

3

How Do Deaf Infants Attain First Signs? WATARU TAKEI

This paper was originally published as Takei, W. (2001) 'How do deaf infants attain first signs?' *Developmental Science*, 4: 71–78.

Abstract

In this study the development and alternation of nonreferential gestures were examined longitudinally in terms of the acquisition of Japanese sign language. Parent–child free-play sessions in their home were videotaped at every monthly visit. Hand activities produced by two deaf infants of deaf parents are described and analyzed. Nonreferential gestures were observed frequently just before the occurrences of the first signs. They consisted of many rhythmic and repetitious movements. Nonreferential gestures became more complex and the number of them also increased as infants grew up. The comparison of nonreferential gestures and first signs revealed the continuity between them in terms of movements. In conclusion, non-referential gestures are equivalent to a manual analog of vocal babbling.

Introduction

Japanese sign language (JSL) is a visual-gestural language created by deaf people and used by approximately 200,000–300,000 Japanese of all ages. It is evident from many linguistic studies that sign language is a fully grammaticized language, not a pantomimic communication system (Klima & Bellugi, 1979; Wilbur, 1987). Sign language is in many ways like spoken language in its acquisition, and in its role as a purveyor of identity, values and information. It is, of course, different in its form. Spoken Japanese and JSL are quite different: e.g. one makes audible words using the small muscles and articulators of the mouth and throat; the other makes visible words by moving the larger articulators of the limbs and body in space.

The acquisition of sign language in deaf infants of deaf parents occurs just as does the acquisition of spoken language by hearing infants of hearing parents with the same maturation timetable (Abrahamsen, Cavallo & McCluer, 1985;

Newport & Meier, 1985; Meier, 1991). First recognizable signs in deaf infants of deaf parents emerge from 8 months to 12 months, and two-sign combinations are produced at about 18 months. The course of sign language acquisition parallels very closely that of spoken language after the emergence of first words or signs.

In the case of spoken language, vocal babbling is observed before infants are able to utter recognizable words. How about the case of sign language? It is difficult to believe that deaf infants instantly produce first signs without any preparation. Deaf infants should be doing something to attain early expressive milestones before the occurrence of first signs.

Prinz and Prinz (1979) observed a hearing infant who had a deaf mother from 7 months to 21 months. The infant exhibited a type of manual babbling behavior in that she would wave her hands around in apparent imitation of signs produced by her parents. Griffith (1985) also reported the existence of manual babbling in a hearing infant who had deaf parents in transition from a prelexical to a lexical form in both speech and sign mode. The infant clapped and rubbed his hands in a circular motion while the investigator and his mother conversed in sign and speech and watched him. But neither Prinz and Prinz nor Griffith revealed details on manual babbling such as its phonological aspects, its qualitative alternations or continuation to first signs.

Petitto and Marentette (1991) were the first to report a manual analog of vocal babbling systematically. They described and analyzed manual activities of five infants. Two of the five were deaf infants of deaf parents; the rest were hearing infants with no exposure to sign language. Data were collected from the five participants at 10, 12 and 14 months. From this study, Petitto and Marentette came up with their definition of manual babbling, which is as follows. Manual babbling (a) was produced with a subset of combinational units that were members of the phonetic inventory of sign language, (b) demonstrated syllabic organization seen only in sign language, and (c) was produced without meaning or reference. It is interesting that manual babbling was reported to occur in deaf infants exposed to sign language much more frequently than in hearing infants. Petitto and Marentette concluded that manual babbling is a product of amodal brain-based language capacity.

However, one question arises. If manual babbling is innate, both deaf and hearing infants should show it in the same quantities and qualities. Otherwise, manual babbling must be influenced by linguistic input and not be a pure product of brain-based language capacity.

Other researchers, Meier and Willerman (1995), doubted whether manual babbling of deaf infants was different from that of hearing infants. They videotaped three deaf girls and two hearing boys at 2-week intervals from 7 months to 15 months. The children's manual activities were divided into three basic categories: (a) communicative and/or meaningful gestures such as points, reaches, waves and symbolic gestures; (b) gestures that on the basis of both form and usage can be identified as signs of American Sign

Language (ASL); and (c) meaningless, nonreferential gestures. The class of nonreferential gestures may turn out to be a superset of the class of canonical manual babbles. Results revealed that there was no sharp distinction between the deaf and hearing groups in the overall proportion of nonreferential gestures used out of the whole set of gestures. However, all three deaf infants used a higher proportion of multicycle, nonreferential gestures than their hearing counterparts. The crucial point here is what deaf infants do so as to produce the first signs.

The present paper describes the acquisition processes of JSL as a first language by two deaf infants of deaf parents, focusing on the prelinguistic and one-word stages.

Method

Participants

The participants were two deaf infants of deaf parents. One was a girl (participant A), the other was a boy (participant B). JSL was the principal means of communication within their home. Both infants had been receiving JSL input from their parents since they were born. Participants A and B began their participation at 5 months and 7 months of age, respectively. Participant B had an older brother who was also deaf. Table 3.1 shows the descriptions of participants and details of observations.

Table 3.1 Description of participants

Participant	Sex	Birth order	Number of visits	Child's age at home visit (months : days)
A	Female	1st	11	4:28 6:10 6:25 7:29 8:12 9:25 10:23 11:20 12:18 13:21 15:3
B	Male	2nd	8	7:26 8:25 9:22 10:18 11:24 13:1 14:7 15:20

Procedure

The major source of data was observations during monthly home visits, each of which lasted about an hour. When the researcher started observations, neither of the infants had produced signs or nonlinguistic communicative gestures.

Parent-child free-play sessions were videotaped in their home at every visit. To prevent the infants from being nervous, toys and books with which the infants were accustomed to playing were used. The

sessions of participant A occurred for a total of 11 visits and of participant B for 8 visits.

After free-play sessions, the parents were asked what the infants had done during the past month. Interviews with the parents enhanced my knowledge of the signs and communicative gestures produced by the infants.

Scoring

All hand activities produced by participants A and B were transcribed and divided into the following four basic categories.

- (a) *Signs*: gestures that can be identified as JSL signs on the basis of both form and content.
- (b) *Communicative gestures*: gestures that are used communicatively and stand for objects, people, places and the like in the surroundings. Communicative gestures consist of three subcategories: (b-1) reaching, (b-2) pointing and (b-3) symbolic gesture. Reaching is an activity of unsuccessful direct attempts to grasp or reach for an object, but it also includes a gesture that stands for request or demand. Pointing is a deictic gesture produced with index finger extended, to single out objects, people and places. Symbolic gesture is the stylized pantomime whose iconic forms varied with the intended meaning of each gesture. Gestures that not only deaf but also hearing infants usually use, such as 'Bye-bye' or 'Give it to me', were coded as symbolic gestures.
- (c) *Manipulating*: hand motions to grasp or handle an object. It included playing with toys. Manipulating has two subcategories: (c-1) manipulating and (c-2) giving.
- (d) *Nonreferential gestures*: gestures that elude semantic interpretation. Nonreferential gestures may be produced in a communicative context of parent-child interaction, but no meaning or reference can be assigned to them. It is likely that nonreferential gestures contain manual babbling, as suggested by Petitto and Marentette (1991). In this study, however, a category of 'manual babbling' was not used because precise phonetic criteria for identifying manual babbling are very difficult to determine. It is questionable whether the definition of babbling in the vocal mode can be applied to that in the manual mode. I decided to use the wider category of 'nonreferential gestures', which is the rest excluding (a) signs, (b) communicative gestures and (c) manipulating.

All of the hand activities were transcribed by two independent coders. The agreement between them averaged 89%.

After making transcriptions of all hand activities, the precise physical forms of nonreferential gestures produced by the infants were coded with

symbols that represented internal features of the hand or hands, such as their handshapes and location in space. Movement of the hand or hands was also coded, and it was analyzed to examine how many times it was repeated.

Results

Sign and nonreferential gesture

Figures 3.1 and 3.2 show the number of signs, symbolic gestures and non-referential gestures produced by participants A and B as a function of age. Participant A was found to produce her first recognizable signs at 11 months. Participant B's first sign production occurred at 13 months. In large-scale studies of children's spoken language development, it was reported that the appearance of the first spoken word occurred at 11–14 months (Capute et al., 1986). Participants in this study attained their first sign in accordance with the timetable for hearing infants.

In the case of participant A, nonreferential gestures started to be observed at 7 months. There was a gradual increase to 10 months, but the frequency of them rapidly declined after 10 months. Interestingly, participant A's first signs occurred just after the decrease of nonreferential gestures. Participant B started to express nonreferential gestures at 7 months. There was a slight increase to 10 months and the number of nonreferential gestures gradually declined except at 14 months. Participant B produced first signs at 14 months. Participant B also produced nonreferential gestures frequently before the onset of signs.

Hearing infants begin to produce syllabic vocal babbling between 6 and 10 months of age (Oller, 1986; Oller & Eilers, 1988). Both participants A and B also began to produce nonreferential gestures during that time.

There was a second marked increase in the frequency of nonreferential gestures in both participants A and B at the onset of signs. Nonreferential gestures produced at and after the onset of signs included some sign-like features, which are different from previous ones in two respects. First, frequencies of nonreferential gestures were not so high, but each nonreferential gesture had many movement cycles. Second, the infants looked at their parents after the production of nonreferential gestures. These features were present in nonreferential gestures that were produced with signs, not in nonreferential gestures produced before the infants produced signs.

Qualitative alternations of nonreferential gestures will be examined next.

Handshape in the nonreferential gestures

Figure 3.3 indicates the handshape repertory of nonreferential gestures produced by participants A and B. Seven handshapes were observed in

Figure 3.1 Number of nonreferential gestures and signs in participant A (age along the horizontal axis is given in years: months: days).

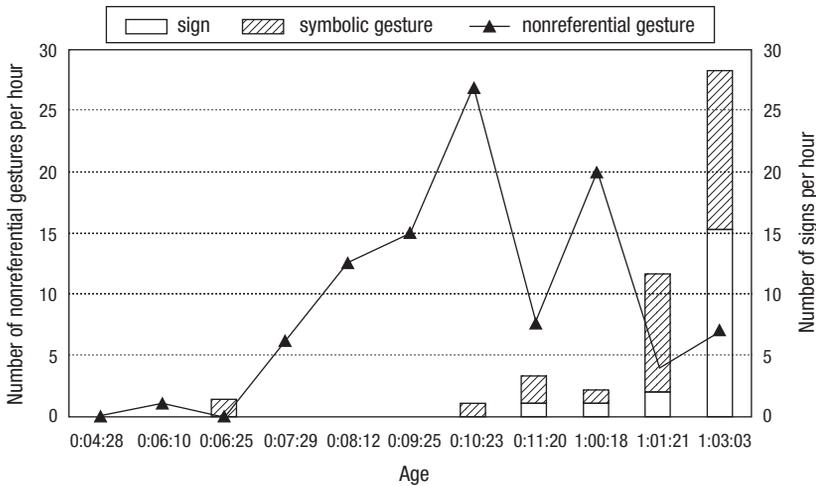
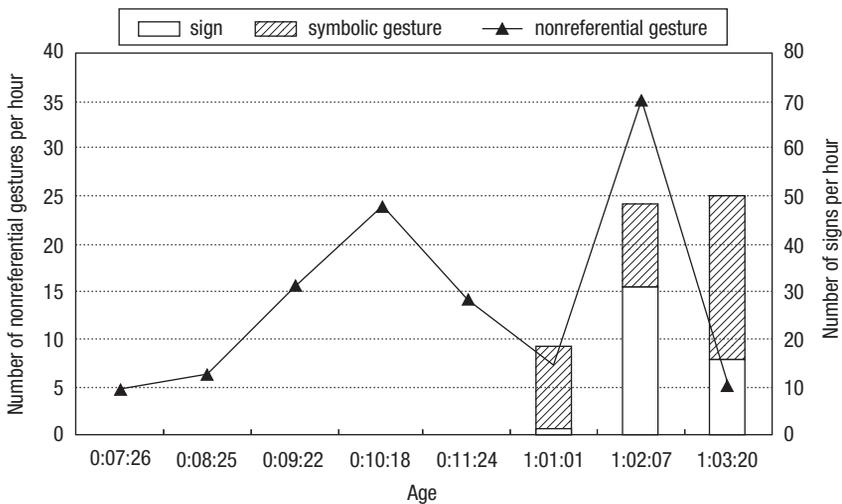


Figure 3.2 Number of nonreferential gestures and signs in participant B (age along the horizontal axis is given in years: months: days).



nonreferential gestures produced by participant A and five handshapes were observed in those produced by participant B. Flat hand (B handshape) was used 75% of the time. The participants in this study were probably able to perform all these handshapes before they were ready to start symbolic communication.

Figure 3.3 Handshape repertory of nonreferential gestures produced by participants (\emptyset indicates a category of nonreferential gesture in which handshapes were not involved e.g. head nodding).

	Type of Handshape	Participant A	Participant B
B		75%	75%
b0		11%	2%
A		9%	8%
B ← → A		2%	3%
G		1%	3%
E		1%	0%
C		1%	0%
\emptyset		0%	8%
		100%	100%

Movement in the nonreferential gestures

Figure 3.4 shows movements used in nonreferential gestures which were observed more than twice at each month of age with participants A and B. In the case of participant A, the infant used the 'banging' movements and 'up and down' movements at the age of 8 months. At about 10 months, 'right and left' movements and 'clapping' were added to the movement repertory of nonreferential gestures. After 12 months, she produced many different movements in nonreferential gestures. For example, she used 'elbow rotation', 'up and down movement with linking hands' and so on. These are often observed in signs of JSL. Nonreferential gestures produced after 12 months of age looked like self-talk in the manual mode, but it was hard to interpret their meaning. In the case of participant B, 'banging' and 'right and left' movements were often observed in nonreferential gestures

Figure 3.4 Movement repertory of nonreferential gestures produced by participants (○ and ● indicate that each type of movement was observed more than twice at that age).

Type of Movement	Participants	Age (months)									
		7	8	9	10	11	12	13	14	15	
Banging	A	●	●		●			●			
	B		○	○	○	○					
Up and down movement	A		●	●	●	●	●	●		●	
	B				○			○			
Right and left movement	A			●	●	●	●	●		●	
	B	○		○	○	○		○	○		
Clapping	A			●	●	●					
	B					○		○	○		
Wrist flexing	A				●						
	B										
Forward and backward movement	A				●		●				
	B			○					○		
Up/down movement with hands linking	A				●		●				
	B										
Elbow rotation	A				●	●	●			●	
	B										
Face touching	A										
	B							○	○	○	
Stamping	A										
	B					○		○	○	○	

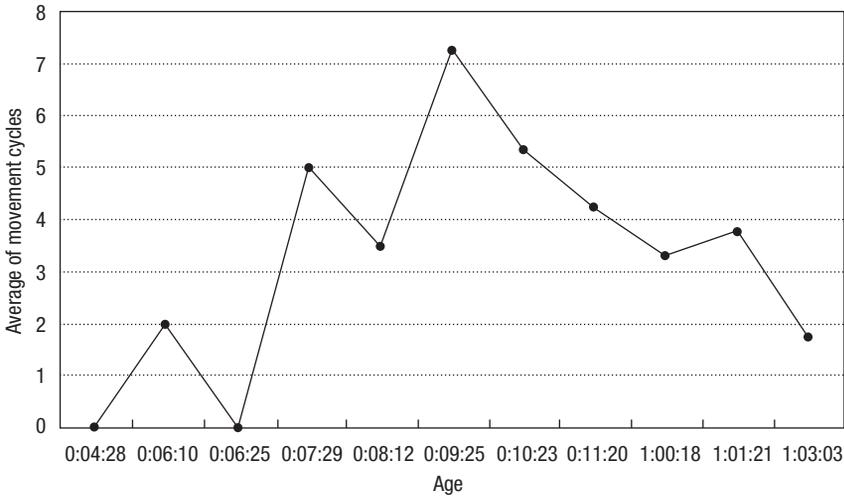
before 12 months of age. In addition to these movements, the infant started to produce 'face touching' and 'stamping' movements after 12 months, which are more complex than previous movements observed.

As the infants grew up, movements used in nonreferential gestures got more complex and varied. Movements observed at an early stage were produced by using only a shoulder joint like 'banging' movements and 'up and down' movements. But movements observed after 12 months needed to use not only shoulder joints but also an elbow-wrist and finger joint like 'elbow rotation' movements and 'face touching' movements. In other words, the participants evolved from nonreferential gestures constructed from large movements to ones that needed fine adjustments.

Repetition of movement in the nonreferential gestures

Some of the nonreferential gestures produced by participants A and B had repeated movement. Figures 3.5 and 3.6 indicate the mean number of movement cycles comprising the nonreferential gestures of participants A and B. The average number of movement cycles rose sharply until 9 months and gradually declined after 10 months in nonreferential gestures produced by participants A and B. In the case of participant B, the average number of movement cycles rose slightly until 11 months and decreased gradually except at 7 months. All nonreferential gestures produced at 7 months were 'banging' gestures, which usually had many movement cycles.

Figure 3.5 Average of movement cycles in nonreferential gestures produced by participant A (age along the horizontal axis is given in years: months: days).



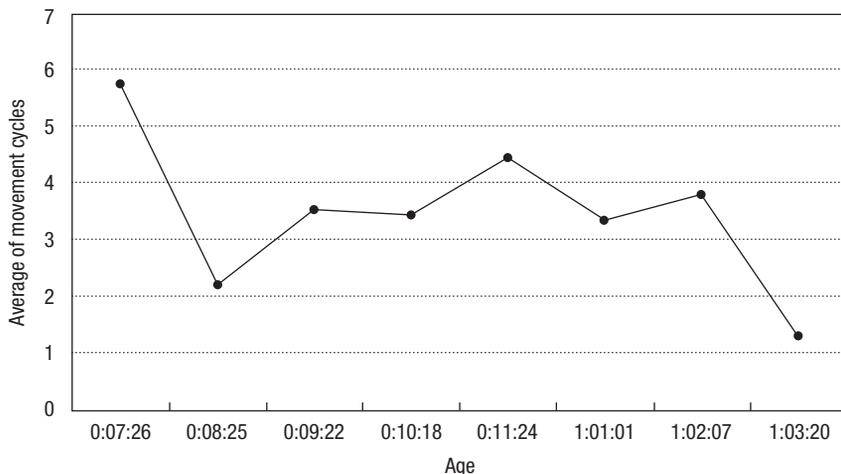
The maximum number of cycles in a nonreferential gesture was 17. Meier and Willerman (1995) reported that deaf infants showed a higher proportion of multicycle, nonreferential gestures than their hearing counterparts. The participants in this study also showed great cyclicity of nonreferential gestures. Nonreferential gestures with highly multicycle movement were observed just before the infants produced first signs. The linguistic environment may help multicycle nonreferential gestures. Multicycle nonreferential gestures influenced by linguistic input may perhaps contribute to the production of first signs.

Continuity between nonreferential gestures and signs

Participant A had attained a vocabulary of seven different signs by 15 months. They were as follows: NONE, DELICIOUS, EAT, CAR, DRINK, FINISH and SLEEP. All the handshapes produced by the participant in signs had been observed in nonreferential gestures before. But most of the handshapes in signs were flat hand (B handshape). Handshapes in signs did not necessarily play an important role in conveying the meaning for young infants because flat hand was not made consciously but naturally.

In the case of participant A, there were similarities between nonreferential gestures and signs especially in the component of movement. Participant A produced signs for DELICIOUS and NONE at 15 months. Those signs consisted of right and left movement, which was observed frequently in nonreferential gestures at about 10 months.

Figure 3.6 Average of movement cycles in nonreferential gestures produced by participant B (age along the horizontal axis is given in years: months: days).

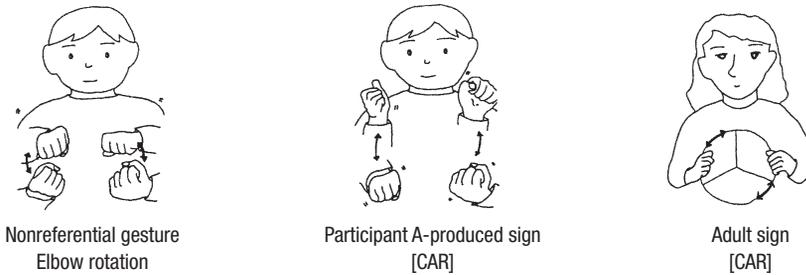


There are several other examples. Participant B had attained a vocabulary of nine different signs by 15 months. They were EAT, BIRD, DOG, HOT, DANGEROUS, ONCE AGAIN, FEARFUL, FINISH and ME. Participant B produced the sign for ME, which was expressed by pointing to the signer's nose, when he was 15 months old. Before the production of signs, similar movements, namely touching his temple with his index finger repeatedly, were observed in nonreferential gestures. It is likely that nonreferential gestures with such movements were altered into the sign for ME.

The sign for CAR was produced when participant A saw a picture of cars in a book at 15 months. She used the elbow rotation movement in the sign. Elbow rotation movement was used as a component of nonreferential gestures before the onset of signs. Interestingly, her parents never used elbow rotation when they produced the sign for CAR to her. Figure 3.7 shows a nonreferential gesture using an elbow rotation movement, the sign for CAR produced by participant A and the adult sign for CAR. These illustrations suggest that deaf infants do not only imitate signs produced by their parents. It follows from what has been said that deaf infants select a movement from the limited movement repertory that they have already acquired to express the acts and objects to which they wish to refer.

Discussion

The study of the acquisition process in the prelinguistic stage has shown two features of nonreferential gestures produced by deaf infants exposed to sign

Figure 3.7 Example of similarity between nonreferential gesture and sign.

language. To begin with, nonreferential gestures were observed 3 or 4 months before the onset of signs. In the vocal mode, canonical babbling is observed a few months before the first word is produced. The relation between nonreferential gestures and signs is quite similar to the case in the vocal mode. Next, nonreferential gestures consisted of multicycle movements. In other words, nonreferential gestures demonstrate the syllabic organization seen in sign language. Canonical vocal babbling is also characterized by syllabic organization. In these circumstances, we can be fairly certain that nonreferential gestures play the role of babbling in the manual mode and contribute to the onset of hands being used as a means of communication.

It is instructive to compare each component of nonreferential gestures with the phonetic inventory of adult JSL. Yonekawa (1984) suggested the number of primes in each parameter such as handshape, movement and location. Handshape, movement and location parameters were 21, 45 and 21, respectively. In the case of participant A, 29% of handshape (six of 21) and 53% of movement inventory (24/45) in adult JSL were used in nonreferential gestures until participant A became 15 months old.

Petitto and Marentette (1991) showed that 32% of the handshape (13/40) and 54% of the movement that made up the phonetic inventory of adult ASL were observed in manual babbling, which is similar to the results in this study. Half of the movements in the phonetic inventory of adult sign language have already been used in meaningless, nonreferential gestures produced before the onset of signs.

Language has two features: form and content. It is likely that nonreferential gestures contribute to the acquisition of forms in sign.

This study examined hand activities of two deaf infants at the prelinguistic stage. The results showed that nonreferential gestures were produced before the onset of signs. The results also suggested that there was continuity between nonreferential gestures and first signs in terms of handshape and movement. Taken together, it is clear that nonreferential gestures serve as a manual analog of vocal babbling. We can say that babbling is not restricted to the vocal modality. It is, instead, an amodal phenomenon that helps infants to acquire the finite inventory of phonetic parameters in sign

language such as handshape, movement and location. More data and studies about hearing and deaf infants without a sign language environment will support the results of this study.

Acknowledgements

This study was supported by a grant from the Ministry of Education, Science, Sports and Culture of Japan (H10-6822). I am grateful to the infants and their mothers for their participation in this study. I also thank Akira Yokkaichi, Sawa Saito and Takashi Torigoe for their valuable comments.

References

- Abrahamsen, A., Cavallo, M.M. & McCluer, L.A. (1985) Is the sign advantage a robust phenomenon? From gesture to language in two modalities. *Merrill-Palmer Quarterly*, 31(2), 117–209.
- Capute, A.J., Palmer, F.B., Shapiro, B.K., Wachtel, R.C., Schmidt, S. & Ross, A. (1986) Clinical linguistic and auditory milestone scale: prediction of cognition in infancy. *Developmental Medicine and Child Neurology*, 28, 762–771.
- Griffith, P.L. (1985) Mode-switching and mode-finding in a hearing child of deaf parents. *Sign Language Studies*, 48, 195–222.
- Klima, E. & Bellugi, U. (1979) *The signs of language*. Cambridge, MA: Harvard University Press.
- Meier, R.P. (1991) Language acquisition by deaf children. *American Scientist*, 79, 60–70.
- Meier, R.P. & Willerman, R. (1995) Prelinguistic gesture in deaf and hearing infants. In K. Emmorey and J. Reilly (Eds), *Language, gesture and space* (pp. 391–409). Hillsdale, NJ: Erlbaum.
- Newport, E.L. & Meier, R.P. (1985) The acquisition of American sign language. In D.I. Slobin (Ed.), *The cross linguistic study of language acquisition*, Vol. 1: *The data*. Hillsdale, NJ: Erlbaum.
- Oller, D.K. (1986) Metaphonology and infant vocalization. In B. Lindblom & R. Zetterstrom (Eds), *Precursors of early speech*. New York: Stockton Press.
- Oller, D.K. & Eilers, R.E. (1988) The role of audition in infant babbling. *Child Development*, 59, 441–466.
- Petitto, L.A. & Marentette, P.F. (1991) Babbling in the manual mode: evidence for the ontogeny of language. *Science*, 251, 1493–1496.
- Prinz, P.M. & Prinz, E.A. (1979) Simultaneous acquisition of ASL and spoken English: Phase 1: early lexical development. *Sign Language Studies*, 25, 283–296.
- Wilbur, R. (1987) *American sign language: Linguistic and applied dimensions*. Boston, MA: Little, Brown.
- Yonekawa, A. (1984) *Shuwa gengo no kijutsuteki kenkyu* [A descriptive study of Japanese Sign Language]. Tokyo: Meiji-shoin.

Commentary: Wataru Takei

How did I study the acquisition of sign language?

I wrote the paper 'How do deaf infants attain first signs?' in 2001 and in it reported some research from my doctoral dissertation. Recent linguistic research on the structure of sign languages has revealed that they are fully fledged languages, comparable to spoken language. However, in sign languages linguistic information is conveyed through movements of the hands, the face and the body and these movements are perceived visually by deaf people. The gestures in sign language, which are called 'signs', are a special set of rule-governed behaviours (Baker & Cokely, 1980). Sign languages are therefore often described as visual-gestural languages.

My interest in the acquisition process of Japanese Sign Language stemmed from personal experience. Although I can hear, both my parents are deaf and as a consequence Japanese Sign Language is one of my mother tongues, the other being spoken Japanese. I cannot remember anything about how I learned Japanese Sign Language and this prompted me to want to study the acquisition of sign language as a graduate student. I was also interested in the extent to which the ability to communicate and to use a language is innate. If language is a learned ability then deaf children will not be able to acquire the lexicon and syntax of sign language without appropriate teaching. However, if the ability to acquire language is innate then all that may be necessary is to provide deaf children with opportunities to communicate with others in sign. In order to explore these questions my colleagues and I investigated two deaf adults who had grown up with little contact with the Deaf community (Torigoe, Takei & Kimura, 1995; Torigoe & Takei, 2001). They lived on an isolated island which is part of the Okinawa Islands just south of mainland Japan. They had no access to a conventional sign language, such as Japanese Sign Language, but nevertheless communicated with one another and with familiar hearing people using a shared system of signs. This home sign system was established through interactions among the two deaf people, their hearing families and neighbours. No one taught the home sign system to the deaf people, but they used it fluently, and it looked like a conventional sign language. Clearly in the absence of spoken language these deaf adults had developed an alternative sign system, which supports the idea of an innate capacity for developing a communication system.

At the outset of my doctoral research I reviewed numerous studies on language acquisition and education for deaf children in order to find out what was already known. A great deal of effort has been put into investigating the acquisition of a spoken language by deaf infants and children. Most studies report that deaf infants and children have difficulty learning spoken language. However, other studies report that they have no difficulty in acquiring sign language because their access to the signed input is not limited.

Over the past few decades, a considerable number of studies have demonstrated that the acquisition of sign language in deaf infants and children follows much the same pattern as the acquisition of spoken language in hearing children. However, perhaps surprisingly, few studies have investigated the period before the first recognisable signs are produced. How deaf infants attain their first signs remains an unanswered question.

Hearing children produce vocal babbling before they utter recognisable words and I was interested in discovering whether something equivalent might be observed in deaf children. In order to investigate this I decided to observe deaf infants of deaf parents since such infants are usually raised in a sign language environment.

One of the problems with this approach is that it is hard to find deaf infants of deaf parents because 90% of deaf people have hearing parents. In other words, most individuals within the community of deaf people do not join deaf culture at birth, whereas hearing infants with hearing parents are exposed to spoken language from birth. One of the characteristics of sign languages in comparison to spoken languages is that they are often restricted to specific communities such as schools for the deaf.

Only 10% of deaf infants receive sign language input from birth. In order to answer my research question I had to find deaf infants with deaf parents before their first birthday. This was more difficult than we anticipated. Deaf children of 3 years old will never become one year old even though deaf children of one year surely become 3 years old. If you want to study the acquisition process of sign language, especially focusing on the period before the occurrence of the first signs, you must find the youngest deaf children possible.

I overcame this problem by finding deaf women who were going to have babies. The rationale was that although the babies might or might not be born deaf they would nevertheless be exposed to Japanese Sign Language and acquire it as their first language. I located four deaf couples who were going to have a baby. One couple were personal friends and the others were introduced to me by teachers who worked at the National School for the Deaf. They had graduated from the school for the deaf a few years before and married recently. I explained the aims of my research. I felt it was important to talk with them personally in their own language, Japanese Sign Language, rather than writing to them or talking to them through an interpreter and, given my background, I could obviously do this. Fortunately, all the couples were very cooperative.

All the parents agreed to participate in the study which involved me observing the mother and the infant interacting once a month. The research on the acquisition process of Japanese Sign Language focused on the period before the first signs appeared. Two of four infants were deaf and the rest could hear. In the paper 'How do deaf infants attain first signs?' I report the findings for the two deaf infants.

I chose the observational method for the study because I wanted to examine how the deaf infants and their parents interacted in a natural setting. I could have adopted an experimental method, but I rejected it for three reasons. First, it is difficult to collect longitudinal data using experiments since a technique which is appropriate at one age may be inappropriate at a different age, especially during the prelinguistic stage when development is so rapid. In my view, experiments are not suitable for capturing changes in development. Second, since only two deaf infants were available to participate in the study I felt that it would be difficult to draw any general conclusions from experimental results. It is true that the same criticism can apply to observational studies but an observational method enabled me to look at changes over time using the same approach. Third, I felt that an experimental setting might be a burden to both the infants and parents.

I visited their homes every month and videotaped the parent–infant free play sessions without giving them any particular instruction. After videotaping, I talked informally with the parents. We talked about changes in the infants during the past month, experiences the infants had had, daily happenings and so on and these informed my observations.

After the two infants had been identified, the data could be collected with ease, but I was faced then with another difficult problem. Few researchers have observed and reported data on the manual babbling of deaf infants, and opinions are divided among researchers on how to define manual babbling. I could not, therefore, use existing definitions to distinguish manual babbling from other hand activities.

It was inconceivable to me that deaf infants would produce their first signs without any prior attempts to produce signs used by their parents. I was sure that there was a manual analogue of vocal babbling in deaf infants being reared within a sign language environment as they developed from a prelexical to a lexical stage. I transcribed all hand activities and assigned them to one of four categories: signs; communicative gestures; manipulating actions; and nonreferential gestures. Signs and communicative gestures are produced with some intention to convey something to another, such as a pointing gesture to request something. They are definitely not manual babbling. Manipulating actions are also different from manual babbling since such actions have the specific aim of, for example, playing with toys. Nonreferential gestures are hand activities that do not belong to the other three categories and are gestures that elude semantic interpretation. Manual babbling could be included in nonreferential gestures.

Video analysis of the hand activities of the participants was hard and stressful work. I watched the video data over and over again in order to transcribe and categorize the hand activities of the infants. I often checked the data repeatedly in slow motion. It took more than 20 hours to analyse one hour of video. There was no window in the room for the video analysis at the university. This meant that I could pay attention to analysing the data without anyone interrupting me, but the video analysis was exhausting when done for a long time. To make the analysis efficient and comfortable, I gave myself rewards such as a cup of coffee and listening to the band Aerosmith as frequently as once every 20 minutes. Thanks to numerous cups of coffee and Aerosmith, 19 tapes, 15 hours in all, were coded in two months. Then, I asked another graduate student who knew sign language to code the hand activities independently. The agreement between us was about 89%. When we disagreed we discussed the hand activity until we reached agreement. In a few cases we were unable to agree and these were discarded from the analysis.

The analysis produced some surprising results. Nonreferential gestures were often observed between 7 and 12 months. This period when deaf infants produced nonreferential gestures was almost the same as when hearing infants are producing vocal babbling. The occurrence of the first signs occurred at about the same time as the development of spoken language in hearing infants. A similarity between nonreferential gestures and the first signs was also observed. In addition, nonreferential gestures consisted of multicycle repetitive movements, similar to the characteristics of vocal babbling of hearing infants which have syllabic organisation like 'mama'.

This study is important because it shows that the acquisition process of sign language parallels the acquisition process of spoken language even before the first signs/words are produced.

When I delivered a paper on the manual babbling of deaf infants to a conference in 1998, I received many encouraging comments. This motivated me to write the paper, 'How do deaf infants attain first signs' for *Developmental Science*. It is important to report the findings of research in journals in order to disseminate the results. It is also a way of repaying the cooperation and kindness of the participants. The paper in *Developmental Science* is the first I have written in English. I am not a native speaker of English, so this was painful and difficult.

I continue to be interested in the question of why deaf infants of deaf parents produce nonreferential gestures. To answer this question, it is necessary to analyse the hand activities of hearing infants of deaf parents, deaf infants of hearing parents, and hearing infants of hearing parents. If nonreferential gestures are observed in deaf infants of hearing parents, the production of them may derive from the hearing loss and have nothing to do with sign language input. On the other hand, if they are found in hearing infants of deaf parents, signing to infants by deaf parents may encourage infants to produce them. It may also be possible to explore the origins of nonreferential gestures through study of hearing infants of hearing parents.

The production mechanism of nonreferential gestures can be explored by studying hearing infants of deaf parents and deaf infants of hearing parents. Having finished writing the paper on the deaf infants of deaf parents I am now analysing the data from hearing infants of deaf parents and hearing infants of hearing parents. 'How do deaf infants attain first signs?' is not an end, only a beginning.

References

- Baker, C. & Cokely, D. (1980) *American sign Language: A teacher's resource text on grammar and culture*. Maryland: T. J. Publishers.
- Torigoe, T. & Takei, W. (2001) A descriptive analysis of early word combinations in deaf children's signed utterances. *Japanese Psychological Research*, **43**, 156–161.
- Torigoe, T., Takei, W. & Kimura, H. (1995) Deaf life in isolated Japanese island. *Sign Language Studies*, **87**, 167–174.