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SUMMARY:
This is the article in which we present the most important findings from our NIH-sponsored longitudinal study of the impact on verbal development of purposefully encouraging infants to use symbolic gestures. Standardized tests of both receptive and expressive language development had been administered at 11, 15, 19, 24, 30, and 36 months to both an experimental group of babies (Baby Signers) and two control groups. Results demonstrated a clear advantage for the Baby Signers, thereby laying to rest the most frequently voiced concern of parents – that Baby Signing might hamper learning to talk. In fact, the good news is that Baby Signing actually facilitates verbal language development.

Abstract

Impact of Symbolic Gesturing on Early Language Development

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The purpose of the present study was to evaluate the effect on verbal language development of purposefully encouraging hearing infants to use simple gestures as symbols for objects, requests, and conditions. To this end 103, 11-month-old infants were divided into three groups, all of whom were seen in the laboratory for a variety of assessments, including standardized language tests at 15, 19, 24, 30, and 36 months. Parents of those in the Sign Training group modeled symbolic gestures and encouraged their infants to use them. Parents of infants in the Non-intervention Control group knew nothing about symbolic gestures or our special interest in language development. As a control

for "training effects" (i.e., effects attributable to families being engaged in a language intervention program), parents of a second control group of infants (the Verbal Training group) were asked to make special efforts to model verbal labels. After comparisons of the two control groups minimized concerns about training effects, comparisons between the Sign Training and the Non-intervention Control group indicated an advantage for the Sign Training group on the vast majority of language acquisition measures. These results provide strong evidence that symbolic gesturing does not hamper verbal development and may even facilitate it. A variety of possible explanations for such an effect are discussed.

Impact of Symbolic Gesturing on Early Language Development

A view of the child as a preformed adult endowed with special linguistic input and output devices is giving way to a view of the child as a creature equipped with ears and eyes and with various moving parts that can be harnessed to form the sounds and sights of its species communicative signals (Studdert-Kennedy, 1991, p. 89)

For many years the phrase "language development" was used almost exclusively in reference to the development of verbal language. A child's first words were touted by parents and researchers alike as marking the onset of the ability to represent concepts symbolically and use symbols for the express purpose of communicating with others. More recently, based in part on increasing appreciation of the ground-breaking theoretical work of Werner and Kaplan (1963), researchers have taken a closer look at the precursors of verbal language with an eye toward delineating the steps by which children gradually become proficient in using arbitrary symbols to stand for real-world phenomena. One of their most thought-provoking ideas is the notion that the development of representational ability requires children to tolerate greater and greater "distancing" of the symbol from the referent. For example, the use of an onomatopoetic symbol (e.g., "woof") to symbolize the sound that dogs make is not quite as "distant" from the referent as the more arbitrary symbol, "barking." The latter makes greater cognitive demands on the child because the relationship must be maintained mentally without support from the environment.

As interest in subtle milestones of language development has grown, including the notion of "distancing" of symbol from referent, so also has interest in the role of physical actions including a variety of kinds of gestures. Such a focus, researchers point out, makes a good deal of

sense given the prominence of sensorimotor schemes (i.e., actions on objects) during the first year of life. For example, the onset of intentional communication is signaled by a small set of gestures which essentially launch the child into purposefully communicating with others. These "performatives" or "deictic" gestures as they are variously called, begin around 10 months of age and include such actions as effortful reaching towards objects to indicate that they are wanted, directing adult attention to objects by holding them up or giving them, and pointing at objects to indicate interest or need (Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979, Messinger & Fogel, 1998). These early intentional gestures, although clearly an advance over merely acting on objects, are still primitive in terms of their representational sophistication. In each case the referential meaning is clear only if the viewer follows the gesture's trajectory to its target. Despite their primitive representational stature, however, there is no doubt these gestures constitute an important early step in symbolic development and pave the way for learning verbal language.

Jumping ahead developmentally, another important milestone in the development of communicative gestures has been found during the 3- to 5-year-old period. Researchers from a number of laboratories (e.g., Boyatzis & Watson, 1993; O'Reilly, 1995) have documented a change across this developmental time span in how children choose to represent an action in pantomime, such as brushing one's teeth or writing with a pencil. At the younger end of this age range the data indicate a strong tendency to depend on a body part to represent the tool itself (e.g., index finger as the toothbrush or pencil), both when children are asked to produce the pantomime themselves and when asked to interpret the action of someone else modeling the pantomime (O'Reilly, 1995). In contrast, by 5 years of age children's representational sophistication has progressed to the point where they are likely to produce (or understand) the relevant action by itself as if the tools were there (e.g., moving the fingers as if one were holding the toothbrush or pencil). In other words, by 5 years of age children are skilled enough at distancing symbol from referent that they apparently need no concrete symbol of the tool at all!

These two milestones, the onset of deictic gestures at 10 mos (with their heavy reliance on context) and the development of representationally sophisticated pantomimes by age 5, leave a long span of symbol development unaccounted for. The purpose of the present paper is help fill this gap by exploring the implications of another form of gesturing, one which we have discovered serves children well in their efforts to communicate with others specifically

during the period between the onset of deictic gestures (at 10 months) and the point in development when verbal words are abundant (about 24 months). It is during this period that children and parents alike become frustrated by the slowness with which verbal language develops. As their deictic gesturing and vocal whining clearly indicate, infants between these ages are highly motivated to communicate about specific things, but may be months away from the fine motor coordination necessary to say the relevant words.

The gestures to which we refer help fill this gap by providing an easier symbolic equivalent in the form of simple physical actions that can be used to represent objects and events (e.g., sniffing for "flower," index fingers tapping together for "more," thumb to mouth for "bottle"). Like deictic gestures, these "symbolic gestures" are communicative in function, but unlike deictic gestures, symbolic gestures carry their meaning in their form. Like the "iconic" gestures produced by the 3-year-old bilingual children studied by Nicoladis, Mayberry, and Genesee (1999), and the pantomimes studied by Boyatzis and Watson (1993), these gestures often resemble their referent concept. Unlike Nicoladis et al.'s gestures, however, they frequently serve nominal rather than predicate functions and substitute for, rather than accompany, speech. And unlike Boyatzis and Watson's pantomimes, symbolic gestures may or may not involve using a body part to represent the object itself. For example, a throwing or rolling action is much more typical as a symbolic gesture for "ball" than a representation of the ball itself (e.g., as a round fist).

In fact, given the apparent constraints on representation observed among 3-year-olds in these earlier studies, the wide variety of forms symbolic gestures can take between 10 and 24 mos is somewhat surprising. The reason for this impressive representational flexibility, we believe, lies in the fact that adults – knowingly or unknowingly – model not only the gestures themselves for infants and toddlers, but also the use of these gestures as tools for communication. In other words, children are learning both "form" and "function" from their communicative partners, including the fact that the form of the gesture must remain constant for communication to be successful. In this context very young children seem willing to adopt whatever gestural form is provided. For example, they take in stride learning the arbitrary motion of moving their hands up and down at the wrist as a symbol for "bye-bye" and nodding their heads as a symbol for "yes." For both parent and child the goal of being able to communicate with one another is foremost, motivating both parties to work hard in a reciprocal fashion. On the one hand, children appear to be quite

vigilant about the association of specific actions with specific contexts and actively imitate these actions, while on the other hand, parents not only model relevant actions but also provide feedback in response to their children's use of the gestures to communicate.

The present study represents a significant extension of our original work on this type of gesturing, work which had as its focus documenting the spontaneous development of symbolic gestures during the second year of life and describing important correlates (Acredolo & Goodwyn, 1985, 1988). From these studies we learned that symbolic gestures are quite common among infants from 10 to 24 months, that they serve a useful function until verbal equivalents are possible, and that they may be abstracted from interactive routines with adults (e.g., spider gesture borrowed from the "Eincy Weency Spider" song), learned by observing models (e.g., shaking the head for "yes" and "no" or panting for "dog"), or borrowed from actions done with the referent object (e.g., rocking motion to represent "swing"). We also found evidence of positive correlations between symbolic gesturing and verbal development: the more symbolic gestures the children had included in their communication repertoires by 19 months, the larger their verbal vocabularies at both 19 and 24 mos (Acredolo & Goodwyn, 1988; Goodwyn, 1986).

Although only correlational in nature, these results suggested that promoting the use of the gestural modality to augment fledgling attempts to talk might be advantageous to infants, both in terms of early communication with parents and later verbal language skills. Moreover, if parents could be persuaded to encourage this type of gesturing, researchers would benefit from examining a larger pool of children engaged in a theoretically interesting form of communication. Preliminary support for these hypotheses was obtained in a pilot study of six infants whose parents were asked to purposefully encourage symbolic gesturing and were interviewed weekly from 12 to 24 mos about their infants' verbal and gestural use of symbols (Acredolo & Goodwyn, 1990). Comparisons to national norms indicated that these children were progressing faster than average in verbal development. However, without a control group of infants drawn from the same population, the results of this small intervention study were uninterpretable.

The present study represents the logical next step. In order to examine this type of gesturing more closely and to ascertain its impact on infant development, especially as it interacts with verbal language development, a longitudinal study was conducted and comparisons

among three groups of infants were carried out. Parents of infants in the experimental group, the "Sign Training" group (ST) were encouraged to provide their infants the opportunity to communicate with symbolic gestures. Families in two control groups drawn from the same population knew nothing about symbolic gesturing. All infants were evaluated using a variety of language measures at 11, 15, 19, 24, 30, and 36 mos. Our search in this study was specifically directed toward group differences in verbal development.

Method

Participants

Participants included 103 infants (58 boys, 45 girls) from a predominantly middle-class area of Northern California. Entry into the study was at 11 mos (+/- 1 week). Infants routinely exposed to a language other than English or who had had more than five ear infections were excluded. Income level data confirmed a middle-income status for the majority of the families, with only 15% of the sample falling below $20,000. Participants were almost exclusively Caucasian (90%), the only exceptions being three African-American, seven Asian-American, and five Hispanic children.

Procedures

Participant groups. The two primary groups included in the study were an experimental group, designated the Sign Training group (n = 32, 19 boys and 13 girls) and a control group, designated the Non-intervention Control group (n = 39, 22 boys and 17 girls). Parents of infants in the Sign Training group (ST group) were individually instructed in ways to promote symbolic gesturing by modeling simple gestures themselves, always being sure to pair the gesture with the verbal word (e.g., "Birdie! [FLAP ARMS] See the birdie!"). They were told to use any physical motions that made sense to them and would be easy to remember in relation to the referent (e.g., clawing motion for cat, index finger wiggling for caterpillar). Videotaped examples of parents and infants using such gestures were used as illustration. In contrast, parents in the Non-intervention Control group (NC) were not involved in training of any sort, nor were they aware of our special interest in language. Inclusion of this particular control group allowed direct comparison of infants who had used symbolic gestures to infants drawn from the same population who were progressing normally in terms of language development.

Control for Training Effects. In the process of training their infants to use symbolic gestures, the ST group parents were automatically focusing special attention on language development, interacting with their infants to a greater extent than they might normally in this domain. As a consequence, without a control for "training effects," it would be difficult to interpret any verbal language advantage of the ST group infants over the "pure" control group (i.e., the NC group); the source might simply be the fact that ST parents were paying particular attention to their infant's progress in learning to talk. In an effort to deal with this problem, a third group of infants, the Verbal Training (VT) group (n=32; 17 males and 15 females), was incorporated into the study as a second control group. Parents of these babies were encouraged to promote the acquisition of verbal language by consciously labeling as many things as possible during daily interactions. The experience of these families in the course of the study was made as similar as possible to the experience of the families in the ST group. As a consequence, just as was true of the Sign Training (ST) group families, the Verbal Training (VT) group families experienced increased social interaction between infant and parents, parental attention to language development, and/or feelings of pride on the part of the families for being part of an "intervention." If these factors, rather than symbolic gesturing, were responsible for accelerated verbal development, then one would expect the Verbal Training (VT) group, as well as the Sign Training (ST) group, to outperform the Non-intervention Control (NC) group on standardized measures. However, if the VT group does not outperform the NC group on these measures, while the ST group does, it becomes much more difficult to dismiss the ST group advantage as simply a function of language "training."

Baseline Measures. To assess the comparability of the groups at the beginning of the study, the three groups (ST, NC, and VT) were compared on a variety of demographic variables and baseline language measures. Demographic variables included sex, birth order, maternal and paternal education (4-pt scale: 1 = high school or less; 2 = some college; 3 = college graduate; 4 = post-graduate work), and family income (6-pt scale: 1 =$0-10,000; 2 = $10-20,000; 3 = $20-30,000; 4 = $30-40,000; 5 = $40-50,000; 6 = $50,000+). The language measures at 11 mos included a maternal report of verbal vocabulary (MacArthur Communicative Development Inventory, Fenson et al., 1993) and a measure of vocalization frequency during a 15-min play session. No significant differences between the groups were found for any measure.

Target Symbols. Although the eventual goal was to get families in the ST group to model many symbolic gestures (of their own invention) and families in the VT group to label many words, a more limited, well-structured task was presented as the initial goal for each family. Specifically, families in these two groups were asked to start by focusing on a specified set of "target" symbols chosen because they were known to be among the easiest to learn within each modality, the assumption being that the sooner parents perceived some effects of the training, the more likely they were to remain invested in the intervention. The target gestures included simple movements for five object and three non-object concepts: "fish" [SMACKING LIPS], "flower" [SNIFFING], "bird" [FLAPPING ARMS], "airplane" [SWOOPING HAND MOVEMENT], "frog" [FIST OPEN AND CLOSE], "Where is it?" [PALMS UP AND OUT], "more" [FINGER TO OPPOSITE PALM], and "all gone" [PALM DOWN, BACK AND FORTH]. The target words included "kitty," "doggy," "ball," "shoe," "boat," "bye-bye," "more," and "all gone."

Follow-up. Several steps were taken to ensure that the ST and VT families would, in fact, model the target gestures or words on a daily basis. First, toys representing the five object concepts for each group were sent home, along with instructions to incorporate the exemplar into a daily routine (e.g., mealtime, bath time, diaper changing, bed time). Second, each family was provided a large, colorful picture book full of examples of many objects, including the targets, to help them find multiple examples of each referent category.

Finally, mothers were advised that they would be interviewed by phone at 2-week intervals, starting 1 week after the orientation visit, and asked to describe in detail their modeling efforts and their infant's language progress. These calls were audiotaped and lasted between 30 and 90 minutes. The use of a speaker phone allowed one interviewer to ask questions and take notes by hand while a second interviewer entered answers directly into a computer record, interjecting his or her own questions when appropriate. Once the call was complete, the computer record was reviewed for accuracy by the interview team and passed along to one of the principal investigators for an additional review. This second review served to formulate questions for the next interview and provide any information parents were requesting.

The goal of these interviews was to gather information about the frequency with which each target symbol was modeled each day and the nature of any use by the child of gestures or words. Mothers

reported whether their child produced any gestures or words spontaneously (rather than as an imitation or as the result of elicitations, such as "What's that?") and, if so, what the context had been (e.g., what specific referent or referents had been labeled). To help jog mothers' memories, interviewers routinely asked whether a gesture or word had or had not been used with typical categories of referents (e.g., "fish" gesture to real fish, toy fish, pictures of fish, fish crackers). Because true symbolic status requires generalization to multiple exemplars, this latter information was important.

Laboratory Sessions

Infants from all three groups were tested in the lab at 11, 15, 19, 24, 30, and 36 mos, each session was videotaped, and a variety of standardized measures of both receptive and expressive language were administered. These included the following:

Vocalization at 11 mos. A baseline measure of each infant's vocal language was obtained using a time-sampling procedure. For each 5-sec interval of the 11-month free-play sessions between mother and infant, coders indicated whether or not the baby had vocalized. Coders were trained to a level of agreement of 90% or greater. The result was an estimate of the percentage of time the infant spent vocalizing.

MacArthur Communicative Development Inventory (CDI) (Fenson, et al., 1993). Although the CDI evaluates several aspects of language competency, it was used in the present study primarily to measure expressive vocabulary. Using a checklist format in which words are categorized semantically to aid recall, mothers indicated which words their children produced consistently. Instructions were given during each lab session before the questionnaire was taken home to be completed and mailed back to the lab. Mothers completed the Infant version of the questionnaire at 11 mos and updated it at 15 mos. The Toddler version was completed at 19 mos and updated at 24 and 30 mos.

Sequenced Inventory of Communicative Development (SICD) (Hedrick, Prather, & Tobin, 1984). The SICD assesses both receptive and expressive language skills in infants 4 to 48 mos. Receptive language abilities are measured through behavioral responses to a variety of verbal commands and assessment results in a receptive communicative age in mos (SICD/RCA). Expressive communicative age (SICD/ECA) is determined through the child's verbal responses to

questions and commands. SICD/RCA and SICD/ECA were determined during home visits at both 15 and 19 mos.

Receptive- and Expressive-One-Word-Picture-Vocabulary Tests (ROWPVT & EOWPVT) (Gardner, 1985). These tests provide receptive and expressive language ages for children between the ages of 2 and 12. To determine receptive language age, four pictures are presented on each trial and the child is asked to point to the one that depicts the meaning of the word (e.g., "Show me the shoe."). Expressive language age is determined by presenting a different picture on each trial and asking the child to label the picture (e.g., "What do you see here?"). Assessment continues until the child responds incorrectly to six consecutive items. Both measures provide scores in terms of language age in months. In the present study the ROWPVT and the EOWPVT were administered at 24, 30, and 36 mos.

Mean Length of Utterance (MLU) and Longest Utterance. A free play session at 24 mos was transcribed and coded to yield an MLU measure for each infant. The calculations were based on a corpus of 50 utterances. Coders were trained to a level of agreement exceeding 90%. In addition, the number of morphemes in the longest utterance among the 50 was recorded for each child, a measure referred to as "Longest Utterance."

Phonemic Discrimination Task. Early in our work on symbolic gesturing we had encountered concern on the part of parents that allowing a young child to rely on nonverbal forms of communication would diminish his or her sensitivity to the individual phonemes out of which vocal words are formed. The notion was that actively practicing the phonemes was critical to perceiving them. To assess this hypothesis, a Phonemic Discrimination Task was included. The task consisted of 21 pairs of one-syllable words that differed from each other in only one component sound, sometimes the vowel sound (e.g., ball and bell) and sometimes the first or last consonant sound (e.g., gum and gun; goat and coat). Pictures of the objects represented by each pair of words were shown to the child pair by pair. As each pair appeared, the experimenter asked the child to point to one of the items. During a second pass through the pictures, the child was asked to point to the remaining item. The total number of correct responses possible was 42.

Results

Acquisition of Symbolic Gestures

To determine if the independent variable had in fact been manipulated, initial analyses focused on whether the infants in the Sign Training group had acquired any symbolic gestures. The data relevant to this question came from the biweekly phone calls to the ST families during which parents described the contexts in which their infants used gestures to communicate concepts. The criteria used to determine when a gesture qualified as a "generalized symbol" were very similar to those used to assign symbolic status to infant gestures in Acredolo and Goodwyn (1988) and identical to those used for both gestures and words in Goodwyn and Acredolo (1993). Salient among these criteria were the following: (a) spontaneous usage by the child (i.e., not following direct modeling or elicitation), (b) occurrence in a stereotyped form, and (c) use in reference to multiple exemplars of the underlying concept beyond the specific context in which the item was initially taught. For example, use of a panting gesture for "dog" had to be extended beyond labeling just the family dog, and use of a gesture for "more" had to be extended beyond a particular routine such as asking for more cookies. The overall goal was to determine when gestures were, in Snyder, Bates, and Bretherton's (1981) terms, "context-flexible." The application of the rules described above was initially done by one coder. A second coder reviewed the interviews for 10% of the subjects. Inter-coder reliability was determined by calculating the number of agreements (i.e., both coders agreed on the interview date during which a specific gesture reached "generalized" status) divided by the number of agreements plus disagreements. Inter-coder reliability was 92%. The three universally acquired symbolic gestures, "bye bye," "yes," and "no," were not included in these analyses.

Applying these criteria, the mean number of symbolic gestures acquired by the infants in the ST group was 20.38 (SD = 12.64), with the mean for the boys (M = 20.69, SD = 12.5) almost identical to the mean for the girls (M = 19.69, SD = 13.81). In comparison, the highest mean number of symbolic gestures in our earlier studies of spontaneous development (i.e., where no special efforts were made to encourage the behavior) was only 5 gestures (Acredolo & Goodwyn, 1988). Thus, the ST parents' efforts to encourage symbolic gesturing was successful. The parental interviews also confirmed that the symbolic gestures enabled the toddlers to express observations about their daily life that were surprisingly detailed in nature. In this sense symbolic gestures reveal abilities that would otherwise go undetected. (See Table 1 for examples and Goldin-Meadow, 1998, for a parallel observation about the utility of the pointing gesture when added to single words.)

Insert Table 1 about here

Verbal Language Comparisons: Overall Strategy

The main goal of the study was to determine whether the experience of using symbolic gestures during the early stages of vocal development would affect development in a positive way. To be as precise as possible in drawing conclusions, the data analyses were organized to allow separate examination of receptive language development and expressive language development at each of the 5 ages (15, 19, 24, 30, and 36 mos), as well as composite receptive and expressive scores across all the ages. In addition, an overall picture of language ability was obtained by combining receptive and expressive language scores into an overall language score for each child at each age. Where more than one measure was contributing to a particular level of comparison (e.g., two measures of expressive language at a single age), the scores were transformed into z-scores and a composite score was obtained by calculating the mean of the relevant z-scores. For example, a composite expressive language score for each child at 15 mos was based on z-scores for two standardized measures, the CDI and the SICD/ECA. Whatever the level of the analysis (age specific or across age) or form of the scores (raw or composite), the performances of the different groups were compared using MANOVA analyses.

Verbal Language Comparisons: Assessing "Training Effects"

All the MANOVA analyses described above were first used to compare the language scores of the children in the Verbal Training (VT) group to those in the Non-intervention Control (NC) group to order to see if merely having parents involved in a language intervention program would facilitate development. The results clearly indicated that training effects were not a concern. Despite the fact that the families in the VT group, like those in the ST group, focused on labeling objects (with words rather than gestures), worked on particular "target" symbols, and were interviewed biweekly about language progress, the VT group did not significantly outperform the NC group on any measure. Moreover, on only two comparisons was there even a statistical trend favoring the VT group. Both involved measures at the earliest assessment (15 mos). They included a comparison of "Overall

Language Composite Scores" at 15 mos, F(1, 61) = 2.79, p = .05, 1-tailed, and a comparison of "Composite Expressive Language Scores" at 15 mos, F(1, 60) = 2.41, p = .06, 1-tailed. The specific nature of all of the comparisons (17 in all) performed between the VT and NC groups are made clear in the next section where the parallel comparisons between the ST group and the NC group are described.

Given that emphasizing verbal labels, as the VT parents were asked to do, would seem to increase child-directed speech -- a pattern predictive of faster language acquisition (e.g., Huttenlocher, Haight, Bryk, Seltzer, & Lyons, 1991) -- it is somewhat surprising that no effect of the VT training protocol was found. One possible explanation for the absence of significant differences between the VT and NC children, of course, is that the VT parents simply did not follow their instructions with the same enthusiasm as the ST parents did. In other words, perhaps the VT parents were not modeling verbal labels. To explore this possibility, data from the first five phone interviews (approximately the first 2.5 months) were examined with specific focus on parental responses to questions about the frequency of modeling the target symbols – target words for the VT parents and target gestures for the ST parents. Contrary to the preceding explanation, the VT parents actually reported engaging in significantly more modeling of their target symbols than the ST parents did (VT: M = 3.7 times per day, ST: M = 2.9 times per day, F[1, 63] = 4.06, p < .05). The absence of a training effect, therefore, seems unlikely to be the result of non-compliance on the part of the VT parents. In our opinion a more likely explanation for the absence of differences between the VT and the NC children is the possibility that the NC parents were also engaged in lots of labeling simply as a function of the population from which all the subjects were drawn: middle-class families from communities surrounding a major university. In other words, we may be seeing a ceiling effect for the impact of labeling on verbal language development at these early ages. Evidence supporting this hypothesis is found in the fact that the NC children, with no intervention at all, still performed better than the national norms on many of the language measures. (See Table 2 in a subsequent section.)

Verbal Language Comparisons: Does Symbolic Gesturing Facilitate Verbal Language Development?

Receptive language. Even though symbolic gesturing is a form of expressive language, it was conceivable that by enabling an infant to take an active role in conversations, which by definition require comprehension as well as production, symbolic gesturing might yield

earlier strides in receptive language development. To test this hypothesis, the ST and NC groups were first compared on a composite receptive language score that reflected each child's performance on all receptive measures across the span of the study. This score was obtained from averaging the z-scores for the SICD/RCA at 15 and 19 mos; the ROWPVT at 24, 30, and 36 mos; and the Phonemic Discrimination Task at 30 mos**.** The results of this MANOVA indicated that children in the ST group scored higher than those in the NC group (ST group: M = .21, SD = .73; NC group: M = -.10, SD = .72; F[1, 69] = 3.24, p = .04).

Parallel results were obtained when the groups were compared at individual ages using 2 (Group: ST vs. NC) X 2 (Sex) ANOVA's. (See Table 2 for component receptive language means at each age). No sex differences were found; however, the group comparisons yielded a difference that approached significance at 15 mos on the SICD/RCA, F[1, 69) = 2.14 p = .07) and then emerged as a significant ST advantage at both 19 mos on the SICD/RCA, F(1, 68) = 5.25, p = .01, and at 24 mos on the ROWPVT, F(1, 66) = 3.22, p = .04). Although the difference continued to favor the ST group over the NC group at 30 and 36 mos, the differences were not significant. These results suggest that, as we had hypothesized, symbolic gesturing fosters rather than hinders the development of language comprehension skills, especially during the second year.

Insert Table 2 about here

Expressive language. As important as receptive language is to researchers, parents are much more likely to measure language progress in terms of expressive language. In fact, when parents express reluctance to try symbolic gesturing with their children, they often argue that enabling a child to communicate nonverbally will decrease the child's willingness to do the hard work of learning to articulate vocal words. We were particularly interested, therefore, in comparing the expressive language scores for the two groups. As with receptive language, comparisons were made for a composite score encompassing scores from all 5 ages and for composite scores representing the specific expressive language measures at the individual ages. (See Table 2 for component expressive language means at each age).

The first comparison involved a composite expressive language score obtained by averaging the z-scores for each child's performance on each of the expressive language measures across the study. These measures included the SICD/ECA at 15 and 19 mos; the EOWPVT at 24, 30 and 36 mos; the CDI at 15, 19, 24, and 30 mos; and MLU and Longest Utterance measures at 24 mos. As in the composite receptive language analysis, analysis of the overall composite expressive language z-scores indicated a significant difference between groups, with the children in the ST group scoring higher than those in the NC group (ST group: M = .17, SD = .7; NC group: M = -.17, SD = .69; F[1, 69] = 4.12, p = .02). Overall, as with receptive language, the experience of symbolic gesturing stimulated rather than impeded expressive language development.

Parallel results favoring the ST group over the NC group were obtained at 15 and 24 mos in MANOVA analyses using composite expressive language z-scores from the individual ages. Specifically, at 15 mos the mean composite z-score for the ST group was .19 (SD = .68) compared to -.26 (SD = .79) for the NC group, a significant difference,

F(1, 59) = 5.46, p < .01. Similarly, at 24 mos the mean composite score for the ST group was .33 (SD = .84) compared to a mean composite score of -.20 (SD = .81) for the NC group, once again a significant advantage for the ST infants, F(1, 59) = 5.92, p < .009.

The group differences at the other three ages (19, 30, and 36 mos) also favored the ST group, with the difference at both 30 mos and 36 mos approaching significance. At 30 mos the mean composite z-score for the ST group was .25 (SD = .82) compared to a mean composite z-score of -.08 (SD = .83) for the NC group, F(1, 59 = 2.30, p = .067. At 36 mos the only measure of expressive language was the EOWPVT, on which the mean z-score for the ST group was .17 (SD = 1.05) compared to -.16 (SD = .82) for the NC group, F(1, 59) = 1.93, p = .08.

The overall pattern of ST superiority for expressive language revealed in these analyses should reassure parents and professionals concerned that encouraging symbolic gestures might backfire by slowing down a child's acquisition of vocal language. Indeed, these expressive language data, like the receptive language data, strongly suggest that there is a positive rather than a negative effect of the symbolic gesturing experience on learning to talk. At no age did the NC group significantly outperform the ST group in either expressive or receptive language ability.

In a real sense this is actually "old news." Motivated by similar concerns expressed by parents and professionals dealing with deaf children, Schlesinger and Meadow (1972) examined the effect on aural language learning of exposure to Signed English using videotaped sessions with a toddler named Ruth. Detailed analyses of the sessions over a 4- month period around Ruth's third birthday indicated an increase over time in her dependence on vocal language, both alone and in combination with signs. The data from the present experimental study certainly lead to the same conclusion for hearing children.

Verbal Language Comparisons: Syntactic Development at 24 mos

Verbal development before age 3 is not simply a matter of acquiring vocabulary items. In addition to vocabulary milestones, such as the first word and first 50 words, the appearance of two-word utterances at approximately 20 mos (Nelson, 1973) marks a very important transition in syntactical development. It is all well and good for a 24- or 30-month-old to have an impressive list of words in his or her repertoire, but if the ability to combine them into short sentences lags behind the norm, then claims about superior language development are misleading. With this in mind, we turn to a comparison of the ST and NC groups on the two measures specifically designed to tap syntactical development, MLU and Longest Utterance. Both were calculated from spontaneous utterances recorded during a play session at 24 mos and compared using one-way ANOVA's. As is apparent from Table 2, children in the ST group were significantly ahead of children in the NC group in MLU, $F(1, 62) = 3.16$, $p < .04$, and very nearly so in the case of the Longest Utterance, $F(1, 66) = 2.74$, $p = .05$. In other words, just as for other components of expressive language development, the experience of symbolic gesturing appears to have a facilitative rather than delaying effect on early syntactical development.

According to data reported by Bates and her colleagues (e.g., Bates, Bretherton, & Snyder, 1988), the ability to combine words into sentences at these early ages is strongly related to lexical vocabulary size. Correlational analyses relating MLU's for the ST children to their performance on expressive language measures (all at 24 mos) provide additional evidence supporting this theory. Specifically, performance on both the EOWPVT and the CDI were significantly related to MLU ($r = .41$, $p < .025$ and $r = .76$, $p < .005$, respectively). Based on these results it seems quite likely that the effect of symbolic gesturing on

MLU was mediated by the positive effect of gesturing on verbal vocabulary growth.

Verbal Language Comparisons: Receptive and Expressive Combined

To provide a "bottom line" summary of the effects of symbolic gesturing on language development in the first 3 years, two final analyses were conducted. In the first, overall language ability at the 5 individual ages was estimated by calculating a composite language score encompassing both receptive and expressive language measures. As had been true in the vast majority of comparisons to this point, comparisons of the ST and NC groups on these scores favored the ST group at all ages. MANOVA analyses indicated that the ST group advantage was significant at 15 mos, $F(1, 60) = 7.46$, $p = .004$; at 19 mos, $F(1, 60) = 3.17$, $p = .04$; and at 24 mos, $F(1, 60) = 5.99$, $p = .008$; and approached significance at 30 mos, $F(1, 60) = 1.76$, $p < .09$. The difference at 36 mos favored the ST group, but was not significant. In no case did the control group children outperform the gesture training children.

The second "bottom line" analysis, although somewhat unconventional, determined if the number of measures (not composites) favoring the ST group over the NC group (regardless of how much) was higher than would be expected by chance alone. The units of analysis for this comparison, therefore, were the 17 individual language measures (see Table 2). Of these 17 measures, 16 yielded a higher mean for the ST group than the NC group. A simple sign-test applied to these data indicated that it was very unlikely that chance alone could account for the high proportion of measures favoring the ST group ($p < .001$). Thus, at every level of analysis, the data are consistent in demonstrating an advantage in verbal language development for those children who were encouraged to include symbolic gestures in their early communicative repertoires.

Discussion

The results of the present study, particularly the comparisons between the Sign Training group and the Non-intervention Control group, strongly support the hypothesis that symbolic gesturing facilitates the early stages of verbal language development. In a significant proportion of the comparisons between these two groups, infants who augmented their fledgling vocal vocabularies with symbolic gestures outperformed those who did not. The fact that no such advantage was

found for the infants in the Verbal Training group provides reassuring evidence that the superior performance of the ST infants was not simply a function of their families being involved in a language-centered intervention program. The explanation seems to lie instead within the gesturing experience itself.

Explaining the Advantage

Increases in infant-directed speech. Among the most well documented factors affecting the rate at which language is acquired is the sheer amount of vocalization directed to the child (Huttenlocher, Haight, Bryk, Seltzer, & Lyons, 1991). One clue, therefore, to why symbolic gesturing is associated with more rapid verbal language development may lie in the way adults tend to respond to an infant who uses a symbolic gesture. As is true of early words as well, the use of a symbolic gesture to label an object or to make a request seems to "pull" language from caregivers as they acknowledge the infant's message or even elaborate on it: "Birdie? That's right! That is a birdie! Oh, there it goes flying away. Bye-bye birdie!" It follows, then, that the more things an infant can and does talk about, the more vocal language the infant will hear in return. Because symbolic gestures tend to be acquired more easily and at earlier ages than their verbal counterparts (Acredolo & Goodwyn, 1992; Goodwyn & Acredolo, 1993, 1998), infants with symbolic gestures in their communicative repertoires gain the benefits of such caregiver responses at earlier ages as well. In other words, a 14-month-old with a 10 word and 10 symbolic gesture vocabulary can elicit caregiver responses to twice as many different things as he or she could without the additional gestural symbols. In addition, it seems quite likely that caregivers who are purposefully encouraging symbolic gesturing by modeling them will be especially vigilant about acknowledging and reinforcing any attempts their baby makes to use them, thereby rarely missing an opportunity to flood the child with relevant vocal language.

Topic selection. A second factor known to contribute to faster rates of verbal language development is the degree to which the infant or toddler, rather than the parent, controls the topic around which joint attention episodes are organized. The classic demonstration of this relationship was provided in a study by Tomasello and Farrar (1986) in which the use of object names by mothers to refer to objects upon which the child was already focused was positively correlated with later vocabulary size. The explanation for this is obvious. Just as we all do, infants tend to pay better attention to things in which they are genuinely interested, as opposed to things in which others think they

should be interested. For example, a toddler at the zoo whose attention is riveted on birds hopping around underneath the elephant is not going to learn much that is useful from a parent who is conscientiously labeling the elephant over and over again! By increasing the number of labels the infant can produce spontaneously, a symbolic gesturing repertoire automatically increases the chance that parents will figure out what it is that the baby wants to talk about and shift their own focus to match. A shared focus, in turn, makes it much more likely that the vocal information the parent provides will make a lasting impression.

The power of "scaffolding." As typically used when researchers describe Vygotsky's (1978) social-cultural theory of cognitive development, the term "scaffolding" refers to guidance provided by adults that narrows the gap between a child's level of ability and the demands of a complex task (Wood, Bruner, & Ross, 1976). The goal is to increase the chance of the child succeeding by making the task a bit easier in some way. A good example occurs when adults help toddlers put together their first puzzles by giving them pieces already oriented in the right direction, or when mothers position babies facing them in order to introduce "roll the ball" or "peekaboo" games (Hodapp, Goldfield, & Boyatzis, 1984). In each case the children gain insights that help them learn their roles in these interactions, thus making future puzzles and games easier.

We suggest that there are several forms of scaffolding at work in the symbolic gesturing effect on verbal development. At a global level, by providing a way around the obstacle posed by the intricacies of spoken words, parents who encourage symbolic gesturing are enabling their toddlers to learn how valuable language can be. This knowledge, in turn, motivates the toddlers to explore all forms of communication – including the more demanding modality of spoken words. Just as learning to crawl increases rather than decreases a child's motivation to walk, use of gestures increases rather than decreases the child's motivation to talk.

At a more subtle level, the symbolic gestures themselves constitute a "scaffold" by enabling children to gather information about the symbolic function in general and about the specific objects, events, and conditions that make up their world. The child with a symbolic gesture for flower, for example, learns that one entity (i.e., a movement) can stand for a very different entity (e.g., flower) for the purposes of communication. He or she also learns that buttercups and dandelions are flowers, but that broccoli is not. Similarly, the child with

a gesture for "noise" can draw her father's attention to dogs barking outside, airplanes flying behind the clouds, or even sounds she can't identify. As a result of day after day of mini-lessons like these -- all in advance of the words themselves -- misconceptions are corrected, concepts are honed, and everything is set for the verbal equivalent to slip right in as a label when it does become available. Without symbolic gestures, much of this conceptual work would be delayed, thus slowing down the whole language learning enterprise.

Implications for Researchers

With symbolic gestures in their arsenal of research tools, researchers now have a new window into the puzzle of language development. Why is it, for example, that infants have such a hard time building their early vocal vocabularies even after the arrival of one or two symbolic words? Symbolic gesturing provides a clue. When infants successfully use a gesture before they can say the corresponding word, they are revealing the fact that much of the underlying work of learning that word has already been done. They obviously understand the concept or category or condition the gesture stands for; they obviously recognize the string of sounds (when voiced by the parent) as equivalent to their gesture; and they obviously have figured out the symbolic function as it applies to language. For these children, at least, the problem is clearly with the articulatory piece of the language puzzle. (See Acredolo, Goodwyn, Horobin, & Emmons, 1999, for other examples.)

Implications for Parents

Although the composite effect of the symbolic gesturing experience on verbal language was positive across the span of the present study, age by age analyses indicated more statistically significant effects early on. By the 36 month comparisons, the ST children were ahead of the controls, but not significantly so. Given that significant positive effects do not appear to last, one might wonder why parents should even bother with symbolic gesturing. The answer is clear to anyone who has lived with a toddler. The period after infants become mobile and before they can talk is a very difficult one for both parents and children. As the parents in the Sign Training group told us over and over again, the availability of symbolic gestures for at least some of the important things in their child's life made communication easier and interactions more positive. Request gestures (e.g., MORE, OUT) helped children get their needs met without crying, symbols for specific foods (e.g., GOLDFISH CRACKERS, CHEERIOS) provided important clarification,

animal gestures (e.g., MONKEY, ZEBRA, GIRAFFE) helped them become active partners during book-reading, descriptive gestures (e.g., HOT, HAPPY, AFRAID) helped them share important insights about their environment, and all of the gestures helped clarify the children's initial, crude verbal labels (e.g., "Oh! You're doing your TURTLE gesture. I guess Tata means "turtle!"). Here are just a few additional examples:

1. A 16-month-old, who awoke crying in the night, was able to point and use his "afraid" gesture (patting his chest) to let his mother know he was afraid of the clown doll on his dresser. Without the gesture, she might have put the doll in bed with him!

2. A 13-month-old excitedly produced his "crocodile" gesture while being strolled through the shopping mall. Mom let him out of the stroller and he toddled back to the store they had just passed and pointed to the Izod insignias on the racks of men's shirts.

3. A 14-month-old was able to use his "hot" gesture (blowing hard) to let his mother know when food was too hot, when his bath water was too hot, and even when the sidewalk at the pool was too hot.

Even these few examples provide tantalizing clues about the ways symbolic gesturing can facilitate and enrich interactions between parent and child. Clearly, our next challenge will be to systematically explore the socio-emotional effects of the gesturing experience. In the meantime, the good news from the present study is that parents need not worry about jeopardizing their child's vocal language development in order to take advantage of this easy alternative to words. In fact, these data demonstrate clearly that the symbolic gesturing experience seems to "jump start" verbal development. There is no reason, therefore, for parents not to simply relax and enjoy any and all symbolic gestures their baby acquires.

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Table 1.

Examples of Symbolic Gestures in Sign Training Children's Repertoires

Referent Gesture Example Usage

Drink Thumb to mouth DS: To ask for bottle

More Index fingers tapping BH: To ask to have picture taken again

Monkey Scratching arm pits KA: To alert dad to very hairy stranger approaching

Hat Patting top of head BH: To Grandma with towel around her head

Cheerios Index fingers to thumbs MR: To request more Cheerios

Fish Smacking lips together KA: To fish toy in tub and goldfish crackers

Water Rubbing palms together CH: With FISH gesture to fish in pond

Book Open/Close with palms AT: With MORE gesture to ask for another book

Pig Tap nose with finger TA: To potbelly pigs at county fair

Camera Hooked hand to eye BH: With MORE to ask for photo to be taken again

Fan One finger up & circling ZB: To helicopter

Gentle Petting back of one hand MB: When legs held too tight during diapering

Smelly Finger to wrinkled nose AZ: To comment on Grandma's bad breath

Afraid Pat chest repeatedly ZW: In response to barking dog approaching

Out Knob-turning action PB: With DOG gesture to indicate "Dog wants out"

Giraffe Hand around neck MR: To giraffes in books and at the zoo

Tractor Steering wheel action NP: When his farmer Dad drives up in his tractor

Where? Palms up KA: When airplane disappeared into the clouds

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Note. Individual children indicated by initials.

Table 2.

Mean Language Age in Mos (and Standard Deviations), Percentile Ranks, or Raw Scores for Sign-Training (ST) vs. Non-intervention (NC) groups on Receptive and Expressive Language Measures at 5 Ages.

Group

Participant Age (and Tests) ST (n = 32) NC (n = 39)

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15 Mos

SICD/RCA[a] 18.4 mos (2.9) 17.3 mos (3.1)

SICD/ECA[b] 17.5 mos (3.17) 16.1 mos (3.11)

MacCDI[c] 60.9 (25.6) 48.9 (30.3)

19 Mos

SICD/RCA 24.4 mos (3.2) 22.7 mos (3.1)

SICD/ECA 21.0 mos (2.92) 21.4 mos (3.10)

MacCDI 52.0 (24.0) 40.3 (30.0)

24 Mos

ROWPVT[d] 29.2 mos (6.3) 26.3 mos (6.9)

EOWPVT[e] 27.4 mos (9.39) 24.2 mos (7.9)

MacCDI 59.1(24.4) 49.8 (29.7)

MLU 2.26 (.8) 1.94 (.66)

Longest Utterance 5.26 (1.88) 4.53 (1.80

30 Mos

Phonemic Discrimination 35.5[f] (3.92) 33.7 (5.19)

ROWPVT 38.6 mos (10.0) 36.9 mos (11.0)

EOWPVT 36.3 mos (10.4) 34.3 mos (9.8)

MacCDI 55.5 (25.7) 45.5 (26.6)

36 Mos

ROWPVT 47.2 mos (11.4) 46.7 mos (11.5)

EOWPVT 47.0 mos (12.2) 42.5 mos (9.7)

Note.

[a] Sequenced Inventory of Communicative Development: Receptive Scale (Language Age)

[b] Sequenced Inventory of Communicative Development: Expressive Scale (Language Age)

[c] MacArthur Communicative Development Inventory (Mean Percentile Rank)

[d] Receptive One-Word Picture Vocabulary Test (Language Age)

[e]Expressive One-Word Picture Vocabulary Test (Language Age)

[f] Mean score out of 42 items