The Signs of Language Revisited

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An Anthology to Honor Ursula Bellugi and Edward Klima

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Explorations of Enhanced Gestural Input to Children in the Bimodal Period

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When Ursula Bellugi began her studies of American Sign Language (ASL) in 1970, she gathered around her a congenial cohort of graduate students from UCSD's departments of linguistics and psychology plus talented collaborators: Bonnie Gough translated the English sentences we pitched at her into ASL, Susan Fischer added analysis, and Ed Klima raised problems. Ursie, then as now, did everything and ran everything. I have one sharp snapshot in my mind's eye of the earliest days of the weekly research meeting: In a not-yet-furnished suite of rooms in The Salk Institute, several of us sat at a round table on brightly colored little plastic stools shaped like angular hourglasses. On the table were pads of paper that we filled with our puzzlements and in the center were shards of Hershey's Special Dark chocolate that we communally munched. My colleagues who study false memory have made me cautious. After visiting Ursie's new lab last spring and discovering her mental album did not contain the same snapshot of the old lab, I was inspired to check with a couple of other members of the group. The chocolate was confirmed immediately, and the stools eventually (by a member of the next cohort).

There is a different snapshot that everyone recalls and everyone except me finds amusing: Asked to form a "D" while trying to learn fingerspelling, I formed an "F" instead and replied to the group's protests by repeatedly insisting "It *is* a D!!" This error illustrates one of the group's early findings: Formationally similar handshapes can be confused in sign, just as formationally similar sounds can be confused in speech (Siple, Fischer, & Bellugi, 1977). Although with practice I became less confused, regrettably I never became proficient in fingerspelling or ASL. Instead, I put most of my efforts into my dissertation on memory for verbs (aided by Ed and Ursie, who both served on my committee). Then I took a position at Rutgers and there my interest in language and cognition took a developmental turn. The desire to understand change and then origins pulled me eventually all the way back to the second year of life, and I couldn't help bumping into the manual modality again—now in a different role than it plays in sign language, an earlier role that is transitional toward any language.

In this chapter I discuss a few pieces of my own and others' research comparing the vocal and manual/bodily modalities.[1] I owe to Ursie and Ed my interest in examining more than one kind of language input, especially involving the manual modality, and I share their more recent interest in examining more than one kind of language learner. I also have a particular interest in considering variability in addition to average values in examining outcomes for particular kinds of input and learner. My data points are in a sparse region of the research space that only slightly overlaps Ursie and Ed's galaxy of findings, but I hope to be convincing that this region is part of the foundation for the whole story of language.

My region of the research space is defined in part by its focus on the single-word period of development (typically in full bloom at 12 to 19 months of age, although it begins as early as 9 or 10 months for some children and continues until 26 months or later for others). When children move beyond this period by beginning to combine words into structured sequences, usually they carry forward a starter vocabulary that betokens the influence that adult culture has already imposed. But the single-word period is distinctive in a number of ways that have more to do with the concerns and competencies of 1-year-olds than with the form of parental language. One characteristic is that early words are connected to nonlinguistic contexts, not to other words. Another is that they develop slowly

[1] Although manual movements are the most noticeable forms involved in gesturing or signing, other bodily movements are important as well. For example, children learn early that a headshake can convey refusal, and in ASL a variety of grammatical (and even lexical) roles are performed by head postures and facial expressions (see Reilly, chap. 22, this volume). I generally use *manual modality* as an abbreviated term of reference for *manual/bodily modality*.

and not always linearly. For example, at 13 months, a child might start saying *kuh* whenever she wants her cup; the word may then fade away until it reappears at 20 months—less bound to context and more adultlike in pronunciation.

A third characteristic of the so-called single-word period prompts me to call it the *bimodal period* instead: During these intriguing months, gestures can play a role as important as that of words. Our illustrative child might reach for the cup while saying *kuh* or might even put her hand to her lips instead of saying *kuh*.

A number of investigators compared the manual and vocal modalities as vehicles for early communication and symbolization. In brief (some details follow), they found that the two modalities are approximately *equipotential*, with three caveats: (a) by at least one indicator (early, spontaneous production of words and signs), manual forms have an advantage over vocal forms; (b) by another indicator (elicited production of words and signs for children whose exposure to sign begins after 12 months), it is vocal forms that have the advantage; but (c) more important than isolated differences in mean performance is the fact that individual children vary dramatically in their spontaneous production in each modality, often for no discernable reason. Data distributions stretch as wide in the manual modality as in the vocal modality when carefully defined (contrary to my initial expectation), and under some circumstances, all possible individual patterns are well-represented (manual and vocal vocabulary both high or both low; manual leading vocal; and vocal leading manual). Although striking, this variability is transitory: As children exit the bimodal period, they typically acquire the language of their parents, whether it is signed or spoken. Acquiring such a language requires, among many other capabilities, procedures for rapid acquisition of the physical form of numerous lexical items. At the end of this chapter, I present data suggestive that such procedures can be equally powerful in both modalities—one of several incarnations of human bimodality that lie beyond the bimodal period.

Our understanding of the bimodal period comes primarily from studies of children growing up in naturally occurring input situations, in which parents make some use of gesture but primarily communicate via a structured language. When this is a spoken language, such as English, researchers generally compare children's words to their manual gestures. This is informative about the most typical course of events, but any differences between words and gestures could be due to differences in the qualities and quantity of parental input rather than something about the modalities as such.

Although gestures are forms that are used intentionally to express meanings, like the vocabulary of a language, parental gesturing lacks syntactic structure and other kinds of systematicity that permeate parental language. Gestures also have a restricted range of functions: For both parents and children, gestures tend to be deictic, performative, interactive, social, and/or routinized (e.g., pointing, reaching to request an object, nodding yes, waving bye-bye). Words can perform these functions, but more notably, they can be disembedded from actions and interactions in order to convey information. For example, common nouns can be used to descriptively refer to a class of animate or inanimate objects or to a member of a class; proper nouns can be used to nondescriptively refer to a particular individual; and verbs and adjectives can be used (in part) to specify actions and attributes. The earliest such uses collectively can be called *labeling* (or *naming*). When words are combined syntactically, reference gets more complex and predication becomes a separate function (see McNamara, 1982). Hence, it is important to observe children acquiring a signed language such as ASL, for whom input in the manual modality exhibits systematicity and a full range of functions, and to compare acquisition of signed and spoken languages.

In naturalistic studies of this kind, input in the manual modality has been treated essentially as a binary subject variable: A child has been exposed either to ordinary gesturing (along with spoken language) or to a signed language (along with gesturing and varying degrees of exposure to spoken language). My own research originated in the following question: What if gestural input is enhanced within an otherwise ordinary spoken-language environment so as to include a number of gestures for animate and inanimate objects, actions, and attributes? Deliberately manipulating the manual-input variable in this way opens up a previously empty region of the research space. As it turns out, most 1-year-olds take to *enhanced gestural input* like ducks to water, and this motivates adults to engage in an increasing flow of gestural interaction.

To enhance input in the manual modality, an adult learns or invents new gestures (sometimes by adapting existing forms) and uses them simultaneously with selected nouns, verbs, and adjectives in the speech stream. These gestures inherit the meanings of the words they accompany and thereby gain the potential to function not only as requests but also as labels and later in more advanced ways. With some hesitation at proliferating terminology, I use *object-related* as a relatively neutral term for gestures (or words) that specify animate and inanimate objects and their actions and attributes; then such terms as *request*, *label*, *reference*, and *predication* can be added to convey their emerging functions.

Like words, such object-related gestures should not be bound to particular contexts, but sometimes they start out this way for children in the early bimodal period. For Linda Acredolo and Susan Goodwyn, who have done the most extensive research on what I call enhanced gestural input, such gestures qualify as *symbolic gestures* once they satisfy certain criteria (Goodwyn & Acredolo, 1993; Acredolo, Goodwyn, Horobin, & Emmons, 1999; based in part on Snyder, Bates, & Bretherton, 1981): (a) multiple uses (e.g., a word must be reported in at least three biweekly parent interviews); (b) spontaneous use (vs. imitated or elicited); (c) noninstrumental use; (d) context-flexible use, as evidenced by more than one exemplar of the same class (possibly including an absent referent), the same exemplar in more than one situation, or the same exemplar in more than one function (usually requesting and labeling). Two additional criteria have the effect of excluding symbolic play schemes, such as briefly putting a toy cup to the lips: (e) the gesture must be communicative in intent; and (f) it must be empty-handed. Some investigators use the term *referential* equivalently to *symbolic*; others use it equivalently to *object-related* (encompassing both symbolic and nonsymbolic usage); and some restrict it to nominals.

In the remainder of this chapter, I sketch some of the most salient results on the bimodal period obtained from naturally occurring input situations and then show how research on enhanced gestural input produces a more complete picture. Just 11 of the participants in my own study of enhanced gestural input were typical bimodal-period children at onset (and 3 others were older). Hence, any persuasive power of this picture relies heavily on the work of others—especially the unparalleled contributions of Acredolo and Goodwyn.

NATURALISTIC STUDIES OF THE BIMODAL PERIOD

Children Acquiring a Spoken Language

At first glance, the two modalities seem to play quite different, complementary roles in the bimodal period and to develop by different timetables for children acquiring a spoken language. A deeper look uncovers the potential for greater parity.

Milestones. The initial milestone events are the emergence of the first few gestures in the few months preceding the first birthday, followed by the appearance of the first word close to the first birthday (on average). The inventory of gestures and words increases across the next half-year (slowly and steadily for most children), but then gestures level off as words burgeon. (This transition was already underway for most of the 20-month-olds studied by Capirci, Iverson, Pizzuto, & Volterra, 1996.)

Forms and Functions. The earliest gestures are nonsymbolic and context bound. They also are remarkably similar across children and include ritual requests, showing, giving, and communicative pointing (Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979). Later gestures are more diverse, but still most are deictic, performative, social, and/or embedded in routinized actions or interactions. Often these are imitative (e.g., finally waving bye-bye in response to a parent who has been enthusiastically waving and saying "bye-bye!"), but some gestures are invented and initiated by the child (usually by adapting them from a song or other routine involving gestures or from an action schema, e.g., raising both arms as a request to be picked up). In form, the prototypical gesture is manual (a handshape or movement of one or both hands and arms, for example, an extended arm and clenched-unclenched hand as a ritual request), but as already noted, some gestures involve other bodily movements. What all gestures have in common is that a reasonably consistent form in the manual/bodily modality is used intentionally to express a reasonably consistent meaning or function and that their primary connections are to contexts and vocal forms, not to other gestures. (Limited kinds of gesture combinations make an occasional appearance, as described later; they reflect an important transitional capacity to combine elements but do not rise to a level I would credit as truly syntactic.)

Words also are meaning-bearing forms, but they occupy a particular, intermediate level (between morphemes and phrases) in the sentences of a culturally transmitted language. Hence, by definition they *can* and must be combined syntactically and *cannot* be wholly invented by the child—two characteristics, beyond modality, by which they apparently differ from ordinary gestures. Also, as noted earlier, words seem to exhibit a broader range of functions than do gestures and in particular are used symbolically (e.g., as context-flexible labels for a class). Generally, at least some of the first 10 words qualify as symbolic (about half for "referential" children and about two for "expressive" children according to Harris, Barrett, Jones, & Brookes, 1988).

More on Forms and Functions. That is the rough sketch. Digging a little deeper reveals that most of the differences are not absolute. First, *words are not as distinct from gestures as they first appear.* Children in the bimodal period use a variety of vocal forms meaningfully. As shown by Halliday (1975) for one child in detail, some are clearly idiosyncratic and transitory and others apparently have their origins in the adult words they resemble. Including all of these in the inventory of vocal forms studied (i.e., not limiting the count to those that approximate adult words) should reduce both the age of emergence and the percentage that are object-related, increase the number that are context bound, and add some that are invented—making the vocal modality more similar in these respects to the manual modality. In fact, investigators such as Bates et al. (1979) and Lock (1980) used the term *vocal gestures* for certain early vocal forms, thereby emphasizing how they functioned rather than whether their forms resembled words. For arguments that the earliest signs and words may have little if any real distinction from idiosyncratic manual and vocal gestures used at the same age, see Abrahamsen, Cavallo, and McCluer (1985), Caselli and Volterra (1990), and Volterra and Caselli (1985).

Despite their resemblance to adult forms, it is not until signs or words become incorporated into a structured linguistic system that they complete the process of differentiation from gestures and forever leave behind the bimodal period. The insufficiency of form alone as the child exits the bimodal period struck Bellugi and Klima (1982) when they noticed that children's mastery of gestural pointing did not ease the transition to use of the same forms within the pronominal system of ASL. The hard part was developing the underlying system, a process traced by Pettito (e.g., 1988).

Just as important to this deeper look, *gestures are not as distinct from words as they first appear.* Children can and do use a small number of gestural labels, even without enhanced gestural input. The most impressive demonstration is in the doctoral dissertations of Susan Goldin-Meadow and Heidi Feldman (see Feldman, Goldin-Meadow, & Gleitman, 1978). Observing children who were receiving spoken language input (but Deaf and therefore not in a position to encode much of it), they found that these children invented numerous "characterizing gestures." Defined similarly to object-related gestures, these clearly attained symbolic status. Eventually they entered into combinations with each other and with deictic gestures (pointing or showing); importantly, many of these expressed relational meanings between two symbols (e.g., Agent + Action). This research provided a formal description of the *homesign* manifestation of linguistic capacity.

A skeptic might respond that necessity was the mother of invention for these children, but Goldin-Meadow and Morford (1985) and others have demonstrated that even ordinary hearing children in an ordinary spoken-language environment invent or pick up a few object-related gestures. Caselli (1983) observed the following developmental sequence (reexpressed in our current terminology): context-bound deictic gestures, context-bound object-related gestures, and finally (around the same time as early words), context-flexible object-related gestures. Volterra (1983) replicated this decontextualization of gestures, and she ascribed symbolic status only to those that were fully context flexible (rather than those that had reached an initial level of context flexibility as in Acredolo and Goodwyn).

The first studies of object-related gestures that involved more than a handful of children were by Acredolo and Goodwyn (1988). In their longitudinal study, 16 mothers kept weekly records of their children's gestures and contexts of use from age 11 months to 20 months. Counting only those gestures that met symbolic criteria, the number per child ranged from 1 to 17 (mean 5.06). The average child had two or three object gestures (usually based on an action performed *on* an object, e.g., sniffing to name FLOWER, or an action performed *by* an agentive object, e.g., panting to name DOG), one or two request gestures (e.g., making a knob-turning movement to request going OUT or moving the hands up and down to request playing the PIANO), and one attribute gesture (e.g., blowing with the mouth for HOT or raising the arms for BIG). Similar results were obtained in a cross-sectional study in which 38 mothers of 16- to 18-month-olds were interviewed (range 0–16 and a mean of 3.9 symbolic gestures—a slightly smaller mean because there is one less gesture in the object category, on average).

More recently, Volterra and her colleagues have expanded their investigations to examine the number and kinds of gestures used by children acquiring Italian (see Volterra & Iverson, 1995). Based on a parental questionnaire for 23 children at 12 months (and not applying symbolic criteria), they found the average child had 11 gestures and 5.5 words. These and other findings indicated to them that presymbolic communicative development is bimodal but may exhibit a gestural advantage for at least some children.

Later they videotaped 12 of the children at 16 and 20 months of age interacting with the mother. One of the most valuable aspects of this project is their decision to code every conceivable kind of gesture (Iverson, Capirci, & Caselli, 1994). In the vocal modality, their word counts included nonword forms with fixed reference (e.g., *baba* for bottle) but not such forms as the urgent *uh uh uh* that may accompany a reaching gesture. (Inclusiveness must be considered when comparing manual and vocal counts.)

Iverson et al. (1994) found that variations on the usual four deictic gestures were prominent, yielding 82% of the tokens at 20 months. There were just 58 additional gesture types across the 12 children at 20 months; they called this mixed bag of nondeictic gestures "representational gestures." Among them, 26 (about 2 per child) were labels: 8 were empty-handed object gestures (usually based on a related action) and 18 specified predicates (actions like DRIVING or attributes like TALL). Another 23 were conventional (social and routinized gestures, such as waving BYE-BYE, shaking the head NO, or putting a finger to the lips for QUIET), 4 were predicates for which an object was in hand (e.g., SQUEEZE a lemon), and 5 were object gestures for which an object was in hand (e.g., briefly "drinking" from a cup as an enactive name, CUP; these are usually regarded as playing a transitional role into symbolic play and have been studied extensively by Bates and her colleagues). In the earlier session (age 16 months), there were 39 different representational gestures with a somewhat different distribution across these subcategories (e.g., fewer predicates, more gestures with an object in hand).

Volterra (1983), Goldin-Meadow and Morford (1985), and Capirci et al. (1996) all found as well that gestures play a transitional role toward syntax by providing a vehicle for simple two-item combinations. Gesture + Gesture combinations usually emerge first (around 15 months). However, in contrast to the findings on Deaf children, one or both of the combined gestures is always deictic (e.g., POINT [at cookie] + GIVE). Within 1 to 3 months, Word + Gesture combinations arise and quickly dominate—especially semantically redundant (and usually simultaneous) combinations like POINT [at cookie] + *cookie* or BIG + *big*, but joined within another 1 to 3 months by more informative combinations like SHOW [torn page] + *broken*. After yet another 1 to 3 months (about 6 months after the first two-gesture combinations), Word + Word combinations make their appearance, and this is finally the means by which two object-related symbols get combined (e.g., *little* + *kitty*). (There is only one example across the three studies of a combination that included two object-related or other representational gestures.) Soon thereafter, truly syntactic utterances sprout in the vocal modality. Individual object-related gestures show little further elaboration, but a flow of gesturing that is temporally coupled to speech eventually develops (David McNeill called this "gesticulation" and published a landmark book exploring it in 1992).

Children Acquiring a Signed Language

What happens when the referential potential of the manual modality is given the same kind of encouragement as is typically available in the vocal modality? Some preliminary answers are available from studies of children whose parents use a signed language such as ASL as the primary language in the home.

Folven and Bonvillian (1991) provided the most extensive data on the developmental sequence by which various functions emerge in the manual modality for children whose primary language environment is ASL. They combined diary and videotaped data in a longitudinal study of 9 children (8 hearing, 1 Deaf) with at least one Deaf parent. When a child formed a recognizable ASL sign in an appropriate context, it was classified as nonreferential if it imitated an immediate model, was part of a routine, anticipated a familiar routine, or named a familiar action. A sign was classified as referential if it was used for "naming new things," such as DOGGIE for an unfamiliar dog or CRY when a baby is crying in a store . Because they based this criterion on Bates et al. (1979), it is likely that varied but not completely unfamiliar exemplars were sufficient. To maintain a consistent terminology within this chapter, I call their referential forms *symbolic signs*. However, it should be noted that for Folven and Bonvillian (1991), this class did not include forms used only to request familiar items, whereas Acredolo and Goodwyn would credit them if multiple exemplars or situations were involved.

Consistent with earlier work by Folven and Bonvillian, signs appeared at earlier ages than are usually cited for words: the first sign occurred by a mean age of 8.2 months and the first 10 signs by a mean age of 13.6 months ($n = 9$). Several investigators had criticized the original claim of early signs on the grounds that inadequate functional or linguistic criteria had been applied (e.g., Pettito, 1988). Indeed, when Folven and Bonvillian limited their analysis to signs qualifying as symbolic ($n = 8$ because contextual information was not available for one child), the first sign was not credited until a mean age of 12.6 months—4 months later than the first nonsymbolic sign and about the same time that most children produce their first symbolic word. In the interim, the four usual deictic/performative gestures appeared, a sequence consistent with other studies in which pointing precedes the first symbolic word. Finally, the children in this study had varying amounts of exposure to spoken language despite the predominance of ASL in their homes. Their first words (both symbolic and nonsymbolic) were observed at an average age very close to that of their first symbolic signs.

With smaller numbers of children involved, Caselli (1983) and Volterra (1983) both found that their own characterizations of gestural development applied equally to children acquiring a spoken or a signed language. For example, Volterra studied 3 children learning Italian and 1 learning Italian Sign Language (LIS) and found developments in the manual modality to be the same until the point at which the child learning LIS produced combinations of two representational items in the manual modality. Those learning Italian produced combinations of representational items only in the vocal modality. Most important here, though, is that all of the children in both studies—whether their primary linguistic input was signed or spoken—did attain a small inventory of object-related (and other representational) gestures.

Taken together, the research results on children acquiring a signed language and those acquiring a spoken language suggest that the earliest signs may not really differ from gestures during the bimodal period of development. In addition to inventing their own gestures, which eventually meet symbolic criteria, both sets of children pick up some of their parents' gestures. Those whose parents use a signed language also pick up some of their parents' signs, using the same process of approximating a parental model. The difference comes at the end of the bimodal period, when only those children who are acquiring a signed language start combining object-related forms in the manual modality. As Volterra has argued, only then are the child's signs actually signs (vs. symbolic gestures that resemble parental signs).

The most obvious way to move more deliberately toward a within-subjects strategy would be to study hearing children with one Deaf and one hearing parent who get lots of exposure to both a signed language and a spoken language (usually not simultaneously). Data do exist on this kind of situation, but generally limited to individual cases (e.g., one is briefly discussed by Meier & Newport, 1990). A good way to get much larger amounts of quantitative data on the consequences of bimodal input is to make enhanced gestural input available to children. A bonus to such a strategy is that the results can then be compared to those on ASL acquisition to get some idea of how much difference the considerable reduction in manual input makes. Hence, we turn now to the question raised earlier: What if gestural input is enhanced within an otherwise ordinary spoken-language environment so as to include an unusually large number of object-related gestures?

ENHANCED GESTURAL INPUT DURING THE BIMODAL PERIOD

Studies of enhanced gestural input occupy a previously almost-empty region of the research space on language acquisition. Figure 20.1 is a sketch of the part of this space that is formed by two dimensions for the nature of *input to the learner* and one dimension for different *types of learners*. Some salient research areas and researchers are located within the space. Not shown are dimensions involving the *age of the learner*, such as the age at which input begins and the age at which language is being assessed; these ages lie somewhere within the bimodal period for most of the research areas shown.

The first thing to notice is the positioning of enhanced gestural input on the manual input dimension. That dimension is anchored by two naturally occurring types of input—ordinary gesturing and ASL—and between these lie a variety of systems deliberately designed to accompany speech. Many borrow signs from ASL, but in construction and purpose they break into two distinct groups: Enhanced gesturing can be viewed as an extension or enhancement of ordinary gesturing, whereas Manually Coded English (MCE) systems are sign–speech hybrids that manually encode aspects of English grammar and morphology and obtain a large open-class vocabulary from ASL citation forms and, often, fingerspelled English words.

Enhanced gesturing has ordinary gesturing as its base but adds some 10 to 100 open-class vocabulary items (usually signs borrowed from ASL or gestures that are adapted from action schemes or invented; for the learner, they inherit the meanings of the English nouns, verbs, and adjectives that they accompany). The resulting inventory of gestures is much more heavily loaded in the object-related category than is ordinary gesturing, and may feature some additional social gestures as well (e.g., HELLO, I-LOVE-YOU). Although more than one word in a sentence may be accompanied by such gestures, there is no explicit encoding of syntax or grammatical morphology in the manual modality—not that of English or ASL or any invented system.

The systems themselves are not so much a continuum as a binary dimension that has sprouted variants engineered to be more Englishlike. However, they are ordered left-to-right to represent increasing frequency with which a child is likely to be exposed to object-related gestures or signs.[2] The second dimension comes closer to being a continuum; it cap-

[2]Note that this differs in a number of respects from Adam Kendon's continuum (see McNeill, 1992, pp. 37–40). Kendon's goal was to isolate and define different types of gestures, whereas the manual input dimension distinguishes different input situations (each a particular mix of different types of gestures).

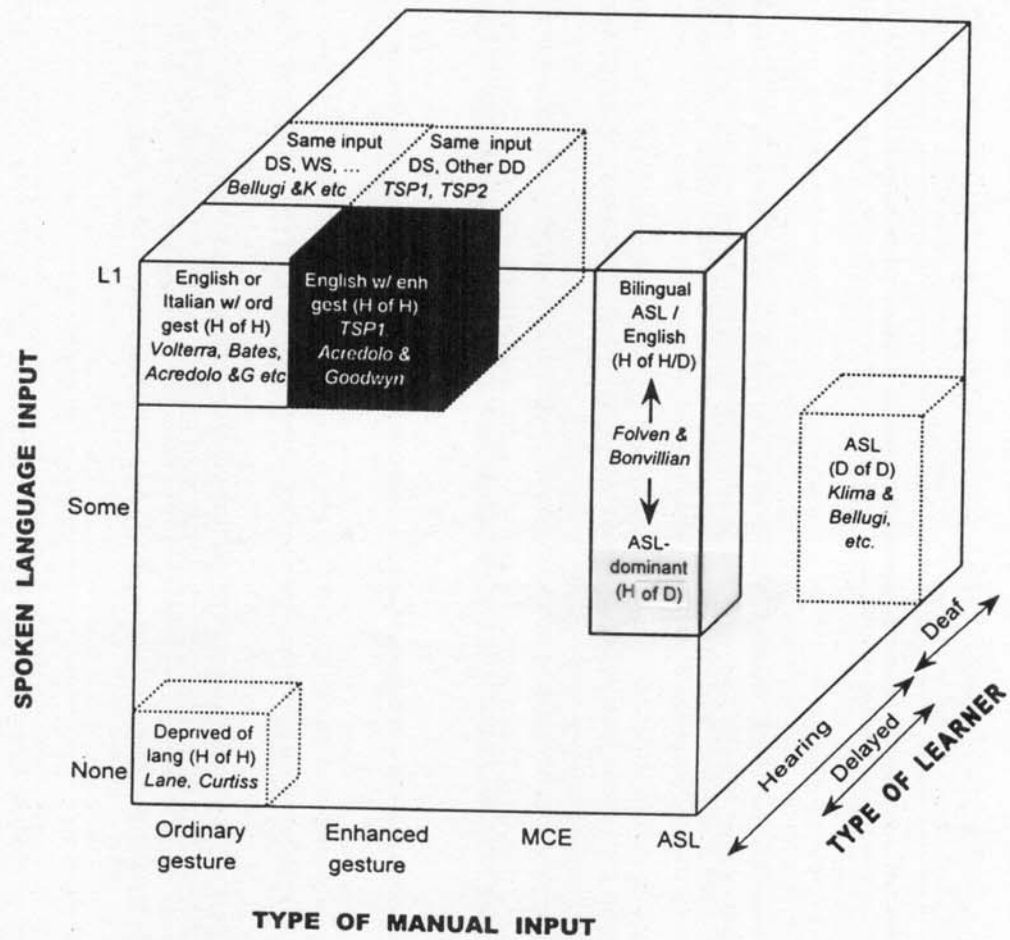

FIG. 20.1. Part of the research space for language emergence in two modalities. Research areas (labeled interior cubes) are each situated at the intersection of a particular manual and vocal input situation and a particular type of learner. Comparisons across research areas enable a better understanding of bimodal development. For example, the current chapter examines studies along the top front edge of the research space (cubes with solid borders), in which typical children provided with enhanced gestural input (black cube) are compared with similar children exposed to ordinary gesture or to ASL. Note that the original compelling comparison by Bellugi and Klima that inspired others to search and research this space involves naturally occurring input situations at two far corners: findings on Deaf individuals acquiring and using signed languages considered against the body of knowledge about hearing individuals acquiring and using spoken languages. More recently, they pioneered comparisons of Williams syndrome (WS) to Down syndrome (DS); this region, and others not discussed in the current chapter, have dotted borders.

[2] Note that this differs in a number of respects from Adam Kendon's continuum (see McNeill, 1992, pp. 37–40). Kendon's goal was to isolate and define different types of gestures, whereas the manual input dimension distinguishes different input situations (each a particular mix of different types of gestures).

tures the fact that exposure to spoken language may range from none through the level typical of a first language.

It turns out that enhanced gesturing along with speech is a highly appropriate environment for children in the bimodal period. It appears to be even better suited than ordinary gesture to the mixing of modalities that characterizes this phase of development. However, enhanced gesturing had its origins in attempts beginning in the 1970s to adapt simultaneous communication to the needs of older hearing children with delayed speech due to such conditions as autism, cerebral palsy, and Down syndrome. Usually the original intention was to make structured language available in the manual modality, and it was not uncommon for the earliest papers to identify that language as ASL. However, the actual input (and output) tended to be closer to enhanced gesturing than to any natural or designed sign language. In any event, these signs qua gestures did prove to be more easily learned than words for many of the participating children.

It occurred to me that there would be considerable benefit in filling a then-empty region of the research space by making enhanced gestural input available to a different population of learners: normally developing hearing children who were in or near the bimodal period of development. First, the results could be inserted into the gap between those on ordinary gesture (at one extreme) and early ASL vocabulary (at the other extreme) to get a more complete picture of each modality's potential during the bimodal period. This newly occupied part of the research space is shaded in Fig. 20.1 (black cube), and the comparison areas have solid borders. Second, if delayed children (older, but developmentally in the bimodal period) were provided with the same enhanced gestural input, we might begin to uncover the developmental roots of later modality assymmetries in particular subgroups of children. This region is directly behind the black cube (with dotted borders).

In the remainder of this section, I focus on the first goal: understanding the typical range of achievements in the two modalities during the bimodal period. I begin with a very brief overview of Toddler Sign Program 1 (TSP1), which I developed in order to study the consequences of using enhanced gestural input along with spoken English for a variety of children (see Abrahamsen et al., 1985, for more details). Then I turn to newer studies from Acredolo and Goodwyn, who followed up their naturalistic research by designing a very user-friendly variety of enhanced gestural input and obtaining extensive data on a large number of children. To my knowledge, these two sets of studies are the primary sources of information on typical development when enhanced gestural input accompanies adults' child-directed speech.[3]

Toddler Sign Program: Overview and a Prediction

Design of enhanced gestural input. In the 1980s, my collaborators and I provided enhanced gestural input to several groups of children. When originally designing our bimodal input, a convergence of considerations led to the decision to use signs borrowed from ASL simultaneously with corresponding target words of English. ASL signs were not the only possible manual forms (Acredolo and Goodwyn used invented, iconic forms), but they were familiar and convenient. Omitting any independent syntax or morphology from the manual modality was also not the only possible decision, but I viewed it as the only reasonable one for two reasons. First, I knew it would be difficult to bring any appropriate sign grammar into alignment with the grammar of English for use in bimodal utterances. Second, the input had to be within the grasp of adults with little or no previous experience with sign language—teachers, parents, and research assistants.

Because my interest was in vocabulary acquisition prior to syntax, I decided to make explicit that only a small target vocabulary would be bimodally expressed; I called this *unbalanced bimodal input* because grammar and many words were instantiated only in the vocal modality, and because input was simultaneous in the two modalities. I also suggested that, properly speaking, the children's signs should be referred to as *sign-gestures* if nonsymbolic, *sign-symbols* if symbolic (symbolic signs or gestures in the terminology of the current chapter), and *signs* if linguistically structured (Abrahamsen et al., 1985, pp. 183–184; cf. the terminology proposed by Erting & Volterra, 1990, and an earlier 1986 version reproduced there). Then, as now, I usually left these distinctions implicit, using the term *sign* in a second, superordinate sense for convenience in referring to our target vocabulary. Most often, these items would have qualified as sign-symbols (but not as linguistic signs) when used by the

[3]Holmes and Holmes (1980) contributed a pioneering case study in which they exposed their hearing child to manually coded English along with spoken English; it is often compared to Prinz & Prinz's (1979) study of a hearing child acquiring ASL as well as spoken English. Of the two studies, Holmes and Holmes comes closest to enhanced gesturing.

adults who were learning them for this project, and as sign-gestures or sign-symbols when picked up by the children. My focus in this chapter is on object-related signs, sometimes with symbolic criteria applied and sometimes not; one set of social signs was also used in the program.

Participants. The first wave of participants were 25 hearing children in an infant stimulation program for ages 0 to 3 years, for whom both chronological ages (CA) and developmental ages (DA) were available.[4] Twelve were developmentally delayed, 4 with Down syndrome and 8 with other biologically-based disorders (including 4 with hydrocephalus—3 treated by shunts and 1 treated medically). Of the 13 normally developing children, 9 were in an age range approximating the bimodal period (CA 13–25 months; DA 12–25 months) at the beginning of the 9-month study and 3 were older (CA 31–32 months; DA 29–33 months). Additionally, data were obtained from 2 children whose participation had already begun before or near the onset of the bimodal period (rather than after it was already underway): The remaining child in the infant program (pseudonym Shawn; CA 12 months, DA 11 months at onset) and 1 child who received the same kind of enhanced gestural input but only at home (inconsistently beginning at CA 5 months and almost daily by late in her first year; her pseudonym is Natasha, and a single developmental assessment at 10 months placed her at DA 9–10 months). Their outcomes differed from those of the other children and are presented separately.

Procedure. I and my research assistants conducted two to four half-hour structured sessions of bimodal input per week, and bimodal input was also provided to some extent by teachers during other activities and by parents using specially designed picture books with illustrations of the targeted signs. Approximately every 6 weeks, the same picture books were used to assess the current set of target sign–word pairs and to pretest the next set: "What's that?" to elicit production and a model to elicit imitation plus follow-ups such as "Can you sign it?" Two measures were calculated for signs and words separately: the percentage that were produced (called

[4]A child's DA is determined by developmental assessments for which norms are available. A 15-month-old (CA) with a DA of 13 months is developmentally at the level of an average 13-month-old. Children within the same DA range (e.g., 16–19 months) should perform more homogeneously than children selected because they fall within the corresponding CA range. Another advantage of grouping children by DA range is that delayed children can be compared to normally developing children who are at the same level of development.

production in the 1985 paper and *elicited production* here) and the percentage that were produced and/or imitated (called *production/imitation* in the 1985 paper and *elicited imitation* here). These measures yielded a good range of quantitative data for comparing groups, ages, and modalities.

Instances of spontaneous production were also recorded based on researchers' direct observations and reports from teachers and parents. For the current chapter, these records were combined with the elicitation results to obtain cumulative measures of sign types and word types at two levels of evidence. Cumulative signs and cumulative words included any item produced at least once (whether elicited or spontaneous). Cumulative symbolic signs and cumulative symbolic words were based on stronger criteria similar to those of Acredolo and Goodwyn: An item was credited if it was produced at least three times involving at least two contexts (e.g., picture book, mealtime, infant room, home, zoo) or functions (e.g., labeling, requesting), and at least one use had to be spontaneous rather than elicited. Contrary to Acredolo and Goodwyn's nonsymbolic measures, imitations did not count (given the amount of eliciting we did, it seemed advisable to err on the side of conservatism).

A Within-Group Prediction From a Between-Groups Result. Abrahamsen et al. (1985) provided a number of results for elicited imitation and production on this first wave of children, including both individual and group data (note, however, that a printer's error resulted in mislabeling of the two subparts of Table 2; the correct DA ranges are in the table title). In what follows, I summarize those results for subsets of the 12 normally developing children who were older than 12 months when they began receiving enhanced gestural input. I also provide individual results for the 2 children whose input began earlier than 12 months, as well as new data on cumulative vocabulary. First, though, I must briefly convey the major finding from the entire group of 25 normally developing and developmentally delayed children, because it was the impetus for closely attending to measures of variability in the present analyses.

We found that our three groups of participants, when equated for overall developmental level (DA 12–19 months or 20–26 months), all performed *similarly on signs* but differed dramatically in acquisition of words First, children with Down syndrome produced and imitated significantly *fewer words* than the normally developing group (i.e., below expectation based on their overall developmental level). Conversely, our particular sample of children with hydrocephalus or other conditions causing delayed development imitated significantly *more words* than the normally developing group (i.e., above what would be expected based on their overall developmental level). This was an island of strength; their elicited production of words was only at the level expected for their developmental level. Yet, we viewed it as a possible precurser to a characteristic of some older children and adults with hydrocephalus: speaking verbosely but with minimal meaning in production ("cocktail chatter" syndrome) or imitation (echolalia).

Hence, the answer to the question in the title of Abrahamsen et al. (1985)—"Is the Sign Advantage a Robust Phenomenon?"—was *no*. Depending on biological status of the learner and the measure examined, one could find (a) no difference, (b) a sign advantage, or (c) a word advantage. What was robust was the *timetable* by which signs themselves emerged, in contrast to the differing timetables for words in biologically different groups. Because the direction of advantage is due entirely to whether words are behind or ahead of schedule, it is more accurate to speak of a word disadvantage than a sign advantage (as pointed out by Meier and Newport, 1990, in arguing that peripheral factors delay the emergence of early words relative to early signs). In retrospect, our choice of title for the 1985 article was somewhat misleading. It is sometimes cited as claiming that there is a sign advantage (which is correct only if one is careful to specify elicited imitation and production for children with Down syndrome below DA 27 months or early-onset children below DA 20 months.) Others have taken our claim of a robust timetable for signs to mean that signs are early in general, when it actually means that biologically different groups share the same DA-entrained timetable on a given measure, whether that is early or late. One cannot even talk about robustness within a single group; it is a characterization of how biologically different groups compare. (See Abrahamsen, Lamb, Brown-Williams, & McCarthy, 1991, for additional discussion as well as results from Toddler Sign Program 2 [TSP2] on additional children with Down syndrome.)

I am not aware of any other studies in which enhanced gesturing has been made available to both normally developing and delayed children; this design can ascertain the expected timetable in both modalities and determine which groups depart from which timetable in which direction. Nonetheless, there is a wealth of evidence on an important part of this story: the typical timetable for spoken language and data on departures from it. It has long been known that substantial delays in speech are common in a wide range of disorders. More recently, due to landmark work emanating from The Salk Institute (e.g., Bellugi, Klima, & Wang, 1997;

Reilly, Klima, & Bellugi, 1990), it has been learned that a rare genetic disorder—Williams syndrome—is characterized by the opposite pattern, particular strength in spoken language. Although slow to get started (Harris, Bellugi, Bates, Jones, & Rossen, 1997), the speech of older children and adults with Williams syndrome is not only fluent but also meaningful and exhibits grammatical and discourse structure beyond expectation—a more impressive speech advantage than the relatively meaningless but verbose language that sometimes arises from hydrocephalus.

Hence, there is convincing evidence beyond the small number of children and disorders studied in the Toddler Sign Program [TSP] that the timetable for spoken language is not robust. Depending on the particular biological disorder and on details such as DA range and what is measured, speech can be somewhat decoupled from overall development in either direction (much better or worse than expected). Given this variability *across* groups, I wondered whether speech would be especially variable *within* groups as well. Perhaps the two extremes of performance on words in children with different biological disorders in TSP1 were an amplification, in some sense, of greater variability in the vocal modality when all systems are intact. If so, distributions of scores (or acquisition ages) for words should be more spread out, with more extreme scores, than those for gestures or signs. This seemed to be supported in a few existing data sets (e.g., Iverson et al., 1994, reported larger standard deviations for gestures than for words), but for reasons indicated later, none were decisive.

The results that follow include some answers to the usual question of whether (or when) both modalities have similar average performance. The question of primary interest here, though, is whether they are equally variable. Contrary to my hypothesis, *variability was the same for signs and words*. Statistical tests of the differences between variances reported later were all nonsignificant ($p > .15$ except one that is reported individually); however, these were limited to late-onset children and were low in statistical power due to low N. Fortunately, the data from Acredolo and Goodwyn that follow the TSP1 results are a goldmine in permitting this question to be more adequately addressed—and yield the same answer.

Toddler Sign Program: Within-Group Results

Mean percentages for both elicited imitation and elicited production are shown in Table 20.1 separately for four DA ranges (13–15 months, 16–19 months, 21–25 months, and 30–39 months). To ensure that each child would contribute data to just one DA category, these percentages were calculated on the two target sets (17 word–sign pairs) that were made available to almost all of the children at the beginning of the program. (Data from 2 children who joined the program late are not included in Table 20.1.) Although truncating the longitudinal data in this manner puts just 2 to 3 children in each DA range, these cross-sectional results are quite orderly.

Elicited Imitation Is Similar for Words and Signs. The elicited imitation measure primarily reflects the ability to imitate a model on request, but it is calculated as a hybrid measure because children who had just produced both the word and sign were not asked to imitate them as well. The means grew from less than 15% for the youngest children to more than 90% for the oldest children. Imitation is often regarded as an uninteresting measure, but here it is clearly developmentally progressive. As children move through and even beyond the bimodal period, they master the physical forms of an increasing number of familiar manual and vocal vocabulary and (as revealed by pretests) eventually become more capable of immediately imitating unfamiliar vocabulary.

The sizable improvement with age also reflects the fact that responding to elicitations is itself a challenge at the lower end of the bimodal age range and still a bit wobbly as late as 21 to 25 months. This is even more apparent in the results for the elicited production measure. Table 20.1 indicates that elicited production, like elicited imitation, is developmentally progressive. Unlike both elicited imitation and spontaneous production, however, it is not a very useful measure early in the bimodal period: elicited production percentages were near zero at DA 13 to 15 months.

The data on each elicitation measure can be combined across DA 13 to 25 months to statistically address this question: How bimodal is the bimodal period? For the 7 children in this range, the mean percentage of

TABLE 20.1
Mean Percentage Correct on the First Two Target Sets for Children Receiving Enhanced Gestural Input

Age Range (Months)			*Elicited Imitation*		*Elicited Production*	
CA	*DA*	*N*	*Signs*	*Words*	*Signs*	*Words*
15–16	13–15	3	13.9	8.6	0.0	2.0
16–18	16–19	2	76.3	67.9	27.7	25.4
22–26	21–25	2	84.1	74.1	46.5	61.2
32–36	30–39	3	90.2	98.0	56.7	85.5

Note: Adapted from Abrahamsen et al., 1985.

target vocabulary that were at least imitated was 51.8 (*SD* 37.2) for signs and 44.3 (*SD* 39.5) for words. The first thing to notice is that ability to approximate forms is similar for signs and words (often but not necessarily with the support of a model). The small difference of 8% in favor of signs does not approach statistical significance (neither does the 8% difference in favor of words at DA 30–39 months). The equipotentiality of modalities is clearly reflected in this measure, regardless of whether the hint of a slight shift with age might later be confirmed. The more important thing to notice is that variability across participants is almost identical for signs and words. The equivalence of signs and words is even more apparent in the fuller, longitudinal data set. Nine children (the 7 just mentioned plus the 2 who joined the program late) had one or more elicitation sessions within DA 13 to 26 months. Combined across sessions, their mean percentages were 54.4 ($SD=24.7$) for signs and 53.0 ($SD=27.2$) for words. The similarity in both means and standard deviations adds to the evidence that the bimodal period is impressively bimodal, even for children in a generally speech-dominant environment.

Elicited Production Is Better for Words Than Signs. Mean production percentages from Table 20.1 for DA 13 to 25 months ($N=7$) are 21.2 ($SD=22.9$) for signs and 25.6 ($SD=129.3$) for words. In the longitudinal data set for the same period (DA 13–26 months, $N=9$), means were 16.7 ($SD=18.6$) for signs and 30.5 ($SD=24.1$) for words. In this latter comparison, words outperformed signs, $t(8)=2.78$, $p=.02$. The small differences in variability are nonsignificant and probably artifactual (variability can be expected to rise with the mean in this range of percentages).

Individuals Differ in Degree, Not Direction, of Effects. Although the spread in scores is about equal for the two modalities, it is equally *high*. The most obvious source is developmental progression across the wide range of ages involved, rather than large individual differences on each measure within each narrower age range. Examination of the data for individuals underlying Table 20.1 reveals that there are only four cases in which a data point from one age group overlaps into those of another age group. Three involve the same child, Michael, whose performance was "too high" on each measure except word production.

The more important question is the extent to which there are individual differences in acquisition of words versus signs. There were enough elicitation trials in the longitudinal data to carry out significance tests within individuals, and this was done in the 1985 article using McNemar tests for correlated proportions on data through DA 35 months. For production, similarity across children in modality preference would certainly be supported if difference scores were positive and statistically significant. In fact, 7 of the 9 children produced more words than signs, a difference that was significant for 4 children (d=22.5% to 41.2%, p<.05 for each) and nonsignificant for 3 (d=8.8% to 11.8%, p>.15 for each); the remaining 2 children had essentially no difference (d=0.0% and –2.5%). The 3 oldest children (DA 30–49 months for the entire study) also produced more words than signs, and this difference was significant for 2 of them. Given this consistency across children in producing more words than signs, the apparent lack of a modality difference at 13 to 19 months in the cross-sectional production data (Table 20.1) was either temporary or a fluke; 4 of the 5 children went on to perform better on words in the longitudinal data.

For the elicited imitation measure, which yielded similar average scores for signs and words, it is a lack of significant McNemar tests that would suggest that the group result also is characteristic of individuals. In fact, the difference scores were within 0%–6% for 7 of the 12 children. The largest difference, and the only one with p less than .10, was a word advantage of 18.2% (p < .05) for Michael. This is not to say there are no interesting individual differences at all; particular children on particular assessments do have more extreme scores. There is no satisfactory way to judge to what extent this reflects simple error variance, unstable effects such as mood on the day of the assessment, or genuine changes in how a particular child is relating to each modality. Whatever fine-grained effects might be lurking in the data, the main conclusions are clear: Means and standard deviations are very similar, except that words are favored in elicited production, and the large size of the standard deviations within each modality is due primarily to the wide range of ages.

Does Age of Onset Matter? This brings us back to the importance of considering the age dimensions that are not shown in Fig. 20.1. Most of the findings just summarized apply to children who were assessed in the DA range 13 to 26 months and did not begin getting enhanced gestural input until DA 12 months or later—after the bimodal period had already been underway for 2 to 6 months or longer. Recall that for 2 additional children, exposure began by DA 11 months. Their elicitation results were so different from those of the later-onset children that age of exposure had to be suspected as a factor.

First, Shaun's exposure to enhanced gesturing began in earnest at 11 months (although he had incidental exposure earlier due to the presence of older participants in different rooms of the same center). Consider his outcomes on two assessments of the first target set (10 mealtime items) at DA 14 to 15 months. (An earlier assessment was essentially a pretest, and he was uncooperative on a fourth assessment.) Shaun showed a remarkably strong sign advantage (more accurately, a word disadvantage). On elicited imitation his sign performance (85% correct) was at the level attained by other children at 21 to 25 months, whereas his word percentage (25%) was a little high for his age but well below the 16 to 19 month level (see Table 20.1). On elicited production (60% of signs vs. 15% of words correct), his sign performance was even more disportionate to his age: Only 1 child (DA 31 months) produced a higher percentage of the same 10 signs. If diary records of spontaneous use through DA 15 months are added to all elicitation results, he produced (not just imitated) every one of the first set of 10 signs at least twice. Of the corresponding words, only the 3 words successfully elicited using pictures met this criterion (but for 4 additional words, one spontaneous use each was observed). Symbolic criteria were satisfied by 7 of the 10 signs and 3 words. Diary records on other signs and words (which were less complete) add at least 4 signs and 11 words, bringing the total symbolic items to at least 11 signs and 14 words.

Natasha was exposed at home to enhanced gesturing inconsistently at 5 months and almost daily by late in her first year; during her second year, the number of sign–word targets increased. At CA 13 to 15 months Natasha used a number of signs at home; for example, at 13 months she could produce nine signs but only two words. However, she hardly responded to elicitation attempts in the laboratory. At 16 to 19 months, she too showed a strong sign advantage (word disadvantage) both on elicited imitation (40.5% on signs vs. 12.7% on words across 79 trials in two assessments) and elicited production (19.0% vs. 7.6%). Her signs then remained stable while words overtook them at 20 to 26 months. (Across 71 trials in three assessments, elicited imitation was 40.8% for signs vs. 67.6% for words; elicited production was 18.3% vs. 42.2%.) In a later assessment of the original two target sets (17 items) at 30 months, she produced 58.8% of the signs and 47.1% of the words. At 47 months, according to her mother, she still occasionally used signs (e.g., signing IN and UNDER while looking at a book by herself).

The outcomes for Shaun and Natasha were tantalizingly different from those of the other participants but raised more questions than they answered. Would all children provided with early exposure to enhanced gesturing show a substantial sign advantage for several months? Is "early" best defined by CA, DA, or by specific milestones such as whether a child has begun talking? I did not obtain answers to these questions myself, but Acredolo picked up the trail when she became intrigued by her own daughter's proclivity for object-related gesturing. In a long-term collaboration using more naturalistic input and assessment methods than ours, Acredolo and Goodwyn have obtained a wealth of data on children getting ordinary gestural input (summarized earlier) and, in a later training study, on children getting enhanced gestural input beginning at 11 months. They have published several important academic papers on this work but also captured the attention of numerous nursery schools in the area of Davis, California, and wrote a parent-friendly how-to book, *Baby Signs* (Acredolo & Goodwyn, 1996).

In the next section, I highlight some of the key findings of Acredolo and Goodwyn's training study in comparison to Folven and Bonvillian's results on children acquiring ASL. Thereafter, I look at "the big picture" by examining selected results from the entire top front edge of the research space in Fig. 20.1, including more of my own counts of symbolic and nonsymbolic cumulative vocabulary.

Acredolo and Goodwyn's Symbolic Gesture Training Studies

A New Way to Enhance Gestural Input and Its Effect on Spontaneous Production. As noted earlier, Acredolo and Goodwyn (1988) found that under ordinary input conditions, children develop a few symbolic gestures—5 on average but as many as 17. They had the idea of training parents to provide enhanced gestural input to their children, thereby encouraging greater use of this special kind of gesturing ("symbolic gesturing" or "baby signs" in their terms). To make it as easy as possible, they showed parents how to invent gestures rather than asking them to learn signs borrowed from ASL. One motivation was their hypothesis that such gestures could, by giving added "practice" to an emerging symbolic function, actually *accelerate* the development of object-related words. This clearly contrasted with a common expectation that too much emphasis on gestures might *interfere* with the development of spoken words.

To get parents of the 32 11-month-olds in their "Sign Training" group started, Acredolo and Goodwyn constructed an initial target set of eight easily formed gestures with salient meanings (FISH, FLOWER, BIRD, FROG, AIRPLANE, WHERE-IS-IT?, MORE, and ALLGONE).

Arguably, all eight are object-related gestures, which potentially could be used either to make a request or to label an object or the existential state of an object. (It is unclear under what circumstances Iverson et al., 1994, would classify the last three gestures as conventional rather than predicative. It is, however, clear that the deictic gesture category was excluded from consideration.) Parents were encouraged to use the eight gestures simultaneously with the corresponding English words at appropriate moments and to come up with additional gestures of interest to their child.[5]

Every 2 weeks, a researcher conducted a detailed telephone interview to obtain information about which gestures and words the child had used since the last call and also about the contexts in which they were used. Information was gathered on all of the child's object-related gestures and words, not just those targeted by the parent. From the interview records, Acredolo and Goodwyn were able to make a monthly tabulation of the cumulative number of forms produced and to determine how many of these had been produced spontaneously and met the other criteria for symbolic status that had been originally developed for their naturalistic studies. The interviews ended after a child acquired 100 words or reached 24 months of age. They also included laboratory sessions to obtain additional measures of progress in spoken English and general development.

Can Outcomes Be Similar When Input Is Not? A wealth of findings can be extracted from this extensive body of data, and Acredolo, and Goodwyn, Horobin, & Emmons (1999) and Goodwyn & Acredolo (1993, 1998) have already offered a variety of new insights about bimodal development. Here I wish to further pursue just one of the questions they have addressed: How does acquisition of symbolic gestures under enhanced gestural input compare to acquisition of symbols (signs or words) under full linguistic input? Is the huge difference in amount and quality of input reflected in the learners' output? Within the manual modality, a between-subjects comparison can be made between the gestures of children getting enhanced gestural input (the "Sign Training" group) and the signs of children getting ASL input. Across modalities, a within-subjects comparison can be made between the gestures and words of children getting enhanced gestural input. The unusually large N permits close quantitative comparisons of means and variability for children, like Shaun and Natasha,

[5]There was also a target set of eight words with no gestures for a separate "Verbal Training" group that I do not discuss; the two groups were compared to successfully confirm the prediction that adding gestures would accelerate word acquisition.

whose exposure to enhanced gestural input begins early—analyses that could be conducted in the TSP1 only for children whose exposure began later.

Comparing gestures to words presents a challenge, however: Some children gallop ahead in acquiring words so rapidly that there aren't enough gestures in the input (or in children's own inventions) to give gestures a chance at parity. Hence, if one compares total number of symbols at a particular age, the outlier scores alone can make not only the means, but the standard deviations as well, higher for words (or signs) than gestures; this was the case for Iverson et al.'s (1994) comparison of gestures to words.

Longitudinal studies provide a way to bypass this difficulty: comparing the ages at which children attain certain early milestones rather than total vocabulary. Folven and Bonvillian (1991) provided data on age at first sign, first symbolic sign, first symbolic word, and tenth sign. Goodwyn and Acredolo (1993) examined age at first symbol and fifth symbol for a subset of children from their final sample and from a pilot study who had not yet produced any symbolic words at the onset of their participation (a restriction that permitted them to show that beginning enhanced gestural input at 11 months results in a gestural advantage, although only a small one, for children who were not yet committed to a modality).

There are many pitfalls in determining the ages at which milestones are achieved and especially in comparing these ages across different studies. Meier and Newport (1990) identified a number of these pitfalls and sought to reach the best possible conclusions about milestones in sign and speech given the available data (which included an earlier report of Folven and Bonvillian's 1991 findings). In brief, they found the evidence persuasive that the earliest words are delayed relative to the earliest signs, and that some disparity in vocabulary size may continue at least through the first 50 items. In contrast, milestones involving relations between cognition and language, such as first symbol, appeared to be achieved at comparable ages for signs and words. They found the evidence on a difference in onset of early combinations unpersuasive but incomplete; they noted that a delay in word combinations, if supported in later research, might be due to difficulties involving form rather than deeper cognitive-linguistic factors.

Acredolo and Goodwyn's use of enhanced gesturing has yielded new evidence against which to examine children's ages at milestones. Although enhanced gesturing is just one of several relevant input situations, it provides an important opportunity to carry out within-subjects comparisons in addition to the more problematic between-subjects comparisons. It also can be compared to other input situations—those with different degrees of imbalance between modalities—to assess the importance of amount of input. Finally, Acredolo and Goodwyn's complete sample of 32 children (vs. the subsample that excluded early talkers) provided an especially valuable opportunity to examine standard deviations in a relatively large sample. To enable me to test my hypothesis that variability would be greater for words than gestures within a group of normally developing children, Linda Acredolo generously made available each child's monthly cumulative totals for gestures and words. In addition to incorporating these in Figs. 20.2 and 20.3, I calculated means, standard deviations, and ranges, which are shown in Table 20.2 along with comparable statistics from Folven and Bonvillian's (1991) findings on ASL signs. (The statistics on tenth ASL sign in Table 20.2 and on total signs in Fig. 20.3 were calculated for this chapter from individuals' data supplied to me by John Bonvillian.) In what follows, AG refers to Acredolo and Goodwyn and FB refers to Folven and Bonvillian.

Comparisons Within and Between Enhanced Gesturing and ASL

Age of Attainment of Milestones: Differences in Means? (Mostly No). Table 20.2 indicates that mean ages at each milestone for both modalities and both studies (when available) are within a month of each other, with the important exception that the first sign is 3 to 4 months earlier than the first word. Comparisons between studies require caution, however, due to a number of methodological differences; the footnotes to Table 20.2 identify some of these differences and describe adjustments that were made to some of the investigators' original numbers (e.g., most of AG's ages reflect my adjustment of −0.5 months). There is also the question of consistency with previous studies; for example, AG's ages for 10th word are a month or two younger than usual. The within-study comparisons are therefore most secure, but any net impact on the between-studies comparisons of more closely aligning the studies is unlikely to change the overall findings.

The modality difference for first form (milestone 1) replicates previous results from Bonvillian's laboratory. Although not obvious in Table 20.2, the relative delay for word forms may continue throughout the bimodal period (see Meier & Newport's 1990 review in which Bonvillian's current and previous ages for 10th sign and 50th sign were judged $1^1/_2$ to 2 months earlier than norms for words). When symbolic criteria are added,

TABLE 20.2
Age (in Months) at Attainment of Milestones for Words Versus Symbolic Gestures (Acredolo & Goodwyn) and Words Versus ASL Signs and Deictic/Performative Gestures (Folven & Bonvillian)

Six Milestones[a]	N (n_g, n_w)[b]	Mean[c] Gestures/Signs	Mean[c] Words	Standard Deviation Gestures/Signs	Standard Deviation Words	Range Gestures/Signs	Range Words
1. First Form[d]							
ASL signs versus words[e]	6 (9, 8)	8.3	11.5	1.80	1.42	6–11	10–15
2. Deictic/performative gestures							
Ritual request	5 (7)	9.2	–	0.84	–	7–11	–
Show, give	5 (7)	10.0	–	1.00	–	9–11	–
Communicative point	5 (7)	10.8	–	0.45	–	10–13	–
3. First symbolic form							
ASL signs versus words[f]	6 (8, 6)	12.5	12.2	2.13	1.42	10–16	10–14
Gestures versus words	31 (32, 32)	11.8	11.9	0.65	0.71	12–15	12–15
4. 10th form							
ASL signs	6 (9)	13.5	–	2.02	–	10–16	–
Gestures versus words	31 (31, 32)	14.1	13.3	1.71	1.63	12–19	12–19
5. 10th symbolic form							
Gestures versus words	31 (31, 32)	14.8	13.8	2.11	1.60	12–19	12–21
6. First combination[g]							
ASL signs	9	16.1	–	–	–	13–19	–
G + W or G + G	24	15.5	–	–	–	–	–
W + W	24	17.9	–	–	–	–	–

[a] Folven and Bonvillian (1991) presented evidence that the milestones are almost always attained in the order shown, except that milestone 1 splits according to modality: The first ASL sign precedes all other developments, but the first word comes between milestones 2 and 3.

[b] Children who lack data on any of the vocabulary milestones (1, 3, 4, or 5) are excluded from the means and standard deviations for milestones 1–5. Ranges include these children on the milestones for which they have data (as indicated by the *n*s in parentheses for gesutres/signs and words, respectively). If the means had been based on these larger *n*s, only the age at first word form would differ by more than 0.2 months (see footnote e).

[c] Some of the means have been adjusted from the original data to better align the two studies, because AG and FB obtained their data at different intervals and calculated their ages differently. For example, AG's "17 months" refers to attainments on or before the 17th monthly birthday; the last data included would be those reported in a telephone interview conducted as close as possible to the exact monthly birthday and therefore would cover (approximately) the 16th month. In Fig. 20.3, this is written as 17.0 months. FB's mean ages were calculated from exact dates (of diary entries and videotapes) that were rounded to the nearest tenth of a month; hence, their means in Table 20.2 do not require adjustment. (However, each child's age for each deictic/performative gesture was reported with no decimal places; these were simply averaged here without adjustment because FB did not specify what range of exact ages were included. Also, child 7 was preterm, and in later publications his age was adjusted by 6 weeks; if adjusted here, the upper end of the range would be reduced by 1 to 2 months for first word, communicative point, and first combination.) AG's mean ages were calculated from cumulative monthly totals, counting each item in the first month at which it was reported as being imitated or produced (milestone 4) or as being used flexibly (milestones 3 and 5). AG's ages were made more comparable to FB's ages by subtracting subtracting 0.5 months (the approximate average discrepancy) from each mean. For 10th form or symbolic form further compensation was needed (because many children went well beyond their 10th item in the month they first reached 10 items); an approximation was achieved by using age at 9th rather than 10th item in addition to subtracting 0.5 months for milestones 4 and 5. For combinations, ages were calculated to the nearest half month and therefore were adjusted by subtracting only 0.25 months (rounded to 0.2) from the reported ages. Descriptions of their underlying calculations of age were obtained from Linda Acredolo and John Bonvillian (personal communications, February 1999).

[d] AG's ages for first form (milestone 1) are not included because all except two children had already achieved this milestone in their first monthly total at 12.0 months. If AG's families had begun enhanced gesturing and data collection several months earlier, age of attainment would probably have been close to FB's ages for milestone 1 and may have have been lowered a bit for some later milestones.

[e] For all 8 hearing children, the mean ages were 12.3 for first word (and 8.5 for first sign). Note that a recent large-*N* norm cited by Meier and Newport (1990) was 11.3 months for first word; this difference of 1 month may be due in part to less than usual exposure to English for some of FB's participants.

[f] FB did not count requests for familiar objects as evidence for symbolic status. This probably made their ages for milestone 3 a few weeks later than they would have been using AG's criteria (which did count such requests if observed for more than one object or context). Moreover, there were several minor differences between FB and AG in what types of items were excluded; these may have partly canceled each other out.

[g] Only 2 of the children acquiring ASL combined words before the study ended; in both cases, this was later than they combined signs. The data on combinations of gestures (G) and/or words (W) are from Acredolo, Goodwyn, Horobin, and Emmons (1999), and exclude 8 children who never combined gestures. For all 32 children, the age for W + W is 18.1 months (see footnote c concerning an age adjustment of 0.2 months).

however, the ages for first form (milestone 3) are quite close, not only within studies but also between studies. This similar timing for the first linkage of an available form to a context-flexible meaning is especially noteworthy when you consider that the input to AG's participants strongly favored words, whereas the input to most of FB's participants strongly favored signs. By milestones 4 and 5, these input imbalances apparently were starting to have some impact; FB did not report data for 10th sign, and AG's modality difference had grown from essentially none to about a month in favor of words. In fact, of the 31 children in Goodwyn's and Acredolo study who attained 10 gestures (one stopped at 8), 14 never attained more than 14 gestures (13 symbolic gestures). Hence, many children are slowing down already by the time of the 10th-gesture milestone, making the 5th-gesture milestone used by Goodwyn and Acredolo (1993) preferable. The difference between modalities was only 0.4 months on this measure: The 5th symbolic word was attained at 13.4 months ($SD = 1.36$) and the 5th symbolic gesture at 13.8 months ($SD = 1.28$). For means, then, the bottom line is that *grossly unequal input can coexist with essentially equal output*. Neither modality nor quantity of input nor linguistic status of input has much effect, if any, on the average age at which the earliest vocabulary milestones are met.

Age of Attainment of Milestones: Differences in Variability? (No). The outcomes just described are important, but our particular interest in this chapter is in the measures of variability rather than means. Recall the prediction that standard deviations (and equivalently, variances) would be larger for words than signs. This was based on the idea that the two extremes of performance on words in children with different biological disorders might be a kind of amplification of greater variability in the vocal modality when all systems were intact. Contrary to this prediction, however, standard deviations were similar in the two modalities in data from children in TSP1. Would this be the case as well for the studies in Table 20.2? Acredolo and Goodwyn's study provides a larger sample with earlier onset of enhanced gesturing. Folven and Bonvillian's sample is about as small as mine but is of interest because his participants received even earlier and more elaborate input in the manual modality.

The outcome is easily summarized. First, simply inspecting the table suggests that age of milestone attainments are no more spread out for words than for gestures or signs. To confirm this, I performed a test of the significance of the difference between correlated variances for the variances computed from each pair of standard deviations in Table 20.2, and also for the results on age at 5th symbol reported earlier. Not a single pair of variances differed significantly. The only one that even approached marginal significance was for AG's data at milestone 5—where variability was a little higher in the manual modality rather than in the vocal modality, $t(29) = 1.71$, $p = .11$. The two tests on FB's data were statistically weak, but there too the small differences between sample variances were in the opposite direction of that predicted.

This is not to say that data sets will never be found in which variability does differ, for any of a number of possible reasons. However, Acredolo and Goodwyn's data set is the best currently available for addressing the question; the only better ones would be (a) word and sign data from two dozen or so children acquiring a spoken language from one parent and a signed language from the other parent (or both languages from both parents), or (b) between-subjects comparisons involving even larger numbers of comparable children acquiring such languages monolingually and followed using similar methods.

Until either of these ships comes in, *I must tentatively conclude that the equipotentiality of modalities is reflected not only in means but especially in measures of variability. The fact that biologically different groups of children vary so dramatically in word acquisition apparently is an outcome of how different kinds of damage impact development and has no deeper cause in a disproportionate variability in speech within our species*. The acquisition of early words does seem to be more vulnerable to damage than early gestures, as evidenced by the large number of children with biologically-based developmental disorders who are delayed in speech beyond their overall delay but can benefit from enhanced gesturing. However, as the group at Salk has shown both behaviorally and neurobiologically (see Bellugi et al., 1997, for a review), Williams syndrome's distinctive effects on the brain have the atypical consequence that spoken language is well-preserved relative to many nonlinguistic abilities. This gives additional force to my revised claim that speech outcomes have to do with type of damage rather than a preexisting disposition to variability in speech (see especially Jernigan & Bellugi's 1994 examination of relative sizes of brain areas for individuals with Williams syndrome vs. Down syndrome).

Number of Symbols: Individual Differences in Modality Asymmetries. Returning to the ordinary children studied by Acredolo and Goodwyn, our main point about variability was that it is the same for both modalities when measured using milestone ages. Two additional points are true of the milestone data but are most clearly displayed in a

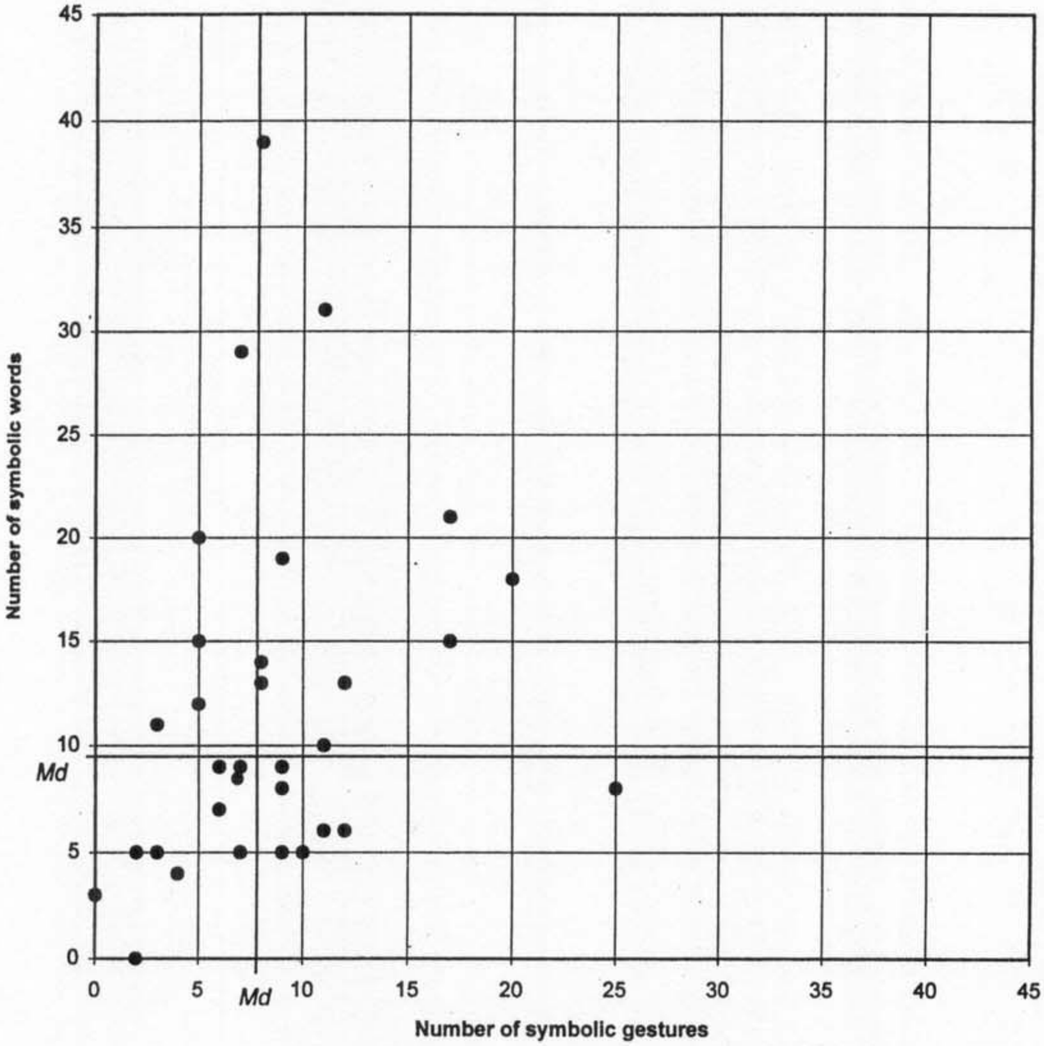

FIG. 20.2. Cumulative number of symbolic gestures and symbolic words through age 14.0 months for each child provided with enhanced gestural input. This scatterplot display is based on data provided to the author by L. Acredolo. Note that the actual age varies slightly across children; the last telephone interview included was made as close as possible to each child's 14th monthly birthday (see Footnote 6).

scatterplot (Fig. 20.2), in which each of 32 data points represents the total number of symbolic gestures and symbolic words for 1 child at age 14.0 months. First, variability is quite high in both modalities. Second, all possible patterns of relation between the two modalities are about equally represented.

A median-split procedure adapted from that of Goodwyn and Acredolo (1998) illustrates this second point. Within the four boxes created by drawing medians for each modality, there are 7 children in each of the two boxes representing a modality asymmetry (word-dominant and gesture-dominant), and 9 children in each of the two boxes representing a balance between modalities (both-low and both-high).[6]

This outcome is far from inevitable. One reasonable hypothesis is that children would tend to have a dominant modality at 14 months (e.g., words if the child is an early talker and gestures otherwise). If true, this would have placed the data points in just the word-dominant and gesture-dominant boxes. Alternatively, if performance is driven by some centralized capacity that is shared by both modalities, one would expect the opposite pattern (equivalent to data points in the both-low and both-high boxes).[7] Perhaps the patterns in Fig. 20.2 result from modality-specific factors overlaid on a developing centralized capacity. If so, and extrapolating from results on ASL, very early onset of enhanced gesturing (e.g., 8 or 9 months) might push the modality-specific factors in a direction favoring gestures and therefore toward a less equal distribution of points. However, variances could remain equal even as the means got pushed apart.

Due largely, although not wholly, to the verbal outliers (children with more than 20 words), summary statistics for words ($M = 12.0$, $SD = 8.68$) are higher than for gestures ($M = 8.6$, $SD = 5.36$) when calculated on the data points in Fig. 20.2. However, if only the children who are actually early in the process are examined (those with 10 or fewer items in each modality), the statistics are very close for words ($M = 5.9$, $SD = 2.70$) and gestures ($M = 5.8$, $SD = 3.12$). This illustrates that the distribution of total number of items for all children at a given *age* includes a mixture of outcomes from different levels of development and therefore is not the best measure for comparing means or standard deviations at a given *level of development* (e.g., the developmental period during which the earliest symbolic words and gestures emerge, as captured by the subset of data for

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[6]These numbers are not identical to the distribution of points as drawn; they incorporate a correction for ties at each median that is equivalent to moving one point from the both-low box into the both-high box and one from the word-dominant box into the both-high box. Also note that age 14 months was was chosen for Fig. 20.2 because it is the last age at which the medians for number of symbolic gestures (7.83) and words (9.25) are fairly close. They then diverge as increasing numbers of children are launched onto a rapid trajectory of word acquisition, at which time effects of the input disparities finally are evident and a fair comparison between modalities is no longer possible.

[7]In fact, that pattern was found on a different measure (elicited imitation) for children in TSP1 who were older at both onset and assessment. On yet another measure (elicited production), scores from the same TSP1 children were equivalent to the both-low and word-dominant boxes. Hence, although it is important to know that all patterns are about equally represented for spontaneous production with early onset, variations with age and measure underscore once again what a complicated set of developments is unfolding.

10 or fewer items.) This is especially the case when the comparison involves two modalities and just one of them will ultimately dominate, and this is one of the reasons I prefer to report results within DA ranges rather than by CA.

The Big Picture: Additional Comparisons Across Studies

The Onset of Symbolic Gesturing. We saw in Table 20.2 that with respect to age at the first symbolic form, there is apparently little or no advantage in being exposed to a full language from birth (e.g., ASL or English) compared to the much reduced input provided in the manual modality by enhanced gesturing. Although this conclusion is somewhat tentative due to differences in methodology and samples, it is unlikely to be altered to an interesting degree by future research. The earliest symbolic signs of a child acquiring ASL apparently are equivalent in many if not all respects to the earliest symbolic gestures of children acquiring English and (revisiting our earlier discussion of terminology) probably should be called *gestures* or *sign-gestures* rather than *signs*.

But this comparison involves enhanced gesturing. What of children with ordinary gestural input? I have not succeeded in locating an explicit age of first symbolic gesture from a large sample of children, but some plausible inferences from AG's own earlier work suggest that enhancing versus not enhancing parental gesturing makes little difference in the age at which this particular milestone is reached.[8] Any differences in development brought by enhanced gestural input should show up later in the bimodal period, when children are increasing their inventories of words and gestures rather than getting them started. Hence, despite the difficulties with total number of items as a measure, it is worth using it to make one final set of comparisons across studies.

Total Symbolic Gestures at the Peak of the Bimodal Period. How many gestures have children attained when the bimodal period is at

[8]First, half of the 16 children in the naturalistic longitudinal study (Acredolo & Goodwyn, 1988, Table 4) attained their first symbolic gesture before their first (nonsymbolic) word; AG do not report that age, but all except 2 of the children in the data set used for Table 20.2 had attained their first word by 12.0 months. Making plausible interpolations, an approximate median age for first symbolic gesture with ordinary input would be very close to the 11.8 months listed in Table 20.2 for children receiving enhanced gesturing.

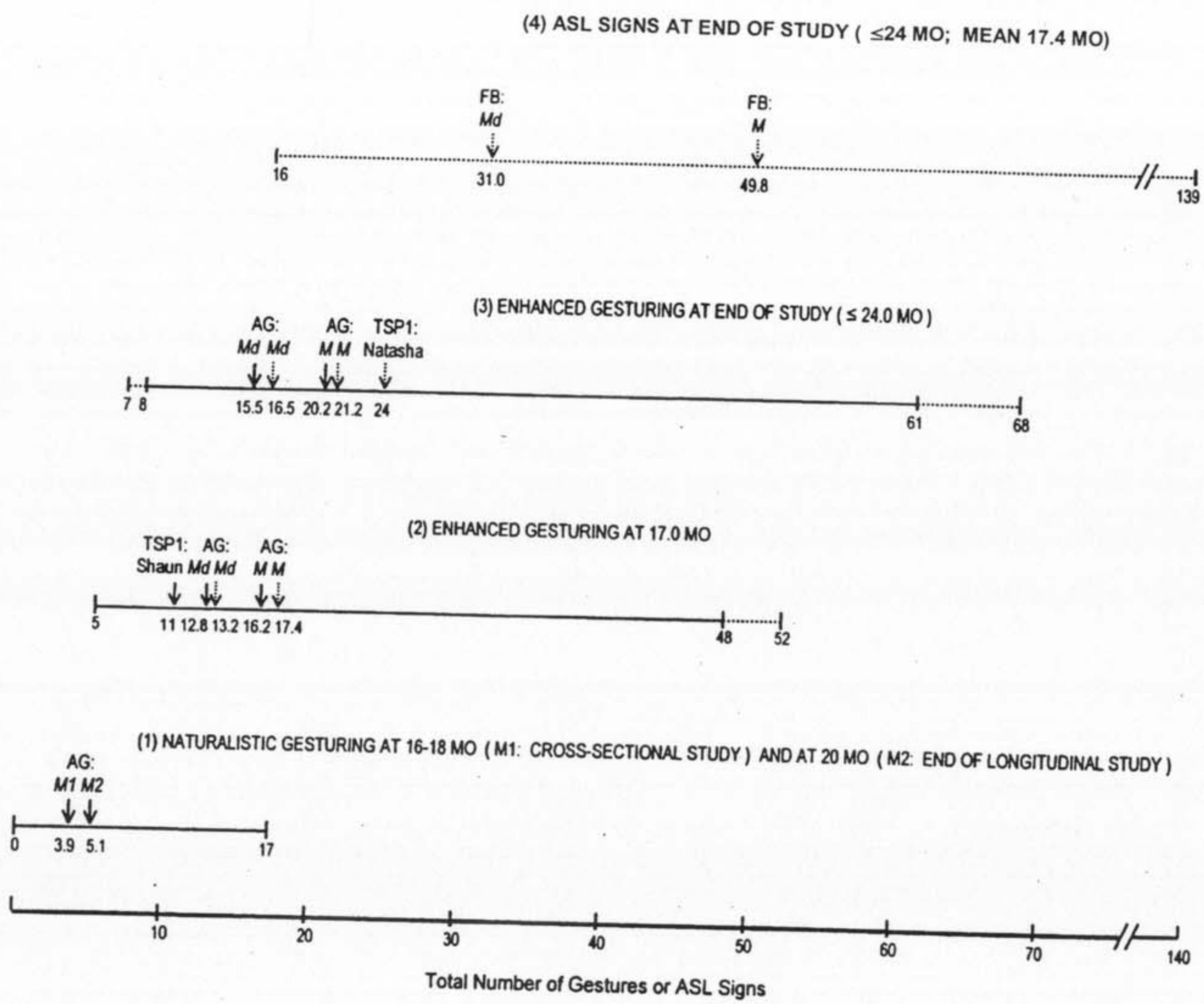

FIG. 20.3. Cumulative number of gestures or signs obtained by several investigators: Acredolo and Goodwyn (AG), Folven and Bonvillian (EB), and Abrahamsen et al. (TSP1). Arrows indicate means and medians and bars indicate ranges. Solid lines indicate results for items meeting symbolic criteria; broken lines add items that did not meet symbolic criteria but were produced spontaneously, elicited, or imitated at least once. Data points representing the 2 early-onset participants in TSP1 are displayed with results at comparable ages from AG: Shaun's cumulative symbolic signs through 17.0 months (on bar 2) and Natasha's cumulative signs (at least one elicited production) through 23.0 months (bar 3).

its peak? Figure 20.3 displays means, medians, and ranges for cumulative vocabulary at the time data collection ended for several of the studies we discussed (plus additional results at 17.0 months for one study). This gives us a somewhat later window than the one provided in Table 20.2 for looking at the impact of quantity and quality of input. At the bottom is the overall yardstick (number of gestures or signs) for assessing the extent to which children are using the manual modality as a vehicle for object-related symbols. (A few social gestures may also be included in some data sets, but deictic gestures are excluded.)

Bar 1 displays data we already noted: the total number of symbolic gestures attained by children acquiring a spoken language under ordinary circumstances (Acredolo & Goodwyn, 1988). Above that are two bars representing the increase obtained by providing an environment of enhanced gesturing (the 32 families in AG's "Sign Training" group for whom milestones are indicated in Table 20.2). Bar 2 (total gestures at 17.0 months) provides the closest comparison to Bar 1 (16–18 months). Bar 3 incorporates whatever additional learning occurred by the end of the study (before 20.0 months for almost half the children but as late as the cutoff age of 24.0 months for 2 children who never attained 100 words). Although there is considerable variability, the increase brought by enhanced gestural input (vs. ordinary gestural input) can be substantial.

Finally, at the top is a bar representing the further increase obtained by providing constant exposure to full linguistic input in the manual modality—the 9 children followed by Folven and Bonvillian (1991) for whom the language of one or both parents was ASL. Their study ended at a mean age that can be estimated as 17.4 months (by using the ages in their 1997 Table 2 to calculate a mean and adding .5). The cumulative sign vocabularies compiled at this time did not consider symbolic criteria, but they can be compared to Acredolo and Goodwyn's total number of object-related gestures at 17.0 months (dotted arrows and ranges). The most prolific signers at 17 months have almost three times as many items as the most prolific gesturers at 17 months, and the mean is almost double. Nonetheless, there is a substantial region of overlap: Almost half of the gesturers (15 of 32) and 7 of the 9 signers have cumulative vocabularies between 16 and 52.

Figure 20.3 also contains data points from the 2 participants in TSP1 whose exposure to enhanced gesturing had begun by 11 months. Recall that Shaun had a cumulative total of 11 symbolic signs at DA 15 months (CA 16.0 months), near the end of the program. This places him slightly below the median of 12.8 symbolic gestures for Acredolo and Goodwyn's children at 17.0 months (as well as their similar median of 12.5 at 16.0 months). At the same age, Shaun had at least 14 symbolic words, many of which had been gained within the most recent month (cf. a median of 28.5 symbolic words for Acredolo and Goodwyn's children at 16.0 months). For Natasha, there was insufficient information to apply symbolic criteria. However, at 23 months the cumulative number of object-related signs she had produced to a picture referent at least once was 24—a bit above AG's comparable mean (broken arrow on Bar 3). Her comparable total for words was 13.

All in all, it appears that bimodal-period children are so ready to lap up whatever meaningful forms are offered to them that even modest enhancements in gestural input can have a disproportionate impact. There are two important limitations to this conclusion, however, that we will explore briefly. First, despite a number of methodological differences between studies, all of the children in Fig. 20.3 began getting enhanced gesturing or ASL input by age 11 months. This suggests that early onset may be a key factor in producing substantial spontaneous and elicited production at 12 to 17 months. However, the only data on later onset children are from TSP1, and the only measures on which they have been compared to the early-onset children are elicited production and imitation (on which they do not show Shaun and Natasha's sign advantage). Might age at onset matter less when spontaneous signs are added to elicited signs? Second, Fig. 20.3 indicates that there is limited growth from 17 months to the end of the study. Has bimodality run its course by 17 months or so? In the next two sections, we show that (a) incorporating records of spontaneous signing does not change the conclusion that early onset matters; and (b) when spontaneous production in the manual modality begins to lag, other measures pick up the pace.

Age of Onset Revisited

First, I carried out the same kind of compilation of diary and other records as described earlier for Shaun, but now through the first 5 months of the program for 5 TSP1 children whose exposure began at CA 13 to 16 months (DA 12–14 months). I limited myself to the first set of 10 target words and signs, because these had the most complete records, and applied the same 10-item limitation to Shaun for comparison (cf. his data point in Fig. 20.3 without this limitation).

For Shaun at DA 13 or 14 months, all 10 signs and 6 of the 10 words were produced at least once; of these, 7 signs and 1 word met the symbolic criteria. None of the children with a slightly later onset came close to this: The two most prolific children produced (in some context) 5 or 6 of the 10 signs (1–2 symbolic) and 7 or 8 of the 10 words (2–3 symbolic). The other 3 children ranged from 0 or 2 signs and 0 or 1 words (all symbolic). Even allowing for the possibility that we missed a few signs that had been mastered but produced infrequently, there is essentially no overlap between these later onset TSP1 participants and the early-onset children for whom symbolic gesture data are available (Shaun in TSP1 and AG's 32 participants).

Another way of comparing the early and late onset children is to tabulate cumulative vocabularies late in the project (at DA 20–26 months) for the same children plus 2 others. By then, 27 target word–sign pairs had been assessed. Even without applying symbolic criteria, cumulative production averaged only 6 signs and 11 words per child; compare AG's mean of 21.1 gestures at their comparable age (24.0 months or less). Hence, by both analyses, *late-onset children lost much of the advantage that enhanced gesturing might otherwise have brought.*

Bimodality Beyond 17 Months: The Importance of What Gets Measured

As noted previously, even early-onset children seem to level off in the manual modality by 17 months or so. One interpretation is that once children have made the transition to speech dominance (as had the majority of their participants by 17.0 months), gesture plays a modified role in which new object-related gestures are of limited salience. But *if outcomes other than spontaneous use of individual vocabulary items are examined, it can be seen that the effects of enhanced input in fact do not level off at 17 months.* First, Table 20.2 shows that although the number of gestures may not be increasing very much, AG's children are using them in transitional combinations of two items (a gesture plus another gesture or a word) more than 2 months before they combine two words. Most interesting, these include combinations in which both items are symbolic gestures—a type of combination that children receiving ordinary gestural input virtually never produce. Again we see that what might seem to be a modest enhancement (adding perhaps not much more than 10 or 20 object-related gestures to ordinary communication) has considerable impact. Furthermore, this provides better evidence than previously available that combinations of two referential manual symbols precedes combinations of two referential vocal symbols.

Another example of continued development is the increasing tendency for children in TSP1 to use signs and words simultaneously, contrary to an earlier tendency (in imitation at DA 12–15 months) to have words for some referents and signs for different referents (Abrahamsen & Lamb, 1987).

A third example can be found in the performance of children at 30 months or beyond. TSP1 offers relevant data from 4 of the 5 oldest children in Table 20.1 (one 31-month-old had left the program after the first target set). These children were learning so quickly that beginning in the 4th month of the program (at 30 months or older), they were provided with a real challenge: 42 signs to learn (38 objects and 4 attributes). In an elicitation 6 to 8 weeks later, each child could at least imitate 97.4% to 100% of the signs and could produce most of them (26–37 signs). Elicited production percentages were 68.4% and 88.1% for 2 children (DA about 30 months by this time) and 71.4% for each of the other 2 children (DA 36–40 months). On a more difficult set of 46 signs for actions and attributes that 3 of these children received next, production percentages were considerably lower (17.4–30.4%, compared to 43.5–65.2% for the corresponding words). On elicited imitation, signs were just a bit lower than words (the sign percentages were 63.0% for one child and 93.5% for two others). Combined with earlier target sets, these results produce cumulative production vocabularies of considerably more than 50 signs per child (and an even higher number of words).

To adapt a term from Susan Carey, these older children were not just "word magnets"; given an opportunity, they were "sign magnets" as well. But why? They were far beyond the age at which children are drawn to signs as a vehicle for spontaneous production and begin to use them symbolically. Indeed, my records of spontaneous use in natural contexts are rather sparse for these children. However, they often were enthusiastic learners during the times set aside to focus on signing and often took pleasure in demonstrating their knowledge.

I would suggest two factors. The less interesting one is that there was a good deal of social support for signing in the program; seeing other children sign (including younger children and speech-delayed children) made this a relevant, if circumscribed, activity. The more interesting factor is that the ability to rapidly master new forms is just as important to acquiring the large vocabulary of a 3- or 4-year-old as is the ability to form meanings and link them to those forms. Elicited imitation is a measure that focuses especially on this ability to approximate adult forms and is useful for assessing it separately. Elicited production assesses which forms and meanings have already been acquired and linked such that the form can be quickly accessed when appropriate. *The procedures for mastering forms apparently can continue to operate bimodally beyond the bimodal period and are modularized enough that they can and will be exercised even in the absence of desire to use the forms to communicate.*

In this connection, note that Acredolo and Goodwyn (1988) gathered data on ability to imitate gestures in the laboratory at 17.0 months; they found no correlation with any of their symbolic gesturing measures and pointed to both the lack of communicative function and to the unfamiliarity of the laboratory situation as explanations. I would suggest, however, that performance on that task might correlate with how quickly or successfully children become "sign magnets" in the ensuing months. To the extent that shared capabilities are involved in the procedures for each modality, the gesture imitation task might also predict children's success as "word magnets."

Concluding Remarks

The desire to communicate, the ability to approximate adult forms, and the ability to use forms symbolically have a complex, intertwined history in the development of each child. These milestones are achieved gradually in that order beginning at 8 or 9 months, and a rather slow process involving not many forms and meanings characterizes the bimodal period until vocabulary speeds up around 20 months and syntax begins to emerge. Very efficient procedures for rapidly acquiring words apparently develop during the transitional period of 20 to 26 months and are quite powerful by 27 or 30 months and beyond. If these older children are provided with enhanced gestural input, procedures for acquiring object-related signs or gestures are almost as powerful and can be measured in elicitation sessions. Finally, well beyond the bimodal period and its immediate successors, gesticulation develops in coordination with speech and becomes the dominant form of bimodal expression through the rest of the lifespan.

Questions to be resolved in the future include (a) Although early exposure to enhanced gesturing or sign language is not necessary for a child of age 30 to 40 months to rapidly master manual forms, would a child with early exposure develop the underlying procedures a bit earlier? (b) For children given either early or later exposure to both words and enhanced gesturing or sign language, would the age at which procedures for rapid acquisition of forms emerge be later or more variable for words than for manual forms? If the answer to either of these questions is yes, some revisions would be in order for the tentative conclusion reached earlier: that high variability in speech across children with different biologically based disorders is *not* rooted in high variability even when all systems are intact. No evidence currently available points to the need for any revision, however.

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