Incidental Word Learning in a Hearing Child of Deaf Adults

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It is unclear how children develop the ability to learn words incidentally (i.e., without direct instruction or numerous exposures). This investigation examined the early achievement of this skill by longitudinally tracking the expressive vocabulary and incidental word-learning capacities of a hearing child of Deaf adults who was natively learning American Sign Language (ASL) and spoken English. Despite receiving only 20% of language input in spoken English, the child's expressive vocabularies at 16 and 20 months of age, in each language, were similar to those of monolingual age-matched peers. At 16 months of age, the child showed signs of greater proficiency in the incidental learning of novel ASL signs than she did for spoken English words. At 20 months of age, the child was skilled at incidental word learning in both languages. These results support the methodology as it applies to examining theoretical models of incidental word learning. They also suggest that bilingual children can achieve typical vocabulary levels (even with minimal input in one of the languages) and that the development of incidental word learning follows a similar trajectory in ASL and spoken English.

Infant word learning begins as a slow, laborious task that involves frequent repetitions of phonological forms paired with specific referents. During the second year of life, however, the nature of word learning changes to where most typically developing 18- to 24-month-olds learn new words incidentally, without direct adult instruction and with only limited exposures to the words' labels and referents. This is exemplified by the fact that between the ages of 18 months and 18 years, children learn an average of 9–10 new words a day (P. Bloom, 2000; Templin, 1957). It is unclear, however, how children achieve this level of proficiency.

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The Developmental Nature of Incidental Word Learning

Incidental word learning in young children has been primarily investigated through studies of fast mapping. Fast mapping refers to the rapid, initial pairing of newly encountered phonological forms with semantic representations. It involves very few exposures of the spoken words (typically less than five, and often as few as one or two) and little to no direct information regarding the words' meanings or defining features (Carey & Bartlett, 1978). Fast mapping has been demonstrated in situations that have included either specific linguistic cues (e.g., "Bring me the chromium tray. Not the red one, the chromium one." from Carey & Bartlett), social-pragmatic cues (such as shifts in speaker's eye gaze; see Akhtar & Tomasello, 2000, for a review), or no overt cues at all (e.g., Mervis & Bertrand, 1994, 1995). Fast mapping typically does not include overt labeling of novel objects, although a few studies have applied the term to overt labeling contexts (See Gray, 2003, 2004, as examples).

In their most basic form, studies of fast mapping involve the presentation of one or more familiar objects

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and a single unfamiliar object. Participants are asked to identify the unfamiliar object by its spoken label, either an unfamiliar word or a nonword (e.g., "Find the *koob*."). By correctly selecting the unfamiliar object (either through pointing, reaching, or communicative eye gaze), children show that they have paired the phonological word to the object. The lexical representations that children form as a result of fast mapping are considered to be incomplete. However, these representations have been shown to be sufficient to be stored in long-term memory (e.g., Carey & Bartlett, 1978; Markson & Bloom, 1997).

Fast mapping is an acquired skill that first appears around 18 months of age. Evidence for this has come from both cross-sectional and longitudinal data. Halberda (2003), for example, examined fast mapping in 38 infants between 14 and 17 months of age. Familiar and unfamiliar objects were shown in pairs. All the children followed requests to find the familiar objects (as indicated by looking at the target objects for longer than chance amounts of time). An age-based response pattern was observed in following requests for the unfamiliar object. Fourteen-month-olds maintained their focus on the familiar object, 16-month-olds looked at both objects at chance levels, and 17-month-olds looked at the unfamiliar object at significant rates. In other words, the 17-month-olds were the only group in this study who demonstrated fast mapping.

Hirsh-Pasek, Golinkoff, and Hollich (2000; see also Hollich et al., 2000) also demonstrated age effects of fast mapping. Over 300 infants between 12 and 27 months of age were seen across more than 20 separate investigations. Each study presented the infants with pairs of unfamiliar objects that differed in perceptual saliency, one high and one low. One of the goals of this research was to determine if infants use an adult's social eye gaze to aid word learning. Their strongest test of this was to have an adult present a novel word label while looking toward the low-salience object (i.e., the one that the child was less interested in). Only children 24 months and older correctly followed the adult's social eye gaze and fast mapped the new label to the less salient object. Although the younger children did not correctly fast map the low-salience object, developmental trends toward this ability were reported between 12 and 20 months of age.

Longitudinal evidence for the development of fast mapping comes from two investigations by Mervis and Bertrand (1994, 1995). Their first study began by showing groups of toys that included four familiar objects and one unfamiliar object to 15- to 20-month-olds. In a counterbalanced order, the infants were asked to reach or point to one of the familiar objects and the unfamiliar object. Half of the children correctly fast mapped the novel labels to their correct referents on at least three of the four trials. The other half of the children correctly fast mapped on only one or none of the trials. No age differences were found between these two performance groups, but the children who fast mapped had significantly larger expressive vocabularies than those who did not (95 vs. 45 words, respectively). The fast-mapping task was readministered to the low-performing group after their expressive vocabularies had grown closer to those of their fast-mapping peers. At this later time, four of the children correctly fast mapped on 2/4 trials, seven on 3/4 trials, and five on all 4 trials. In their second study, Mervis and Bertrand reported a similar pattern of fast-mapping development in three children who presented delays in expressive vocabulary growth. Although these studies have been criticized for their definitions and use of the vocabulary spurt (P. Bloom, 2000; Goldfield & Reznick, 1990, 1996), their results, as well as those the other investigations presented, demonstrate that fast mapping is a skill that typically develops during the second year of life.

Models of the Onset of Incidental Word Learning

There is currently much debate regarding the nature of incidental word learning (see Golinkoff et al., 2000, for a recent review). One viewpoint suggests that incidental word learning is primarily the result of the acquisition and application of knowledge from within the language being learned. Mervis and Bertrand (1994), for example, discussed their results in relation to a developmental lexical principles framework. This framework suggests that as children acquire more linguistic knowledge (specifically more lexical–semantic knowledge), they make generalizations and develop principles that aid in future acquisition and organization (see also Golinkoff, Mervis, & Hirsh-Pasek, 1994). Specifically, Mervis and Bertrand proposed that children who were unable to fast map were still acquiring the linguistic base needed to develop the novel name—nameless category principle. This principle aids incidental word learning by stating that unknown words should be paired with objects (or actions) that the child does not currently have a name for. Without this principle, the infants had no particular reason to pair the novel words with familiar or unfamiliar objects.

Smith (2000) presented a linguistic-knowledge-based argument in the development of another principle, the shape bias. Her proposal begins with the observation that the early vocabularies of English-speaking infants and toddlers primarily consist of count nouns, which name objects with particular shapes. As children recognize this consistency, they develop a bias toward extending newly learned word labels to objects with shapes similar to the original referent and not to objects with different shapes. The shape bias has been shown to facilitate further semantic acquisition by constraining the field of potential referents for novel words (e.g., Landau, Smith, & Jones, 1998). As a result, children who have developed the shape bias need relatively few exemplars to correctly apply novel words to the correct referents.

Some linguistic-knowledge-based models of word learning are not rooted in the lexical principles framework. Saffran (2001), for example, demonstrated that 8-month-olds can detect statistical regularities from a speech stream and use these regularities to identify potential word units. Although Saffran did not discuss her results in terms of incidental word learning, the identification of specific sound sequences as potential word units from the speech stream is an important subcomponent to word learning. Another example is the work of Storkel and colleagues (e.g., Storkel, 2004; Storkel & Morrisette, 2002), who have shown that toddlers and preschool-aged children use regularities in the phonological and lexical characteristics of the words within their existing vocabularies (e.g., phonotactic probability and neighborhood density) to facilitate new word learning. There are also data to suggest that children as young as 9 months old are able to identify the types of common and rare sound sequences examined by Storkel (Jusczyk, Luce, & Charles-Luce, 1994).

Not all models of the onset of incidental word learning agree with these linguistic-knowledge-based proposals. P. Bloom (2000) and L. Bloom (2000; L. Bloom & Tinker, 2001), for example, advocate models in which lexical advancement occurs as a result of children's improved abilities in interpreting and/or influencing adult communication. Both these models focus on skills related to communicative intention that are based on the function of communicating, rather than the specific pragmatic forms that are used by individual languages (which may be prone to linguistic knowledge effects).

P. Bloom's (2000) model links the ability to learn words incidentally with the child's developing theory of mind. According to this model, the better in tune the child is to perceiving and acting upon the other's communicative intention (regardless of the linguistic form being used), the more words will be acquired. P. Bloom supported this argument by presenting evidence related to the lexical principle of mutual exclusivity. This principle is based on the supposition that objects cannot have more than one label. Mutual exclusivity helps with fast mapping by restricting the pool of potential referents to which novel words can attach to (i.e., only to things that do not have labels; see Merriman & Bowman, 1989, for further description). According to P. Bloom, if this principle is lexically based, it should only apply to words; if it is communication based, it should also apply to facts; and if it is a skill of global cognition, it should apply to all systems.

P. Bloom (2000) stated that there is little direct evidence testing his theory of incidental word learning being rooted in communication, not language (especially related to individual principles, see p. 69). He presented some support from an unpublished study by Diesendruck and Markson in which 3-year-olds participated in tasks involving the mapping of unfamiliar objects to either novel words (a lexical condition) or facts, such as "This is the one that my sister gave me." (a communication condition). The children demonstrated evidence of mutual exclusivity use in both conditions. P. Bloom stated that this was achieved because the children were able to use their theory of mind to correctly read the pragmatic intent behind the adult's expressive utterances, whether lexical or communicative. It is unclear, however, if infants at the onset of incidental word learning are able to apply theory of mind in the same manner.

The intentionality model (L. Bloom, 2000; L. Bloom & Tinker, 2001) is similar to P. Bloom's (2000) proposal in that it is the child's mind that brings about incidental word learning, not specific linguistic knowledge. The intentionality model differs by placing the child as the primary active agent in word (and language) learning. According to L. Bloom, "It is the child's content of mind that determines which words are learned and whether what an adult does is useful for word learning" (p. 21). The intentionality model suggests that language acquisition is the result of the child's engagement in the social context, the cognitive effort to process the information, and the tension that results from the interaction of these two forces. It offers three explanatory principles to describe how the child's intentionality guides word learning: relevance, discrepancy, and elaboration. In order for a potential learning situation to be useful, the child must find it worthy of his/her attention and energy. This is the principle of relevance. Discrepancy refers to the degree to which what the child has in mind differs from the evidence available in the learning context (including linguistic and social-pragmatic cues). The child's desire to resolve discrepancies is a motivation for word learning. Elaboration is another motivator for new word learning and expression. It describes the need to acquire new linguistic forms to interpret and express the child's increasingly complex and abstract mental states.

Evidence for most of the components of the intentionality model has come from analyses of spontaneous play interactions between infants and their mothers. Engagement has been examined by comparing the timing of children's emotional expressions (i.e., affective states) and their acts of speech production (L. Bloom & Beckwith, 1989; L. Bloom & Tinker, 2001). The emotional expressions that children exhibited consistently occurred with greater frequency right around (just before and after) speech acts. This suggests that the children were speaking primarily when they were emotionally engaged in an object or activity. Evidence for children being the driving force behind communicative acts comes from L. Bloom, Margulis, Tinker, and Fujita (1996). In this investigation, mothers were shown to speak more often in response to their children's productions, rather than leading the child's utterances. In each of these investigations, data were collected from children who had only recently demonstrated the expressive vocabulary spurt (typically around 18 months of age). This skill level of participants is relevant to our investigation because, as presented earlier, there is evidence of a positive correlation between the vocabulary spurt and the onset of incidental word learning (Mervis & Bertrand, 1994, 1995).

There are two models of fast mapping that incorporate features from both the linguistic and the communicative intention viewpoints. The emergentist coalition model (Hollich et al., 2000) is based on the suppositions that (a) children can use a variety of attentional, linguistic, and social cues to facilitate word learning; (b) these cues are weighted differently across development; and (c) word-learning principles (i.e., developed biases or generalizations) develop and change over time. In doing so, this model accounts for infants' word-learning skills as a result of both generalizations based on regularities within the language and improvements in understanding and using communicative partners. Likewise, Tomasello's (2003) usage-based theory of language acquisition describes three different processes in word learning. The prerequisite process involves the ability to segment speech and conceptualize referents. The foundational process focuses on joint attention and social/cultural cues to word learning. Finally, the facilitative process includes the use of linguistic cues for word learning. It is important to note that although these models include both linguistic knowledge and communicative intention as tools for word learning, they each promote the idea that these tools are used to greater effects at different points in development. For example, Tomasello describes the following order of occurrence: the prelinguistic process beginning to work prelinguistically, intention-reading processes coming into use at 1 year of age, and linguistic processes accelerating growth during the preschool years. One goal of this paper is to examine whether linguistic knowledge or communicative intention is having a greater effect at, and only at, the onset of fast mapping.

The linguistic knowledge and communicative intention models of incidental word learning each attempt to explain how children are able to learn new words without direct teaching or repeated exposures to novel words and their referents. The support for the linguistic-knowledge-based models has come primarily from laboratory studies of fast mapping, whereas support for the communicative-intention-based models has been primarily from observations of parent–child interactions. To date, there have been no investigations that have directly compared the two. The present investigation offers a first look at the relative influences that these processes have on the onset of incidental word learning.

Bilingual Children and Models of Incidental Word Learning

One way to help determine if the onset of incidental word learning is the result of increases in specific linguistic knowledge or communicative intention is to study word learning in bilingual children. The amount of exposure that bilingual children have to each language they are acquiring appears to have an effect on their rates of vocabulary acquisition. Those who are exposed to two languages equally tend to acquire the vocabulary within each language at rates that are similar to monolingual peers (e.g., Petitto & Kovelman, 2003; Petitto et al., 2001). Bilingual children receiving differential language exposure, however, tend to be more skilled in vocabulary within the dominant language than the subordinate language (L1 and L2, respectively; Pearson, Fernandez, Lewedeg, & Oller, 1997). In other words, the number of words that bilingual children know in each language is proportional to the amount of exposure they have had to that language. The linguistic knowledge and communicative intention views make clear predictions with regard to the onset of incidental word learning in L1 and L2. If the ability to learn words incidentally is primarily based on linguistic knowledge, then it should occur first in L1 and some time later in L2 (once sufficient knowledge of L2 has been achieved). If, on the other hand, incidental word learning is largely the result of advances in communicative intention, the differences between the child's understanding of each language should not strongly influence his/her word acquisition. As long as the child has had sufficient minimal exposure to the subordinate language (Pearson et al., 1997), fast mapping should appear in both languages at relatively the same time.

One bilingual population that is particularly relevant to this study is hearing children of Deaf adults (HCDA). These children are simultaneous, native learners of two languages, American Sign Language (ASL) and spoken English. The languages that they are learning are important for this study because they are quite distinct. ASL and spoken English share few linguistic properties (such as phonological forms and word order), as compared, for example, to spoken English and other West Germanic languages (such as Frisian and Dutch) that share many properties. This is of interest because if the two languages being acquired share fewer properties, then there is a decreased chance that specific knowledge of one language will either facilitate or interfere with the acquisition of the other language. It is noted, however, that although distinct, ASL and spoken English overlap in some aspects of development (including the distribution of semantic–grammatical categories and frequent early words, see Bonvillian, 1999). Although both languages are being learned simultaneously, infant hearing children of two Deaf adults are likely to acquire ASL as their dominant language, as a result of their parent's input, and spoken English as a subordinate language from others in the environment, such as grandparents or neighbors. This reflects the L1–L2 relationship outlined above. In addition, even though one language is dominant, these children are receiving consistent exposure to both languages within naturalistic contexts.

A potential pitfall of comparing incidental word learning in ASL and spoken English is the notion of an early sign language advantage. It has been proposed that children produce their first signs significantly earlier than their first spoken words (see Emmorey, 2002, and Schick, 2003, for recent reviews). Evidence for this proposal is based primarily on observations of Deaf children's first signs occurring, on average, 2–4 months prior to hearing children's first words (e.g., Anderson & Reilly, 2002; Bonvillian, Orlansky, & Novack, 1983). Despite this evidence, it is unclear if a sign advantage truly exists and, if so, what to make of it.

Critics of this proposal have pointed out that a sign advantage has not been observed in all children and that consistent criteria for identifying expressive signs and words have not been applied (both within and across studies; e.g., Caselli & Volterra, 1990; Petitto, 1988). When a sign advantage has been observed, it has not been shown to continue past the one-word/sign stage (Meier & Newport, 1990). One area that has been missing from this debate is whether a sign advantage, if there is one, applies to receptive semantic skills. The present investigation hopes to add this discussion by examining incidental word learning in ASL and spoken English.

The limited data that have been gathered on the language development of HCDA have focused primarily on spoken English acquisition, with an emphasis on vocabulary skills. Results from studies of receptive vocabulary have been contradictory. For example, Brelje (as cited in Schiff-Myers, 1993) and Schiff-Myers (1993) found no significant differences in the receptive vocabularies of HCDA preschoolers and their peers. On the other hand, Murphy and Slorach (1983), Sachs, Bard, and Johnson (1981), and Schiff-Myers and Ventry (1976) found deficits in the receptive vocabularies of HCDA preschoolers (based on data from a combined total of 59 children). No information was reported on these children's receptive ASL vocabularies. This is unfortunate because there is evidence to suggest that bilingual children at the early stages of word use have smaller vocabularies in each language than their monolingual peers, but their aggregate vocabulary size is similar to that of monolingual children (Pearson et al., 1997).

Studies of expressive vocabulary suggest that HCDA use words at fairly typical rates. Prinz and Prinz (1981) reported that an HCDA who was acquiring ASL began to produce signs several months before hearing children produce their first word. This child produced signs prior to spoken words, although the child's spoken English development paralleled that of typically developing monolingual children. Similar expressive skills were also reported by Schiff (1979), who found that HCDA used words from the same categories and produced the same number of semantic–syntactic relations as hearing children from hearing homes.

Objectives of the Present Investigation

This paper is an initial exploration into the nature of incidental word learning as it develops in a bilingual infant. This single case study followed the semantic development of a 1-year-old HCDA, from her first expressive uses of signs through a dramatic increase in her expressive ASL vocabulary. Using methods similar to those of Mervis and Bertrand (1994), we examined the child's expressive vocabulary size and ability to fast map new objects in ASL and spoken English. This study was designed to address questions that relate to the feasibility of directly comparing the linguistic knowledge and communicative intention models, the expressive vocabulary development of bilingual HCDA, and the incidental word-learning abilities of young ASL users. This work was motivated by the following questions.

Will an HCDA who is simultaneously acquiring ASL (L1) and spoken English (L2) be able to fast map in either language when she is at the first stages of expressive vocabulary use in ASL? Will she be able to fast map in either language after she has demonstrated a significant increase in her ASL expressive vocabulary? Based on the results of these two questions, will the ability to fast map occur first in L1 and later in L2, or will fast mapping occur in both languages at the same time? If the onset of the ability to learn words incidentally is based on language-specific knowledge, then we predict that the child will incidentally learn new words in ASL prior to doing so in spoken English. If this acquisition of this skill is the result of advances in the child's communicative intention, then the incidental word learning should occur in both ASL and spoken English around the same time. By addressing these questions, the present investigation should yield important information about methods for examining the nature of incidental word learning. As stated earlier, prior studies on the influences of linguistic knowledge and communicative intention have typically focused on only one of these viewpoints directly. In this investigation, both viewpoints are directly addressed. Also, this is the first attempt to evaluate the nature of incidental word learning by tracking its development in both languages being acquired by an individual child.

Would the expressive vocabulary development of a child who is natively acquiring two languages, but with *different amounts of exposure to the languages, be similar or different across the languages being learned?* Based on the findings of Pearson et al. (1997), we expect that the child's expressive vocabulary will reflect the amounts of language exposure that she has received. That is, we predict that she will have a larger expressive vocabulary, at least early on, in ASL than in spoken English.

Is incidental word learning acquired at similar states of development in ASL and spoken English? Very little is currently known about the development of incidental word learning in native ASL users. This is because there have been very few such investigations to date. Those that have (Lederberg, Prezbindowski, & Spencer, 2000; Lederberg & Spencer, 2001) have focused on Deaf and hard-of-hearing preschoolers of hearing parents, children who were not likely to have been exposed to ASL on a daily basis as infants. The results of those studies are germane because, like Mervis and Bertrand (1994, 1995), they reported a strong relationship between expressive vocabulary size and the ability to fast map. This paper hopes to add to the knowledge base of ASL development by examining the early-development incidental word-learning skills of a native ASL user.

Method

Participant

This single case study followed the semantic development of an HCDA. The child, henceforth referred to by the pseudonym "Beth", was a White female, aged 16 months at the time of the first session. This age was selected for two primary reasons. First, by 16 months, Beth had demonstrated comprehension and production of signs and words in both ASL and spoken English. Based on parent report, her expressive language skills at this time, however, were not indicative of having gone through a dramatic increase in vocabulary use in either language. Second, Beth had not shown consistent responses to requests to point to familiar objects until 15 months of age. This skill was important because the fast-mapping task used required pointing (and/or reaching) as the method of object identification.

Beth was a hearing, bilingual user of ASL and spoken English. Both her parents were Deaf and used ASL in communicating at home, with each other and with Beth. Her parents each had college degrees and were working professionally. Beth's parents reported no concerns for her motoric, cognitive, or linguistic development. They estimated that in a typical week, 80% of the language stimulation that Beth received was through ASL and 20% was through spoken English. Although parental estimates of language exposure are not precise measures, Pearson et al. (1997) found that these estimates can account for between 46% and 67% of variability in vocabulary learning. At home, Beth was exposed to ASL and spoken English throughout the day. Sources of spoken English included her parents, grandparents, friends, visitors, and the television. Beth attended day care on the Ohio School for the Deaf campus, where she was exposed to ASL the entire time with only a small amount of simultaneous spoken English used.

Procedures

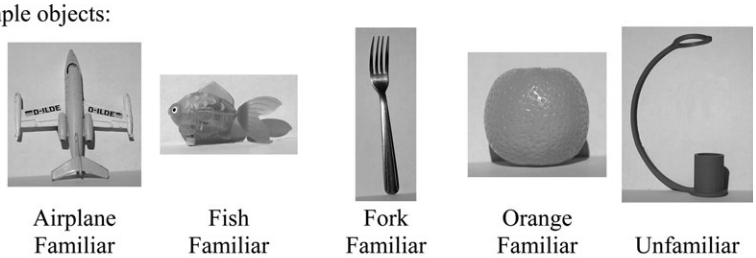
All the procedures took place in the family's home, over two separate sessions. The first session took place when Beth was 16 months old. The second session occurred 4 months later, when she was 20 months old. The procedures included measures of (a) Beth's expressive vocabulary size in ASL and spoken English and (b) her ability to fast map novel labels in ASL and spoken English.

Expressive vocabulary measures. Prior to each session, Beth's parents completed the expressive vocabulary portions of the MacArthur Communicative Developmental Inventory (CDI) for ASL (Anderson & Reilly, 2002). This checklist consists of more than 500 words, grouped by categories (e.g., animals and clothing). Her parents were instructed to place a mark by each word for which they had seen Beth produce a sign. In the same manner, the MacArthur CDI: Words and Gestures (Fenson et al., 1994), which includes over 600 words, was completed by a hearing friend of the family. The hearing friend was a neighbor who also worked in the day-care classroom that Beth was attending. Beth's mother estimated that this friend interacted and communicated with Beth approximately 3–4 hours per weekday.

Fast mapping. The procedures for the fast-mapping task were based on those used by Mervis and Bertrand (1994). The same experimenter, the second author, conducted both sessions. In each of the sessions, six fast-mapping trials were conducted. The first three trials presented novel signs in ASL and the last three included novel spoken English words. The ASL trials were conducted before the spoken English trials in both sessions to allow for the most direct comparisons of performance between sessions. Figure 1 illustrates the selection field and requests made within a given trial. Each trial presented Beth with four objects that were familiar and one object that was unfamiliar. She was given up to a minute to visually and tactically explore all five objects. No direct linguistic or social-pragmatic cues were given during this time. The experimenter then lined the objects in a row and requested one of the familiar objects (e.g., "Show me the *fish*."). After Beth responded, the objects were reordered and a request to identify a second familiar object was made. Following her response, the objects were shuffled a final time and Beth was asked to identify the unfamiliar object based on novel label (either a nonsense sign or spoken word). The placement of the familiar objects and the unfamiliar object was varied so as not to clue her to the correct response. Responses of reaching toward, pointing to, and/or picking up the unfamiliar object were counted as correct fast mapping. If she did not respond to the initial request, then the request was rephrased and repeated.

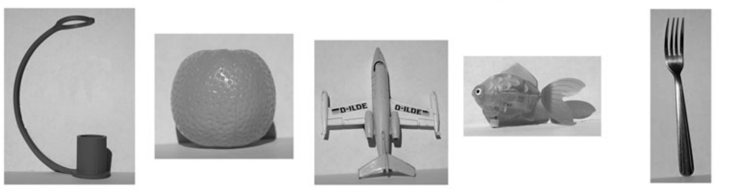
All the familiar and unfamiliar objects that were presented to Beth were either toys or household items. The familiar objects were selected from items on the word lists of the ASL and spoken English versions of

Sample objects:



Request for a familiar object: "Where is the fish?"

Request for a second familiar object: "Show me the orange."



Request for the unfamiliar object: "Get the gip."

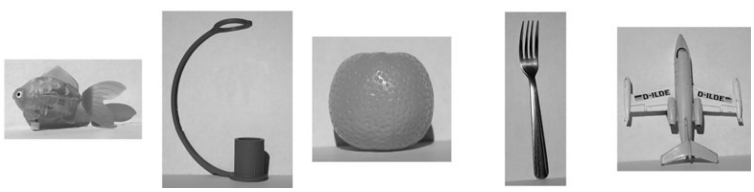


Figure 1 Sample of the requests made during an individual fast-mapping trial.

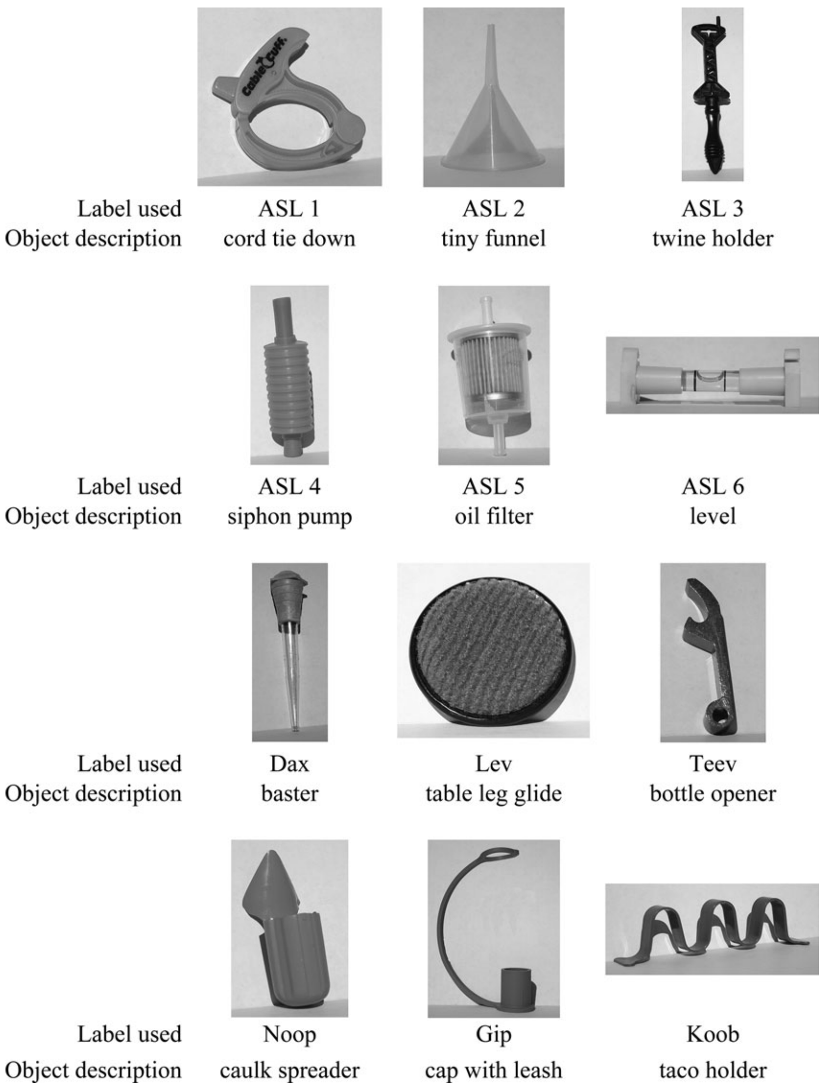


Figure 2 Pictures and descriptions of the unfamiliar objects used in the study.

the MacArthur CDI (Anderson & Reilly, 2002; Fenson et al., 1994). These inventory checklists were used in choosing the objects because they are collections of signs/words that children are first able to understand and say. Some examples of the familiar objects include a spoon, a toy car, a toy dog, and keys. The unfamiliar objects were selected to represent objects that young children are highly unlikely to have had exposure to. None of the unfamiliar object labels appeared on either the English or ASL versions of the MacArthur CDI. Most were so unfamiliar that adult pilot subjects were unable to correctly name them. As a group, the unfamiliar objects were similar to the familiar objects in terms of size, color, and material (e.g., metal, rubber, and plastic). This was done so that undue attention was not brought to the unfamiliar objects. Figure 2 contains photos and brief written descriptions of the unfamiliar objects used.

The requests for the unfamiliar objects included nonsense labels, either signs or words. The nonsense labels were developed to reflect the phonological forms used by early learners and follow the phonotactic rules of ASL and spoken English. The development of the ASL nonsense signs began with a review of literature on phonological aspects of first signs (e.g., Bonvillian & Siedlecki, 2000) and an examination of the hand shapes, palm orientations, locations, and movements included within the signs listed on the ASL adaptation of the MacArthur CDI (Anderson & Reilly, 2002). The most commonly occurring of these phonological features were combined in various ways to create new nonsense signs. A set of 10 nonsense signs were then shown to a Deaf, native ASL user (who is also an ASL instructor). Based on her feedback regarding whether the nonsense signs (a) were similar to real signs already having semantic meaning, (b) followed rules for ASL, and (c) were pragmatically appropriate, six of the nonsense signs were selected to be used in this study. These signs are described in detail in the Appendix.

The spoken nonsense words used were *dax, lev, teev, noop, gip,* and *koob.* These words were all consonant–vowel–consonant combinations, which is one of the early word combinations that young children are able to produce. The nonsense words also consisted primarily of early developing stop and nasal phonemes.

Before conducting this study with Beth, the procedures for spoken English were piloted on two 2-year-old hearing children of hearing adults. Although these children were slightly older, the trials allowed us to become comfortable with the procedures. The trials also helped us to determine how to present the objects and to test the familiarity or unfamiliarity of the objects.

Results

Data were collected at each session on Beth's expressive vocabulary size and her ability to fast map novel labels. Her performances in ASL and spoken English on each of these measures were calculated individually. Table 1 presents a summary of the number of expressive vocabulary items that she was credited for having produced, her performances on the fast-mapping trials, and probability estimates for her fast mapping. Probability estimates were calculated to examine the likelihood that Beth's fast-mapping performances were the result of guessing or random object selection. There was a one-in-five (0.20) chance of a correct, but random, selection of the unfamiliar object and a four-in-five chance (0.80) of randomly picking incorrectly (i.e., one of the familiar objects) within each trial. Probability across the three trials was calculated by multiplying the chance of her response within each trial by the total number of possible iterations of the pattern. For example, the probability of correctly responding to two of three trials was 0.096 (or 9.6%), which is the result of 0.20 × 0.20 × 0.80 (the chance level for each trial's response) × 3 (reflecting the following possible iterations: trials 1 and 2 correct, trials 2 and 3 correct, and trials 1 and 3 correct).

Session 1

Beth's expressive vocabularies for each language at the first session were similar. She was credited with producing 94 signs in ASL and 74 words in spoken English. Normative data from each of the vocabulary instruments administered suggest that both her expressive sign and speech vocabularies were within the normal range for monolingual signers and speakers. Data presented in the MacArthur CDI for ASL (Anderson & Reilly, 2002), for example, show that 16-month-old Deaf children of Deaf adults (the only comparative group available) typically produce ~90 signs. Similarly, her production of 74 spoken words corresponded to a score between the 55th and 60th percentile ranks, as compared to 16-month-old hearing children of hearing adults (Fenson et al., 1994).

The vocabulary items that Beth was credited for having produced at 16 months of age were done so

Table 1 Beth's expressive vocabulary, fast-mapping accuracy, and probability of fast-mapping performance for each language, at each session

Task	Language	Session 1 (16 months)	Session 2 (20 months)
CDI expressive vocabulary	ASL	94	236
	Spoken English	74	219
Number of items fast mapped	ASL	2/3	2/3
	Spoken English	1/3	3/3
Probability of fast-mapping performance[a]	ASL	0.096	0.096
	Spoken English	0.384	0.008

[a]Based on a one-in-five (0.20) chance of correctly responding to each trial.

Table 2 Performance on requests to identify the unfamiliar objects by their associated ASL signs or spoken English words during fast-mapping trials

Session	Mode	Label	Number of requests	Object selected	Accuracy
1	ASL	ASL 1	1	Unfamiliar	Correct
		ASL 2	4	Unfamiliar	Correct
		ASL 3	1	Familiar and unfamiliar	Ambiguous/incorrect
	English	Dax	6	Unfamiliar	Correct
		Lev	6	Familiar	Incorrect
		Teev	6	No response	Incorrect
2	ASL	ASL 4	1	Unfamiliar	Correct
		ASL 5	2	Familiar	Incorrect
		ASL 6	1	Unfamiliar	Correct
	English	Noop	4	Unfamiliar	Correct
		Gip	2	Unfamiliar	Correct
		Koob	2	Unfamiliar	Correct

primarily in only one language. Of the 168 total items that were checked, 107 signs/words were included on both checklists. Beth produced 50 of these items exclusively in ASL (47%), 17 in spoken English only (16%), and 40 overlapped both languages (37%; e.g., producing both the sign airplane and the spoken word). In other words, approximately 63% of the labels that she was credited for having produced were done so in only one language, whereas 37% were observed in both ASL and spoken English.

On the fast-mapping task, Beth correctly identified at least one of the two requested familiar objects on each trial (regardless of the language used). By doing so, she demonstrated the ability to follow requests to select specific objects. Incorrect responses to the familiar object requests were typically the result of a lack of attention to the examiner's request and/or interest in another specific object. When Beth was not attentive, the examiner prompted her to look at all the objects and then repeated the request. These behaviors were also seen following some of the unfamiliar object requests. Up to six requests were made for a single object before Beth's first response. More request repetitions were needed during the first session than in the second one.

Beth's performances on the fast-mapping task are presented in Table 2. The data in this table reflect her first response to the examiner's requests (even though some of the requests were made more than once). During the first session, Beth correctly fast mapped the novel signs to the unfamiliar objects on the first two trials. Her performance on the third trial was ambiguous but counted as incorrect. Beth responded to the request by simultaneously picking up one of the familiar objects and the unfamiliar object. The probability of being correct on two of three trials by chance was 0.096 (9.6%). On the spoken English trials, Beth responded correctly on only one trial, a probability of 0.384 (38.4%). Her erred responses included a selection of one of the familiar objects and identification of a phonologically similar word. The phonologically related error occurred on the third spoken English trial. Her initial response to this trial was to point to her teeth. This error appears to reflect the phonological similarity between *teeth* and the target word /tiv/. The examiner then verbally identified the word as "teev not teeth". Beth did not respond to two subsequent responses to identify the teev.

Session 2

By the time of the second session, Beth's vocabulary had dramatically increased in both languages. Her expressive vocabulary in ASL and spoken English remained comparable as she was credited for 236 signs and 219 spoken words. As with her expressive vocabulary performances at 16 months of age, these rates of sign and word use are both within the average range for monolingual age-matched peers. Among the labels that Beth was credited for having produced at 20 months, 225 were included on both vocabulary checklists. She produced 34 items (15%) only in ASL, 44 (20%) just in spoken English, and 147 (65%) in both languages.

Beth's performance on the fast-mapping task during the second session revealed an increase in spoken English but not ASL. Beth correctly fast mapped two of the three novel signs and all three of the novel words. The probability estimates for these performances were 0.096 (9.6%) and 0.008 (0.8%), respectively. As shown in Table 2, her ASL error was on the second trial of the session (sign ASL 5), in which she chose one of the familiar objects.

Discussion

This investigation examined the early semantic development of an HCDA who is learning naturally acquiring ASL and spoken English with different amounts of exposure. Her expressive vocabulary and fast-mapping abilities in both languages were measured when she was 16 and 20 months of age. The questions that were addressed focused on the comparison of two semantic models as they relate to the onset of incidental word learning, expressive vocabulary development in bilingual children receiving different amounts of language input, and the development of incidental word learning in young ASL users.

Insights Into the Onset of Incidental Word Learning

During Session 1, Beth correctly fast mapped on 67% of the ASL trials and 33% of the spoken English trials. This pattern suggests that her fast-mapping abilities were stronger in ASL than English. This interpretation, however, is weak, given that she only fast mapped one more object in ASL than in English. Further support comes from the comparison of the probability estimates of her response patterns. There was a less than 10% chance that Beth's fast-mapping performance in ASL was the result of random selection. The probability of her performance on the English trials during the first session, however, was four times as much (38.4%). This suggests that Beth was more proficient at fast mapping in ASL than spoken English at 16 months of age. During the second session, Beth also had a 1-point difference between fast mapping in ASL and English. This time, however, she correctly mapped more objects to spoken English words than to ASL signs. Probability estimates for both languages at Session 2 were quite low (less than 10% of responding by chance). By 20 months of age, therefore, Beth had become a proficient fast mapper in both ASL and spoken English.

By showing a differential pattern of fast mapping across languages, Beth's performance during the first session more closely matched the prediction made by the linguistic knowledge models of word learning. This would suggest that she had used her developing knowledge of ASL to become a more proficient word learner. Because we only measured one aspect of language development in relation to fast mapping (i.e., expressive language), it was beyond the scope of this study to determine what, in particular, Beth might have acquired about ASL that promoted this semantic development. One potential interpretation is based on the lexical principles frameworks discussed earlier (e.g., Golinkoff et al., 1994). This suggests that Beth used what she had previously known about ASL signs and made new predictions for how to apply novel signs to unfamiliar objects.

The results of this investigation provide an initial suggestion that linguistic knowledge plays a more significant role at the onset of incidental word learning than advances in communicative intention. They do not, however, rule out the influence of communicative intention on early word learning. In this fast-mapping task, Beth only experienced the novel labels when asked to identify the objects. By not engaging her in conversations that included the novel labels, Beth was provided with little motivation to learn the novel words (as suggested in the intentionality model) and no social-pragmatic feedback from the examiner (as suggested in P. Bloom's model). At the same time, however, no direct linguistic cues (which might have influenced the result toward the linguistic-knowledge-based models) were provided either. In other words, no overt cues toward either model were provided. To perform well on the fast-mapping task, therefore, Beth had to rely on her previous experiences with both the languages being used and her internal communicative intention abilities.

Although the methods used in this study were based on prior investigations, directly comparing the two incidental word-learning models and examining fast mapping in both languages being acquired by a bilingual child were unique to this investigation. Evidence that this method was successful includes the apparent ease at which Beth accepted the linguistic switch from ASL to spoken English during the fast-mapping tasks and her performance matching one of the predicted outcomes.

The longitudinal design of this study allowed us to document the development of Beth's incidental word-learning skills in spoken English. In 4 months time, she progressed from limited proficiency to 100% accuracy. This suggests that incidental word learning in spoken English was not an unobtainable skill for Beth, so comparing performance across languages was valid. Her spoken English performance also demonstrated that fast mapping is not a skill that everyone automatically has; rather, it is a developed ability. This matches the results of the second study of Mervis and Bertrand (1995), in which children who were initially unable to fast map could do so at later dates.

There are a few aspects of this investigation, however, that make us cautious about over interpreting the results. The first is the limited number of trials that were presented in each session. Each session included six trials, with three questions per trial (for a total of 18 questions per session). This limited number of trials was selected because we were concerned that more trials for a 1-year-old would result in fatigue and inattention. As seen with both sessions, it was difficult to use her response accuracy alone to determine if performance was truly better in one language than the other. Second, across both sessions, Beth required as many as six requests on an individual question before identifying an object. Repetitions are not unexpected when making requests of a 1-year-old and they occurred for both familiar and unfamiliar items. It is difficult, however, to interpret the impact of the need for repeated requests on the results. Some repetitions appeared to be due to Beth focusing exclusively on one of the objects, whereas others related to the examiner making frequent requests within a short time period (e.g., four requests within 5 seconds). Inattention and fatigue may have also played a role in the need for these requests, as well as her poor performance in spoken English during the first session. At 16 months of age, responding to 18 requests may have been too much for Beth. Although this is a potential confounder, it is noted that she responded quickly and accurately to at least one of the familiar requests on each of the spoken English trials, suggesting that she was still maintaining at least some attention to the task. Finally, the single subject nature of this investigation is only suggestive of the skills used for fast mapping in the general population.

Expressive Vocabulary

Based on her parent's reports of the amount of exposure that Beth received in ASL and spoken English (80% and 20%, respectively) and the prior data on expressive vocabulary development in bilingual children (e.g., Pearson et al., 1997; Prinz & Prinz, 1981), we suspected that (a) her vocabularies in both languages would be below those of monolingual age-matched peers and (b) her ASL vocabulary at Session 1 would greatly exceed her spoken English vocabulary. Neither of these suspicions, however, turned out to be accurate. At both of the sessions, Beth's expressive vocabularies for ASL signs and spoken English were within the average range for monolingual peers and were very close in total number to each other. In this manner, Beth's bilingual vocabulary acquisition was more like those described in children receiving more equivalent amounts of bilingual exposure (Petitto & Kovelman, 2003; Petitto et al., 2001). Although Beth's expressive ASL vocabulary was greater than her spoken English vocabulary at Session 1 (94 signs vs. 74 words), the difference did not appear to be critical.

There are a number of possible reasons for these occurrences. For example, Beth may be a precocious word learner. There is a great deal of variety in the vocabulary sizes of infants and toddlers (as exemplified by normative data from the spoken English version of the MacArthur CDI), and Beth may be at the upper end of this range.

Another explanation for Beth's strong expressive vocabularies in both ASL and spoken English may have to do with the timing of our measures. The first session was conducted at 16 months of age because Beth had demonstrated the ability to consistently identify objects upon request (per parent report), yet had not shown considerable increases in her expressive vocabularies. By starting data collection at this age, we may have caught Beth as she was transitioning from a single-language to a dual-language system. Some prior work on bilingual language acquisition (including simultaneous ASL and English) has proposed that children begin with one semantic system, in which few word labels overlap between languages (e.g., Pearson et al., 1997; Prinz & Prinz, 1981). As their language skills increase they develop two separate semantic systems in which items overlap. Prinz and Prinz reported evidence of this change in an HCDA between 14 and 21 months of age. Evidence that Beth had begun this transition prior to the first session comes from the 37% of vocabulary overlap measured at the time of Session 1. Further support for Beth's development of two semantic systems is the doubling of overlap that had occurred 4 months later. Thus, it may have been that Beth's vocabulary skills at the time of the first session were developed to a greater degree than we had anticipated.

Petitto and colleagues (see Petitto, 2000, 2005, for reviews) have offered an alternative account to the single- to dual-language model that may also explain Beth's strong expressive vocabulary skills. They proposed that bilingual children have distinct representations of the separate languages being learned right from the start of acquisition, based on findings related in the areas of babbling and vocabulary development. When examined from this point of view, the similarities between Beth's expressive ASL and spoken English vocabularies and those of monolingual peers are not so surprising.

Whether Beth was moving from a single- to dual-language system or started with a dual system, her vocabulary performance begs the issue of how much exposure is necessary for typical language development. In her case, it appears that 20% of communicative input in a given language was enough to lead to age-expected vocabulary development. Normal monolingual language development in bilingual children receiving less than equivalent language input is not without precedent. Schiff (1979), for example, tracked the morphological and syntactic development of hearing 2-year-olds of Deaf parents, who received less than 20 hours of English input per week from normal speakers. These children were similar to monolingual peers in the areas of semantic–syntactic relations, utterance types, and morpheme use. Beth's performance followed the finding of Pearson et al. (1997) of a significant correlation between expressive vocabulary development and language exposure (even in children receiving as little as 20% input in one language) in Spanish/English bilinguals. Her vocabulary skills in the subordinate exposure language (i.e., spoken English), however, were significantly greater than those of the participants of Pearson et al., who, as stated earlier, achieved vocabulary levels that matched those of monolingual peers only when nonoverlapping words in both languages were counted together.

Incidental Word Learning in ASL

Although Beth was not Deaf herself, she was a native learner of ASL. At 16 months of age, she was skilled at learning novel signs through incidental exposure. To our knowledge, this study presents the first direct evidence of fast mapping by an infant learning ASL. This finding is primarily attributable to a dearth of investigations on fast mapping and infant signers. As noted earlier, prior work on incidental learning through signs has focused on preschoolers who were not native sign learners (Lederberg & Spencer, 2001; Lederberg et al., 2000). Beth's ability to fast map in ASL is supported by previous research. A number of studies, for example, have shown that lexical development in native ASL users is quite similar to that of native English speakers (see Schick, 2003). Likewise, Mervis and Bertrand (1994) reported that their English-speaking participants who were initially able to fast map were between 15 and 20 months of age and had mean expressive vocabularies of 95. Both Beth's age and ASL vocabulary size during the first session matched these data. In other words, the sign advantage that some researchers have reported in early expressive development did not appear to be occurring with Beth's expressive sign acquisition. This suggests that the acquisition of incidental word learning follows along a similar trajectory in ASL and spoken English. This is not completely unexpected, as overlap between ASL and spoken English development in the areas of grammatical and semantic categories, and frequent early words have been reported (see Bonvillian, 1999, for review). Additional work on the early word-learning abilities of ASL users is clearly needed.

Summary

The ability to learn words through incidental exposure is a milestone of early language development. In this investigation, a bilingual HCDA exhibited expressive vocabularies in ASL and spoken English (at both 16 and 20 months of age) within the average range for monolingual peers. At 16 months of age, she appeared to fast map novel labels more proficiently in ASL than in spoken English. Four months later, she was an adept incidental word learner in both languages. The results of this investigation demonstrate that models of the nature of incidental word learning based on linguistic knowledge and communicative intention can be compared directly. They also suggest that minimal levels of individual language input (in this case, 20% of language exposure) may be all that are needed to achieve typical vocabulary levels and that the ability to fast map follows on a similar developmental course in ASL and spoken English.

APPENDIX

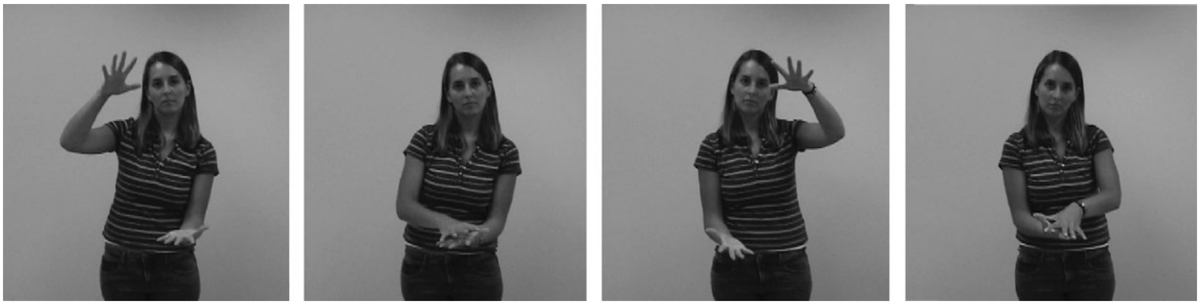
The six nonsense ASL signs are presented below, in both picture and text forms.

ASL 1 This sign begins with two C-hands with palms facing forward. Hands begin apart and each follows a U-shaped path until the thumbs meet in the center.

ASL 2 This sign begins with both hands in the closed 5-hand position, palms together facing center. The hands open downward so that the palms move to face the floor with the thumbs still touching each other while the closed 5-hand position simultaneously opens to the open 5-hand position.

ASL 3 This sign begins with the dominant hand in an open C-hand position. The hand is placed beside the forehead, with the palm oriented forward. The C-hand then traces an arc from the forehead to the chin while the hand is flipped causing the palm to face toward the body.

ASL 4 This sign begins with both hands in the C-hand position, palms facing center. Dominant hand begins the signs above the subordinate hand. Each hand follows a C-shaped path, ending with the subordinate hand over the dominant hand.



ASL 5 This sign begins with both hands in the 5-hand position. Hands are placed about one foot apart with the palm of the top hand facing downward and the palm of the bottom hand facing upward. Clap the top hand down onto the bottom hand, flip the hands over and clap them again.

ASL 6 This sign begins with the dominant hand in the O-hand position and the subordinate hand in the open 5-hand position with the palms facing each other. The fingertips of the O-hand initially touch the palm of the 5-hand. The O-hand slowly moves away from the 5-hand while opening into the open 5-hand position. Sign ends with two open 5-hands facing each other.

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