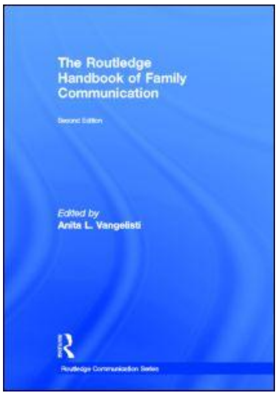

The Routledge Handbook of Family Communication

Anita L. Vangelisti

Infant Communication

Publication details
https://test.routledgehandbooks.com/doi/10.4324/9780203848166.ch15
Barbara Gruenbaum, Nicole Depowski, Kathleen E. Shaw, Heather Bortfeld
Published online on: 01 Nov 2012

15

Infant Communication

Barbara Gruenbaum, Nicole Depowski,
Kathleen E. Shaw, and Heather Bortfeld

Introduction

We know that a great deal of language development takes place in the first year of life. During this initial period, infants are immersed in the ambient language(s), which—coupled with a dynamic period of neural development—drives rapid and robust language learning. A key factor in this process is the infant's own active elicitation of responses from his or her caregivers. This communicative give-and-take helps create for the infant an environment rich in linguistic structure, which is fundamental for language development to take place. In this chapter, we will review data that highlight the dynamic nature of caregiver–child interaction and how such interaction supports language learning. Specifically, we will discuss the degree to which children enter the world primed to learn the ambient language(s), the learnable structures that are inherent in languages, and how communicative interaction between caregivers and infants potentiates and supports infants' learning of these structures.

Infants Start Learning *In Utero*

Strict interpretations of language development as completely experience driven or completely innately guided have softened in recent years, concomitant with emerging evidence suggesting that, although the biological basis for learning about language is in place and at work much earlier in development than was previously thought, changes in the environment have substantial effects on language outcome as well. Indeed, there is evidence that environmental tuning is at work in utero. This work highlights how biology and environment have already combined prenatally to set the process of language learning in motion.

Research focused on prenatal infants, while difficult to conduct, has been important to our emerging understanding of how exposure to sound in the womb gives babies a head start with language. The womb acts as a low-pass filter for sounds in the mother's environment, including the voices of those around her and her own. Furthermore, where others' voices will vary in intensity depending on where they are relative to the mother, the mother's own voice is present for the developing fetus at a relatively constant volume and with more clarity than other voices, given the internal nature of the source of that voice (e.g., mother's vocal folds, articulators). This means that, in addition to the external voice, internal bone and membrane conduction supplements the signal, providing infants with a relatively robust and consistent source of speech input. How this signal interacts with the maturation of the infant's auditory system is important to informing our understanding of what infants have already learned about language when they enter the world.

Using changes in the fetal heart rate as their dependent measure, Lecanuet and colleagues (1995) obtained some of the first physiological data to suggest that fetal hearing occurs before 28 gestational weeks. In fact, the fetus appears to respond to sound at 22 gestational weeks (Hepper & Shahidullah, 1994) and habituates to repeated sounds around 32 gestational weeks (Morokuma et al., 2004). Moreover, as infants near term, their sensitivity to more complex auditory stimuli improves, allowing them to perceive variations in music (Kisilevsky et al., 2004) and to differentiate between familiar and novel rhymes (DeCasper et al., 1994). Thus, the concept of "experience," rather than strictly referring to information available to the infant postnatally, implies a currently unknown threshold in prenatal auditory processing as well. Needless to say, this has not simplified theoretical debates about the degree to which nature and nurture come into play in early language development; it has only served to push the focal age for this debate earlier. But these data represent an important advance in our understanding of the toolkit with which infants enter the world.

With the understanding that birth is not the initial point at which infants are exposed to environmental sounds, behavioral researchers have capitalized on measures of infant attention to establish whether and which prenatal experiences underlie postnatal perceptual biases. This work has made it clear that fetal exposure to sound instills infants with a variety of sensitivities once in their postnatal world. For example, newborns can discriminate speech from nonspeech when played forwards, though not backwards (Ramus et al., 2000). In terms of language specific characteristics, neonates prefer their native one over another, unfamiliar language (Moon, Panneton-Cooper, & Fifer, 1993), can distinguish between stress patterns of different multisyllabic words (Moon et al., 1993), and can categorically discriminate lexical versus grammatical words (Shi, Werker, & Morgan, 1999). Finally, three-day-olds are sensitive to word boundaries (Christophe et al., 1994), can distinguish between two rhythmically dissimilar languages (Mehler et al., 1988; Nazzi, Bertoncini, & Mehler, 1998; Ramus et al., 2000), and can differentiate between good and poor syllable forms (Bertoncini & Mehler, 1981). These represent just a sampling of the findings demonstrating that mechanisms available prenatally position neonates to successfully navigate the earliest stages of the language learning process.

Preference for Maternal Speech

The preceding highlights how prenatal exposure to sound shapes infants' biases for particular structural characteristics of speech; infants likewise have been prepared to respond to social aspects of the signal. The best example of this is that neonates, who have been processing a wealth of maternal speech prenatally, have a strong preference for stimuli presented in their mother's voice once born. DeCasper and Fifer (1980) found that, three days after being born and even given only minimal postnatal maternal contact, an infant's sucking response was greater when it produced the maternal voice over another female's voice. Not only do neonates prefer their mother's voice over that of another woman, but familiarity with that voice interacts with the learning of speech structure.

For example, DeCasper and Spence (1986) found that prenatal exposure to maternal speech influenced other forms of postnatal auditory preferences. In their study, the researchers asked women to read a passage aloud each day during the last six weeks of their pregnancy. After the infants were born, they were tested using an operant-choice procedure to see whether they preferred the familiar passage over a novel passage. Results indicated that the infants did, indeed, find the familiar passage more reinforcing, while the control group demonstrated no specific preference for one or the other passage.

This preference for mother over other manifests in utero as well. Kisilevsky and colleagues (2003) investigated the ability of human fetuses to recognize their own mother's voice over the voice of an unfamiliar woman. The researchers placed a loudspeaker at about 10 cm above the mother's abdomen and played three stimulus trials, each beginning with silence, continuing with a voice (either that of the mother or unfamiliar woman) and, again, ending with silence. Results showed that fetal heart rates increased for the mother's voice but decreased for the unfamiliar woman's voice relative to the baseline established during the silent segment of each trial. This finding clearly demonstrates that infants can differentiate between the mother's voice and that of a stranger while still in the womb. Finally, DeCasper and colleagues found that fetuses 37 weeks old differentially responded to nursery rhymes that their mothers had recited daily for the previous four weeks (DeCasper et al., 1994). In other words, the mother's voice serves to stimulate not only maturation of the fetal auditory system, but also rudimentary social biases that will serve as the foundation for normal postnatal emotional development.

Interestingly, although newborns will work harder (by sucking more) to elicit maternal voices over another female's voice, they will not alter their patterns of sucking to elicit paternal voices over another male's voice. Using an operant choice procedure, DeCasper and Prescott (1984) tested newborns to determine whether they would prefer the father's voices to that of other males. The data revealed no specific preferences, one way or the other. Subsequent studies by the same researchers revealed that the infants could discriminate between the voices but that the voices apparently lacked reinforcing value, thus failing to elicit differential sucking. Similarly, in another study, young infants did not show a change in heart rate after hearing the father's voice but did after hearing the mother's voice (Ockleford et al., 1988); this lack of heart rate change was not due to an inability to discriminate among male voices. Overall, infants appear to prefer their mother's voice to that of a female stranger, yet they do not appear to prefer the voices of their fathers (Ward & Cooper, 1999) relative to that of a male stranger. These and other findings add support to the notion that early preferences for speech are specific to the mothers' vocalizations. Although one might assume that the father's voice is a relatively high frequency stimulus for the developing fetus, at least in most cases, the combination of frequency and source robustness of the mother's voice appears to give this particular auditory signal precedence over all other acoustic stimuli that are available to the infant prenatally.

Mothers Produce—and Infants Prefer—Infant-Directed Speech

Although infants initially prefer maternal vocalizations over all others, additional work has revealed that this preference is, in large part, driven by the exaggerated intonation with which maternal vocalizations are typically produced. Indeed, in an important early study, Mehler and colleagues (1978) found that 30-day-old infants only preferred their mothers' vocalizations over an unfamiliar woman's if the mothers' voices were properly intoned. If the mothers spoke with a flat intonation, infants showed no difference in their preference for their own mother's voice relative to the vocalizations of the female stranger. But mothers typically do speak in an animated manner when addressing their infants, a form of speech often referred to as "motherese" (Newport, 1975). It is precisely this bias on the part of mothers, as well as infants' preference for it, that has made motherese, or infant-directed speech, one of the focal areas of research for understanding infant communication.

Infant-directed speech is characterized by a variety of prosodic cues, such as exaggerated stress and pitch changes. These appear to help infants locate phrase boundaries (Jusczyk, 1997), decode syntactic structures of sentences (Morgan & Demuth, 1996), and come to a primitive form of semantic differentiation (Mehler et al., 1988). Researchers posited that the exaggerated pitch contours in infant-directed speech are useful to language development precisely because they attract and hold attention, improve sound localization, and improve awareness of contrast and coherence (Fernald & Simon, 1984). Indeed, behavioral data from infants over the first year of life support this theory. For example, prosodic cues are among the first that infants use to distinguish between languages (Cutler, Dahan & van Donselaar, 1997), thus allowing them to differentiate native from nonnative speech at birth. Moreover, infants can distinguish low-pass filtered infant-directed speech from similarly filtered adult-directed speech (Cooper & Aslin, 1994) in the first month of life. And, since boundaries of prosodic units are also often word boundaries, infants can use prosody to at least begin to segment fluent speech (Christophe & Dupoux, 1996). Thus prosody, particularly infant-directed prosody, makes speech salient. As such, it is an early and important contributor to language learning.

We have highlighted that the mother's voice is something infants come into the world recognizing and preferring. Interestingly, the infant-directedness of speech interacts with the familiarity of a speaker's voice. For example, if mothers' voices were somewhat intoned, then one-month-olds preferred the mother's voice over that of an unfamiliar woman regardless of whether they were speaking directly to the infant or to another adult (Cooper et al., 1997). However, this lack of preference between infant-directed speech and adult-directed speech is unique to maternal vocalizations. When the same researchers replaced the maternal vocalizations with vocalizations of unfamiliar women, infants then preferred the infant-directed speech over the adult-directed speech. Why is it that infants prefer infant-directed over adult-directed speech among strangers, but display no preference between the two when their mothers are the ones doing the speaking? The reason may be due to the fact that early in infancy, infants process their own mothers' voices differently than the voices of strangers. One view is that, since the mothers' vocalizations are so crucial to the developing infant, preference for her voice overrides preference for infant-directed speech. In other words, infants allocate more attentional resources towards their mothers' speech as a function of the emerging emotional bonds between them (Purhonen et al., 2004).

Infants' preferences for these two forms of speech—the mother's voice in particular and infant-directed speech in general—interact to orient them from an early age towards important sensory information in their environment. As infants gain experience postnatally, they develop a significant preference for maternal infant-directed speech over all other acoustic information. This is because when infants are about four months old their mothers begin to increase their use of exaggerated—infant-directed—speech. They increase the pitch of their voices and expand its range and variability over time. And they repeat themselves, a lot. Infants likewise are attracted to these properties, quickly learning to listen when their mothers' attention is on them, thereby gaining experience from the interaction. They thus begin to show a significant preference for maternal infant-directed speech over maternal adult-directed speech.

Given that the tendency for mothers to speak in an exaggerated way to their infants is consistent across languages (Fernald et al., 1989; Fernald & Morikawa, 1993), it may be that the infant-directedness of speech is a key factor in infants' language learning. While this point is debatable (and is, in fact, vigorously debated), it does seem that infants develop their preference for maternal infant-directed speech postnatally, and are thus not biologically predisposed to exhibit such a preference. They do, however, enter the world with a bias to listen to the mother's voice, a significant factor underlying the development of mother–infant communication.

Infant-Directed Speech or Happy Speech?

While the acoustical properties of infant-directed speech appear to underlie its effectiveness in attracting infants' attention, the particular components that drive infants' extended preference are less clear. There is evidence that the preference for affective speech begins very early in infancy. Infants are able to discriminate between positive and negative emotions when they are born (Mastropieri & Turkewitz, 1999), and respond differently to positive and negative emotions as conveyed by tone of voice (Fernald, 1992; Papousek et al., 1990). It is unsurprising then that the positive effect in infant-directed speech predicts a positive attitude and thus captures infants' attention more than neutral or negative speech. Positive effect in any form of speech encourages infants to pay attention to the person producing it, particularly familiar individuals (e.g., caregivers), whereas negative speech may pose a threat and motivate an infant to withdraw from the speaker in whatever way possible. Therefore, the influence of the affective quality of infant-directed speech has been the focus of much recent research.

In an important initial study on this issue, Kitamura and Burnham (1998) found that infants did not show a preference for infant-directed relative to adult-directed speech when speakers' pitch characteristics varied but their effect remained constant. Conversely, if speakers' pitch characteristics were held constant but their effect varied, then infants did demonstrate a preference for the infant-directed speech. This experiment provided a clear demonstration of the importance of the affective component of infant-directed speech—as distinguishable from pitch alone—in the preference that infants convey for it. Of course, people are generally happy when they address infants, so the issues of pitch and effect are tightly intertwined. Singh, Morgan, and Best (2002) replicated and extended Kitamura and Burnham's study by constructing stimuli in which effect and pitch were manipulated independently. They likewise found no preference for infant-directed over adult-directed speech given a constant (positive) effect. They noticed, however, that when adult-directed speech contained more positive effect than the infant-directed speech, infants preferred it. This shows that the higher and more variable pitch characteristics of infant-directed speech are not sufficient to determine infants' speech preferences. Rather, the (positive) affective properties of speech directed to infants interact with the tendency to exaggerate pitch contours, driving infants' preference for and attention to it.

Since "happy talk" draws infants' attention in a positive way, caregivers (and doting others) are more inclined to manipulate their vocal acoustics to elicit this response (Singh et al., 2002). Indeed, and perhaps unsurprisingly, adults rate infants' facial responses to infant-directed speech as more "attractive" than their facial responses to adult-directed speech (Werker & McLeod, 1989). Infants' preference for positive emotion, along with adults' inclination to produce happy talk when speaking to them, is thus an important contributor to their preference for infant-directed speech.

All of this may seem fairly obvious, but clear documentation of the forces driving infant preference matter at least in part because the positivity underlying this form of speech has been shown to affect infant development as well. In recent years, advances in infant-friendly neurophysiological techniques have allowed researchers to link previously established behavioral preferences to underlying neural processes. For example, maternally produced infant-directed speech has been shown to increase activity in infants' frontal cortex, a region important to the development of emotion processing capabilities into adulthood (Naoi et al., 2011). Frontal lobe development is related to positive emotions and positive interactions between mothers and infants (Davidson & Fox, 1982; Dawson et al., 1999), and it may contribute to the strength of the emotional bond between mother and infant (Purhonen et al., 2004). Indeed, when neonates' cortical activity was assessed while they listened to stories read by their mothers in either infant- or adult-directed speech, there was greater frontal lobe activity during the infant-directed speech readings (Saito et al., 2007). In short, the emotional properties of infant-directed speech contribute to positive interactions with caregivers, which in turn may serve as the basis for social learning by providing infants with the opportunity to interpret emotional signals from others and to react to them (Naoi et al., 2011).

The Beginning of Communication

Maternally produced infant-directed speech not only has strong influences on infants' processing of emotions, but also on establishment of the communication process itself. In an ERP study comparing infants' responses to words pronounced by their mother and by an unfamiliar woman, researchers found that early auditory components were accelerated in response to the mother's voice, and that infants were better able to learn words from their mothers (Dehaene-Lambertz et al., 2010). Maternal vocalizations elicit neural activity in the left hemisphere, particularly in the posterior temporal lobe (Dehaene-Lambertz et al., 2010; Purhonen et al., 2004), a network of cortical regions that will eventually emerge as the hub supporting language processing in the developing brain.

Maternal infant-directed speech affects early development of this language network in a variety of ways. First, infants strengthen emotional bonds by allocating attentional resources to their own mother's voice (Purhonen et al., 2004). Attending to the mother's speech can be highly rewarding for infants, providing additional motivation for infants to devote their attention to and selectively prefer their mothers' speech over the speech of others (Barker & Newman, 2004; Cooper et al., 1997). By securing infants' attention, maternal infant-directed speech allows infants to gain experience with the linguistic structure of their native language, while making language-related events more salient to the infant (Naoi et al., 2011). Infants can then begin segmenting the speech stream and learning the myriad object-label associations in their world (Graf Estes et al., 2007), a difficult process that is the foundation of subsequent language development.

Effect of Depressed Mothers on Child Language

The findings reviewed thus far serve to clarify the relationship between infants' speech preferences and processing biases. Clearly, maternal infant-directed speech is a critical component in infants' early language learning. The earliest infant preferences tend toward the perceptually salient, language-general (even nonlinguistic) aspects of an auditory scene, including infant-directed speech and positive effect (Mastropieri & Turkewitz, 1999; Singh et al., 2002) as reviewed here. Generally, infants can rely on their caregivers to produce speech full of such characteristics, and language development proceeds normally. But what happens to an infant's language when these aspects of the speech signal are compromised, as is the case in the speech of depressed mothers?

Positive speech greatly affects infants' social and linguistic development and, not surprisingly, there is growing evidence that an abundance of negative or neutral speech can have a detrimental effect on early development. For example, Weinberg and Tronick (1998) found that infants as young as three months are sensitive to their mothers' depression. Indeed, depressed mothers differ from nondepressed mothers in their effect and in the style of interaction they display with their infants. Depressed mothers express less positive effect, are less responsive, and tend to be emotionally withdrawn from their infants (Bigatti et al., 2001). In turn, infants of depressed mothers show impairment on a number of typical functions, including social, emotional, and cognitive ones (Weinberg & Tronick, 1998). While much research has been devoted to the negative effects of maternal depression on infant developmental outcomes in general, it has been more difficult to determine whether these effects directly relate to changes in the expression of emotion in the maternal speech itself.

Given that the affective quality of mothers' speech plays a role in language learning, it stands to reason that the lack of positive effect in depressed mothers' speech should affect this process. Indeed, Breznitz and Sherman (1987) found that depressed mothers vocalize less often and do not respond as quickly to the cessation of their children's speech as nondepressed mothers do. Since these depressed mothers do not reinforce communication, their children learn to keep interaction to a minimum and speak less in general. Similarly, Bigatti and colleagues (2001) observed that depressed mothers engage in fewer literacy-enhancing behaviors with their children than nondepressed mothers. When four years old, the children of depressed mothers scored lower on measures of language ability; by age five, maternal depression affected the children's performance in school (Bigatti et al., 2001). Additionally, depressed mothers were found to be less likely to use complex language with their children (e.g., questions, explanations, suggestions), which in turn affected the children's language abilities (Bigatti et al., 2001). These are just a handful of the results showing that negative maternal effect, both specific to speech and conveyed more generally, contributes to poor developmental outcomes, including language outcomes, in the children exposed to it.

While the general affective difference in speech produced by depressed mothers relative to nondepressed mothers is a factor in early language development, the quantity and complexity of language used by these mothers also appears to play a role. Many of the studies reviewed here focused on effects of maternal depression on language in children well past infancy. But research on the relationship between the sheer volume of language exposure during early infancy and subsequent language learning highlights another avenue by which maternal depression can influence the learning process, even in the first year of a child's life. In the next section, we review findings on the contribution of quantity of exposure to language development.

Structure in the Signal: Quality and Quantity Matter

From the inception of formal study of infant- and child-directed speech, researchers have noted the high frequency of exact and periphrastic repetitions of phrases and sentences

(Ferguson, 1964; Snow, 1972); the individual words contained in these phrases and sentences necessarily are repeated as well. In addition to speech quality, quantity of exposure has emerged as a key factor in the language learning process. Interestingly, quantity is something that was long taken for granted as a relative constant. In a seminal study, however, Hart and Risley (1995) demonstrated that the raw number of words children hear varies enormously as a function of a family's socioeconomic status, with average income families producing up to double the number of words as is produced by lower income families. These researchers made the (then provocative) suggestion that such differences in frequency of exposure might underlie the reliable differences in literacy outcomes observed as children from these families enter and proceed through formal education.

A wealth of research conducted since Hart and Risley's (1995) study has shown that the amount of language that infants and young children are exposed to before the age of three is, indeed, positively correlated with ensuing language production skills and cognitive development more generally (e.g., Arterberry et al., 2007; Bornstein & Haynes, 1998; Huttenlocher, 1991, Huttenlocher, 1998; Pan et al., 2005; Shonkoff & Phillips, 2000). This is often mediated by socioeconomic status (Hoff, 2003). It stands to reason then that the amount of language infants experience—even during the earliest stages of postnatal life—should affect the acquisition process. To understand how this may be, it helps to understand that particular aspects of language structure are consistent across languages. In recent years researchers have demonstrated that infants are highly sensitive to such structure, particularly when they have ample language around them from which to extract structural regularities.

Earlier, we reviewed findings on the influence of prosody (particularly that employed in infant-directed speech) on how infants attend to speech. We observed that, while prosodic form varies across languages, the infant-directedness of mothers' speech to infants does not. This prosodic structure helps infants separate continuous speech into smaller chunks of speech. Young learners can then use a variety of distributional strategies to pull words out of the chunks themselves. The simplest example of this is that *a priori* knowledge of certain high frequency words (e.g., the infant's own name) (Bortfeld et al., 2005) can help further delineate where other words begin and end. In other words, while prosodic organization of speech provides initial edges in otherwise continuous speech, continued exposure to the regular patterns within the smaller "chunks" of speech those edges create, allows infants to break them down further. This does, in fact, appear to be the case, as a wealth of recent evidence has highlighted different forms of structural information in the speech signal.

As demonstrated by Saffran and colleagues (Saffran, Aslin, & Newport, 1996), infants deal with the speech segmentation problem at least in part by taking advantage of distributions inherent in speech. In this study, infants were exposed to artificial languages that were synthesized so that there were no acoustic cues to word boundaries and no silences between syllables. The languages consisted of concatenated strings of trisyllabic nonsense words. Despite having no acoustic cues to guide the segmentation process, infants were able to distinguish between the languages' words (consistent trisyllabic strings) and "part words" (in this case, trisyllables created by pairing the syllable from the end of one word with the first two syllables of another) when these subsequently were presented to them in isolation. The researchers argued that the only way infants could distinguish words from partwords in these experiments was on the basis of the statistical coherence between syllables of words as compared to the lack of statistical coherence between partword syllables. Although words occurred more frequently than part words in the original experiment, these researchers subsequently demonstrated that infants' ability was not simply a function of frequency. Rather, infants discriminated words from part words on the basis of differences in their transitional probabilities (that is, the odds that one syllable would follow another) because the transitional probabilities are higher between syllables that are part of the same word and thus consistently occur together relative to those between partword syllables (Aslin et al., 1998).

The original research on this matter employed speech stimuli with nothing but statistical form, a design feature that was necessary to establish that infants can segment speech on the basis of statistical cues alone. Subsequent research has demonstrated that statistical structure interacts with a variety of other cues to structure, such as the prosodic contours inherent in infant-directed speech (Bortfeld & Morgan, 2010; Hay et al., 2011). While a review of the details of this more recent research is beyond the scope of this chapter, suffice it to say that if infants are learning about language based on the interaction of word frequency, the structural distributions within and between those words, and the acoustic cues that highlight which words go together, then the more speech an infant hears, the more likely he or she will be able to use all these cues as a guide to learning language. Consistent with Hart and Risley's (1995) original argument, there is now plenty of evidence that early differences in the amount of speech children are exposed to influences language ability in subsequent years of life. Indeed, researchers have returned to the rather obvious conclusion that language begins with simple exposure (and lots of it), inspiring a new generation of "talk-to-your-children" public service announcements. Indeed, if structure is inherent in the signal, then exposure to more of that signal will better allow a child to learn the structure.

The Importance of Adult–Infant "Conversations"

But if exposure matters, does it matter where the exposure is coming from? The push to get kids listening to more language—any language—has, in fact, raised as many questions about language learning as the research it was based on answered. For example, is overheard speech (e.g., speech between other speakers) as helpful as speech directed to the child him or herself? Does speech from electronic media count towards the total exposure tally? Does it matter if the speech is infant-directed, or will adult-directed speech serve the same purpose? These are just a sampling of the questions that the push for more exposure has raised. Of course, things are rarely as simple as they seem, and recent research suggests that mere exposure to adult speech is not sufficient for the development of language. Rather, an emerging view is that the most critical aspect of adults' speech to infants is that it fosters attempts on the infants' part to actually speak. Therefore, speech that does not foster a child's own speech, such as electronic television programs, may actually be counterproductive in helping children learn language.

Data support this view. In a recent study, Zimmerman and colleagues (2009) observed that the frequency of adult–child conversations was associated with robust language development. Conversely, after controlling specifically for interactive speech, no correlation was found between exposure to speech from television and other media and a child's subsequent language development. Rather, it appears that heavy media exposure during the early childhood years has a deleterious effect on language learning outcomes. Just a handful of these negative effects are: delays in language development, poor overall language development, poor reading skills, poor math skills, and problems with attention (Zimmerman & Christakis, 2005; Zimmerman et al., 2007; Zimmerman et al., 2009). One way that media can produce these negative outcomes is simply by reducing a child's opportunities for verbal interactions with his or her caregivers. Adding support to this argument are data showing that the number of conversational turns that adult caregivers and their children share is positively correlated with scores on a well-validated measure of language development (Zimmerman et al., 2009). Clearly, two-sided conversations are extremely important for language learning to proceed. Therefore, parents should not only be encouraged to provide their children with language input by speaking and reading to them, but they should try to get their young children speaking as much as possible too.

Two-Sided Conversation Provides Structured Input and Structured Feedback

Language is embedded in a social context and language learning takes place in the context of responsive social exchanges between caregivers and children. Of course, caregivers can elicit speech from their infants and young children in a variety of ways, particularly by being sensitive to their language abilities and responding to their efforts to speak in a supportive and contingent manner. Adults are most efficient at promoting language development when they calibrate their own speech to be just challenging enough for their child; neither so simplistic that the child learns nothing from the model, nor so sophisticated that the child is confused. Because maintaining adult speech in this range depends on a caregiver being in touch with his or her child's rapidly changing abilities, a caregiver's own frequent exposure to the child's language (e.g., through active conversation) will help guide appropriate tuning to the child's specific developmental level (Zimmerman et al., 2009).

But how do conversations between caregivers and infants proceed, given their inherent one-sidedness? Recent research on this topic has demonstrated that optimum occasions for language learning occur when adult speech is focused on and relevant to an infant's own attentional focus. Caregivers who are responsive to the foci of their infants' attention may specifically support advances in language development by providing labels for objects and events when they are receiving joint attention, thereby easing the challenge to infants of matching linguistic symbols to their referents and reinforcing the social-communicative function of language itself. When caregivers are particularly sensitive to their infants' interests and abilities, they will often match the semantic and syntactic content of their utterances to the children's level of understanding. For example, maternal speech that systematically matches infants' own speech on a variety of features strongly predicts children's linguistic abilities (Tamis-LeMonda et al., 2001). Mothers who respond to their children's communicative attempts during exploratory bouts key into the same topics of interest as their infants. The children "signal" choices about communication and mothers react to those signals in a sensitive manner. In this way, mothers provide infants with semantically relevant and interpretable speech because they follow up on topics introduced by the child him- or herself.

Aside from simply providing appropriate language structure at the appropriate time, direct, contingent interaction allows parents to provide error correction, whether explicitly or implicitly. Poverty-of-the-stimulus arguments (Chomsky, 1980) notwithstanding, early language development has been shown to benefit from active correction of errors by adult speakers. More conversations mean more opportunities for mistakes and corrections to be made, not to mention an increase in opportunities for children to use and consolidate newly acquired language. Finally, more conversation is a sign of greater adult responsiveness to a child's communication (Zimmerman et al., 2009), and thus the quality of the child's model for how to coordinate his or her attention with that of the social partner. A child's coordination skills have been shown to influence development of representational abilities in subsequent activities, such as in the language used during play (Adamson et al., 2004; Carpenter et al., 1998; Delgado et al., 2002; McCune 1995; Morales et al., 2005). The prevalence of "two-sided conversations" between caregivers and infants relate to the subsequent achievement of several language milestones (Nicely et al., 1999; Rollins, 2003; Tamis-LeMonda et al., 2001).

Contingent Learning: From Caregivers to Infants (and Back Again)

Beginning at the earliest stages of communication, infants' noncry vocalizations serve as salient social signals, and caregivers (socially and emotionally) reinforce these vocalizations. Indeed, contingent vocal responses to prelinguistic vocalizations are a typical characteristic of caregivers' reinforcing behavior. For example, caregivers spontaneously responded to 30–50 percent of noncry sounds in spontaneous interactions with their infants (Goldstein & West, 1999), and this responsiveness facilitated subsequent development of phonology and speech (Goldstein & Schwade, 2008; Goldstein et al., 2003; Gros-Louis et al., 2006). Several factors have been identified in this process.

First, maternal feedback to prelinguistic vocalizations influences the production of more developmentally advanced vocalizations, suggesting that effects of maternal responsiveness on vocal development start during the prelinguistic phase. In an analysis of unstructured play sessions between mothers and infants, mothers responded contingently to prelinguistic vocalizations over 70 percent of the time, and with more vocal responses than any other kind of response (e.g., gazes, smiling, physical contact) (Gros-Louis et al., 2006). Therefore, the form of behavioral responses from infants' social partners can encourage infants' own production of particular vocalizations, infants' vocal development (through the introduction of new sounds), and infants' efforts to improvise approximating speech sounds.

Second, adults' sensitivity to differences in prelinguistic vocalizations suggests that they may respond differently to different sounds, serving as a scaffold for language development. For example, mothers not only provided contingent responses to their infants' vocalizations, but those responses were specific to particular vocalization types (Gros-Louis et al., 2006). Mothers provided distinct verbal feedback to vowel-like and consonant–vowel vocalizations, giving interactive-vocal responses significantly more to consonant–vowel clusters than vowel-like sounds. These, in turn, resulted in an increase in the production of more developmentally advanced vocalizations on the part of the infants (Gros-Louis et al., 2006). Thus, co-occuring responses by mothers, in addition to their contingent responses, provide information to infants about the effectiveness of their vocal production. In this way, mothers encourage the use of particular sounds, giving them meaning, and frame interactions with infants through them (Papousek & Papousek, 1989).

But much of this research is correlational. To examine the role of caretaker–child interaction in vocal development in a more controlled way (i.e., beyond observations of natural, spontaneous interaction scenarios), researchers instructed mothers precisely *when* to respond to infant vocalizations (Goldstein, King, & West, 2003). Half of the infant–mother pairs tested were trained to respond contingently to infant's vocalizations with nonvocal social responses like smiling and touching, while the other half were instructed to respond based on the response schedules of the mothers in the contingent group, but to do so noncontingently. Infants who received social feedback contingent on their vocalizations produced more developmentally advanced vocalizations during the manipulation, as well as after maternal responding was no longer being manipulated, compared to those infants who received feedback independent of when they vocalized. Similar results have been observed in studies of unstructured mother–infant interactions (e.g., Hsu & Fogel, 2003).

In yet another study, when caregivers responded contingently to infants' vocalizations with speech, infants structured their own sounds to match the phonological patterns they heard (Goldstein & Schwade, 2008). For example, when infants were given vowel sounds as feedback, they produced more vowel sounds, but when they were given words as feedback, they produced more consonant–vowel combinations. This demonstrates that infant vocalizations can themselves be operantly conditioned with appropriate social reinforcement. In fact, changes in vocalizing in response to high levels of social reinforcement are a key characteristic of infant–caregiver dyadic interaction, and infants who learn the contingency between their own vocalizations and the responses of their caregivers have thus learned to influence the behavior of social partners; an important step forward in early communicative development.

In short, caregivers' contingent and positive responses to infants' vocalizations influence and advance these prelinguistic productions. Infants learn that their own vocalizations elicit responses, marking the beginning of their use of vocalizations as bids for social interaction. In this way, infants learn to guide the structure of interactions and to predict the outcome of ensuing interactions (i.e., to communicate). Thus, a functional perspective has emerged whereby infants' sounds can be understood not only in terms of their acoustic properties but also in terms of their ability to regulate and be regulated by social interactions with receivers of the sounds. This is infant communication.

Conclusion

Communication is inherently social. At the earliest stages of development, infants are being influenced by the sounds around them. Subsequently, caregivers' biases to communicate in particular ways help infants focus their attention specifically on speech sounds. The inherent structure of the speech signal together with the contingent structure of the infant–caregiver interaction serve to highlight regularities in speech and in interactive form; infants respond to this, as reflected in their subsequent productions of new vocal forms. Particular maternal responses, such as imitations and expansions, correlate positively with language development. Through these responses, infants learn the association between the production of certain sounds and their outcomes. Finally, caregivers' input during social interactions and early "conversations" scaffold language learning by providing information about activities and objects that are the focus of infants' attention in the first place. In sum, socially guided communication is fundamental to infants' initial vocal development, laying the foundation for subsequent advances in language learning.

References

Adamson, L. B., Bakeman, R., & Deckner, D. F. (2004). The development of symbol-infused joint engagement. *Child Development, 75,* 1171–87.

Arterberry, M. E., Midgett, C., Putnick, D. L., & Bornstein, M. H. (2007). Early attention and literacy experiences predict adaptive communication. *First Language, 27,* 175–89.

Aslin, R. N., Saffran, J. R., & Newport, E. L. (1998). Computation of conditional probability statistics by human infants. *Psychological Science, 9,* 321–24.

Barker, B. A., & Newman, R. S. (2004). Listen to your mother! The role of talker familiarity in infant streaming. *Cognition*, *94*, B45–B53.

Bertoncini, J., & Mehler, J. (1981). Syllables as units in infant perception. *Infant Behavior and Development*, *4*, 271–84.

Bigatti, S. M., Cronan, T. A., & Anaya, A. (2001). The effects of maternal depression on the efficacy of a literacy intervention program. *Child Psychiatry and Human Development*, *32*, 147–62.

Bornstein, M. H., & Haynes, O. M. (1998). Vocabulary competence in early childhood: measurement, latent construct, and predictive validity. *Child Development*, *69*, 654–71.

Bortfeld, H. & Morgan, J. (2010). Is early word-form processing stress-full? How natural variability supports recognition. *Cognitive Psychology*, *60*, 241–66.

Bortfeld, H., Morgan, J., Golinkoff, R., & Rathbun, K. (2005). Mommy and me: familiar names help launch babies into speech stream segmentation. *Psychological Science*, *16*, 298–304.

Breznitz, Z., & Sherman, T. (1987). Speech patterning of natural discourse of well and depressed mothers and their young children. *Child Development*, *58*, 395–400.

Carpenter, M., Nagell, K., & Tomasello, M. (1998). Social cognition, joint attention, and communicative competence from 9 to 15 months of age. *Monographs of the Society for Research in Child Development*, *63*(4), 1–174.

Chomsky, N. (1980). *Rules and representations*. Oxford: Basil Blackwell.

Christophe, A., & Dupoux, E. (1996). Bootstrapping lexical acquisition: the role of prosodic structure. *The Linguistic Review*, *13*, 383–412.

Christophe, A., Dupoux, E., Bertoncini, J., & Mehler, J. (1994). Do infants perceive word boundaries? An empirical study of the bootstrapping of lexical acquisition. *Journal of the Acoustical Society of America*, *95*, 1570–80.

Cooper, R. P. and Aslin, R. N. (1994). Developmental differences in infant attention to the spectral properties of infant-directed speech. *Child Development*, *65*, 1663–77.

Cooper, R., Abraham, J., Berman, S., & Staska, M. (1997). The development of infants' preference for motherese. *Infant Behavior & Development*, *20*, 477–88.

Cutler, A., Dahan, D. & van Donselaar, W. (1997). Prosody in the comprehension of spoken language: A literature review. *Language and Speech*, *40*, 141–201.

Davidson, R. J., & Fox, N. A. (1982). Asymmetrical brain activity discriminates between positive and negative affective stimuli in human infants. *Science*, *218*, 1235–37.

Dawson, G., Frey, K., Panagiotides, H., Yamada, E., Hessl, D., & Osterling, J. (1999). Infants of depressed mothers exhibit atypical frontal electrical brain activity during interactions with mother and with a familiar, nondepressed adult. *Child Development*, *70*, 1058–66.

DeCasper, A. J., & Fifer, W. P. (1980). Of human bonding: Newborns prefer their mothers' voices. *Science*, *208*, 1174–76.

DeCasper, A. J., Lecanuet, J., Busnel, M., & Granier-Deferre, C. (1994). Fetal reactions to recurrent maternal speech. *Infant Behavior & Development*, *17*, 159–64.

DeCasper, A. J., & Prescott, P. A. (1984). Human newborns' perception of male voices: Preference, discrimination, and reinforcing value. *Developmental Psychobiology*, *17*, 481–91.

DeCasper, A. J., & Spence, M. J. (1986). Prenatal maternal speech influences newborns' perception of speech sounds. *Infant Behavior and Development*, *9*, 133–50.

Dehaene-Lambertz, G. G., Montavont, A. A., Jobert, A. A., Allirol, L. L., Dubois, J. J., Hertz-Pannier, L. L., & Dehaene, S. S. (2010). Language or music, mother or Mozart? Structural and environmental influences on infants' language networks. *Brain and Language*, *114*, 53–65.

Delgado, C. E., Mundy, P., Crowson, M., Markus, J., Yale, M., & Schwartz, H. (2002). Responding to joint attention and language development: A comparison of target locations. *Journal of Speech, Language, and Hearing Research*, *45*, 715–19.

Ferguson, C. A. (1964). Baby talk in six languages. *American Anthropologist*, *66*, 103–14.

Fernald, A. (1992). Human maternal vocalizations to infants as biologically relevant signals: An evolutionary perspective. In J. H. Barkow, L. Cosmides, & J. Toobey (Eds.), *The adapted mind: Evolutionary psychology and the generation of culture* (pp. 391–428). Oxford: Oxford University Press.

Fernald, A., & Morikawa, H. (1993). Common themes and cultural variations in Japanese and American mothers' speech to infants. *Phonetica*, *57*, 242–54.

Fernald, A., & Simon, T. (1984). Expanded intonation contours in mothers' speech to newborns. *Developmental Psychology*, *20*, 104–13.

Fernald, A., Taeschner, T., Dunn, J., Papousek, M., 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.

Goldstein, M. H., King, A. P., & West, M. J. (2003). Social interaction shapes babbling: Testing parallels between birdsong and speech. *Proceedings of the National Academy of Sciences*, *100*, 8030–35.

Goldstein, M. H., & Schwade, J. A. (2008). Social feedback to infants' babbling facilitates rapid phonological learning. *Psychological Science*, *19*, 515–22.

Goldstein, M. H., & West, M. J. (1999). Consistent responses of human mothers to prelinguistic infants: The effect of prelinguistic repertoire size. *Journal of Comparative Psychology*, *113*, 52–58.

Graf Estes, K., Evans, J. L., Alibali, M. W., & Saffran, J. R. (2007). Can infant map meaning to newly segmented words? Statistical segmentation and word learning. *Psychological Science*, *18*, 254–60.

Gros-Louis, J., West, M. J., Goldstein, M. H., & King, A. P. (2006). Mothers provide differential feedback to infants' prelinguistic sounds. *International Journal of Behavioral Development*, *30*, 509–16.

Hart, B. & Risley, T. R. (1995). *Meaningful Differences in the Everyday Experience of Young American Children*. Baltimore, MD: P. H. Brookes.

Hay, J. F., Pelucchi, B., Graf Estes, K., & Saffran, J. R. (2011). Linking sounds to meanings: Infant statistical learning in a natural language. *Cognitive Psychology*, *63*, 93–106.

Hepper, P. G., & Shahidullah, S. B. (1994). Development of fetal hearing. *Archives of Disease in Childhoold Fetal Neonatal Edition*, *71*, F81–F87.

Hoff, E. (2003). The specificity of environmental influence: socioeconomic status affects early vocabulary development via maternal speech. *Child Development*, *74*, 1368–78.

Hsu, H. C., & Fogel, A. (2003). Social regulatory effects of infant nondistress vocalizations on maternal behavior. *Developmental Psychology*, *39*, 976–91.

Huttenlocher, J. (1991). Early vocabulary growth: relation to language input and gender. *Developmental Psychology*, *27*, 236–48.

——(1998). Language input and language growth. *Preventive Medicine*, *27*, 195–99.

Jusczyk, P. W. (1997). *The Discovery of Spoken Language*. Cambridge, MA: MIT Press.

Kisilevsky, B. S., Hains, S. M. J., Jacquet, A. Y., Granier-Deferre, C., & Lecanuet, J. P. (2004). Maturation of fetal responses to music. *Developmental Science*, *7*, 550–59.

Kisilevsky, B. S., Hains, S. J., Lee, K., Xie, X., Huang, H., Ye, H., Zhang, K., & Wang, Z. (2003). Effects of experience on fetal voice recognition. *Psychological Science*, *14*, 220–24.

Kitamura, C., & Burnham, D. (1998). The infant's response to maternal vocal affect. In C. Rovee-Collier, L. Lipsitt, & H. Hayne (Eds.), *Advances in infancy research* (vol. XII, pp. 221–36). Stamford, CT: Ablex.

Mastropieri, D., & Turkewitz, G. (1999). Prenatal experience and neonatal responsiveness to vocal expressions of emotion. *Developmental Psychobiology*, *35*, 204–14.

McCune, L. (1995). A normative study of representational play in the transition to language. *Developmental Psychology*, *31*, 198–206.

Mehler, J., Bertoncini, J., Barrière, M., & Jassik-Gerschenfeld, D. (1978). Infant recognition of mother's voice. *Perception*, *7*, 491–97.

Mehler, J., Jusczyk, P., Lambertz, G., Halsted, N., Bertoncini, J., & Amiel-Tison, C. (1988). A precursor of language acquisition in young infants, *Cognition*, *29*, 143–78.

Moon, C., Panneton-Cooper, R., & Fifer, W. P. (1993). Two-day-olds prefer their native language. *Infant Behavior and Development*, *16*, 495–500.

Morales, M., Mundy, P., Crowson, M. M., Neal, A. R., & Delgado, C. E. F. (2005). Individual differences in infant attention skills, joint attention, and emotion regulation behavior. *International Journal of Behavioral Development*, *29*, 259–63.

Morgan, J., & Demuth, K. (Eds.) (1996). *Signal to syntax: bootstrapping from speech to grammar in early acquisition*. Mahwah, NJ: Lawrence Erlbaum Associates.

Morokuma, S., Fukushima, K., Kawai, N., Tomonaga, M., Satoh, S., & Nakano, H. (2004). Fetal habituation correlates with functional brain development. *Behavioural Brain Research*, *153*, 459–63.

Naoi, N., Minagawa-Kawai, Y., Kobayashi, A., Takeuchi, K., Nakamura, K., Yamamoto, J., & Kojima, S. (2011). Cerebral responses to infant-directed speech and the effect of talker familiarity. *Neuroimage*, *59*, 1735–44.

Nazzi, T., Bertoncini, J., & Mehler, J. (1998). Language discrimination by newborns. Towards an understanding of the role of rhythm. *Journal of Experimental Psychology: Human Perception and Performance*, *24*, 1–11.

Newport, E. L. (1975). Motherese: the speech of mothers to young children. Ph.D. dissertation, University of Pennsylvania.

Nicely, P., Tamis-LeMonda, C. S., & Bornstein, M. H. (1999). Mother's attuned milestones. *Infant Behavior and Development, 22,* 557–68.

Ockleford, E. M., Vince, M. A., Layton, C., & Reader, M. R. (1988). Responses of neonates to parents' and others' voices. *Early Human Development*, *18*, 27–36.

Pan, B. A., Rowe, M. L., Singer, J. D., & Snow, C. E. (2005). Maternal correlates of growth in toddler vocabulary production in low-income families. *Child Development*, *76*, 763–82.

Papousek, M., Bornstein, M. H., Nuzzo, C., Papousek, H., & Symmes, D. (1990). Infant responses to prototypical melodic contours in parental speech. *Infant Behavior and Development*, *13*, 539–45.

Papousek, M., & Papousek, H. (1989). Forms and functions of vocal matching in interactions between mothers and their precanonical infants. *First Language*, *9*, 137–58.

Purhonen, M., Kilpeläinen-Lees, R., Valkonen-Korhonen, M., Karhu, J., & Lehtonen, J. (2004). Cerebral processing of mother's voice compared to unfamiliar voice in 4-month-old infants. *International Journal of Psychophysiology, 52,* 257–66.

Ramus, F., Hauser, M. D., Miller, C., Morris, D., & Mehler, J. (2000). Language discrimination by human newborns and by cotton-top tamarin monkeys. *Science*, *288*, 349–51.

Rollins, P. R. (2003). Caregivers' contingent comments to 9-month-old infants: relationships with later language. *Applied Psycholinguistics*, *24*, 221–34.

Saffran, J. R., Aslin, R. N., Newport, E. L. (1996). Statistical learning by 8-month-old infants. *Science*, *274*, 1926–28.

Saito, Y., Aoyama, S., Kondo, T., Fukumoto, R., Konishi, N., Nakamura, K., Kobayashi, M., & Toshima, T. (2007). Frontal cerebral blood flow change associated with infant-directed speech. *Archives of Disease in Childhoold Fetal Neonatal Edition*, 92, F113–16.

Shi, R., Werker, J. F., & Morgan, J. L. (1999). Newborn infants' sensitivity to perceptual cues to lexical and grammatical words. *Cognition*, *72*, B11–B21.

Shonkoff, J. P., & Phillips D. (2000). *From neurons to neighborhoods: The science of early childhood development*. Washington, DC: National Academy Press.

Singh, L., Morgan, J. L., & Best, C. T. (2002). Infants' listening preferences: baby talk or happy talk? *Infancy*, *3*, 365–94.

Snow, C. E. (1972). Mothers' speech to children learning language. *Child Development*, *43*, 549–65.

Tamis-LeMonda, C. S., Bornstein, M. G., Kahana-Kalman, R., Baumwell, L., & Cyphers, L. (1998). Predicting variation in the timing of language milestones in the second year: an events history approach. *Journal of Child Language*, *25*, 675–700.

Tamis-LeMonda, C. S., Bornstein, M. H., & Baumwell, L. (2001). Maternal responsiveness and children's achievement of language milestones. *Child Development*, *72*, 748–67.

Ward, C. D., & Cooper, R. (1999). A lack of evidence in 4-month-old human infants for paternal voice preference. *Developmental Psychobiology*, *35*, 49–59.

Weinberg, M. K., & Tronick, E. Z. (1998). Emotional characteristics of infants associated with maternal depression and anxiety. *Pediatrics*, *102*, 1298–304.

Werker, J. F., & McLeod, P. J. (1989). Infant preference for both male and female infant-directed talk: a developmental study of attentional and affective responsiveness. *Canadian Journal of Psychology*, 43, 230–46.

Zimmerman, F. J., & Christakis, D. A. (2005). Children's television viewing and cognitive outcomes: a longitudinal analysis of national data. *Archives of Pediatric & Adolescent Medicine*, *159*, 619–25.

Zimmerman, F. J., Christakis, D. A., & Meltzoff, A. N. (2007). Associations between media viewing and language development in children under age 2 years. *Journal of Pediatrics*, *151*, 364–68.

Zimmerman, F. J., Gilkerson, J., Richards, J. A., Christakis, D. A., Xu, D., Gray, S., & Yapanel, U. (2009). Teaching by listening: the importance of adult-child conversations to language development. *Pediatrics*, *124*, 342–49.