Young Children's Acquisition of the Formational Aspects of American Sign Language: Parental Report Findings

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Parental Report Findings

THIS ARTICLE examines the course of young children's acquisition of the sign language formational aspects of location, handshape, and movement. We confess, however, that we did not initially intend to study how children learn to form signs. Rather, our interest in this topic grew out of another research undertaking, which was a longitudinal study of sign language vocabulary acquisition. That research involved visiting the homes of deaf parents and videotaping them interacting with their young children (Bonvillian, Orlansky, and Novack 1983). But during the first round of home visits, it became clear that we were witnessing another very interesting phenomenon: The young children often did not make many of their signs in exactly the same way as their parents, yet the parents in most instances appeared to understand their children's productions. Because of this observation, the focus of the investigation expanded to

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include making systematic records of the children's and their parents' sign formation. The question of how young children learn to form signs has continued to intrigue us to the present day.

Several reasons explain why we found studying children's sign formation a compelling enterprise. One was that young children's acquisition of the formational aspects of a sign language was a relatively unexplored area. Any patterns of development that we uncovered would likely represent a real contribution to the field. A second reason was that sign languages have readily observable articulators (primarily the hands and the face), owing to their very nature as visual–gestural languages. In contrast, the oral articulators of spoken languages are much more difficult to ''observe,'' especially in young children under naturalistic conditions. Accurately describing how children formed their signs thus appeared to be an attainable objective. A third reason was that the differences in language modalities between signed and spoken languages would enable us to make cross-modal, as well as cross-linguistic, comparisons in the search for universal or divergent processes in language development. More generally, a study of how children learned to form signs promised to provide insights into how biological, perceptual, and linguistic factors affected the learning of a language.

Soon after we began collecting systematic records of parent and child sign production, it became clear that we would need to answer two important questions before we could begin to analyze our videotape records. The first was how we should transcribe the signs we had captured on videotape. The second question was whether we should concentrate our initial efforts on the information provided by the parents or focus instead on the children's signing. When we began transcribing the videotapes in the 1980s, the answer to the first question seemed self-evident. At that time there was only a single well-recognized, systematic description of the formational structure of individual signs: the approach developed by William Stokoe.

In his pioneering investigations of American Sign Language (ASL) sign structure, Stokoe (1960; Stokoe, Casterline, and Croneberg 1965) identified three formational aspects that distinguished any one ASL sign from another. These three aspects were (a) the place or location where a sign was made, (b) the shape or configuration of the

hand (or hands) making the sign, and (c) the action or movement of the hand (or hands) forming the sign. In this depiction of sign formational structure, each of these three aspects or categories was described as consisting of a limited set of formational elements (or ''cheremes'' according to Stokoe) that functioned in a manner largely analogous to that of phonemes in spoken languages.

In the years since Stokoe first advanced his model of sign structure, other investigators (e.g., Liddell and Johnson 1989; Wilbur 1993) have proposed different ways to look at sign structure. Most contemporary researchers, however, have continued to recognize the three formational aspects of location, handshape, and movement as the basic units of phonological contrast in ASL signs (Coulter and Anderson 1993; Wilbur 1987). Another important reason for transcribing the signs on our videotape records using the cherological notation system developed by Stokoe was that the two detailed case studies of the acquisition of the handshape aspect of signs that had been conducted previously—the investigations by Boyes-Braem (1973, 1990) and McIntire (1977)—had relied heavily on Stokoe's analysis of sign formational structure. If we wished to compare our findings with theirs, then we would need to use a system that would enable us to conduct such systematic comparisons.

The second question we needed to answer was in many ways more problematic. When confronted with numerous hours of videotape and many hundreds of signs to transcribe and analyze, we had to decide whether to focus our efforts initially on the parents' reports of their children's sign production or on the children's directly observed sign productions. We elected, in both of our longitudinal studies of sign language acquisition (Bonvillian et al. 1985; Folven and Bonvillian 1991), to focus initially on the parental report information.

The principal reason for this decision was that we felt that the parental reports provided an account of the children's emerging sign skills that was more complete and, in some ways, more accurate. During the approximately one hour that we visited each home on a monthly basis, the children typically produced only a fraction of the new signs their parents claimed they were making. In many instances we did not capture on videotape the children producing these signs until several months or more had passed since the parents reported

they had first made them. If we had relied solely on our videotape records of the children's sign productions, then the onset order of their new sign productions and of the formational aspects from which these signs were composed would have been inaccurate. Furthermore, many of the young children's sign productions were not made directly into the camera, making the transcription considerably more difficult. Although we have not yet finished all our analyses of the parental report data, we have always planned to return to the videotapes to analyze the children's directly observed sign productions to complete our investigation. Only when that last phase of the investigation is completed will we have provided a relatively thorough account of sign language phonological acquisition during the children's first two years.

In the account of children's sign phonological acquisition based on findings from an initial longitudinal study (Bonvillian et al. 1985), the emphasis was on the relative frequency that each different location, handshape, and movement appeared in the different signs produced by a dozen young children of deaf parents. Many of the children in this first study, however, had already been producing signs before systematic videotape record keeping was begun. To develop a more complete account of early sign phonological development, information on sign formation would need to be obtained as children began producing their first signs or even before. Partly to overcome this limitation, a second longitudinal study of sign acquisition was undertaken during the late 1980s (Folven and Bonvillian 1991). In this investigation most of the young children had not yet begun producing recognizable signs at the time of our first home visit. This article focuses on the findings from this second longitudinal study.

Some of the findings included in this article have already been reported (Bonvillian and Siedlecki 1996, 1998; Siedlecki and Bonvillian 1997). Other findings, especially those based on examinations of error patterns and analyses of systematic substitutions, have not been reported previously.

Method

Participants

Nine young children (three boys and six girls) and their sign-using parents participated in the study (see Table 1). One child was deaf;

Table 1 Description of Participants

Child	Sex	Child's Hearing Status	Parents' Hearing Status	Child's Age (in mos.) during Home Visit Period	Number of Different Signs Transcribed
1	Female	Deaf	Both deaf	6–14	23
2	Male	Hearing	Both deaf	6–15	31
3	Female	Hearing	Both deaf	6–18	18
4	Female	Hearing	Both deaf	7–18	31
5	Female	Hearing	Mother deaf, father hearing	7–18	51
6	Male	Hearing	Both deaf	8–17	46
7	Male	Hearing	Both deaf	5–18[a]	16
8	Female	Hearing	Father deaf, mother hearing	11–16	139
9	Female	Hearing	Both deaf	14–18	93

[a] Child's age adjusted slightly to account for preterm birth.

the other children were reported by their parents as having normal hearing. At the time the study began, seven of the children were 8 months old or younger. The remaining two children were 11 and 14 months of age. Eight children were born after a full-term pregnancy. One child was born an estimated two months preterm; his age was adjusted in this study to be six weeks younger than his birth age. All the parents and children were Caucasian.

In seven of the families, both parents were deaf; in the remaining two families, the mother was deaf in one and the father deaf in the other. The two hearing parents were employed at academic institutions for deaf students. Most of the deaf parents had attended residential schools for deaf students. The majority of the parents also had attended either Gallaudet University or the National Technical Institute for the Deaf, both of which are institutions of higher learning for deaf students in the United States. All of the parents reported that they were fluent signers. In one family the parents reported that they often used the sign language of their native land with each other but that they used ASL with their child. The two hearing parents observed that they often spoke as they signed in their interactions with their children. In these instances, the parents would put ASL signs into English word order. Many of the children also were exposed to

spoken English through their hearing neighbors, relatives, and baby-sitters, as well as television. Despite the differences in language environments among the families, each child's early sign production was expected to resemble that of the other children in the study as ASL signs were the principal form of language input for all the children.

Procedure

Home Visits. Information about each child's sign language acquisition was obtained primarily through a series of home visits, which took place about once every four to six weeks, with each visit lasting about one hour. The number of home visits varied widely among the families, ranging from as few as five to as many as twelve separate visits. By prior agreement with the parents, the home visits were discontinued once a child began to combine signs.

During the first home visit, each set of parents was given a notebook in which to record their child's sign language productions. (The parents of the two oldest infants in the study had been maintaining diary accounts prior to their participation in the study.) The parents were asked to record in their notebooks the English gloss (or translation equivalent) of each new sign their child made, the date this sign was first produced, how the sign was formed, and the context in which the sign was used. The parents also were asked to enter any changes in pronunciation of previously acquired signs. During each visit the researchers discussed with the parents those notebook entries they had made since the previous home visit (Folven and Bonvillian 1991). This approach ensured that the notebooks were kept relatively up-to-date and helped convey to the parents the types of information we wished they would record.

During each home visit the parents demonstrated on videotape how their child formed each new sign in his or her lexicon. During the videotaping the parents often reviewed their notebook records of their child's signing to assist them in their demonstrations of their child's new sign productions. The parents also showed, on camera, how they formed each of the signs that their child had recently acquired. These parental sign models served as the standard for comparison purposes in subsequent analyses of each child's sign production

accuracy. In addition to the parental sign demonstrations, videotape records were made each visit of parent–child interaction. During these interactions the parents were encouraged to elicit sign productions from their child.

Coding. The videotape records of the parents demonstrating how their children formed the different signs in their lexicons were transcribed using the notation system developed by Stokoe (1960; Stokoe et al. 1965). Several additions to the Stokoe system were included in the present transcriptions to accommodate some of the special characteristics of young children's sign formation (see Siedlecki 1991, 1992). The parental depictions of how they formed those signs that served as the models for their children's signs were also transcribed using Stokoe notation.

Interrater percentage agreement scores were consistently high for the three independent coders who transcribed the parental demonstrations of how their children formed their signs. The average interrater percentage agreement for transcriptions of the location aspect was 96.7%, 94.4% for the handshape aspect, and 90.8% for the movement aspect. In determining coding agreement in the transcriptions of sign movements, only the initial movements of multimovement signs were compared.

Both advantages and disadvantages to relying on parental reports in child language research exist (Dale et al. 1989; Nelson 1973). Among the advantages are that parents spend much more time with and observe their children in a much wider range of situations than would be realistically possible for investigators. Thus parental records may include more instances of language use than investigators would obtain in periodic home visits. Also, parents often become quite adept at understanding and interpreting their children's utterances. A disadvantage of relying on parents is that parents vary in their ability to understand and to describe their children's language and in their attention to the task. In the past most studies that have relied heavily on parental reports have focused on children's lexical growth. In the present study, however, the parents were asked not only to record new entries in their children's lexicons but also how their children formed these signs. Nevertheless, it should be recognized that the

parents were asked to demonstrate how their children formed their signs; the parents were not asked to transcribe them.

Because of the present study's reliance on the accuracy of parental reports, we felt that it was important to obtain an estimate of the accuracy of these reports. To accomplish this, we first transcribed a representative sample of the children's actual sign productions from the videotape records. We then compared these transcriptions with those based on parental reports. The percentage agreement between the parental reports and the children's actual sign productions was 87.9% for the location aspect of signs, 78.8% for the handshape aspect, and 84.8% for the movement aspect. With an overall agreement of about 84% between the parental reports and the records of the children's sign productions, we felt sufficiently confident in the accuracy of the parental reports to continue relying on them in our analyses.

Results and Discussion

We used a variety of different approaches in our effort to determine the course of the young children's acquisition of sign formational aspects. One approach was to calculate how often each of the cheremes (or sign phonemes) in the children's signs matched those in their parents' models for those same signs. This approach provided an index of the accuracy of the children's production of each of the different location, handshape, and movement cheremes. The second approach was to determine the relative order that the different location, handshape, and movement cheremes first appeared in the signs produced by each child. This provided an indication of the order of onset or emergence of the different cheremes in each child's signs. A third measure of acquisition consisted of counting how often each different chereme occurred in the signs that comprised each child's sign lexicon. This approach provided an index of production frequency of the different cheremes. A fourth approach involved examining the errors the children made in forming signs to determine whether there were systematic substitution or error patterns in their sign formation. Our final approach was to determine whether sign formational aspect acquisition was consistent across the different

children. Although we expected the outcomes of these various approaches to be interrelated to some extent, we also expected each approach to add to our understanding of the acquisition of sign formational aspects.

Both clear similarities and marked differences appeared between the children and their parents in their sign formation (Siedlecki and Bonvillian 1993). The children were most like their parents in their production of the location aspect of signs. Altogether, the children produced the location aspect correctly in 83.5% of their signs. Moreover, virtually no change in the children's accuracy of location production was found over the course of the study. Indeed, even the youngest children typically produced most of their signs in their correct locations.

In contrast, the handshape aspect of signs constituted the area of greatest disagreement in sign formation between the children and their parents. In only 49.8% of the children's signs was the handshape on the active hand the same as that of the parents' sign models. The young children did, however, improve noticeably in the accuracy of their handshape formation with increasing age.

Finally, of the three formational aspects, the movement aspect was produced with intermediate accuracy; it was produced significantly less accurately than locations but more accurately than handshapes. Altogether, in 61.4% of the children's sign productions, all of the movements present in the parent sign target were produced accurately. In general, the children's signs typically were relatively simple in their overall form, with over two-thirds of the children's signs containing only a single movement.

Across the nine children studied, a highly consistent pattern of relative production accuracy occurred for the three formational aspects. For all the children, the handshape aspect was produced the least accurately of the three aspects (Siedlecki and Bonvillian 1993). In contrast, the location aspect typically was produced the most accurately; this was the case for eight of the children. In one child, however, the movement aspect was produced slightly more accurately than the location aspect. Thus, with only a single exception, the children as a group were quite consistent in the relative accuracy of their

production of the three formational aspects: Locations were produced the most accurately, movements next, and handshapes the least.

Locations

Considerable consistency occurred across children in their acquisition of the location aspect of signs (Bonvillian and Siedlecki 1996). That is, certain sign locations typically were produced earlier, more accurately, and more often than other locations (see Table 2). In general, the locations that were produced first by the children also were those that were produced most often. More specifically, neutral space or place (the area in front of the signer's body), the chin, the forehead, and the trunk were the four locations where most of the children's earliest signs were made. Furthermore, all the children produced these four different locations in at least one sign. The locations that were the next most likely to be produced were, in descending order of likelihood, the 5 (or spread) hand, the cheek, the B (or flat) hand, the mid-face, and the whole head. When the children

Table 2 Acquisition Order of ASL Locations Using Three Measures

	Measure			
Location	Accuracy of Production	Ordinal Position	Production Frequency	Mean
neutral space	5.0	2.6	1.0	2.9
trunk	4.0	4.4	3.0	3.8
chin	8.0	3.1	2.0	4.4
forehead	7.0	3.4	5.0	5.1
5 hand	2.0	6.7	8.0	5.6
cheek	6.0	7.1	4.0	5.7
mid-face	9.0	7.5	6.0	7.5
pronated wrist	2.0	12.1	12.0	8.7
neck	2.0	12.2	13.5	9.2
whole head	10.0	8.5	9.0	9.2
B hand	16.0	7.5	7.0	10.2
A hand	11.0	11.6	10.0	10.9
forearm	12.0	11.8	11.0	11.6
G hand	14.0	11.3	13.5	12.9
C hand	14.0	13.0	15.5	14.2
V hand	14.0	13.1	15.5	14.2

Note. Adapted from Bonvillian and Siedlecki (1996).

made their signs on their heads or bodies, the location aspect in most instances was correct. (The location aspect of a child's sign was scored as correct if it was the same as, or nearly the same as, the principal location of the parent's model for that sign.) In contrast, most of the signs made with a stationary hand location were produced by the children with much lower accuracy. Finally, across the nine children, the rank order in location production frequency was quite consistent; only minor individual differences occurred.

Altogether there were 74 instances in which the children produced a sign in what we scored as an incorrect location. Careful examination of these ''errors'' in sign formation, however, revealed that the children might be considered to be even more accurate than the over-80% accuracy for the production of the location aspect of their signs that we originally reported. We say this because in nearly half (35 of 74 or 47.3%) of all sign locations that were scored as errors, the children made their signs in essentially the correct area. The reason the children were scored as incorrect in 21 of these instances was that the handshapes on their hands that served as the formational base were not the same as their parents' handshapes on their base hands. In 14 other instances, the children again made their signs in the same general area as their parents did, but this time the children used their nondominant hand as a base, whereas their parents produced their versions of these signs without support in neutral space. Thus, difficulties the children had with their use of their nondominant hands as the formational base for some of their signs accounted for nearly half of their location ''errors.''

Another substantial portion of the children's location errors consisted of signs made in an area adjacent to the correct location of their parents' sign models. For example, a parent might have made a particular sign on her chin, whereas her child formed that sign on his cheek. Altogether, 21 of the children's 74 location errors (28.4%) occurred when the children made their signs on areas adjacent to the correct parental locations. Such an outcome might be interpreted as indicating a near miss in the children's sign formation.

Finally, the last major grouping of location aspect errors, 12 of 74 or 16.2%, consisted of the children forming their signs in neutral space, whereas their parents made their versions of these signs in

contact with different parts of their bodies. In at least some of these cases, the children may actually have had difficulty extending their arms to reach the specific locations used in their parents' signs.

Although we have long advanced the view that the location aspect is the most accurately produced formational aspect (Siedlecki and Bonvillian 1993), we must admit that another interpretation is possible. That interpretation would be that the parents might not recognize their children's early gestural productions as signs unless they are made in or about the same area as the parents' models for these signs. If the children did not make a sign/gesture close to where their parents made their version of the sign, then the parents might not either recognize or record their children's gesture as a sign. In this latter interpretation, it would be the parents who relied critically on the location aspect to recognize their children's sign productions.

Handshapes

The analyses of each child's handshape production focused on the child's initial handshape on his or her active hand. Although the handshape aspect was the least accurately produced formational aspect, it was also the one aspect in which the children showed clear improvement in production accuracy with increasing age (Siedlecki and Bonvillian 1997). More specifically, when the children were 13 months old or younger, they used the correct handshape of their parental models in only 42.7% of their signs. By the time they were 14 and 15 months of age, their handshape accuracy had improved to 49.0%. Toward the end of the study, when most of the children were 16 to 18 months old, the handshape aspect was correct in 58.2% of their signs.

The accuracy of the children's handshape production also improved with increasing vocabulary size. One factor in the children's relatively low accuracy of handshape production is that they initially used only a small subset of the total number of handshapes that were employed in their parents' signs. In the children's sign lexicons, four handshapes predominated; they were the 5 (or spread hand), G (index finger points), A (fist), and B (flat hand) handshapes (see Table 3). It is not clear, however, whether this limited range of handshape production by the children should be attributed to their difficulties

TABLE 3 Rank Order of Acquisition of ASL Handshapes Using Three Measures

Handshape	Measure			Mean
	Accuracy of Production	Ordinal Position	Production Frequency	
Level 1				
5	4.0	2.3	1.0	2.4
G	2.0	3.2	3.0	2.7
Level 2				
B	5.0	3.8	2.0	3.6
A	3.0	4.3	4.0	3.8
Level 3				
[baby O]	1.0	10.3	6.5	5.9
O	7.0	6.3	5.0	6.1
C	10.0	5.5	6.5	7.3
L	9.0	7.9	8.0	8.3
Level 4				
V	8.0	10.3	9.5	9.3
K	6.0	10.7	13.0	9.9
X	11.0	10.2	9.5	10.2
3	12.0	9.6	11.0	10.9
H	13.0	10.3	13.0	12.1
E	14.0	10.4	13.0	12.5

Note. Adapted from Siedlecki and Bonvillian (1997). This table includes only those handshapes produced by the children.

in forming handshapes or in perceiving the handshapes used in their parents' signs.

Altogether, the children formed the signs in their lexicons with handshapes different from those of their parents a total of 221 times. In most instances, the children employed earlier learned handshapes in place of the handshapes present in their parents' sign models. Examination of such handshape substitution patterns revealed that five handshapes accounted for the large majority of the children's handshape substitutions. The handshape that was most frequently produced by the children in place of the handshape in their parents' signs was the 5 handshape. It was used instead of the parents' handshape 68 times, accounting for 30.8% of the children's handshape substitution errors. It was followed, in descending frequency of substitution errors, by the G handshape (57 times or 25.8% of errors), the A handshape (34 times or 15.4% of errors), the B handshape (32 times or

14.5% of errors), and the O (tapered hand; thumb touches fingertips) handshape (15 times or 6.8% of errors). Taken together, these five handshapes accounted for 206 or 93.3% of those instances in which the children used handshapes different from those of their parents' sign models. It should be noted, however, that individual children differed widely in which of these five handshapes they were more likely to substitute for the handshape aspect in their parents' sign models.

The children's handshape substitution patterns are in accord with two depictions of handshape complexity and acquisition. In 1974 Battison identified the A, B, 5, G, C (curved hand), and O handshapes as unmarked (i.e., more natural or basic) handshapes. The present finding that five of these six handshapes accounted for nearly all of the children's handshape substitutions would be in accord with Battison's observation that these handshapes are the more basic. Not only did these handshapes appear in most of the children's signs, but they often appeared in the children's signs in place of handshapes that Battison identified as marked.

In addition, the children's handshape substitution patterns provide support for the handshape acquisition sequence presented in Siedlecki and Bonvillian (1997). In 168 of their 221 (76.0%) handshape substitutions, the children formed their signs using handshapes from earlier learned levels for handshapes from later learned levels according to the Siedlecki-Bonvillian acquisition sequence. The other principal account of handshape acquisition order, the Boyes-Braem (1973, 1990) model, did not account for the present children's substitutions quite as well. When the Boyes-Braem model was applied to the present findings, 59.3% of the children's handshape substitutions were from earlier acquired stages of handshape acquisition.

Movements

Although the accuracy of production of the movement aspect of signs changed little over the course of the study, the children's production of this formational aspect advanced in two important ways (Bonvillian and Siedlecki 1998). First, the number of different movements produced by the individual children increased as they got older

and their vocabularies grew in size. Second, the complexity of the children's production of the movement aspect also increased. Whereas nearly all of the children's early sign productions consisted of a single movement, the proportion of multimovement signs produced by the children grew considerably as they got older. It should also be noted that, over the course of the study, the children, as a group, produced all 24 of the different sign movements that Stokoe, Casterline, and Croneberg (1965) had identified (see Table 4).

Of the different movement cheremes, contacting action was by far the most frequently produced. It was included in 287 of the signs in the children's vocabularies. By way of comparison, the next most frequently occurring movement chereme, downward movement, was present in only 42 of the children's signs. Closing action also was among the more frequently produced actions in the children's early signs. The opening and closing of the hands also is often seen in young children regardless of whether or not they are learning to sign.

One of the few other discernible trends in the children's sign movement acquisition was the children's more accurate production of bidirectional movements than unidirectional movements. It is likely that bidirectional sign movements (e.g., to-and-fro, up-and-down) are acquired earlier than unidirectional movements because they are easier to produce developmentally. Bidirectional movements resemble children's early rhythmical behaviors. A unidirectional movement, however, requires that the child time the return movement so as to differentiate it from the primary movement. This involves more deliberate coordination than that of bidirectional movements. The order of acquisition of the remaining sign movements was quite variable.

Analyzing patterns of phoneme substitution in the movement aspect of signs was more difficult than conducting the corresponding analyses for the location and handshape aspects. The reason the movement aspect proved more difficult was that an individual sign may have up to three different movements, whereas an individual sign was coded as having only a single location or handshape phoneme. Because the parents' sign models sometimes contained multiple movements, it was often not possible to determine which

Table 4 Acquisition Order of ASL Movements Using Three Measures

Movement	Measure			Mean
	Accuracy of Production	Ordinal Position	Production Frequency	
Level 1				
contact	3.0	2.1	1.0	2.0
Level 2				
close	8.0	4.7	4.0	5.6
downward	6.5	8.7	2.0	5.7
Level 3				
twist	4.0	11.9	5.0	7.0
nod/bend	9.0	9.7	3.0	7.2
side-to-side	10.0	8.2	6.0	8.1
to-and-fro	5.0	13.6	10.5	9.7
up-and-down	11.0	10.6	8.0	9.9
Level 4				
wiggle	12.0	11.6	9.0	10.9
link	1.5	16.1	17.0	11.5
away	19.0	10.9	7.0	12.3
toward	13.5	12.4	13.0	13.0
cross	1.5	15.6	22.5	13.2
upward	16.0	13.1	12.0	13.7
rightward	13.5	13.1	17.0	14.5
circular	18.0	15.8	10.5	14.8
interchange	6.5	17.1	22.5	15.4
supinate	20.0	12.3	14.0	15.4
converge	16.0	15.7	17.0	16.2
leftward	21.0	13.7	15.0	16.6
open	16.0	17.4	21.0	18.1
pronate	22.0	14.9	20.0	19.0
diverge	23.0	15.4	19.0	19.1
enter	24.0	18.3	22.0	24.0

Note. Adapted from Bonvillian and Siedlecki (1998).

movement phoneme in a child's sign was being used by that child for a particular movement phoneme in the parental sign model. For this reason, we elected to focus our analyses of movement substitution patterns on only those children's signs in which the movement substitutions were clearly evident.

Despite the difficulties of analyzing the movement aspect of signs, we were able to discern several distinct error or substitution patterns. One was for the children to introduce contacting action into their

sign productions. The children produced contacting action in place of another movement phoneme in their parents' sign models a total of 22 times. In contrast, the children rarely failed to produce contacting action when it appeared in their parents' sign models. A second trend was for the children to use an earlier learned movement in their signs in place of later learned movements. Finally, the children were much more likely to use bidirectional movements instead of the unidirectional movements of their parents' sign models than the other way around.

Concluding Remarks

In addition to the specific trends in chereme or sign phoneme acquisition discussed here, we would like to mention several more general trends that we observed. One is that the process of chereme acquisition occurred over an extended period. Even though we visited the families for a number of months, none of the children produced more than a fraction of the total possible array of location, handshape, and movement cheremes. At the same time, it should be noted that there were considerable individual differences in the rates at which the children acquired the formational aspects of ASL signs.

A second noticeable trend is that there were many indications of consistency in the children's acquisition patterns. This was evident both at the general level (e.g., the location aspect of signs typically acquired first) and at the individual chereme level (e.g., certain handshapes were acquired before others). Finally, it appears that some of the acquisition trends that were observed may rest on more fundamental perceptual–motor learning processes. For example, the children's more rapid acquisition of bidirectional than unidirectional movements may reflect their earlier development of such movements independent of sign production.

Although we believe that the present findings represent a contribution to the field of sign language acquisition, they are limited in two important ways. One limitation is that the study relied primarily on parental reports. In the future, it will be important to supplement the present findings with those obtained directly from the videotapes of the children's sign production. At the same time, we do not anticipate many major changes in the results. We say this for two reasons.

One is that the parents appeared to be quite adept at capturing the formational structure of their children's early sign productions. The second reason is that many of the findings from the present study have been confirmed in two other recent investigations of sign language acquisition that were based on young children's directly observed sign productions (Conlin et al. 2000; Marentette 1996; Marentette and Mayberry 2000). Another important limitation of the present study is that data collection ended when most of the children were about 18 months of age. As a consequence, little is known about the changes in sign formation that occur in the years that follow. In the future it will be important to expand the scope of the present study by following children throughout the preschool years.

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