

Co-Speech Gesture Input as a Support for Language Learning in Children With and Without Early Language Delay

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Abstract

The current paper provides empirical support for adults using co-speech gesturing with children with and without early language delay. The discussion starts broad by showing that co-speech gestures are already in the child's language environment. We then show that encouraging co-speech gesturing by adults promotes language development and use in children. The discussion is then narrowed to the review of the finer aspects of word learning which sets the stage for how iconic gestures can be utilized in language therapy. Finally, we show that pairing iconic gestures with word models promotes word learning.

Children with early language delay (ELD; also referred to as late talkers) tend to be referred for evaluation between the ages of 18- to 35-months due to concerns of too few words said or delay to combine words in their utterances (Rescorla, 2011). Language delay for this group of children occurs in the absence of gross impairments affecting the motor, cognitive, sensory, genetic, or psychiatric systems (e.g., autism, cerebral palsy, deafness, blindness, Down syndrome, etc.). In this paper we explore *co-speech gesture* input as one way to support language learning in this group of children. In our discussion, we start broad by showing that co-speech gesturing by adults is a good visual cue to the language that children hear because they are already present in the child's language environment. We then report on studies that encourage the use of co-speech gesturing by adults; studies report positive results on general language performance, over time, in young children with and without ELD. Later in the paper, we narrow our discussion to the use of co-speech gestures as a visual scaffold during word teaching, in particular.

What are Co-Speech Gestures?

An adult's co-speech gesturing provides a visual support to a child learning new concepts (e.g., Capone Singleton, 2012; Capone & McGregor, 2005; Ellis Weismer & Hesketh, 1993; Flevares & Perry, 2001; Goldin-Meadow, Kim, & Singer, 1999; McGregor & Capone, 2004; McGregor, Rohlfing, Bean, & Marschner, 2009). An example of co-speech gesturing is an adult pointing to a police car in temporal synchrony with telling a child "oh look, a police car!" Co-speech gestures are made with the hands, but can also be facial, arm, or other body movements that are simultaneously produced with spoken language. They can be indicators such as pointing, or iconic representations. Iconic gestures reflect an aspect of the referent's meaning in the form they take (also referred to as *representational* gestures or *baby signs*; Acredolo & Goodwyn, 1996). For example, holding two fingers up in a "V" can represent a *bunny* because they look like a rabbit's ears. Extending an index

finger to the gesturer's mouth and rounding the lips can represent a *bubbles wand* because both the shape and the function of that object are reflected. Moving the right hand to under the left hand highlights the spatial relationship *under*. Co-speech gestures can reinforce what is said by conveying the same information (i.e., point to *car* and say "car"), or can supplement the spoken message by conveying additional information not heard in the spoken part of the message. For example, a preschool teacher might tell a mother "Marcus completed a puzzle today," while extending an open palm to an area of the rug. Whereas the teacher's spoken message tells what Marcus did, the teacher's gesture indicates where he did it. In some cases a speaker may use gesture to compensate for words that are on the threshold of activation but failed to be retrieved (i.e., that are on the tip of the tongue).

Co-Speech Gesturing Is All Around Us

Sometime between 9- and 12-months of age an infant will begin to follow an adult's pointing which suggests that she or he will have already been exposed to adult pointing well before this (Butterworth & Grover, 1990). Adults point while saying words to scaffold communication success for the infant. Scaffolding is a support provided the child to promote learning and success toward a goal (Sawyer, 2006a). In the above example, the goals are (a) to achieve joint attention between mother and infant so that the infant can (b) fast map the word-referent pair. When a word is fast mapped it means the child has linked the referent to the heard word (Carey, 1978).

Adults spontaneously gesture to children over the typical course of a day (Flevaris & Perry, 2001; Goldin-Meadow, Kim, & Singer, 1999; Iverson, Capirci, Longobardi, & Caselli, 1999; Zammit & Schafer, 2010). In at least three countries—the United States, Britain, and Italy, researchers find that mothers are using a *gestural motherese*, akin to spoken motherese, directed toward toddlers under two-years of age (Iverson et al., 1999; O'Neil, Bard, Linnell, & Fluck, 2005; Özçalışkan & Goldin-Meadow, 2005). Gestural motherese is conceptually simple and is comprised mostly of pointing to indicate objects in the surrounding environment; it reinforces what mothers are saying to their children. Like spoken motherese, gestural motherese is meant to help the infant link what is happening around them to the language they hear. Iverson et al. (1999) found that mothers use gestural motherese approximately 15% of the time. Mothers are also using iconic co-speech gestures while talking about objects (Zammit & Schafer, 2010). Zammit and Schafer (2010) documented that mothers used both iconic and pointing gestures with their infants. This was a longitudinal study that started when the infants were nine-months of age. Interestingly, it was the mother's use of iconic gestures, not pointing, that was associated with emergence of the object words in the receptive lexicons by toddlerhood.

As children move toward learning more abstract and complex concepts in school their teachers take up the task of instruction using a multi-modal approach. One combination of modalities is gesture and spoken language (Flevaris & Perry, 2001; Goldin-Meadow, Kim, & Singer, 1999). Teachers use gestures in combination with their spoken language to explain strategies for solving math problems such as the place value of individual numbers to first graders, and mathematical equivalence to third and fourth graders. Flevaris and Perry (2001) reported that teachers use gesture more often than objects, pictures, and writing to supplement oral instruction. Gestures are also paired with these other nonverbal scaffolds.

Teacher's co-speech gesturing is not in vain for children are indeed glean information from gestures. For example, in Goldin-Meadow et al. (1999) teachers provided instruction on mathematical equivalence, and children were asked to solve problems and then explain the strategies they used to solve them. Children used strategies to solve the problems they had only seen in the teachers' gestures during instruction; teachers had not taught the strategies verbally. In other words, children took advantage of the adult's gestures to clarify these abstract mathematical concepts.

Does Co-Speech Gesturing by Adults Impede the Child's Language Learning?

Co-speech gestures are directed to children in the communicative environment, but does co-gesturing by adults impede the child's language development? Would it be harmful to encourage parents and clinicians to use gestures while talking with children? The empirical answer has been a resounding *no*. The presence of co-speech gesturing does not hinder the child's language development and use (Capone & McGregor, 2004; Goodwyn, Acredolo, & Brown, 2000). In fact, not only does co-speech gesturing not impede language development and use, it actually facilitates both.

“...[W]hen parents [and professionals] express reluctance to try symbolic gesturing with their children, they often argue that enabling a child to communicate nonverbally will decrease the child's willingness to do the hard work of learning to articulate vocal words.” (Goodwyn et al., 2000, p. 94). Goodwyn et al. (2000) put this urban legend to rest. They trained a group of parents to produce iconic co-speech gestures with their infants and found their co-speech gesturing fostered spoken language development—both receptive and expressive, through the second year of life. A group of parents who were trained to increase their talk to children, and a second group of parents who received no training were two comparison groups. Infants who were exposed to iconic co-speech gestures outperformed infants in both comparison groups on individual measures of receptive and expressive language at 15-months, 19-months, 24-months, 30-months, and 36-months of age, as well as on composite scores from the measures combined. Formal tests used to measure receptive and expressive language were those familiar to the clinical practice of speech-language pathology including the Sequenced Inventory of Communicative Development (SICD; Hedrick, Prather, & Tobin, 1984), the Receptive and Expressive One-Word Picture Vocabulary Tests (ROWPVT, EOWPVT; Gardner, 1985), Mean Length of Utterance (MLU), and Longest Utterance.

Is it also possible that children with ELD, in particular, might be adversely affected by co-speech gesturing because they show less robust endowment for language from the start? Again, the science says that gesturing by adults does *not* worsen the language performance of children with ELD. In fact, results are consistent with that of their typically developing peers. The data thus far show that children with ELD benefit from co-speech gesturing input by adults (e.g., Ellis Weismer & Hesketh, 1993, Grimminger, Rohlfing, & Stenneken, 2010; McGregor & Capone, 2004). For example, Grimminger et al. (2010) asked mothers of toddlers with and without language delay to use gesture as well as speech to instruct their child on following directions of varying difficulty. When compared to the mothers of typically developing peers, the mothers of toddlers with language delay used more co-speech gestures and held them longer in the child's view when prompting complex directions. By doing so, the toddlers with ELD were just as accurate as their typical language peers on the task.

McGregor and Capone (2004) applied a longitudinal, iconic co-speech gesture intervention with a set of quadruplets who were at biological and environmental risk for language delays (e.g., Tough et al., 2002; Tomasello, Mannle, & Kruger, 1986). Their biological risks included premature birth, low birth weight, and the medical and developmental issues that can co-occur with these birth factors. Being of multiple birth they were also at environmental risks due to reduced one-on-one caregiver interaction. With the iconic co-speech gesture intervention, words that were paired with the iconic co-speech gestures emerged in these infants' spoken lexicons before other words that they simply heard in the environment. In fact, the infants were so adept at learning the words taught with gestures that the researchers needed to add words to the children's training protocols mid-way through the study.

In this first section we showed that co-speech gesturing occurs naturally in the ambient environment via parents and teachers. Co-speech gestures instinctually emanate from adults to

scaffold less sophisticated partners who need support following the language and concepts being talked about. The scientific literature shows that increasing co-speech gesturing toward children with and without language delay is not harmful to language development or use. On the contrary, both types of language learners use gestured information to boost their use of language. Improvements are observed on- and off-line, and over time. Therefore, we make the preliminary conclusion that co-speech gesturing by clinicians and parents can capitalize on what adults are already doing instinctually to support learning.

In the next section we narrow the focus of the paper to *iconic* co-speech gestures and word teaching, in particular. Being visual, iconic gestures can support word learning without taxing phonological processes in working memory. We first review vocabulary development in typical word learners and those who are delayed in the process. This vocabulary development review provides a framework for using co-speech gestures as a treatment scaffold. We close the paper with a review of the evidence-base that supports iconic co-speech gesturing to teach words to children with and without ELD.

Vocabulary Development in Children With and Without Early Language Delay

By 24-months of age, typically developing toddlers have become very facile at establishing new word-referent pairs in memory (i.e., fast mapping). Vocabulary size at 24-months is then positively correlated with the average length of utterance at 30-months of age; the larger the early vocabulary the longer the later utterance (Nelson, 1973). Many typically-developing children have early vocabularies that are dominated by object words (i.e., nouns). Children with noun-dominant vocabularies early on tend to have larger vocabularies overall, and they reach other semantic and morpho-syntactic milestones sooner than children with more equivocal lexicons. Specifically, children with many nouns in their early lexicons show (a) a word spurt by 24-months, (b) have a larger verb vocabulary after that, (c) use decontextualized talk, and (d) are responsive to questions (Bates, Bretherton, & Snyder, 1988). Children who do not present with a noun-dominance early on fail to show these rich language characteristics.

A similar relationship between vocabulary size and language development is true of late talking children (Rescorla, Mirak, & Singh, 2000). Rescorla et al. (2000) found that even though late talking children had smaller vocabularies than is typical, those late talkers with larger versus smaller vocabularies made greater gains in subsequent vocabulary and grammar milestones over time. The small percentage of children who persist with their language delay into the school-age years will then show impairments in other domains of language, namely morphology and syntax. Their delay in morphological development is characterized by protracted acquisition of verb morphemes to indicate tense and agreement, and delays in developing complex sentences (e.g., Ebbels, van der Lely, & Dockrell, 2007; Rescorla & Roberts, 2002; Rice, Wexler, & Hershberger, 1998).

Children with persistent language impairments show continued difficulty in learning new words and retrieving the words they do know (e.g., McGregor, Newman, Reilly, & Capone, 2002; Oetting, Rice, & Swank, 1995). These are children who need more exposures than the typical child to establish a word-referent pair in memory and more exposures to subsequently enrich those entries. Weak semantic knowledge and less durable links between semantic knowledge and the word form in memory are at the root of word retrieval failures for children with language impairments (e.g., Dollaghan, 1987; McGregor, Friedman, Reilly, & Newman, 2002; Oetting et al., 1995). It is here—in establishing the link between word and referent, and in enriching semantic knowledge, that iconic co-speech gestures can be used to scaffold word learning. Iconic gestures reflect semantic information thereby making it explicit. When gesture is paired with the word model, it illustrates the link between the two.

With a seemingly clear relationship between an early object-dominated vocabulary and continued development within (semantic) and across (morpho-syntax) language domains, establishing a rich object vocabulary for the young child with ELD is a primary goal. As the clinician plans for intervention it is useful to know that children's expressive noun vocabulary size is also positively related to their use of a special word learning strategy known as the *shape bias* (Gershkoff-Stowe & Smith, 2004; Smith, Jones, Landau, Gershkoff-Stowe, & Samuelson, 2002; Smith, Jones, & Landau, 1996; Smith, Jones, Yoshida, & Colunga, 2003). The shape bias refers to the child's preference toward the feature of shared perceptual-sameness to extend a word to new instances (versus same texture or size). In other words, typically developing children assume all ball-looking things are called "ball," all cup-looking things are called "cup," etc., even if all balls and cups have not been labeled for them previously. Children who are precocious at shape-based word extensions have larger noun vocabularies than those who are not. To the contrary, Jones (2003) showed that children with ELD—defined by their scant vocabulary, do not show a shape bias when extending words. If attention to shape when learning new object words is important to growing a large object vocabulary, then the clinician can make the object's shape explicit for the child with an iconic co-speech shape gesture; empirical studies that test shape gestures against other gestures are reviewed below.

Iconic Co-Speech Gestures as a Visual Scaffold for Word Learning

In this last section we review the empirical evidence that supports iconic co-speech gestures as a support for word learning in children with and without ELD.

Spatial Terms

Two studies have examined the use of co-speech gesturing to teach comprehension of spatial terms (Ellis Weismer & Hesketh, 1993; McGregor et al., 2009). Ellis Weismer and Hesketh (1993) applied an intervention of iconic co-speech gestures to teach three spatial terms (i.e., *away from*, *on top of*, *besides*) to six-year old children with language impairments. With intervention, children with language impairments comprehended the words when they were taught with iconic co-speech gestures over learning them without gestures. Ellis Weismer and Hesketh (1993) also observed that children with the most significant comprehension impairments showed the greatest benefit from the gestured input.

In McGregor et al. (2009) typically developing two-year old children were taught to understand the word *under* in one of the following three conditions—co-speech gesture, or co-speech picture cue, or speech-only. Children learned to recognize the meaning of *under* in both the gesture and picture conditions but children who learned *under* with gestural support were able to extend that understanding to a novel context with different stimuli. Children also retained knowledge of the term when tested days later, whereas children who initially learned *under* with a picture did not. The results are compelling when considering the fact that the vast number of commercially-available clinical materials include picture cards, yet pictures may not be yielding the richest learning. McGregor et al. (2009) showed that word learning with an iconic co-speech gesture was richer and more durable than using a picture or no visual scaffold for children two-years of age.

Object Labels

Two published studies, an on-going study, and a pilot project of children with ELD are reviewed next (Capone Singleton, 2012; Capone & McGregor, 2005). In each of these studies object words are taught with iconic co-speech gestures and then compared to a control condition. Control conditions paired words with no gesture, or another gesture that did not convey semantic information (e.g., pointing). Children participated in two to three teaching sessions and were tested at fast- and/or slow-mapping learning intervals. Slow mapping refers to the subsequent exposures a child has with a word-referent pair after it has been established in memory. Exposure to stimuli, words, and other lexical factors are controlled between teaching conditions in each study to isolate the effect of iconic co-speech gesturing on word learning.

Children's naming accuracy, over time, is the measure of word learning. Naming is defined as those words that children name on their own (uncued naming) and those that children name when given a retrieval cue if needed ("it's a *gesture*"; cued naming). The retrieval cue is meant to activate those words that are just on the cusp of activation in memory. Both uncued naming and cued naming have been shown to reflect the richest instances of learning over just recognizing a taught item from an array (Capone & McGregor, 2005). Therefore, we refer to uncued and cued naming together as "naming".

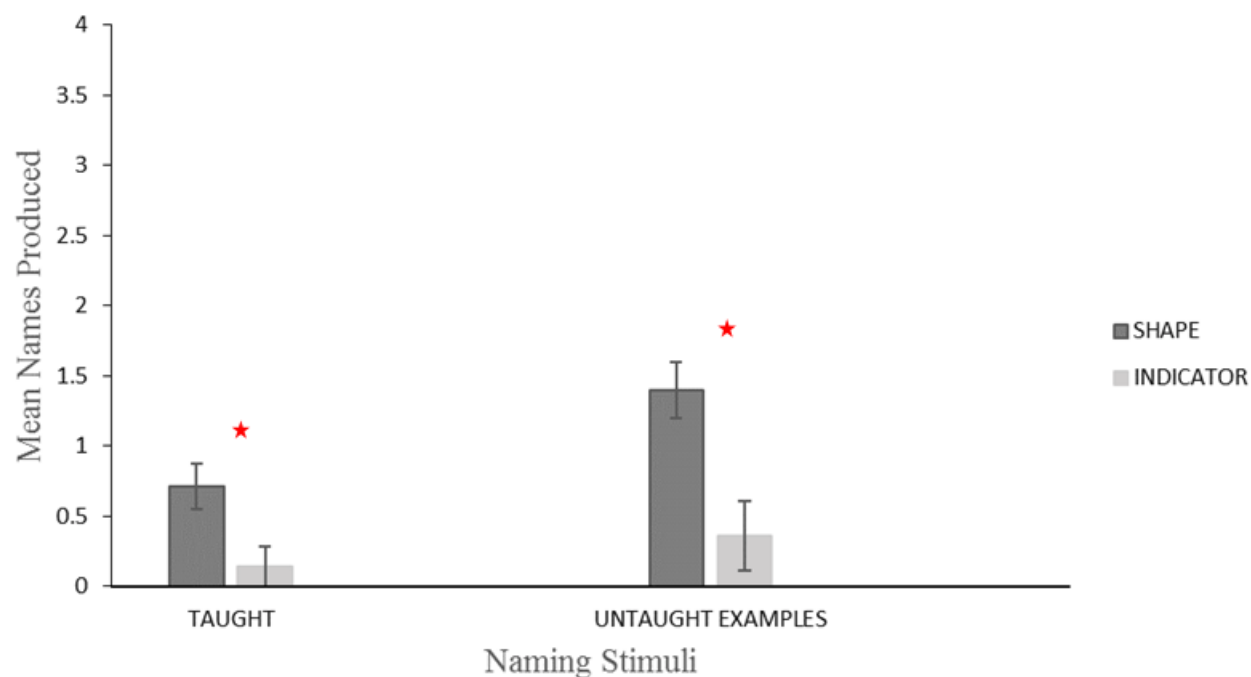
In Capone and McGregor (2005) 2.5-year-old toddlers were taught six object words in three conditions—shape condition, function condition, no gesture condition. An iconic co-speech gesture reflected the shape of an objects versus the function of another object in the first two experimental conditions (shape and function, respectively). The no gesture condition paired no gesture with the word model for another object during teaching. Children participated in each condition learning two objects per condition. Capone and McGregor (2005) found that after just one exposure shape gestures boosted fast mapping the words; toddlers identified the taught objects reliably only in the shape condition. After three teaching sessions, children then named significantly more objects in the shape and function conditions than in the no gesture condition. Therefore, teaching children words with iconic co-speech gestures that highlighted defining features of objects—shape or function, lead children to richer word learning over just hearing word models during teaching.

In a follow-up study the no gesture control condition was replaced with pointing while modeling the word (Capone Singleton, 2012). Capone Singleton (2012) replicated Capone and McGregor (2005) by showing that co-speech shape gestures led children to establish more word entries from the start over co-speech function or point gestures. At the final test, teaching words with co-speech function gestures was marginally more successful than co-speech pointing but co-speech shape gestures were significantly more successful than the co-speech point condition. Next, Capone Singleton (2012) examined whether or not children would extend those taught names to untaught example objects. The words taught with shape gestures were extended significantly more often to name untaught example objects than the words taught with function or point gestures. In sum, when children learned words with shape gestures they named taught objects and used these names in novel instances.

Currently, Capone Singleton and colleagues are conducting a word learning study with preschoolers that compares naming of taught objects between two teaching conditions. In one condition, children learn two words with a co-speech shape gesture, and in the second condition they learn words with an indicator co-speech gesture. The indicator for one object is an open palm toward the object while naming it. The indicator for the other object is a sustained tap in front of the object while naming it. Like previous studies, this is a repeated measures design such that each child participates in both the shape and the indicator conditions.

Figure 1 illustrates naming performance collected thus far. A paired *t*-test compares performance between the two teaching conditions in (a) naming of taught words, and in (b) extending those words to untaught examples of the taught objects. Thus far, the shape condition has outperformed the indicator condition in children learning more taught words, $t(13) = 2.28, p = .04$, and in children extending more taught words to new instances of those objects, $t(13) = 2.69, p = .02$. Our lab has made the preliminary conclusion that like toddlers, preschoolers use shape gestures to boost their object word learning, and do so over other types of co-speech gestures that simply direct attention to the referent of the heard word.

Figure 1. Naming Performance of Word Learners Between Co-Speech Gesture Conditions.



Note. Red asterisk indicates statistically significant difference between conditions at the $p < .05$.

Pilot Study of Children With ELD

Children with ELD are defined by their small expressive vocabulary size; naming is the task used to measure expressive vocabulary size. It is also known from the earlier review of vocabulary development that children with ELD need more exposures to link a word to its referent, to enrich that word-referent pair, and that they do not show a shape bias. Given the success co-speech shape gestures have had in promoting word learning for typically developing children at fast and slow mapping intervals, and the positive response children with ELD have had with co-speech gestures in other studies, we have been hypothesizing that children with ELD might do well with co-speech shape gestures as a scaffold in word learning.

Table 1 presents pilot data from seven children with ELD, their demographic information, and the inclusion criteria that they met to participate. The age-range of participants is consistent with identification of children with ELD. Participants were reported to be enrolled in speech-language intervention, and/or performed below the 10th percentile on a measure of expressive vocabulary or other formal language test. The final columns of Table 1 list the word learning conditions that each child participated. All children participated in the co-speech shape gesture condition, and all children except ELD7 participated in the co-speech function gesture condition. Each child participated in a control condition that was either no gesture ($n = 4$), a co-speech point gesture ($n = 4$), or other indicator co-speech gesture ($n = 1$). While the word teaching procedures were consistent between children, there is variance in word stimuli and control conditions that were applied between the children. Therefore, it is not possible to statistically analyze these data as a group. Instead, we provide a descriptive overview of the children's results. In Table 1, a condition listed in bold indicates the child learned a word under that condition.

Table 1. Method and Results for Six Participants with Early Language Delay (ELD).

Participant	Age	Race	Gender	Inclusion: Formal Testing	Performance Percentile	Enrolled in Intervention	Gesture Teaching Conditions:		
							Iconic	Indicator	None
ELD 1	28 months	C	F	MCDI	5 th	Yes	Shape , Function		None
ELD 2	33 months	AA	M	PLS	<10 th	Yes	Shape, Function		None
ELD 3	30 months	C	M	EVT	1 st	Yes	Shape, Function	Point	None
ELD 4	27 months	C	F	MCDI	<5 th	Yes	Shape , Function	Point	None
ELD 5	27 months	C	F	MCDI	25 th	Yes	Shape , Function	Point	
ELD 6	30 months	As	F	MCDI	<5 th	Yes	Shape, Function	Point	
ELD 7	32 months	C	F	EVT	18 th	Yes	Shape	Palm up Table Tap	

Note. C = Caucasian, AA = African American, As = Asian, F = female, M = male, MCDI = MacArthur Bates Communicative Development Index, PLS = Preschool Language Scale, EVT = Expressive Vocabulary Test. Gesture teaching conditions in bold indicate word learning in the picture naming task.

Results illustrate that six of the seven children learned at least one word, with five of those six children learning words with co-speech gestures. If naming is the defining difficulty for children with ELD it would appear that co-speech gestures largely supported six children in a task that is known to be most difficult for them. Eight words were learned across the seven children. Six of the effective co-speech gestures were iconic gestures, and one word was learned with a co-speech point gesture. Five of the seven children with ELD benefitted from a shape gesture paired with the word model. Thus far, the results from this pilot group are consistent with the findings from the literature. Iconic gestures that highlight the shape of objects may be an effective scaffold when teaching object names. Further systematic study of iconic co-speech gesturing is needed to confirm the trends observed here.

Conclusion

The use of co-speech gesture by adults when communicating with children with ELD has been considered best clinical practice within the field of speech-language pathology (e.g., German, 1992; Linder, 1993; Manolson, 1992). The current paper reviewed the scientific evidence that supports co-speech gesturing when communicating with children with and without ELD. The data illustrate that co-speech gesturing occurs naturally in the child's language environment already, and does not impede language learning or use. Iconic co-speech gestures seem to be one scaffold readily available to the speech-language pathologist when teaching new words. Iconic gestures convey information in the visual modality so they can be paired, simultaneously, with the word model. The (very) brief highlight of early vocabulary development provided here can guide intervention and the use of co-speech gestures. We recommend that clinicians:

1. ensure object names are at least one word class taught;
2. use iconic gestures to provide an enriched quality of exposure to words;
 - a. Make the object's shape explicit with an iconic gesture.
 - b. Make the object's function explicit with an iconic gesture.
3. pair gestures *with* words to make the word-referent *link* more explicit (i.e., use co-speech gestures); and
4. use a gesture as a retrieval cue to aid children in producing words that may be on the cusp of activation.

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