had any additional disabilities.

Students' levels of hearing loss ranged between 41dB and 125dB in the better ear. The participants included both students fitted with hearing aids, and those who did not use hearing aids. Their distribution according to hearing loss (Clark, 1981) is shown in Table 1.

Table 1 Distribution per category of hearing loss

Category of hearing loss	Number	Percentage
Moderate (41 - 55 dB)	44	32%
Moderately severe (56 - 70 dB)	50	36%
Severe (71 - 90 dB)	17	12%
Profound (90 dB ~)	27	20%

Most of the schools that participated in the research adopted Combined Method¹⁾ programs, a smaller number adopted Oral programs, and one school employed Cued Speech. As for the communication methods that students used on an everyday basis, they reportedly varied between Japanese Sign Language, Contact Sign²⁾ and Signed Japanese, depending on whether the interlocutors were hearing or had hearing disabilities.

Assessment instruments. Because of the lack of standardized assessment instruments for D/HH students in Japan, a sign language test and a Japanese test were designed for the purpose of the present study. The Japanese test (named the Pilot Japanese Test, PJT) was based on a standardized measure of Japanese designed for learners of Japanese as a Foreign Language and aimed at measuring students' knowledge of grammar and reading comprehension. Its contents and the evaluation of its technical adequacy make the subject of a manuscript submitted for publication (Iurascu, 2009), and will not be discussed here. A sign language test was also devised, following the design of other Sign Language measures, such as American Sign Language and the Sign Language of the Netherlands. The Pilot Japanese Sign Language Test (PJSLT) is a multiple-choice comprehension test, in which the stimuli were given on videotape, and the answer choices were given in a response booklet, either as still frames extracted from the video recording, or as drawings. The instructions are given both on videotape in sign language with Japanese subtitles and in the response booklet, in Japanese, in order to ensure that all students understand the requirements, irrespective of their preferred language³⁾.

The test was signed by a native deaf signer, and the type of sign language used was a combination of Contact Sign and Japanese Sign Language. The test was initially intended to be entirely signed in Japanese Sign Language. However, as the signer read a Japanese script while signing, the Japanese of the script influenced her signing, leading to accidental occurrences of sequences of signs in Contact Sign, in which the order of the signs matches Japanese word order.

The test was made up of six tasks, which dealt with: (1) knowledge of synonyms; (2) knowledge of antonyms; (3) comprehension of temporal concepts; (4) comprehension of spatial concepts; (5) comprehension of verb agreement; and (6) general narrative comprehension. A total of 23 items was comprised in the PJSLT, and one point was given for each correct answer (see Table 2).

The theoretical grounding and the testing format of the first two tasks of the PJSLT were inspired by Hoffmeister’s ASL measure (2000). Hoffmeister considers knowledge of synonyms, antonyms, and plural-quantifiers as an indicator of metalinguistic awareness in Sign Language. Metalinguistic awareness is defined by Schirmer (2000) as the ability to think consciously about language. Bialystok (1991) suggests that there are three stages in acquiring a language: (1) an oral or conversational stage, (2) a literate stage, and, finally, (3) a metalinguistic stage. According to the bilingual functioning frameworks proposed by Cummins (1991), acquiring literacy skills in the second language depends greatly on the developmental stage which was reached in the first language. If D/HH children reach the stage when they can analyze their use of sign language, this is expected to facilitate their ability to learn how to read and write.

Table 2 Contents, number of items, and scoring of PJSLT

Tasks	Items	Maximum points
Task 1 (Synonyms)	3	3
Task 2 (Antonyms)	3	3
Task 3 (Temporal concepts)	4	4
Task 4 (Spatial concepts)	4	4
Task 5 (Verb agreement)	5	5
Task 6 (Narrative comprehension)	4	4

As in Hoffmeister’s measure, in the first task of the PJSLT a single sign was given as a stimulus, and students were prompted to find the synonym of the stimulus sign out of four choices. The stimulus and the four answer choices were given on videotape and also in the answer booklet, as still frames. The four choices were chosen as follows: (1) a semantic distracter (a sign that has meaning similar but not synonymous to that of the stimulus); (2) a phonologic distracter (a sign which has phonological characteristics⁴ that are similar to those of the stimulus, but which carries different meaning); (3) a nonsense distracter (a sign which bears no semantic or phonologic resemblance to the stimulus); and (4) the correct answer. The synonyms task comprised one demonstration example, and three items at various levels of difficulty. The demonstration example was the easiest of all four, as it dealt with common concrete concepts (see Figure 1).

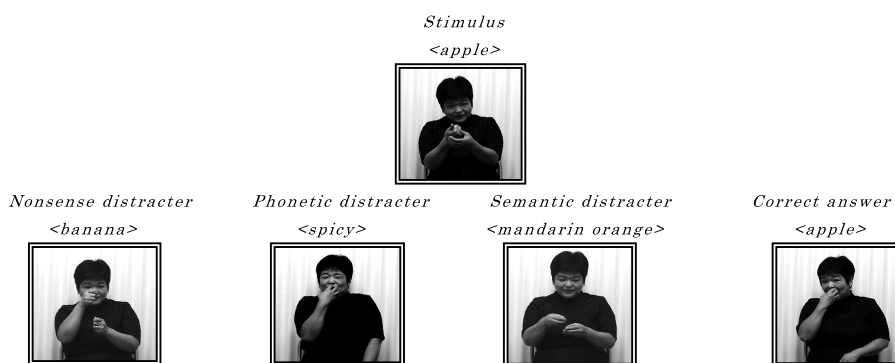


Figure 1. Stimulus and answer choices of the demonstration example in Task 1

The second task dealt with antonyms and was constructed in the same manner as Task 1. It consisted of one demonstration example and three testing items. The demonstration example is shown in Figure 2.

The third and fourth tasks consisted of four items each and addressed the comprehension of

temporal and spatial concepts. These tasks were inspired by tests designed by Prinz, Strong, and Kuntze (1994) and Jansma, Knoors, and Baker (1997). Students' ability to process temporal and spatial information was tested by means of short signed sequences followed by questions. To answer to questions, students had to choose one of four drawings given in the response booklet. Finding the correct answer required comprehension of temporal concepts like tomorrow, this morning, duration (in hours and in days), days of the week, as well as performing basic arithmetical operations involving these concepts (e.g., 'My sister's birthday is on the 23rd of September. I have only three days left to buy her a nice birthday present. Question: What is today's date?'), as well as spatial concepts like *in front of*, *behind*, *next to*, *on*, *under*, *left* and *right* (e.g., 'In Hiroshi's room there is a desk next to his bed. On the desk there is a computer, and next to the computer there is a stereo. Question: Where is Hiroshi's computer?').

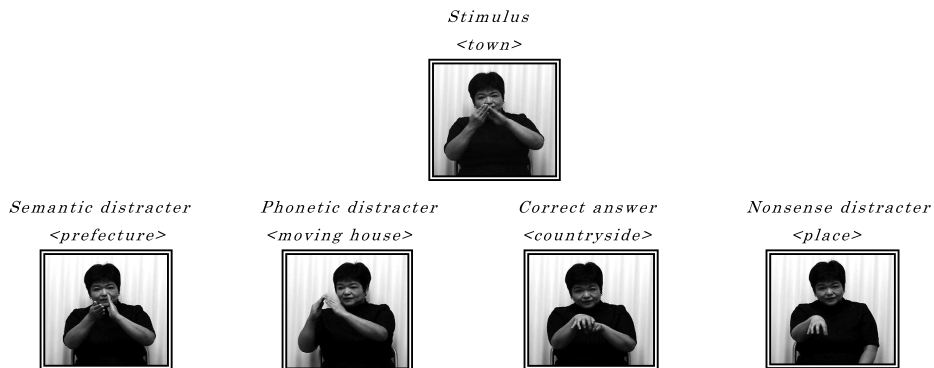


Figure 2. Stimulus and answer choices of the demonstration example in Task 2

The fifth task tested verb agreement and it was made up of one demonstration example and five items. Tasks dealing with verb agreement were included in tests devised by Maller, Singleton, Supalla, and Wix (1999), Padden and Ramsey (2000) and Jansma, Knoors, and Baker (1997). In the fifth task of the PJSLT, statements in which the roles of agents and patients vary were given, and students were asked to identify the drawings that match the statements. Figure 3 shows the example of Task 5.

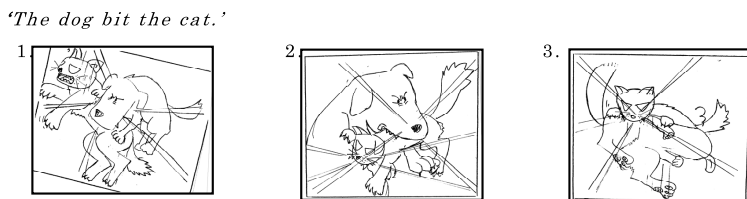


Figure 3. Script and answer choices of the demonstration example in Task 5

The sixth task was a general narrative comprehension task. General narrative comprehension was tested in measures designed by Prinz et al. (1994) and Chamberlain and Mayberry (2000). In the present test, a short signed narration was given on videotape, followed by four signed statements referring to explicit information from the story, which students were asked to mark as true or false.

Out of the six tasks, the first and second tasks were designed to measure metalinguistic awareness of JSL, and required knowledge of vocabulary. The third and fourth tasks tested the

students' ability to understand and process temporal and spatial information in sign language. The fifth task dealt with grammatical aspects specific to JSL, and the sixth task tested general narrative comprehension.

Administration procedure. The testing was carried out in a group format, which corresponded to the class size at the particular time of the test. Both the PJS�T and the PJT were administered at the same time. The tests were administered by the teachers of the respective schools. The teachers' role was to distribute the testing booklets and play the videotape. In order to reduce memory constraints, teachers were instructed to replay the stimulus and the response items if the students requested it. No time limit was imposed for completing the tests.

Students' scores were subsequently analyzed focusing on the distribution of scores in relation to students' grades, the analysis of the items of the PJS�T, the test's reliability and construct validity. Data were analyzed using SPSS for Windows version 12.

3. Results and discussion

Descriptive statistics. First, the mean and the standard deviation of students' scores were calculated ($M=16.40$, $SD=3.87$) and the frequency distribution of scores was analyzed. A Kolmogorov-Smirnov test of normality confirmed that the distribution of the scores was normal. As the participants were students in different grades, a one-way ANOVA was calculated among students' grades and their total scores, and individual task scores. No significant differences were found among the total scores of the first, second and third graders $F(2, 138)=.99$, $p=.37$. Similarly, no significant differences were found among their task scores. This indicated the absence of developmental trends in D/HH high school students' JSL proficiency. In other words, age was not a factor in JSL proficiency.

Reliability. As the PJS�T was an unspeeded test, the reliability of the test was estimated using Cronbach's alpha coefficient of internal consistency. The obtained coefficient was $\alpha=.61$. The reliability of a test can be influenced, among other things, by the length of the test, the homogeneity of the items, and the range of ability of the students who take the test (Alderson, Capham, and Wall, 1995). This rather low coefficient of reliability was the result of the fact that the PJS�T was a short test, made up of 23 items, and its tasks were heterogeneous, as they addressed a large range of abilities (i.e., metalinguistic awareness, processing of temporal and spatial information, verb agreement and narrative comprehension).

Item analysis. Along with descriptive statistics and reliability measures, another pretesting procedure required in the development of norm-referenced tests is item-analysis. Items (i.e., the individual questions in a test) are analyzed by focusing on two characteristics: facility values, which indicate how difficult an item is by calculating the proportion of students who answered it correctly; and discrimination indices, which show how well an item discriminates between good and poor students, by calculating the ratio between item scores obtained by top-scoring and low-scoring students. For a test to be able to discriminate well between students with different levels of ability, and therefore to yield a greater variability of test scores, facility values of items should be close to 50%, and it is generally agreed that discrimination indices should be greater than, or equal to, .4 (cf. Alderson et al., 1995).

For the PJS�T, the range of difficulty of the items was widely spread, ranging between 17% (the most difficult item) to 87% (the easiest). This big variation was the consequence of the fact that each task was designed to contain items of various degrees of difficulty. This was most visible in Task 2 (Antonyms): Item 2.3 had a facility value of 19%; Item 2.1, 62%, and Item 2.2, 86%.

This wide variation in the difficulty of items translated into low discrimination indices (only 38%

of the items had discrimination indices equal or greater than .4). However, out of all the tasks of the PJSLT, Task 3, which dealt with temporal concepts, had the highest discrimination indices and its facility values were the closest to the recommended 50% (i.e., 30%, 42%, 60% and 40%). At the same time, Task 3 was the most difficult task of the test. This might be the result of the fact that the comprehension of temporal concepts requires processing of sequential information, which has been known to be particularly difficult for D/HH students (Marschark & Mayer, 1998). Task 5, which deals with general narrative comprehension, was the easiest, with facility values ranging between 67% and 86%.

To summarize, item analysis showed that on the whole, the items in the PJSLT had a rather wide range of difficulty levels and they did not always discriminate well between good and poor test-takers. Nevertheless, the task dealing with temporal concepts contained some of the best constructed items of the test.

Validity. Bringing validity proofs for a newly-designed sign language test is a rather difficult task, mainly because of the scarcity of research on the development of Sign Language proficiency tests. Although several sign language tests have been developed to date, very few of them reported validity data. In Japan, no data on other JSL measures is available for comparisons. Therefore, the validity analysis of the PJSLT focused on correlations between task scores, and on comparisons between D/HH high school students' scores on the PJSLT and the Japanese test, PJT, which was administered at the same time.

The correlations among the six tasks were indicators of how well the different aspects of language ability correlated with each other. As each task was designed to test a different aspect that contributes to providing an overall picture of language ability, the correlations were expected to range between .3 and .5 (Alderson et al., 1995).

However, the Pearson correlation matrix in Table 3 shows that the tasks generally correlated low, and some of them did not correlate at all. However, Task 3, which dealt with temporal concepts, correlated with all the other tasks. The reason for these low correlations lies in the design of the test. On one hand, the linguistic aspects tested by each task were more different from each other than those making up more traditional proficiency tests. That is, items testing metalinguistic awareness were expected to correlate low with items testing general narrative comprehension. Similarly, items testing the processing of spatial concepts were not expected to be very similar to items testing the comprehension of verb agreement. On the other hand, the small number of items in each task (i.e., three to five items per task), as well as the widely-spread difficulty levels of the items contributed to the low correlation indices between task scores.

Table 3 Inter-task correlation matrix for the PJSLT

	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
Task 1		.16*	.21**	.04	.17*	.03
Task 2	.16*		.24**	.20*	.01	.18*
Task 3	.21**	.24**		.22**	.23**	.23**
Task 4	.04	.20*	.22**		.15	.18*
Task 5	.17*	.01	.23**	.15		.16
Task 6	.03	.18*	.23**	.18*	.16	

* $p < .05$, ** $p < .01$.

Because there are no other tests of JSL proficiency for D/HH students available for comparison, it was hard to establish the concurrent or predictive validity of the PJSLT. However, there have been studies in which the predictive validity of newly-designed sign language tests was analyzed by comparing their scores with scores obtained by the same test-takers on a

validated measure of literacy (Singleton & Supalla, 2003). In the present study, the analysis of the correlation between scores obtained by the D/HH high school students on the PJSLT and the PJT provides not only support for the validity of the PJSLT, but also useful insights into the relationship between sign language proficiency and literacy skills.

As the PJT scores were not normally distributed and required the use of non-parametric statistical instruments, Spearman rank-correlation coefficients were calculated between the scores of the two tests. There seemed to be a positive correlation between the total scores of the PJSLT and PJT ($r_s=.19, p<.05$). The relatively small coefficient is thought to be the effect, on one hand, of the validity and reliability issues of the pilot tests, and, on the other hand, of the different aspects of linguistic ability which were measured by the two tests. For a more detailed analysis of the relationship between the aspects of linguistic ability addressed by the two tests, correlation coefficients were also calculated between scores on each of the tasks making up the PJT and PJSLT (Table 4).

Table 4 Inter-task correlation coefficients between the PJT and the PJSLT

	PJT T1	PJT T2	PJT T3	PJT T4	PJT T5
	Particles	Inflections	Compound verbs	Gap-filling	Reading comprehension
PJSLT T1 Synonyms	.03	.15	.11	.14	.01
PJSLT T2 Antonyms	.21**	.20*	.20*	.13	.09
PJSLT T3 Temporal concepts	.19*	.18*	.19*	.17*	.16
PJSLT T4 Spatial concepts	.12	.08	.14	.08	.03
PJSLT T5 Verb agreement	.03	.07	.07	.07	.01
PJSLT T6 Narrative comprehension	.22**	.26**	.29**	.19*	.16*

* $p<.05$, ** $p<.01$.

Task 6 of the PJSLT, which dealt with general narrative comprehension, correlated with all tasks in the PJT. This suggested that general narrative comprehension in JSL correlates with both knowledge of Japanese grammar and reading comprehension. Also, Task 3 of the PJSLT, which tested the comprehension of temporal concepts, correlated with all the tasks of the PJT, with the exception of the reading comprehension task. This suggested that comprehension of temporal concepts in JSL is related to knowledge of Japanese grammar. The explanation might be offered by sequential processing, which is the common denominator between the knowledge of Japanese grammar and the comprehension of temporal information in JSL, as both understanding a spoken language and manipulating temporal concepts require processing of information that is presented sequentially. The lack of correlation between the comprehension of temporal concepts in JSL and reading echoed previous research according to which deaf students' sequential short-term memory for phonological information was unrelated to reading ability (Waters & Doehring, 1990). Task 2 of the PJSLT, which tested knowledge of antonyms and was considered to be an indicator of metalinguistic awareness, correlated with all the grammar tasks of the PJT. This suggested that there is a relationship between metalinguistic awareness of JSL and the acquisition of Japanese grammar.

4. Conclusions

The PJSLT provided essential insights into the various different factors involved in assessing D/HH students' linguistic abilities. The results of the test offered a glimpse at the way JSL proficiency might relate to and support the acquisition of Japanese literacy. However, as this is only an initial attempt towards developing a JSL tests for D/HH students, further improvements are necessary, such as increasing the length of the test and eliminating the items with levels of difficulty which are too high or too low.

Several conclusions can be drawn from the correlations between scores on the PJSLT and the PJT: (1) a good level of general narrative comprehension in JSL may support the development of literacy skills; (2) developing D/HH students' ability to process sequential information might improve their access to the grammar of the spoken language; and (3) metalinguistic skills in JSL might support the acquisition of Japanese grammar.

These results are very insightful with regard to the connection between sign language proficiency and development of literacy skills. Nevertheless, given the drawbacks in the design of the tests employed in the present study, it is believed that improved versions of the tests would elicit even more useful information on the characteristics of D/HH students' literacy.

5. Further research

Further research would require improvements in the design of the JSL test, especially with regard to increasing the number and homogenizing the difficulty level of the items. Furthermore, it would be useful to further investigate the correlations between the two languages under different experimental conditions, which involve language production and open-ended test items and avoid the limitations of multiple-choice comprehension tests. Understanding the particular ways in which sign language proficiency relates to Japanese proficiency is crucial in identifying which sign language skills could be employed to support the acquisition of reading skills by D/HH students.

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- 1) The 'Combined Method' is a combination of speech and Signed Japanese, similar to Simultaneous Communication. It is the most widely used communication method in Japanese deaf schools.
 - 2) Contact Sign is a type of natural language mixing, which includes both elements of sign language and spoken language and is similar to language mixing by hearing bilingual children (Knight & Swanwick, 2002).
 - 3) Preferred language is a term used in deaf studies to differentiate the first language, which is the language used by D/HH children at home (and could be either sign language or the spoken language, if they have hearing parents), from the language which could be most easily developed to a level appropriate to their age and stage of development (Knight & Swanwick, 2002).
 - 4) Signs are made up of minimal units (i.e., hand configuration, movement and place of articulation), the same way spoken words are made up of phonemes (Stokoe, 1960). These minimal units are called phonological traits or characteristics of signs.