

# 2 Modularity and Constraints in Early Lexical Acquisition: Evidence From Children's Early Language and Gesture

Laura Ann Petitto  
*McGill University*

## THE ONTOGENY OF LANGUAGE AND GESTURE

Only one explanation of human language ontogeny fully accounts for over a decade of findings in my laboratory concerning signing and speaking children's use of early lexical and gestural forms: Humans are born with a predisposition to discover particular sized units with particular distributional patterns in the input, guided by innately specified structural constraints (e.g., Jusczyk, 1986; Petitto, 1984, 1985a, 1985b, 1987; Pinker, 1984; Pinker & Bloom, 1990). At birth, this nascent structure-seeking mechanism is sensitive to the patterned organization of natural language phonology common to all world languages (e.g., Fernald et al., 1989), be they spoken or signed (e.g., rhythmic, temporal, and hierarchical organization) and is particularly sensitive to structures in the input that correspond to the size and distributional patterns of the syllable in spoken and signed languages (e.g., Mehler & Fox, 1985; Petitto & Marentette, 1991a). Irrespective of whether an infant is exposed to spoken or signed languages, this nascent structure-seeking mechanism is capable of utilizing whichever channel (or modality) is receiving the structured input—and it will do so without any modification, loss, or delay to the timing, sequence, and maturational course associated with reaching all linguistic milestones in language acquisition (e.g., Petitto, 1984, 1985a, 1985b, 1986, 1987, 1988; Petitto & Marentette, 1990, 1991b), providing systematic language exposure begins very early (preferably at birth). For example, deaf children acquiring signed languages from birth and hearing children acquiring spoken languages from birth achieve all linguistic

milestones on an identical time course (e.g., Petitto, 1984, 1985a, 1985b, 1986, 1987, 1988).<sup>1</sup> Even more surprising, "bi-lingual" hearing children in deaf or deaf and hearing homes, who are exposed to both a signed and spoken language from birth, achieve all linguistic milestones in both modalities at the same time (e.g., vocal and manual babbling, first words and first signs, first grammatical combinations of words and signs, respectively, and beyond), and on the same maturational time course as other monolingual hearing and deaf children (Petitto & Marentette, 1990, 1991b); indeed, their general pattern of language acquisition follows those reported in the literature for hearing children in bi-lingual homes acquiring two spoken languages (e.g., Genesee, 1987). One would expect that if speech were more suited to the human brain's maturational needs in ontogeny, this very group of children would attempt to glean every morsel of speech that they could get from their environment—perhaps even turning away from the signed input—favoring instead the speech input. But this is not what happens. Signed and spoken languages are acquired effortlessly by these children, and all of the children, including the deaf children of deaf parents, acquire signed languages in the same way, at the same time, exhibiting the same linguistic, semantic, and conceptual complexity (stage for stage) as hearing children acquiring spoken languages (see also Petitto & Charron, 1987).

Such findings compel the conclusion that all infants initially attend to and seek to discover very particular aspects of language structure at birth, irrespective of the modality of the input. Indeed, linguistically structured input—and not modality—is the critical factor required to trigger human language acquisition. This early template or structure-seeking mechanism constitutes the initial contents (or, "representation") of the nascent human language capacity at birth, which matures throughout development. At birth, it is initially blind to modality; it is "amodal" (i.e., it is capable of seeking specific structures in multiple modalities). When specific structures in the input correspond with those in the infant's nascent template, a tacit decomposition of the elements of the match begins. The product of such decompositions can then serve both as the units over which infants discover the permissible segments and combinatorial rules of their target language, and as the basis from which systematic motor production programs of early language units are

<sup>1</sup> One group of researchers has claimed that first signs are acquired earlier than first words (e.g., Bonvillian, Orlansky, & Novack, 1983). However, see Petitto (1988) for a critique of why these claims are unfounded. See also Bellugi and Klima (1982), Meier (1991), Newport and Meier (1985), and Petitto and Marentette (1990, 1991b) for a review of the early lexical and later grammatical milestones in signed language acquisition; these studies demonstrate that signed and spoken languages are acquired in surprisingly similar ways and on a similar time course, despite the modality differences.

derived: Hence, witness the existence of vocal and manual babbling. Each completed analysis permits the child to extract larger and larger components of language structure from the input, thereby propelling very early linguistic development from one period to the next. Again, this entire process is not special to speech. Importantly, the infant's structure-seeking mechanism permits him or her to begin the language acquisition process through very early tacit analysis of particular structures in the input—especially the general prosodic and sublexical phonological structures of language—well in advance of the infant having to know either the meanings or the grammar of the target language.

It follows from my arguments that the means by which the language capacity can be expressed *in ontogeny* need not be restricted (a priori) to exactly two modalities, spoken and signed. For obvious reasons, any productive system of language must be (a) perceivable, (b) producible by the human body, and (c) potentially segmentable (a restricted set of segments must be capable of multiple combinatorial possibilities). In principle, properties of the human body that satisfy these constraints could serve as language articulators (i.e., a means for expressing the contents of the language capacity). Although the oral-aural (speech) and manual-visual (sign) modalities are clearly best suited for language transmission and reception in ontogeny, it is possible that—under certain extraordinary circumstances—other units (perhaps the lower limbs in combination with facial markers) could serve as a vehicle by which the contents of the language capacity can be expressed. Note, however, that motor production systems alone do not constitute knowledge of language, as one essential feature of language is its underlying structure, and the structure of language is not wholly derived from the organization of any given motor production system—be it the hands, face, or mouth—although, clearly, a given modality does exert some influence on language structure. This fact is immediately apparent when considering the structure of signed and spoken languages: Both signed and spoken languages are produced with radically different articulators (both are subserved by different neurological motor substrates in the brain), yet both exhibit identical levels of language structure (e.g., phonological, morphological, syntactic, semantic, discourse). Moreover, both signed and spoken languages are acquired in highly similar ways, with babbling serving as one particularly revealing example: The *common* syllabic organization observed both in the vocal babbling of hearing infants and in the manual babbling of deaf (and hearing) infants exposed to signed languages, despite radical modality differences, could only be the product of a *common* brain-based structure seeking mechanism (e.g., Petitto & Marentette, 1991a).

The claim, then, is that humans are born with a nascent structure-

seeking mechanism, blind to modality, which initially attends to and seeks to discover particular units with particular distributional patterns in the input, corresponding in size and organization to the phonetic and syllabic units common to all languages (spoken or signed). The saliency of particular types of patterns over others in the input is entirely commensurate with what we know about other brain-based biological systems, such as the visual system. For example, the specialization of particular cells to particular patterns of visual stimuli (e.g., form, size, and orientation) is a well-known system of this sort (Hubel & Wiesel, 1959). However, the nascent human language capacity can seek particular linguistic patterns in multiple modalities (e.g., the pursuit of particular patterns is neither restricted to visual nor to speech stimuli). Implicit in this theory is the claim that the infant's tacit structure-seeking analyses are the product of innately specified mechanisms that respond to specific patterns unique to world languages (i.e., units possessing phonetic and syllabic size and organization, as well as the phonological and prosodic markers specified earlier), and not to general perceptual, or general cognitive dimensions. In this way, they are domain-specific pattern analyzing mechanisms. Particularly dramatic support for this claim comes from the study discussed here in which young deaf infants consistently differentiate between signs (identical to words) and gestures throughout development, even though signs and gestures reside in the same modality, and even though some signs and gestures share formation and referential properties. The infants' failure to confuse signs and gestures suggests that gestures must violate the structural requirements of the nascent structure-seeking mechanism and that a structure-seeking mechanism exists, sorting through the input and searching for a particular structure and no other. Thus, as is shown here, *aspects* of human language acquisition must be driven by language-specific knowledge—knowledge that is not wholly derived from infants' general cognitive capacities (see also Petitto, 1984, 1985a, 1985b, 1987, 1988).

A clear implication here is that, in ontogeny, humans can acquire language in either the spoken or signed modalities, be they hearing or deaf. Once the child is exposed to structured linguistic information in one modality (e.g., the verbal modality in hearing children), the alternative, "unused" modality (e.g., the gestural-visual modality in hearing children), can then serve secondary signaling and augmenting functions. However, signaling and augmenting functions are "piggybacked" onto the child's emerging linguistic and conceptual capacities and not vice versa.

Like other biological phenomena, mastery of a target competence—in this case, a target language—depends on the organism's ability to receive and maintain a steady sample of input despite a constantly varying environment (e.g., Mayr, 1982; Shatz, 1985). Young infants' early gestures

(e.g., pointing), provide them with a mechanism by which they can attract a caretaker's attention, who then responds with a communicative exchange that invariably contains linguistic content. Indeed, it is widely known that young children's gestures elicit rich linguistic input from caretakers, especially names for things (e.g., Shatz, 1985). This use of gesturing constitutes a "mechanism of self-control" (e.g., Shatz, 1985; see also Petitto, 1985b, 1988). That is, early gestures ensure that the young infant receives and maintains ample linguistic input. This input constitutes the "data" over which the child tacitly performs his or her language structure-seeking analyses that will ultimately yield "knowledge of language" (e.g., Chomsky, 1975; Gleitman & Wanner, 1982; Petitto, 1987, 1988; Pinker, 1979, 1984).

Children's later gestures (e.g., 12–24 months) serve an important augmentative function. They are used to augment (through emphasis) the child's failed communicative interactions, which, at first, typically involved only their primary linguistic system. As is shown in this chapter, support for this claim comes from a variety of observations, including: (a) Symbolic gestures (empty-handed gestures that "stand for" or "represent" referents) in hearing and deaf children occur only *after* children are able to first comprehend and/or produce the corresponding primary linguistic form (i.e., the word or sign, respectively). The reverse ordering was never observed. (b) Young children (from around 11 months old and beyond) produce even their *earliest* lexical forms in constrained ways that correspond to different word/sign types (object names, property words, event words, etc.; Carey, 1982; Huttenlocher & Smiley, 1987; Keil, 1989; Markman, 1989; Petitto, 1988; Quine, 1969). However, their use of symbolic gestures within this same time period were used both within and across word/sign type boundaries; this revealing finding suggests that the knowledge underlying gesture and language is distinct, and provides key insights into the nature and type of linguistic and conceptual constraints underlying children's early lexicon. (c) Children use their symbolic gestures largely to augment their primary linguistic system (be it spoken or signed), often when a communicative interaction between adult and child fails and almost always to request objects rather than to identify or name them.

To review, once systematic input is received in a primary channel, the alternative channel can then assume global signaling and augmenting roles, drawing from and driven by the contents of the blossoming linguistic capacity. However, without systematic input, the "unused" channel—again, the gestural-visual modality in the case of hearing children—remains an unsystematic signaling device, which then takes on very different, but nonetheless useful, language-eliciting and language-augmenting functions. The distinction between primary linguistic systems

and gestures is so powerful in ontogeny that the language-gesture distinction is maintained even in infants acquiring signed languages. Indeed, the child exposed to signed languages carves out this distinction even though the input channel contains both language and gesture in a single gestural-visual modality, and even though language and gesture in signed languages can be tantalizingly close in their formational and referential properties. That the language-gesture distinction is observed even in extremely young infants acquiring signed languages provides additional support for the claim that the human infant is predisposed to discover particular linguistic structures in the input, guided by innately specified structural constraints that have unique (domain-specific) representation and that can be mapped onto multiple production channels at birth—as signed language studies have clearly demonstrated that the newborn's specifically linguistic structural analyses of the input is not specific to the speech modality. Importantly, hearing children's very ability to produce gestures reflects their residual capacity to receive and produce language in the gestural-visual modality, should they have been exposed to it.

Thus, comparative analyses of gesture and language provide a clear window into the biological foundations of human language. Later, I focus on one type of gesture in language acquisition, the symbolic gesture, because the perceived similarities between this particular type of gesture and children's first words have been used to support extremely powerful theories of mind (e.g., Acredolo & Goodwyn, 1985, 1988; Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979; Bates, Bretherton, Shore, & McNew, 1983; Goodwyn & Acredolo, 1991; Lock, 1978; Piaget, 1962; Shore, O'Connell, & Bates, 1984; Werner & Kaplan, 1963). Although a clear prediction of the theory that I have just outlined is that children's early lexical and gestural use will be similar on some dimensions, it clearly predicts that critical *differences* should also exist between them. Similarities will occur because augmentative gestural signaling is parasitic on the child's emerging linguistic and conceptual capacities. Differences will occur because aspects of language (e.g., the infant's structure-seeking capacity) constitute domain-specific knowledge.

However, current research on children's gestures has focused nearly exclusively on the similarities between gestures and language rather than on the differences between them. Indeed, many researchers compare young children's gestures and early lexicon, stressing the similarities between the two, and then conclude that gestural communication and language are fundamentally continuous because of these similarities. Aside from the fact that language is often defined in simplistic ways in the service of such comparisons (e.g., language exclusively in terms of its "communicative function"), the basic problem with this approach is that it

makes the hypothesis that gestures are positively related to human language wholly *unfalsifiable*. What is the metric for counting similarities? How many must there be in order to conclude that the young child's gestures resemble the use of language in an interesting way (e.g., see Seidenberg & Petitto, 1987)?

That similarities exist between children's symbolic gestures and first words is not denied in this chapter; children's symbolic gestures and early lexicon do share referential and communicative properties. Nevertheless, I show here that despite these similarities, key differences exist that shed new light on the unique constraints that underlie human language acquisition in particular, as compared with other general cognitive and communicative capacities to symbolize. In the course of doing so, I hope to provide insights into the nature of gestures, the constraints that underlie early lexical knowledge, and, most importantly, the types of knowledge underlying human language acquisition.

### Types of Gestures in Human Development

All humans gesture. An intriguing feature of human development is that infants also produce gestures well before the onset of their first words. Many children continue to gesture while producing their early words and beyond. Summarized here are the variety of gestural types common to most children.

Beginning around 9 months and continuing throughout the first 3 years, infants use indexical gestures ("pointing gestures") in a wide variety of contexts, performing various communicative functions, such as requesting and denoting. By 13 months, however, children display a fascinating ability to produce a variety of non-indexical gestures and other manual actions with and without objects in hand. For example, if presented with an empty cup, most children will bring it to their lips and produce drinking-like motions ("actions with objects"). Or, when desiring to be held, many children will raise their arms above their heads to be picked up; likewise, when desiring an object, many children will produce the classic "beg gesture," whereby they hold out their hand, often opening and closing it ("empty-handed instrumental gestures"). Further, children also produce a variety of culturally established gestures (e.g., waving "hello" and "bye-bye"; "yes" and "no" head nods) and routinized gestures in games (e.g., "itsy-bitsy spider") that are found in many societies ("social gestures"). Later, around 15 months, children produce empty-handed gestures for things and events in the world ("symbolic gestures"). For example, if presented with a closed jar, some children will spontaneously produce an empty-handed "twist" gesture.

The main distinction drawn among the various types of gestures involves the extent to which gestural types *symbolize* referents (e.g.,

object, person, place; what is referred to) and events in the world, rather than simply refer to them. Minimally, a gesture is a manual form that refers to or picks out a referent or event in the world. Gestures, however, can also be used to symbolize ("stand for" or "represent") a given referent or event. Although the pointing gesture can refer to (or pick out) referents and events, it typically does not symbolize them. Indeed, a single pointing form can refer to a potentially infinite class of referents. Further, there is a literal, physical identity between the form of "actions with objects" and what one does with a given object once in hand ("brushing" actions with brushes is what one does with a brush to realize its function). Similarly, the form of instrumental gestures appears to be part of the action associated with a given referent or event. For example, the form of the "beg" or "give me" gesture appears to be tied to the actual behavior used in the act of receiving (or taking), rather than a schematic representation of it (the child enacts rather than depicts). In contrast, the form of symbolic gestures involves some degree of representation. The child could, but does not, actually twist open a jar when producing the "twist" gesture. Symbolic gestures preserve partial information about actions that are associated with objects (e.g., twisting hand motions when opening jars), but they are not the enactment of the designated activity (e.g., children do not literally open a jar). In this sense, then, it has been argued that, for example, a form such as the "twist" gesture is a schematic representation for jars because they can be said to both refer to (pick out) and represent (symbolize) the referents (e.g., Bates et al., 1979; Bates et al., 1983; Werner & Kaplan, 1963).

#### Attributions of Lexical Status to Children's Gestures: When are Gestures Said to be Linguistic?

Little controversy exists over children's indexical gestures, social gestures, and other clearly nonlinguistic activities (e.g., scratching, reaching, grabbing). Most researchers studying the gestures of hearing children set aside these three types, as they are typically not judged to have lexical (linguistic) status. An analysis of instrumental gestures was provided earlier and in Petitto (1988). However, "actions with objects" and "symbolic gestures" remain the subjects of controversy, with the linguistic status of symbolic gestures constituting the most lively debate of all. Indeed, symbolic gestures and their referential and representational (symbolic) status have been directly compared to the referential and representational status of children's first words, with identical linguistic status (grammatical and semantic) attributed to both (e.g., Acredolo & Goodwyn, 1985, 1988, 1990; Bates et al., 1979; Bates et al., 1983; Goodwyn & Acredolo, 1991; Lock, 1978; Piaget, 1962; Shore et al., 1984;

Werner & Kaplan, 1963). Consequently, the existence of symbolic gestures has been regarded as providing critical insights into the knowledge that underlies the human language acquisition process.

*Actions With Objects in Hand.* Initially, some researchers made very strong claims about children's "actions with objects." Indeed, previous researchers referred to this type of manual activity as "gestures with objects," and they explicitly claimed that the 13-month-old's manual activities with objects did not constitute *prelinguistic* acts at all. Rather, they were said to be the gestural equivalents of linguistic names for things and were considered to be a kind of "noun or object name" (Bates et al., 1983). It was claimed that when a child produces an action with an object in hand (e.g., drinking motions with a cup), the use of this hand activity is *functionally identical* to the child's early use of words (e.g., saying *drink* upon noticing a cup). Similarly, the word "cup" is used with cups and not other objects. In the same way that a child uses the word "cup" to pick out a referent as being a member of a known class or kind, it was argued that the child's use of the *action* for cup is also showing that this gestural act is true of the objects that belong to the class or kind "cup." The presumption here is that children will not produce *function violations*. That is, children will not "drink" with, for example, a hammer, because this manual act is not "true" of the class or kind within which hammer resides.

I have argued elsewhere that the claims made here are most probably false (Petitto, 1985a, 1985b; see especially 1988). First, close examination of children's entire range and use of actions with objects (ages 9 through 20 months) reveals that they are not used in a way that is functionally identical to children's use of early words. Children (13 months and beyond) will produce methodical and repetitive sequences of actions with objects in hand with no apparent communicative function or intent. That is, they do not use "actions with objects" communicatively, whereas they do so freely with their corresponding first words occurring within the same time period. For example, children will produce the action for cup without any apparent communicative intent (eye gaze fixed at object rather than adult), but will use the word "cup" in rich and varied ways to identify cups, to comment upon liquid being added to a cup, to be given a cup, and so forth (with eye gaze to adult, and/or from object to adult or vice versa). Second, children (13 to 18 months) routinely begin by making function violations when producing actions with objects, suggesting that object functions must be learned, and are learned over time. Although 13-month-old children would pick up a spoon, place it in an empty cup, and "stir," they were equally likely to pick up other objects that shared certain critical physical dimensions with spoons and "stir"

with them as well (e.g., hammer, mirror); importantly, children produced correctly many of the words for objects *prior* to producing the correct functions (or actions) associated with the same objects (Petitto, 1988). Thus, it appears that children's "actions with objects" in hand are not used identically to linguistic names or "nouns." Rather, they appear to be complex actions associated with objects, an observation originally made by Piaget (1962).

*Symbolic Gestures.* Children's empty-handed symbolic gestures are by far the most interesting type of gesture, and they are the focus of this chapter. Because there appears to be general correspondences between this type of gesture and children's early lexicon, they have recently received much attention. In general, some children produce symbolic gestures within the same time period when they exhibit a period of rapid vocabulary growth (15 to 18 months, or 18 to 24 months). Both symbolic gestures and words are used communicatively and intentionally; both are used referentially; both appear to have some representational component; both appear to be used in functionally correct ways. Thus, researchers have claimed that children's early *symbolic gestures* and early *words* are deeply equivalent; symbolic gestures are said to have lexical status, albeit in the gestural mode. Moreover, they are said to be parallel expressions of reference. Indeed, the single persistent assertion common to many current studies is that symbolic gestures and words have equal symbolic status, that is, gestures *mean* the same thing as words (e.g., Acredolo & Goodwyn, 1985, 1988, 1990; Bates et al., 1979; Bates et al., 1983; Goodwyn & Acredolo, 1991; Lock, 1978; Piaget, 1962; Shore et al., 1984; Werner & Kaplan, 1963).

#### Consequences for Theories of Mind

The previous interpretation of children's symbolic gestures and words has been used to support a very powerful theory of mind. Because both gesture and word are said to have equal symbolic status, it has been argued that the representation of language in the brain is routed in general cognitive capacities (cognitive-general model). Indeed, correspondences between early symbolic gestures and first words have been regarded as "... providing support for the hypothesis that strides in cognitive abilities such as memory, categorization, and symbolization underlie [the first symbolic gesture and first word] milestone in both modalities" (Goodwyn & Acredolo, 1991, p. 2). Although the identical data would also support the equally plausible hypothesis that similarities between gestures and words are driven by a specifically linguistic capacity, this possibility is not considered. Instead, the interpretation here

has been used to challenge a major alternative theory of language representation in child development, one in which language is considered to be a distinct mental capacity, reflecting domain-specific knowledge that is not wholly derived from general cognitive capacities (domain-specific model). In this latter view, distinct representational structures underlie language but no other communicative capacity such as gesturing; we know this view as a "modular" model of the brain.

Thus, we have a situation in child development where very strong claims are being made about the brain-based knowledge that underlies human language acquisition, which, in turn, rely entirely on the claim that children's gestures and language are used in symbolically and functionally equivalent ways.

*Existing Evidence.* None of the brain-based claims that gestures and words have equal symbolic status are based on *data samples* and/or *data analyses* that would support the claims (e.g., Acredolo & Goodwyn, 1985, 1988, 1990; Bates et al., 1979; Bates et al., 1983; Goodwyn & Acredolo, 1991; Lock, 1978; Piaget, 1962; Shore et al., 1984; Werner & Kaplan, 1963). For example, although Goodwyn and Acredolo (1991) employ very commendable criteria for what constitutes a symbolic gesture or word, the basic data sample of the children's *gestures* were collected from audiotaped telephone interviews containing mothers' *verbal* reports. That is, the gestures produced by the children were never actually seen or analyzed by the experimenters; this is true for the children's words as well. The data in this and related studies include:

1. lists of symbolic gestures and their English glosses, as well as their grammatical categories (e.g., common noun, proper noun);
2. the age at which the mother said that her child first produced symbolic gestures (as compared with first words); and
3. the manner in which the mother said the symbolic gestures were used (spontaneous, imitative, elicited) and acquired (directly taught by a parent, spontaneous imitation/parental actions, etc.) as compared with words.

In summary, use of mothers' reports—which involve a mother's attributions of meaning to her child's forms and are typically based on her memory of its use—makes it difficult to interpret these researchers' potentially important claims.

Mothers' reports cannot be used as a primary data in child language, either for words (e.g., Huttenlocher & Smiley, 1987) or gestures (e.g., Petitto, 1985a, 1985b, 1988). As Brown and Hanlon (1970) noted, parents pay far more attention to the meaning of their children's utterances rather

than to the syntactic form. The identical phenomenon exists when parents evaluate their children's gestures (Petitto, 1985a, 1985b, 1988). Parents do not interpret children's gestures based on how they were used in the past, or whether there are consistent correlations between particular gestural forms and their referents. For example, in studies of parental attributions in my laboratory (e.g., Petitto, 1988), one parent, in the same taping session, attributed a *single meaning* to her child's gesture, even though the child used *multiple gestural forms*, in the identical context, at different times. Conversely, a *single gestural form* was interpreted as having *multiple meanings* at different times throughout the session; these findings are representative of the other mothers in our studies. In the same study, a deaf researcher was asked to transcribe a videotape of a *hearing* boy aged 10 and 11 months (see Petitto, 1988, for details). Based on the child's natural repertoire of gestures (e.g., reaching, grasping, banging, pointing gestures, and other motoric hand movements), she reported nearly 100 "sign" utterances, including complex sign combinations. Thus, parents and researchers alike, freely attribute a variety of complex desires, intentions, and knowledge to children's gestures, based on their interpretation of what they think the child means, rather than on the actual gestural form used to convey it.

In order to assess claims about the symbolic status of gestures, the appropriate data needs to be gathered. That is, children's actual gestures must be studied, rather than the researcher's English glosses of mothers' reports of their children's gestures. Once the data is gathered, the following types of analyses can be conducted: (a) identification of the gestural forms, relative frequency, and distribution of all forms both within and across children over time; (b) the range of referents over which the forms are applied (and vice versa); and (c) a comparison of the forms/range of referents for both gestures and words, and all other analyses detailed here.

### Predications and Objectives

If symbolic gestures *mean* the same thing as words, it would follow that they are used in ways highly similar to children's use of early words, particularly their words for objects. Construed as a testable hypothesis about the language acquisition process, the prediction is that there will be consistent word and gesture use with regard to the same or highly similar range of objects in the world.

Studying the question in the context of signed languages offers a unique window into the knowledge that underlies human language acquisition. In signed languages, both gesture and language reside in a single modality, the gestural-visual modality. Thus, the existence of signed languages

provides a "natural experiment" regarding the two conflicting models of the brain. For hearing children, gestures and words are produced using different modalities (gestural and vocal), which may clue them into any different referential properties of early gestures and words, should they exist. This is not the case with children acquiring signed languages. If children's gestures and early lexical items have equal symbolic status (mean the same thing), we might expect to see especially close correspondences between them in children acquiring signed languages. If, however, distinct knowledge structures underlie children's gestural and lexical use, then their use should differ. Indeed, when I first began this research, one question intrigued me most: Will the young signing children show *any* evidence of differentiating gestures from signs given that both are in the same modality?

In the remaining portion of this chapter, I focus largely on what I have learned about young hearing and deaf children's symbolic gestures. I provide the first analyses of the form of children's symbolic gestures, especially with regard to the range of referents over which the form(s) are applied. I also provide the first comparisons between the range of referents for symbolic gestures and the range of referents for early words in hearing children and early signs in deaf children. This makes it possible to determine whether symbolic gestures and early language have equal symbolic status.

### SUBJECTS

To examine the questions asked earlier, I summarize the findings from one group of six children whose results are representative of all of the other children studied in my laboratory. The six subjects included three hearing children of hearing parents acquiring spoken languages (languages: two French, one English), and three profoundly deaf children of deaf parents acquiring signed languages (languages: two Langue des Signes Quebecoise, LSQ, one American Sign Language, ASL),<sup>2</sup> ages 8 through 20 months.<sup>3</sup>

<sup>2</sup>ASL and LSQ are two entirely distinct, natural signed languages. Further, neither language is the signed counterpart of the spoken majority language (e.g., English or French, respectively). Each signed language has its own grammar (linguistic units and rules for combining them).

<sup>3</sup>Videotaping and data analyses for all but two of the hearing children were conducted until the children were over 4 years old. However, ages 8 through 20 months capture the relevant period under question in the literature (the transition from prelinguistic to linguistic expression). See Petitto and Kampen (in prep.) for additional details.

## METHODS

## Procedures

Monthly videotapes of each child and a parent were collected (see Petitto & Kampen, in prep., for a full report on the procedures and analyses used in this study). After an initial warm-up period in which the child played with toys, four controlled elicitation tasks were administered to assess the child's production and comprehension of words and/or signs and gestures, including common gestures and those produced by the children themselves. Every videotaping session also contained a period with (a) the parent and child in free play and (b) the child alone in free play. Further, monthly reports of the child's lexical and gestural activity were collected from the parent using the Bates and Fenson assessment battery ("MacArthur Communicative Development Inventory: Infants and Toddlers"), and detailed experimenter reports were also made at the end of each taping session. Videotaped sessions served as the primary data in this study and parental and experimenter reports were used only to ensure that our samples were representative of the child's behavior at any given age.

## Data Transcription

Detailed transcriptions of the entire content of each videotape were made by two independent observers and entered into a computer database. Transcriptions were entirely theory-neutral. In this transcription system, the precise physical form of the child's every manual activity is coded with diacritics that represent the internal and external features of the hand(s), such as its handshape, movement, and location in space; head, face, and body movements are also coded (see also Petitto, 1988; Petitto & Marentette, 1991a). Then, the precise manner of use is coded for each manual activity, including whether the form

1. was produced in a spontaneous, imitative, or elicited manner;
2. was used with or without objects in hand;
3. was used "referentially" (used in relation to a referent in the world; if so, the precise referent was specified);
4. was used "communicatively" (produced with clear communicative intent; e.g., involved eye gaze with an adult);
5. had "conventional meaning" (manual activity with established cultural meaning that was not the standard sign in either ASL or LSQ);<sup>4</sup> or
6. was a standard word or sign (or "lexical form"; more on this later).

<sup>4</sup>For example, the common form used to convey "quiet" (index finger to pursed lips while producing a "shhh" sound) is used by deaf and hearing children and adults to indicate "quiet," but the sign QUIET in ASL (and in LSQ) is produced with a different handshape and movement.

Information about the apparent function of the manual form for the child as well as detailed information about the context were also coded. Finally, mothers' manual activity was also coded. Mothers' reactions to the child's manual activity (mothers' apparent interpretation), and the child's reaction to the mother's manual activity were also coded. Children's verbal productions were coded in a similar manner, except that extremely detailed phonetic transcriptions were not made for each form; in particular, an unidentifiable vocalization would be coded as a "voc" and then the other information would be subsequently coded.

*Unique Features of Transcription System.* Use of this transcription system permitted frequency and distributional analyses of all of the types of children's manual and verbal activities over time, and across thousands of contexts, in a way that has simply never before been provided in the literature. Moreover, it permitted within and across child comparisons of manual and verbal activities in a manner that has also never been provided before. Importantly, this transcription system permitted the following crucial analysis necessary to make attributions of meaning to children's forms: For every manual and verbal form, it was possible to identify the precise range of referents that it was produced in relation to. Conversely, for every referent, the exact manual and verbal form(s) that were used with it were also wholly identifiable.

## Data Analyses

The overall behavioral patterns and their frequencies and distributions were identified within and across children over time, for example (a) empty-handed activity; (b) manual activity with objects in hand; (c) head, face, and body movements; and (d) lexical forms (including ill-articulated and proto-forms; see Petitto & Kampen, in prep., for details). Children's use of empty-handed activity was compared with their use of manual activity with objects in hand, and children's use of empty-handed activity was compared with their use of lexical forms. Of particular interest was the nature of the relationship between a given form and its referent—in other words, we were interested in a form's meaning as well as the range of meanings that children expressed through their use of gestures and lexical forms.

*The Set of "Symbolic Gestures" and the Set of "Lexical Forms".* Similar criteria were used to determine whether a manual or verbal form was to be considered a candidate for inclusion in the set of "symbolic gestures"



or the set of "lexical forms," respectively. Both manual and verbal forms minimally had to "refer." Operationally, this meant that a form had to be used in relation to a referent (e.g., eye gaze includes gaze to a target referent, and/or related referents if none existed in the world). There were also the following form requirements:

1. As was noted in the introduction, the form of symbolic gestures contains a representational component; thus, to be considered a candidate for inclusion in the set of symbolic gestures, in addition to referring, a manual form also had to contain a representational component; that is, the child may not have actually produced the manual form by physically manipulating a target referent.
2. To be considered a candidate as a "lexical form," a further requirement was that verbal or manual forms had to be produced according to the standard—or approximation to standard articulatory constraints of the adult word or sign (respectively); importantly, the child did not have to produce the exact adult form (ill-formed and ill-articulated forms, baby words and signs, and proto words and signs were accepted), and the child did not have to demonstrate adult usage (adult meaning).

These criteria both capture the critical features used to identify children's symbolic gestures and words in the literature and, at the same time, they are over-inclusive relative to them. For example, a form did not have to be produced spontaneously in order to be considered a candidate for inclusion in the set of "symbolic gestures" or set of "lexical forms"; the analyses of possible symbolic gestures was also expanded to include forms produced nonmanually (i.e., on the face, head, and body). This procedure was adopted to "stack the deck against our hypothesis," that is, to find as many candidates for our analyses as possible, should they exist.

*Attribution of Meaning: Do Symbolic Gestures and Lexical Forms Have Equal Symbolic Status?* The identical criteria were used to evaluate the symbolic status of the forms just discussed. In order to determine whether children's set of "symbolic gestures" and set of "lexical forms" had equal symbolic status (i.e., the *same meaning*), it was necessary to determine the child's grasp of the meaning of lexical and symbolic gestural forms.

The study of word meaning has a long, thorny history, and at least three critical distinctions must be made when studying it: (a) What is the meaning of a word? (b) What is an individual's grasp of the meaning of a word? and (c) How can researchers determine an individual's (a child's)

meaning of a word?<sup>5</sup> In Petitto (1985a, 1985b, 1988), I attempt to answer these questions. I discuss cognitive notions of reference and argue that the meaning of, for example, a common noun, is the range of referents over which it could potentially refer (be applied). Like others, I argue that an individual's word meanings have both intensional and extensional referential properties, and that an individual's word meanings are conceptually constrained across kinds or types of words (e.g., kinds of objects, kinds of events, kinds of possessions, kinds of locations). I further argue that a revealing way to determine the child's grasp of the meaning of a word is to examine the range of referents over which a given word is applied. Here, I use similar analyses to examine the meaning of children's lexical and symbolic gestural forms.

In this study, meaning is determined by observing the relationship between a child's form (be it lexical or symbolic gestural) and the entire range of referents over which the form applied. Once this is done, the meanings of all of a given child's lexical forms and all of her symbolic gestural forms are compared, within the child and across children. Note that the more general problems associated with extensional (associationist, and/or behaviorist) theories of word meaning are not at issue here, nor do they detract from the value of using this particular method as an operational measure of children's competence (e.g., see Petitto, 1985a, 1985b, 1988; see also Huttenlocher & Smiley, 1987, for an excellent discussion of the controversy over determining word meanings in child language, and the database that is required in order to make attributions of meaning to children's lexical forms).<sup>6</sup> Once the sets of symbolic gestures and lexical forms were identified, the following analyses were used to assess their meaning: (a) was a given form used systematically (i.e., was it used in a stable manner across multiple contexts); (b) was a given form used in relation to a referent, was this use systematic, was this use restricted to a particular referent or was it applied over a range of referents; (c) if a form was applied over a "range of referents," did it constitute a restricted or unrestricted class? Whether a form was used in communicatively and semantically varied ways was also evaluated.

Children's symbolic gestures and lexical forms could—or could not—have been used in the ways detailed here. To be clear, these analyses were

<sup>5</sup> I thank Paul Bloom for pointing out the need to make this particular distinction explicit.

<sup>6</sup> Huttenlocher and Smiley (1987) stated that "Indeed, the data from mother reports are not highly concordant with independent observational data [refs]. Regular observations of a sufficient number of utterances, using a standard method of recording context, are essential in getting a proper data base" (p. 67). Though arrived at independently (e.g., Petitto, 1984, 1985a, 1985b, 1987, 1988), similar methods are used in the present study.

seeking to determine any shared pattern of use between the two sets, should they exist, and it was unbiased as to whether a given form was a standard lexical form in the adult language, a gesture, or otherwise.

### Reliability

Reliability was assessed for both data transcription and data analysis procedures by two independent coders, with an overall reliability of 89.7% (see Petitto & Kampen, in prep.).

## RESULTS

A select sample of the analyses conducted on the present data are provided here (see Petitto & Kampen, in prep., for a full report). There were 4,841 protocols collected from the six children over the course of 12 months. As is standard in the literature, 145 (2.99%) of the manual forms were excluded from further analysis because they either occurred one time only ( $n=39$ ) or they were culturally established social gestures and/or routinized gestures in games ( $n=106$ ); note, however, that symbolic gestures occurring one time only were not excluded from analysis. Manual forms occurred alone ( $n=2,986$ ) and in combination with other forms ( $n=1,133$ ); combinations were comprised mostly of points plus manual actions, or combinations of manual actions, as there were virtually no empty-handed, non-indexical gesture plus gesture combinations in the entire corpora. Most all of the children's manual activity with objects and empty-handed activity were produced spontaneously, which was also true of most of their tokens of lexical forms ( $n=577$ ).

Here, I first provide an overview of the types and frequency and distribution of the gestures produced alone by the children; this information should provide a basis to interpret the findings regarding symbolic gestures, per se. Then, I provide an overview of how children used symbolic gestures as compared to their early lexicon. One striking finding of this study involved the constrained ways in which children used even their earliest lexical forms; the significance of this finding relative to children's use of symbolic gestures is discussed in the final pages of this chapter.

### Gestural Types, Frequency, and Distribution

*Types.* Six types of manual activity were observed:

1. *motoric hand activity* (e.g., banging, scratching; beginning (b.) around 9 months (mths) and peaking (p.) 15–18 (mths);

2. *pointing* (e.g., to objects, locations, b. 7–9 mths, p. 18–24);
3. *social gestures* (e.g., waving “hello,” “bye-bye,” “yes-no” head nods; b. 12 mths and beyond) and other highly routinized manual forms common in parent-child games (e.g., patty-cake);
4. *actions with objects in hand* (e.g., brushing with a brush; b. 12 mths and beyond);
5. *instrumental gestures* (e.g., raising arms to be picked up; b. 12 mths, p. 15–18 mths);
6. *symbolic gestures* (e.g., empty-handed downward movements at side of head while gazing at a comb; b. 14–18 mths—save 1 form that appeared at 12 months in one child—p. 18–24 mths.).

The aforementioned represents the types and approximate developmental sequence of children's manual activities. These findings are entirely commensurate with other data reported in the literature (e.g., Bates et al., 1979; Bates et al., 1983; Zinober & Martlew, 1985)—although researchers typically do not provide type and frequency data as well as distributional analyses of types over time, especially with regard to children's entire range of manual productions over time (studies by Goldin-Meadow, e.g., Goldin-Meadow & Morford, 1985, constitute the only exception to my knowledge).

*Frequency and Distribution of Types.* The types of manual activity produced by the hearing and deaf children, as well as their relative frequency of occurrence, are shown in Fig. 2.1. What is most striking about Fig. 2.1 is that both the types and the frequencies of gestures are highly similar across the two groups of children.

Symbolic Gestures vs. All Other Gesture Types

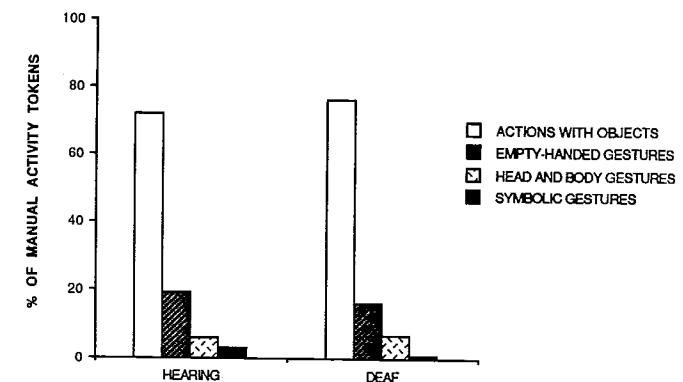


FIG. 2.1. Types and relative frequency of manual activity in the hearing and deaf children.

Figure 2.2 shows the relative frequency and distribution of gesture types over time for all of the children. Several important points to note are:

1. Actions with objects were by far the most frequent type found in all six children ( $n=44$  types, 1,888 tokens). The 1,888 tokens were used mostly in noncommunicative ways, consisting largely of actions associated with playing with specific objects (e.g., hammering a peg, brushing hair with a hairbrush; 68%), followed next by nonrelevant motoric actions with objects (e.g., banging, swatting; 29%); the relatively few instances of communicative use involved some token of demonstrative "showing" (e.g., child offers object to an adult 1%), and "requests" (e.g., child holds up one object, such as a toy coin, to obtain a similar one in adult's hand; 2%).
2. Empty-handed activity ( $n=12$  types: 485 tokens) included instrumental gestures ( $n=3$  types), which were used almost exclusively to request referents, and empty-handed manual activity produced in play ( $n=9$  types; e.g., stroking, patting, pressing); this "empty-handed activity" type of manual activity was significantly less frequent as compared with actions with objects, and they were even less frequent than pointing ( $n=509$ ). Head and body gestures occurred less frequently than most of the other types ( $n=7$  types, 104 tokens), but not less than symbolic gestures.
3. Symbolic gestures were the least frequent type to occur of all ( $n=6$  types, 48 tokens). Thus, across all children, there were only 48 tokens of symbolic gestures out of 4,507 tokens, or (1.1%).

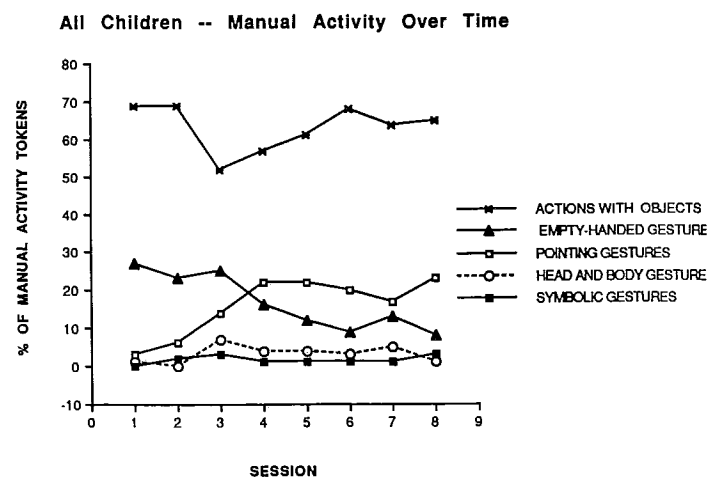


FIG. 2.2. Distribution and relative frequency of manual activity by type for all children over time.

Although infrequent, symbolic gestures were nonetheless produced with apparent communicative intent, they appeared to be appropriate to the context, they were referential and contained a representational component. Are *these* forms fundamentally similar to the way children used their first words?

#### Use of Symbolic Gestures as Compared to Use of the Early Lexicon

The hearing and deaf children spontaneously used symbolic gestures in similar contexts (only in the presence of a referent) and with a similar communicative function (to request). Both groups of children extracted similar salient perceptual features from referents that were then produced in gestural form. For example, hearing and deaf children's symbolic gestures for a toy telephone all involved the feature of bringing the telephone receiver to the ear, although the specific forms of this (and other) symbolic gestures varied within and across children. Some symbolic gestures were used first by the child and some were used by parents and then subsequently used by the child. In either case, parents tended to produce the symbolic gesture themselves.

The hearing and deaf children produced their early lexicon on the same time course; deaf children do not acquire first signs earlier than hearing children acquire first words (see footnote 1). Indeed, deaf and hearing children achieved all early (lexical) and later (grammatical) linguistic milestones on a similar time course and sequence (see also Petitto & Marentette, 1990, 1991b). Furthermore, the children used their early lexicon with similar communicative functions (e.g., to name objects). Finally, the semantic and grammatical content of both groups of children's lexicon were strikingly similar (see also Petitto & Charron, 1987).

Thus, there were similarities between hearing and deaf children's use of symbolic gestures, and there were similarities between hearing and deaf children's lexical use. However, there were important differences between both groups of children's (a) use of symbolic gestures versus their (b) use of the lexicon that are described here.

*Frequency of Symbolic Gestures Versus Words/Signs.* The children's symbolic gestures occurred infrequently relative to their words and signs. There were only 48 tokens of symbolic gestures (see Table 2.1) as compared with 577 tokens of lexical items (see Table 2.2). Three of the six types of symbolic gestures were used by all six children, and the three remaining types were used by one hearing child only; indeed, as is shown in Table 2.1, one hearing child (H2) produced all six types and the most tokens, revealing that there are individual differences in children's propensity to produce symbolic gestures.

TABLE 2.1  
Number of Types/Tokens of Symbolic Gestures  
Produced by the Deaf and Hearing Children

	Deaf			Hearing		
	D1	D2	D3	H1	H2	H3
Types	2	2	1	1	6	2
Tokens	7	4	4	2	17	14

TABLE 2.2  
Number of Types/Tokens of Lexical Items  
Produced by the Deaf and Hearing Children

	Deaf			Hearing		
	D1	D2	D3	H1	H2	H3
Types	22	8	12	11	57	2
Tokens	207	24	52	25	267	2

*Distribution of Symbolic Gestures Versus Words/Signs.* Symbolic gestures enter the children's behavioral repertoire relatively late, around 14–15 months (save one form produced by one child that her mother used, i.e., smacking lips for cookies) and their frequency and distribution remains atypically constant over time. Conversely, children's vocabulary production begins around 12 months and continues a dramatic rise throughout the entire period when symbolic gestures maintain a constant pattern of infrequent use. Thus, although children's early lexical use climbs and increases in frequency, their use of symbolic gestures does not increase and remains infrequent. Symbolic gestures are indeed a non-robust phenomenon in child development.

*Lack of Increased Complexity Over Time.* Unlike children's early lexical development, symbolic gestures exhibit a flat mean length of utterance (MLU; Brown, 1973). That is, there was no increase in the internal complexity of symbolic gestures—either formationally or referentially—over time, even though the complexity of children's words and signs increased steadily over time.

Although it is true that, unlike words and signs, children typically do not get systematic gestural models, parents do produce their children's symbolic gestures (as well as pointing, instrumental gestures, and actions with objects). Thus, it remains a puzzle why children would not use symbolic gestures more if they had equal symbolic status with lexical forms.

*Inconsistent Forms.* An example of a symbolic gesture is as follows. One symbolic gesture—the “phone” symbolic gesture—was used in relation to a toy telephone and was produced by four of the six children (two deaf, two hearing). It was produced in relation to the same toy telephone but its form varied both within a child and across children: (a) a clenched fist at the side of the head, (b) a flat hand at side of head, (c) two flat hands at side of head. Interestingly, the form was typically accompanied by opening/closing mouth movements plus vocalizations, even in the deaf children who, clearly, could not hear, and whose parents used TTYs (a form of teletype machine). Note that variation of form was common for all of the 48 tokens of symbolic gestures reported here. However, we simply did not find a similar degree of variation in the form of children's early words across instances of use and/or contexts.

*Restricted Communicative and Discourse Functions.* Symbolic gestures were used by the children largely in “request” contexts ( $n=36/48$ ; 75%); for example, to get something from someone. Only three tokens (6.25%) of symbolic gestures were used to “comment upon” (or name) a referent, and eight tokens (16.67%) were produced as responses to questions (e.g., “what do you do with this?”). Conversely, the children's lexical items were used largely to “comment upon” or name referents.

Interestingly, children would spontaneously produce symbolic gestures in discourse contexts where use of their primary linguistic channel had somehow failed—either because they were misunderstood by an adult or because they did not have the corresponding word in systematic production (recall that comprehension–production asymmetries exist in early acquisition, e.g., Golinkoff & Hirsh-Pasek, 1987). That is, symbolic gestures were used in ways that *augmented* their primary linguistic channel.

*Context Dependent.* All of the children's symbolic gestures were exceedingly context dependent and this did not change over time. That is, gestures (symbolic or otherwise) were used only when the object referred to was physically present. The referent was nearly always an object (as opposed to a person, location, attribute, etc.), and their forms always reflected some salient physical action associated with the referent. Although some early words/signs in our corpora were initially context dependent, their frequencies were greater than symbolic gestures, the forms were consistent, they were used with a broad communicative scope (they did not exhibit a restricted communicative function), and they ceased to be context dependent over time.

*Order of Occurrence.* Symbolic gestures appeared only *after* the child was able to *comprehend* and/or produce the meaning of the word or sign

to which the gesture corresponded. Said another way, words and signs were comprehended *prior* to the onset of such symbolic gestures. No child produced a symbolic gesture unless he or she first had the corresponding word in comprehension, and/or production, suggesting that children's use of symbolic gestures is dependent on their knowledge of language rather than the reverse.

*Kind Boundaries.* To understand the meaning of the manual and verbal forms for the child, each form was examined in relation to the range of referents over which it was applied (form-referent pairings). Similarly, each referent was examined in relation to the range of forms that were used with it (referent-form pairings; see section on attribution of meaning). The analysis revealed that the form-referent (and referent-form) pairings observed with the children's lexical forms were different from those observed with symbolic gestures.

When the hearing and deaf children produced a lexical form, the range of referents over which it was applied formed particular word (sign) types or kinds, that is, type of object names, type of action/event words, type of property words, and so forth. For example, four of the six children produced the lexical form "open" (two deaf, two hearing). When "open" was produced by these children, it was used to refer specifically to the *action or event* involved in opening a variety of things (e.g., jars, refrigerator doors, boxes). Importantly, the lexical item "open" was not also used as the *name* for the object being opened; for example, "open" was not used as *the name* for jars—it was not used as the word or sign for glass containers with lids. "Open" was not used as a type of object name, nor was it used *to name* specific objects that are kept in jars (e.g., cookies; "open" was not used as the name for sweet round objects that are eaten). That is, "open" was never used both as a type of action/event word and as a type of object name. Instead, "open" and other action/event words (e.g., "give") were produced with proper extensions unique to the type "action and event words." This finding was true of all of the children's lexical forms, across all word/sign types. Each child's use of each lexical form was constrained along particular word/sign types from its first use and across many contexts over time.

Indeed, with few exceptions (3/577 tokens; 0.5%), the children used their lexical forms in ways that did *not* cross the boundaries of different word/sign types (see Petitto & Kampen, in prep., for details). Although the meaning of a given lexical item may have been under- or over-extended relative to its meaning in the adult language, it was not used in ways that violated the boundaries of its type. This finding corroborates those reported in a study of lexical use and meaning by Huttenlocher and Smiley (1987) in slightly older hearing children (range 11–30 months). However, the present study provides the first evidence that children's

earliest lexical items are constrained along kind boundaries even when acquiring signed languages.

Unlike words or signs, when children produced a symbolic gesture, the range of referents over which it was applied did not always form particular types or kinds of object names, event words, property words and so on. It was common for a child to use a particular symbolic gesture in relation to, for example, a known type of related object in one context and, in another context, to use the same symbolic gesture in relation to objects from a different type. Variable use of the same or similarly formed symbolic gesture was common in the children.<sup>7</sup> For example, four of the children (two deaf, two hearing) produced a curved index finger pointed toward the far back of the mouth ("point-in-mouth"), and one hearing boy produced this form 12 times; his use of this gesture aptly captures the children's use of their symbolic gestures. He produced the form (a) upon noticing the experimenter playing a toy flute, (b) when requesting a raisin, (c) when requesting a grape that was inside of a tightly closed jar after failing repeatedly to open it, and so on. Thus, the child produced one form with at least three different referents: flute, raisin, and grapes (we assume for the moment that the jar itself was not the referent in the third case mentioned). One interpretation of this symbolic gesture is that the child has used the form "point-in-mouth" in relation to object types, with the raisins and grapes constituting the object type "things one eats" (*form-object type*). In this view, the child's use of the form in relation to the flute would be a problem, because the flute, although an object, is clearly a different type of object from "things one eats." A second interpretation is that the child has used the form "point-in-mouth" in relation to action/event types (*form-action/event type*). In other words, the child's symbolic gesture could have been functioning in a verb-like manner. Here, too, the child's intended action/event type is not obvious. The form "point-in-mouth" may be conveying the action/event "eat" regarding the raisin and grapes, but the flute is still a problem. Thus, a problem for either of the two interpretations is that the child produced a form that has crossed type boundaries, and this did not occur with the children's lexical items.

Although it is always possible to argue that the "point-in-mouth" gesture is being used to convey a more general action/event type (e.g., "put in mouth"), the possible attributions are potentially infinite. For example, the second and third cases could also be further attributed to meaning "hungry," as in "I'm hungry" ("I want that raisin/grape").

<sup>7</sup> Even though the children's form of symbolic gestures were variable, there was no evidence that each variation of a form was a different symbolic gesture (e.g., similar to a different word or sign) in their repertoire of forms.

Although this is, in principle, true of attributing meaning to children's single words (e.g., Bloom, 1973), children do help narrow the possibilities through their use of actual lexical forms. In fact, a more parsimonious explanation of the "point-in-mouth" symbolic gesture—and other symbolic gestures—is that the children are producing stylized context-bound actions associated with referents (whose form implicitly contains other information such as the referent's location), and that these forms are not functioning as symbols that "stand for" (or represent) the referents.

Especially dramatic differences between language and gesture are uncovered when both types of information occur in the same modality. Two of the deaf children (age 20 months) produced the symbolic gesture "twist" in relation to jars at the same time that they produced the fully articulated adult sign OPEN.<sup>8</sup> Whereas OPEN was used exclusively to convey the action of opening (e.g., boxes, jars, drawers), the symbolic gesture "twist" was used in relation to the following range of referents: jar (the object itself), the specific objects in jars (e.g., cookies, raisins), to open (to get the jar opened), to close (to get the jar closed). Interestingly, the gesture was used only after the children's use of the lexical item OPEN had failed to get a response from an adult. That is, the "twist" gesture was used exclusively as an apparent last resort, to emphasize and augment primary linguistic information.

It could be argued that symbolic gestures violate Markman's mutual exclusivity principle (ME) (e.g., Markman, 1989).<sup>9</sup> Briefly, the ME principle postulates that young children assume that each object category has one category term: "A single object cannot be both a cow and a bird or a dog" (p. 187) (see also Gleitman & Wanner, 1982; Slobin, 1985). In the present study, recall that all symbolic gestures are produced only after the child first has the corresponding lexical form in comprehension and/or production. For example, the children who produced the symbolic gesture for the toy telephone first produced the lexical item "telephone." Because a single object appears to have at least two category terms—the gesture connoting the object (in some contexts) and the lexical sign—this situation may constitute an apparent violation of the ME principle, thereby revealing yet another way that early language and gesture differ.

To review, there were important differences between children's use of lexical items, be they words or signs, and their use of gestures. Children's use of lexical items was consistently constrained along word/sign type

<sup>8</sup> The "twist" gesture was also produced by the three hearing children.

<sup>9</sup> I thank Sandeep Prasada (Department of Brain and Cognitive Science, MIT) for first pointing this out to me.

boundaries, whereas their use of gestures was variable. Even when the lexical item and the gesture were in the same modality, the lexical item did not cross type boundaries, but the gestures often did.

*No Gesture + Gesture Combinations.* There were no combinations of symbolic gestures, even during the period when hearing and deaf children were producing two-word and two-sign combinations (respectively). That is, there were no symbolic gesture + symbolic gesture combinations, even though there were word + word combinations in the hearing children and sign + sign combinations in the deaf children.

### Summary

Hearing and deaf children's use of symbolic gestures was similar. Hearing and deaf children's use of the early lexicon was also similar. However, the hearing and deaf children's use of symbolic gestures versus their use of the lexicon differed. Several factors differentiated children's use of symbolic gestures as compared to their use of words and signs. They were as follows:

1. The frequency of symbolic gestures was low (they constitute a non-robust phenomenon in child development).
2. The distribution of symbolic gestures remained uncommonly steady over time.
3. The forms and referential complexity of symbolic gestures did not increase over time ("flat MLU").
4. The forms of symbolic gestures were inconsistent.
5. Symbolic gestures were used with restricted communicative function (largely requests).
6. Symbolic gestures were far more context dependent than the children's words or signs.
7. Symbolic gestures were produced only after children first had the corresponding word or sign in comprehension and/or production and were often used to augment a failed communicative exchange involving their primary linguistic system.
8. Symbolic gestures were used in ways that crossed the boundaries of word/sign types in some contexts and did not do so in other contexts; however, children's use of words and signs were consistently used in ways that followed the boundaries of word/sign types.
9. There were no symbolic gesture + symbolic gesture combinations, even though children were combining their lexical items.

## DISCUSSION AND CONCLUSION

## On the Nature of Gestures

All manual activity termed *gestures* in the literature are not the same, and they occur with vastly different frequencies. Most of the manual activity that children produce are really actions—not gestures—with objects in hand, and the next frequent class to occur, empty-handed gestures, are used with grossly restricted forms and communicative functions. Symbolic gestures are the least frequent type of gestures to occur in spontaneous development, and they occur late relative to children's first words or signs. Once children begin to use symbolic gestures, its power is meager as compared to that of the word or sign.

That all children produce actions with objects in hand most frequently indicates that this information plays some role in the representation of objects as well as the corresponding words that symbolize them, particularly regarding the *functions of objects* (what one does with an object; what it is used for). However, it cannot be said that the functions of objects and the situational contexts within which they occur, make up the contents of children's early lexical representations (e.g., Bowerman, 1980; Nelson 1974; Snyder, Bates, & Bretherton, 1981). Indeed, the representation of human language involves much more than its communicative function, even in very young children. As is indicated in the present study, as well as other related studies (e.g., Petitto & Marentette, 1991a), specifically linguistic structural information regarding *language form*, and other *conceptual constraints* (e.g., constraints on word/sign types) also appear to be part of the young child's lexical representations.

As was indicated in the introduction, gestures serve a useful role in ontogeny. Early gestures (e.g., pointing) appear to be a primitive signaling device, on the same ontogenetic continuum with crying. They elicit language and attention. Gestures elicit language rich in referential information; they elicit names for things (e.g., Shatz, 1985). Also in the introduction is the observation that later symbolic gestures appear to serve a secondary role in language ontogeny—one that augments the child's primary linguistic system. Symbolic gestures appear to be parasitic on language rather than the reverse (e.g., see also Goldin-Meadow & Morford, 1989; McNeill, 1985); recall that words and signs occur first in comprehension and/or production in language ontogeny before the child produces a symbolic gesture.

Recent claims regarding the equal symbolic status of children's gestures are wholly unsupported by the present data (e.g., Acredolo & Goodwyn, 1985, 1988, 1990; Goodwyn & Acredolo, 1991). For example, Acredolo and

Goodwyn (1985, 1990), provide a case study of the first author's daughter, Kate Acredolo. The child was reported to have 40 symbolic gestures possessing the same symbolic status as words. In addition, they reported that Kate produced these symbolic gestures *prior* to age 19 months, that is, before her vocabulary spurt. Although these reports are interesting, the authors do not provide crucial information required to evaluate their claims. First, the authors do not report the relative frequency and distribution of the child's other gestures as compared with her symbolic gestures, thereby rendering the impression that her production of 40 symbolic gestures was more robust than it may have been. As was seen in the present study, once the relative frequency and distribution of symbolic gestures was compared to the full range of gestures produced by a child, we find that symbolic gestures are a nonrobust phenomenon in child development. Second, and most importantly, approximately 95% of the child's types of symbolic gestures were either directly taught to the child or "encouraged" (e.g., "Once Kate's interest in such gestures were noticed, the adults around her began to encourage the development of new gestures by pairing discrete actions with objects and conditions," Acredolo & Goodwyn, 1990, p. 18).

Given that symbolic gestures were directly taught or encouraged, it is of little surprise that the child in the study, as well as those in other studies (e.g., Goodwyn & Acredolo, 1991), produced symbolic gestures in a manner resembling early words and, at times, earlier than their words. Indeed, what I believe these researchers are picking up is an *artifact* of the fact that humans can learn either a signed or spoken language with no loss or delay in the timing and sequencing of language milestones.<sup>10</sup> When taught specific symbolic gestures (especially those used by the parents themselves), the child is merely learning lexical, or quasi-lexical, items in another modality—and, in the case of hearing children, a modality that could have been used for acquiring signed languages.

A final puzzle is this: Given that adults both teach and use symbolic gestures, why don't we see *more* symbolic gesturing in children? Why aren't there greater similarities of use between children's early symbolic gestures and early words? In understanding the answer to these questions, the essential features of early language representation are laid bare. Gestural input to children lacks critical regularities in structure, both sublexically and syntactically. The forms of parents' symbolic gestures vary, and parents do not produce combinations of symbolic gestures. In other words, gestures are not formed from a restricted set of combi-

<sup>10</sup> See especially Petitto and Marentette's (1990, 1991b) study of hearing children in bilingual signing and speaking homes who acquire both signed and spoken language milestones on the same maturational time course.

natorial units and are not hierarchically organized; indeed, they lack phonology, prosody, and syntax. Gestures do bear meaning and communicative information. However, proposals in child language that offer either the semantic or the communicative functions of language as being the exclusive explanatory mechanism that drives very early language acquisition are not supported by the present research. As seen here, meaning and/or communicative function alone, although important, are simply not adequate to support the use of a gesture as a form that possesses equal status with the word or sign.

The basic units of language structure that infants need in the input are not present in symbolic gestural input. Specifically, sublexical, phonetic, and syllabic organization as well as other phonotactic information (prosodic cues that bind segments into phrasal, clausal, and lexical bundles) are absent. The innate predisposition to discover these particular linguistic structures in the input is so strong that the child does not systematize symbolic gestural input, even though it shares similarities of reference and meaning with words. Without syllabic and phonotactic information, infants cannot set up the nascent representations of *language form* that I would argue are part of the very early representation of language, and are required before children can progress to adult linguistic competence. Like words and signs, children use symbolic gestures meaningfully. Unlike words and signs, the internal formational and referential complexity of symbolic gestures does not increase over time, demonstrating both the strengths and the limits of a referential system without structured input.

#### Constraints on Early Lexical Knowledge

Looking across individual meanings of words and signs, as compared to symbolic gestures, certain commonalities characterize the words and signs, but not the gestures. Children did not use particular words or signs across the bounds of different word/sign types (e.g., object names, property words, event words; e.g., Huttenlocher & Smiley, 1987), but did so with gestures. These results indicate that children's first lexical use is constrained along the bounds of word/sign types—even in signed languages (for other discussions of constraints on early lexical acquisition see Carey, 1982; Gelman & Coley, in press; Keil, 1989; Macnamara, 1982; Markman, 1989; Quine, 1969; Waxman, Shipley, & Shepperson, in press).

#### Knowledge Underlying Language Acquisition

There are similarities between symbolic gestures and language in human development. However, critical differences exist between them that have

not received much attention in previous research on this topic. The child's clear differentiation between language and gesture in ontogeny suggests that distinct forms of knowledge govern their use. Indeed, young deaf infants' differentiation of language and gesture—even though both reside in the same modality—provides dramatic support for this analysis.

My claim, then, is that aspects of the structural and conceptual underpinnings of children's knowledge and use of language are fundamentally distinct from their knowledge and use of gesture. Knowledge of language is not wholly derived from a general cognitive capacity to symbolize. Instead, the findings from this and related studies compel us to conclude that domain-specific knowledge is involved in the human language acquisition process. Specifically linguistic and conceptual constraints are at work from birth to help the child discover particular structures in the input and not others.

#### ACKNOWLEDGMENTS

I am especially grateful to Kevin N. Dunbar for discussing the issues in this chapter with me and for his insightful comments on earlier drafts of the chapter. I also thank Marta Meana, Paul Bloom, and Susan Goldin-Meadow for comments on an earlier version of this work. This research was supported by Natural Sciences Engineering Research Council of Canada, McGill IBM Cooperative Project, and McDonnell-Pew Center Grant in Cognitive Neuroscience.

#### REFERENCES

- Acredolo, L. P., & Goodwyn, S. W. (1985). Symbolic gesturing in language development: A case study. *Human Development, 28*, 40-49.
- Acredolo, L. P., & Goodwyn, S. W. (1988). Symbolic gesturing in normal infants. *Child Development, 59*, 450-466.
- Acredolo, L. P., & Goodwyn, S. W. (1990). Sign language in babies: The significance of symbolic gesturing for understanding language development. *Annals of Child Development, 7*, 1-42.
- Bates, E., Benigni, L. F., Bretherton, I., Camaioni, L., & Volterra, V. (1979). *The emergence of symbols: Cognition and communication in infancy*. New York: Academic Press.
- Bates, E., Bretherton, I., Shore, C., & McNew, S. (1983). Names gestures and objects: Symbolization in infancy and aphasia. In K. Nelson (Ed.), *Children's language* (Vol. 4). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Bellugi, U., Klima, E. (1982). The acquisition of three morphological systems in American Sign Language. *Papers and Reports on Child Language Development, 21*, 1-35. Stanford, CA: Stanford University.
- Bloom, L. (1973). *One word at a time*. The Hague: Mouton.
- Bonvillian, J. D., Orlansky, M. D., & Novack, L. L. (1983). Developmental milestones: Sign



- language acquisition and motor development. *Child Development*, 54, 1435-1445.
- Bowerman, M. (1980). The structure and origin of semantic categories in the language-learning child. In M. L. Foster & S. Brandes (Eds.), *Symbol as sense*. New York: Academic Press.
- Brown, R. (1973). *A first language: The early stages*. Cambridge, MA: Harvard University Press.
- Brown, R. & Hanlon, C. (1970). Derivational complexity and order of acquisition in child speech. In J. R. Hayes (Ed.), *Cognition and the development of language*. New York: Wiley.
- Carey, S. (1982). Semantic development: The state of the art. In E. Wanner & L. Gleitman (Eds.), *Language acquisition: The state of the art* (pp. 347-389). Cambridge: Cambridge University Press.
- Chomsky, N. (1975). *The logical structure of linguistic theory*. New York: Plenum Press.
- Fernald, A., Taeschner, T., Dunn, J., Papousek, M., de Boysson-Bardies, B., & Fukui, I. (1989). A cross-language study of prosodic modifications in mothers' and fathers' speech to preverbal infants. *Journal of Child Language*, 16, 477-501.
- Gelman, S., & Coley, J. (in press). Language and categorization: The acquisition of natural kind terms. In S. A. Gelman & J. P. Byrnes (Eds.), *Perspectives on language and thought: interrelations in development*. Cambridge: Cambridge University Press.
- Genesee, F. (1987). *Learning through two languages*. Cambridge, MA: Newbury House.
- Gleitman, L., & Wanner, E. (1982). Language acquisition: The state of the state of the art. In E. Wanner & L. Gleitman (Eds.), *Language acquisition: The state of the art* (pp. 3-48). Cambridge: Cambridge University Press.
- Goldin-Meadow, S., & Morford, M. (1985). Gesture in early language: Studies of deaf and hearing children. *Merrill Palmer Quarterly*, 31, 145-176.
- Goldin-Meadow, S., & Morford, M. (1989). Gesture in early child language. In V. Volterra & J. Erting (Eds.), *From gesture to language in hearing and deaf children* (pp. 249-262). Berlin: Springer-Verlag.
- Golinkoff, R. M., & Hirsh-Pasek, K. (1987, October). *A new picture of language development: Evidence from comprehension*. Paper presented at the 12th Annual Boston University Conference on Language development. Boston, MA.
- Goodwyn, S. W., & Acredolo, L. P. (1991, April). *Symbolic gesture versus word: Is there a modality advantage for onset of symbol use?* Paper presented at the Biennial Meeting of the Society for Research in Child Development, Seattle, WA.
- Hubel, D. H., & Wiesel, T. N. (1959). Receptive fields of single neurons in the cat's visual cortex. *Journal of Physiology*, 148, 547-591.
- Huttenlocher, J., & Smiley, P. (1987). Early word meanings: The case of object names. *Cognitive Psychology*, 19, 63-89.
- Jusczyk, P. W. (1986). A review of speech perception research. In K. Boff, L. Kaufman, & J. Thomas (Eds.), *Handbook of perception and human performance* (Vol. 2). New York: Wiley.
- Keil, F. (1989). *Concepts, kinds, and cognitive development*. Cambridge: MIT Press.
- Lock, A. (Ed.). (1978). *Action, gesture, & symbol*. New York: Academic Press.
- Macnamara, J. (1982). *Names for things*. Cambridge, MA: MIT Press/Bradford Books.
- Mayr, E. (1982). *The growth of biological thought*. Cambridge, MA: Harvard University Press.
- Markman, E. (1989). *Categorization and naming in children: Problems of induction*. Cambridge: MIT Press/Bradford Books.
- McNeill, D. (1985). So you think gestures are nonverbal? *Psychological Review*, 92, 350-371.
- Mehler, J., & Fox, R. (Eds.). (1985). *Neonate cognition*. Hillsdale, NJ: Lawrence Erlbaum Associates.
- Meier, R. (1991). Language acquisition by deaf children. *American Scientist*, 79, 60-70.

- Nelson, K. (1974). Concept, word and sentence: Interrelations in acquisition and development. *Psychological Review*, 81, 267-285.
- Newport, E., & Meier, R. (1985). The acquisition of American Sign Language. In D. Slobin (Ed.), *The crosslinguistic study of language acquisition* (Vol. 1, pp. 881-938). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Petitto, L. A. (1984). *From gesture to symbol: The relationship between form and meaning in the acquisition of personal pronouns in American Sign Language*. Unpublished doctoral dissertation, Harvard University, Boston, MA.
- Petitto, L. A. (1985a, October). *On the use of pre-linguistic gestures in hearing and deaf children*. Paper presented at the 10th annual Boston University Conference on Language Development. Boston, MA.
- Petitto, L. A. (1985b). "Language" in the pre-linguistic child (Tech. Rep. No. 4). Montreal: McGill University Department of Psychology.
- Petitto, L. A. (1986). *From gesture to symbol: The relationship between form and meaning in the acquisition of personal pronouns in American Sign Language* (pp. 1-105). Bloomington, Indiana: Indiana University Linguistics Club Press.
- Petitto, L. A. (1987). On the autonomy of language and gesture: Evidence from the acquisition of personal pronouns in American Sign Language. *Cognition*, 27(1), 1-52.
- Petitto, L. A. (1988). "Language" in the pre-linguistic child. In F. Kessel (Ed.), *Development of language and language researchers: Essays in honor of Roger Brown* (pp. 187-221). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Petitto, L. A., & Charron, F. (1987). *Semantic categories in the acquisition of Langue des Signes Quebequoise (LSQ) and American Sign Language (ASL): A comparison of signing children's first signs with speaking children's first words* (Tech. Rep. No. 7). Montreal: McGill University, Department of Psychology.
- Petitto, L. A., & Kampen, D. (in prep.) *The ontogeny of language and gesture: Are early symbolic gestures names for things?*
- Petitto, L. A., & Marentette, P. F. (1990, October). *The timing of linguistic milestones in sign language acquisition: Are first signs acquired earlier than first words?* Paper presented at the 15th annual Boston University Conference on Language Development, Boston, MA.
- Petitto, L. A., & Marentette, P. F. (1991a). Babbling in the manual mode: Evidence for the ontogeny of language. *Science*, 251, 1493-1496.
- Petitto, L. A., & Marentette, P. F. (1991b, April). The timing of linguistic milestones in sign and spoken language acquisition. In L. Petitto (chair), *Are the linguistic milestones in signed and spoken language acquisition similar or different?* Symposium conducted at the Biennial Meeting of the Society for Research in Child Development, Seattle, WA.
- Piaget, J. (1962). *Play, dreams and imitation*. New York: Norton.
- Pinker, S. (1979). Formal models of language learning. *Cognition*, 217-283.
- Pinker, S. (1984). *Language learnability and language development*. Cambridge, MA: Harvard University Press.
- Pinker, S., & Bloom, P. (1990). Natural language and natural selection. *Behavioral and Brain Science*, 13, 707-778.
- Quine, W. V. (1969). *Ontological relativity and other essays*. New York: Cambridge University Press.
- Seidenberg, M. S., & Petitto, L. A. (1987). Communication, symbolic communication, and language in child and chimpanzee: Comment on Savage-Rumbaugh, McDonald, Sevcik, Hopkins, and Rupert (1986). *Journal of Experimental Psychology, General*, 116(3), 279-287.
- Shatz, M. (1985). An evolutionary perspective on plasticity in language development. *Merrill-Palmer Quarterly*, 31, 211.
- Shore, C., O'Connell, B., & Bates, E. (1984). First sentences in language and symbolic play. *Developmental Psychology*, 20(5), 872-880.

- Slobin, D. (1985). Crosslinguistic evidence for the language-making capacity. In D. Slobin (Ed.), *The crosslinguistic study of language acquisition Vol. 2: Theoretical issues* (pp. 1157-1256). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Snyder, L., Bates, E., & Bretherton, I. (1981). Content and context in early lexical development. *Journal of Child Language*, 8, 565-581.
- Waxman, S., Shipley, E., & Shepperson, B. (in press). Establishing new subcategories: The role of category labels and existing knowledge. *Child Development*.
- Werner, H., & Kaplan, B. (1963). *Symbol formation*. New York: Wiley.
- Zinober, B., & Martlew, M. (1985). The development of communicative gestures. In M. D. Barrett (Ed.), *Children's single-word speech*. New York: Wiley.

# 3 Constraints on Word Learning: Speculations About Their Nature, Origins, and Domain Specificity

Ellen M. Markman  
Stanford University

Word learning is an inductive feat accomplished by the 2-year-olds of our species. To explain how such young children with limited information-processing abilities can so readily figure out what words mean, investigators have hypothesized that children are predisposed to elevate some hypotheses about word meanings over others. By greatly reducing the hypothesis space, these constraints on hypotheses help render the inductive problem soluble. Although the focus of this chapter is on three specific word-learning constraints: the whole-object, taxonomic, and mutual exclusivity assumptions, my goal is to consider broader fundamental questions about the nature of constraints on learning.

To begin, I briefly review the evidence for the three word-learning constraints. I then address misconceptions about the nature of biological constraints that pervade recent discussions of constraints on word learning where word-learning biases are interpreted as implying rigid, hard-wired, innate mechanisms that are immune from input. I argue that such constraints should be thought of as default assumptions, as probabilistic biases that provide good first guesses but not final solutions. Another misconception is to interpret these biases as necessarily being language specific. Analyses of other domains reveal, however, that all three assumptions appear in contexts other than word learning. This is not to say that they are completely general because, although some domains are governed by very similar principles, clear, important exceptions can readily be found. Domain specificity bears on questions about the origins of these constraints in that if comparable principles are found in other domains they may well be recruited for word learning. As