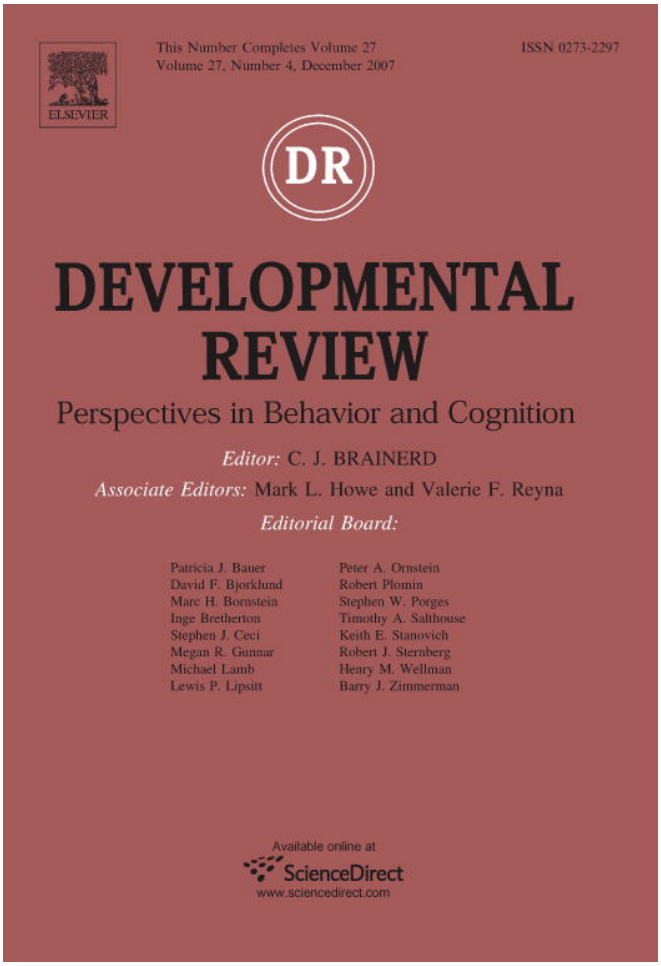

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Beyond babytalk: Re-evaluating the nature and content of speech input to preverbal infants

Melanie Soderstrom *

Department of Cognitive and Linguistic Sciences, Brown University, 190 Thayer Street, Box 1978, Providence, RI 02912, USA

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Abstract

Infant-directed maternal speech is an important component of infants' linguistic input. However, speech from other speakers and speech directed to others constitute a large amount of the linguistic environment. What are the properties of infant-directed speech that differentiate it from other components of infants' speech environment? To what extent should these other aspects be considered as part of the linguistic input? This review examines the characteristics of the speech input to preverbal infants, including phonological, morphological, and syntactic characteristics, specifically how these properties might support language development. While maternal, infant-directed speech is privileged in the input, other aspects of the environment, such as adult-directed speech, may also play a role. Furthermore, the input is variable in nature, dependent on the age and linguistic development of the infant, the social context, and the interaction between the infant and speakers in the environment.

Keywords: Infant-directed speech; Babytalk; Maternal speech; Speech input; Language development; Preverbal infants; Prelinguistic infants

The nature of the input is a crucial part of our understanding of the development of language in human infants, regardless of one's theoretical perspective. Language researchers who see the input as a degenerate or underspecified form of an underlying grammar argue in favor of infants possessing specific innate grammatical knowledge. Those who reject innate knowledge find answers within the nature of the input itself, and the

* Fax: +1 401 863 2255.
E-mail address: melsod@brown.edu.

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interaction of our general cognitive processes with that input.[1] Some of the controversy stems from a difference of opinion about what we mean by the input. Ask a formal linguistic or a developmental psychologist about the characteristics of "the input", and you will get widely divergent answers. Are we talking about a formal characterization of the structural properties of the language being learned? Or are we talking about "speech" in all its ambiguous, degenerate and disfluent glory? What about the speaker—should we only consider maternal input? What about the father, other caregivers, the nanny, the older sibling, the local shopkeeper or the ubiquitous television? Should we only consider speech directed at the infant, or all of the speech bouts produced in hearing range? For speech directed at the infant, what age should we consider? In order to answer *how* the input is relevant to the process of language development, we must have a clear understanding of what constitutes "the input". The following examination of the literature on infant-directed speech and other sources of speech input will provide some preliminary evidence regarding this latter question, and highlight areas in need of further research.

The ambiguity is not simply terminological, but reflects important theoretical differences in the relationship between the language learner and the input. For the generative linguist, the writing of the Wall Street Journal may provide an ideal testing ground for abstract questions of learnability. The developmental psychologist, on the other hand, sees the characteristics of speech input *to children* as critical to the process. This perspective has led to a focus on the properties of the speech most salient in the child's environment—maternal speech (Brown, 1973; MacWhinney, 2000). However, this perspective in the language development literature sometimes excludes consideration of potentially important additional sources of input, from other speakers such as father and sibling, and to other listeners, such as adult–adult talk within the child's hearing. A small number of studies do exist on these topics, and these will also be examined below.

Another important consideration is the age at which the input is being examined. Recent advances in perceptual studies of infants suggest that some of the most interesting developments take place much earlier in infancy than has previously been supposed—younger than 18 months, 12 months, or even in some cases, 6 months. For example, the lack of functional morphemes, both function words and inflectional markers, in toddlers' speech has been noted since Brown's seminal work (Brown, 1973). Yet work in the perceptual domain suggests that infants are sensitive to function words as young as 11 months (Shady, 1996; Shafer, Shucard, Shucard, & Gerken, 1998), and inflectional morphemes by 16–18 months (Santelmann & Jusczyk, 1998; Soderstrom, White, Conwell, & Morgan, 2007), well before they are producing multi-word utterances, let alone fully inflected sentences. The production data suggest that the relevant "input" might be that of maternal speech to 2-year-olds. By contrast, the perceptual data suggest that we should look much earlier, before infants are even producing their first words. Another example comes from lexical development. While analysis of infants' own productions places the onset of word learning at 10–12 months, perceptual studies find evidence for some form-meaning pairs at 6 months, including "mommy" and "daddy", which infants at this age differentiate both from each other and from strangers of the same gender, and the body terms "hand" and "feet" (Tincoff, in preparation; Tincoff & Jusczyk, 1999). Infants recognize their own

[1] For further discussion on this topic, see two recent comprehensive debates in The Linguistic Review (2002) and Journal of Child Language (MacWhinney, 2004 and following replies).

names at an even younger age (Mandel-Emer, 1997; Mandel, Jusczyk, & Pisoni, 1995). These word familiarities also help infants in word segmentation (Bortfeld, Morgan, Golinkoff, & Rathbun, 2005). These findings highlight the importance of examining what infants are hearing before they begin actively producing words.

With a focus on speech input to preverbal infants,[2] this paper will ask the following questions: What is the nature of maternal, infant-directed speech input to preverbal infants? How do the properties of infant-directed speech influence acquisition? What is known about alternative sources of input to the infant—in different contexts, at different ages, from different speakers, etc? The first section will explore what constitutes the input to infants. The second section will examine what is known about the prosodic, phonological, lexical and syntactic properties of infant-directed speech. The third section will examine some effects of maternal speech on development. The fourth section will examine alternative sources of linguistic input. The final section will discuss the implications of these various findings, and consider areas for future study.

Defining the input

What do infants hear?

In the mid-twentieth century, researchers began to document a special form or register of speech that was used primarily when talking with children and infants (Bynon, 1968; Casagrande, 1948; Ferguson, 1964). This register was referred to as "baby talk" or "motherese". This paper will use a recent more neutral term, "infant-directed speech" (ID speech), which also serves to disambiguate it from "child-directed speech" (CD speech) where necessary. From early on, it was noted that similar registers are also used in other circumstances, such as when "conversing" with the family pet (Hirsh-Pasek & Treiman, 1982; Mitchell, 2001, 2004; Mitchell & Edmonson, 1999), or dealing with others who lack power but who generate strong feelings of affection, such as the sick (Levin, Snow, & Lee, 1984) or elderly (Caporael & Culbertson, 1986; Ryan, Hamilton, & See, 1994). Some properties of CD speech are also found in "foreigner talk", when native speakers interact with non-native speakers (e.g. Snow, van Eeden, & Muysken, 1981). The use of similar speech toward targets other than children might lead to one to ask whether it might be a misnomer to call it infant- or child-directed. However, there is some evidence that ID speech does have unique properties. For example, pet-directed speech does not contain hyperarticulation of vowels, while ID speech does (Burnham, Kitamura, & Vollmer-Conna, 2002), and pet-directed speech contains shorter sentences, more imperatives and repetitions, and fewer questions, declaratives and deictics than ID speech (Mitchell, 2001).

Numerous studies have shown that young infants, and even newborns, prefer listening to infant- over adult-directed (AD) speech samples (Cooper & Aslin, 1990; Fernald, 1985; Pegg, Werker, & McLeod, 1992). However, because the focus has been on demonstrating how *early* this preference can be found, there is very little evidence regarding how long the preference lasts. The effects that infant-directed speech might have on young infants might be very different from that of a similar register on older infants and young children. What

[2] There are other exemplary reviews that focus on maternal speech to young toddlers and older children (e.g. Gallaway & Richards, 1994; Snow & Ferguson, 1977).

little evidence exists suggests that such development differences do exist. One study in Japan (Hayashi, Tamekawa, & Kiritani, 2001) found a U-shaped function, with 7- to 9-month-old infants showing no preference for ID speech, and a subsequent recovery in preference at 10–14 months. However, a more recent study in the United States (Newman & Hussain, 2006), while replicating the lack of preference for ID speech at 9 months, failed to find a recovery in preference at 13 months.[3] The finding across both studies suggests that infant preference for ID speech is not uniform across the developmental timeline. This leads to the possibility that at least some of the properties of ID and CD speech, particularly acoustic properties, may be of less importance for older infants. More research is clearly needed to determine the ages at which preferences for ID speech are found, and what characteristics these preferences are based on.

The discrepancy across the English and Japanese studies also suggests that infant preference, or lack thereof, for ID speech may be governed by factors other than age and the specific nature of the ID speech, such as the language or society in which the infant is exposed. However, at least some aspects of the preference do seem to be maintained across languages. Infants' early preferences for ID speech seem to be guided by the intonational, rather than amplitude or durational, characteristics of ID speech (Fernald & Kuhl, 1987). This preference has been found across languages with different intonational properties—English-learning infants prefer Cantonese ID speech to AD speech, as do Cantonese-learning infants (Werker, Pegg, & McLeod, 1994). It has also been found across genders—infants prefer male as well as female ID speech over AD speech (Pegg et al., 1992; Werker & McLeod, 1989).

Interestingly, preference for ID speech may develop first for *unfamiliar* voices, and only later for familiar voices. One-month-olds show a preference for ID speech when spoken by a stranger, but show no preference for ID over AD speech when both are spoken by their own mother. By contrast, 4-month-olds show a preference for ID speech in both stranger and maternal speech contexts (Cooper, Abraham, Berman, & Staska, 1997). Newborns show a decrease in movement to their mother's voice in AD speech compared with their mother's voice in ID speech, or to a stranger's voice in either AD or ID speech (Hepper, Scott, & Shahidullah, 1993), suggesting that they do *discriminate* maternal AD and ID speech. The lack of evidence for an early preference for maternal ID speech is less surprising when one considers that the maternal AD register will likely be more familiar from fetal experience, particularly for the primiparous mother.

The question of the speakers to which infants might attend has also been studied. A variety of studies using behavioral and physiological measures have found that infants discriminate or prefer their mother's voice to that of a stranger (Brown, 1979; DeCasper & Fifer, 1980; Friedlander, 1968; Hepper et al., 1993; Mehler, Bertoncini, Barriere, & Jassik-Gerschenfeld, 1978; Mills & Melhuish, 1974; Ockleford, Vince, Layton, & Reader, 1988), but not when the mother was asked to speak in a monotone (Mehler et al., 1978). A possible preference for father's voice over that of a stranger has not been as carefully studied. A small number of studies have found discrimination of father's voice from that of other voices in newborns and 4 month olds, but did not find evidence for preference (DeCasper & Prescott, 1984; Ward & Cooper, 1999). Other studies which suggest a

[3] However, there is evidence for differential brain activity in 13-month-olds (as well as 6-month-olds) between ID and AD speech (Zangl & Mills, 2007). This points to differences in how the two registers are experienced by infants at this age, but does not by itself establish that ID speech is in any way preferred or favored.

possible preference effect are difficult to interpret. One study of 4-month-olds found suppression of vocalization compared with a same-sex stranger, while that of the mother was associated with an increase in vocalization (Brown, 1979). A small study of infant heart rate responses to speech found similar responses to mother's and father's voice, but few effects reached significance, and only for the mother (Ockleford et al., 1988). The finding that infants prefer male ID speech over male AD speech (Pegg et al., 1992) suggests that male speech is at least not without interest to infants. Since these studies were all done with very young infants, it is possible that the preference for father's voice develops more slowly after birth than preference for mother's voice, given the infant's lesser exposure to the father's voice than the mother's prior to birth.

Implications

These numerous studies provide evidence that infant-directed speech and maternal speech play an important role in an infant's development. But they do not rule out that other speech forms or registers and speech from other speakers might also form part of the input to the infant as language learner. That infants show a preference to attend to a particular speech type does not establish that this speech type is the exclusive, or even primary, source of input. One recent study (van de Weijer, 2002) found that only 15% of the speech heard by an infant was directed at that infant. More than half the speech in the infant's environment was adult-directed. A further 30% of the speech the infant heard was directed at an older sibling—twice as much as was directed at the infant. Studies of infant preferences have generally not distinguished between infant- and child-directed speech (the experimental stimuli are usually produced in the absence of a target listener, infant *or* child), to the extent that these registers might differ.

The question of what constitutes the input to infants is therefore far from resolved. Clearly, female, maternal speech plays a central role in the experience of the infant. The following two sections will examine the properties of this speech in greater detail. But it is also important to consider the extent to which other forms of speech, and other sources of speech input, may also be used by the infant in developing linguistic knowledge. The subsequent sections will expand on other aspects of the speech input to which infants may be exposed.

The properties of infant-directed speech

Studies of infant preference suggest that maternal, infant-directed speech has an important role to play in the experience of infants during language acquisition. This role may differ based not only on the age of the infant or the language being learned, but also on the characteristic under consideration. Such effects do not have to be entirely beneficial. Some properties of ID speech may in fact pose a problem for the language learner, by distorting the signal in a way that impedes acquisition, or may be entirely neutral to language acquisition. Here, we consider a number of properties of ID speech, and discuss their possible effects.

Prosodic properties of ID speech

It is well-established that speech to infants (as well as young children) in American English and other languages is characterized by a variety of intonational and prosodic characteristics. These include higher and greater variability in pitch (Fernald et al.,

1989; McRoberts & Best, 1997; Papousek, Papousek, & Symmes, 1991; Remick, 1976; van de Weijer, 1997), as well as lengthening of vowels and pauses (Albin & Echols, 1996; Bernstein Ratner, 1986; Fernald et al., 1989; van de Weijer, 1997). They also include specific intonational contours used in particular contexts (Katz, Cohn, & Moore, 1996; Papousek et al., 1991; Stern, Spieker, & MacKain, 1982). These exaggerated properties have been suggested by many researchers (e.g. Cruttenden, 1994; Ferguson, 1977; Fernald, 1989; Garnica, 1977; Sachs, 1977) to serve as a mechanism for getting the infant's attention and communicating affect. This affective and attentive role may be considered beneficial for language development, by drawing the infant's interest to the linguistic signal. However, a more interesting and controversial possibility, to be considered in the next section, is that specific aspects of these acoustic properties may more directly aid acquisition.

Lexical and phonological properties of ID speech

Some of the earliest work on "baby talk" (e.g. Bynon, 1968; Casagrande, 1948; Ferguson, 1964; Voegelin & Robinett, 1954) relied on parental or informant reports. These studies therefore focused on creating lists of lexical items and noting cross-linguistic similarities between these words, such as phonological simplification, reduplication, the addition of diminutive suffixes (but a contrasting decrease in the use inflections), and a preponderance of CVC and CVCV word structures. These kinds of speech alterations have not been studied in detail in speech to preverbal infants per se. However, one more recent study of diminutives found relatively widespread usage in speech to infants as young as 14 months, and differences in their usage based on factors such as speaker gender and listener age and gender (Berko Gleason, Perlmann, Ely, & Evans, 1994). While it is easy to see how some of these properties might be useful to the language learner, other aspects of diminutives seem potentially troublesome. For example, diminutive suffixes might be helpful in word segmentation due to their regularization of stress patterns and invariance of word endings (Kempe, Brooks, & Gillis, 2005), but it is difficult to see for example how full lexical replacements like the child-directed "bunny" would be helpful in learning the adult form "rabbit".

One phonological property that has been investigated in some detail in preverbal infants is the voice onset time (VOT) distinction. Eimas, Siqueland, Jusczyk, and Vigorito (1971) demonstrated that very young infants, like adults, demonstrate categorical perception of this property of phonemes. Several studies have examined whether ID speech differs from AD speech in this property, but the findings are mixed. One study found an increase in acoustical separation in ID speech between voiced and voiceless stops, causing greater phonological clarity, but only with infants already producing their first words (Malsheen, 1980; Moslin, 1979). Two mothers speaking to 15- and 16-month-old infants produced less VOT overlap between the voiced and voiceless stops in their speech to their infants than to other adults, while mothers of 6- and 8-month-olds and 2- and 5-year-olds produced contrasts similar to the adult forms. This effect was generated by an increase in the VOT of voiceless stops in speech to the middle age group. While it is tempting to conclude that the mothers were exaggerating their phonological distinctions for just that age group that might benefit, there is recent perceptual evidence that 15-month-olds have highly sophisticated phonological feature representations, including the voicing distinction (White, 2006). If infants have already mastered these phonological distinctions by 15 months, the mother's phonological clarity at this age seems less relevant to the infant's having acquired the distinction. This may be a case where infant-directed modifications are mismatched with the actual language-learning needs

of the infant. It would be interesting to see whether mothers of 12-month-olds show exaggerated contrasts, like the mothers of 15-month-olds.

Other studies have found possible differences in *overall* VOT, across both voiced and voiceless (which might serve to increase or decrease the overall perceptibility of these phonemes), but results are at best difficult to interpret, and may be an example of ID modifications that are detrimental to the needs of the infant. An early study (Baran, Laufer, & Daniloff, 1977), found no VOT differences overall between AD speech and ID speech of three mothers to 12-month-old American infants, but some significant differences were found when these distinctions were examined individually by place of articulation and mother. These tended to be *decreases* in infant-directed voiceless VOT compared with adult-directed, indicating decreases in discriminability. Sundberg and Lacerda (1999), examining speech to Swedish 3-month-olds, found an overall decrease in infant-directed VOT in *both* voiced and voiceless consonants. On the other hand, a recent study with Norwegian infants under 6 months found overall *increases* in voiced and voiceless velar and alveolar stops, and voiced /b/, but not voiceless /p/ (Englund, 2005).

Differences in vowel length before syllable-final voiced and voiceless consonants show more promise for beneficial effects of ID modifications. In AD speech, vowels are lengthened prior to voiced consonants compared with voiceless consonants. Mothers speaking to their children between 9 months and 2.3 years showed double the lengthening effects (Bernstein Ratner, 1984a). However, this study did not examine age-related differences, so it is not possible to determine the specific nature of the speech to the younger infants in the study. Mothers also produce vowels with more disparate formant structures in speech to infants (Bernstein Ratner, 1984b; Kuhl et al., 1997), which would be beneficial to infants in forming vowel categories. Recent evidence suggests that Japanese-speaking mothers and English-speaking mothers produce different distributions in the phonetic cues that differentiate these vowels in their respective languages. Japanese-speaking mothers alter those cues that are more relevant in Japanese, while English-speaking mothers alter the cues relevant for English vowel distinctions (Werker et al., 2007). This latter finding is exciting, because it provides stronger evidence that an alteration in maternal speech properties is not simply a random change in speech pattern, but rather a change that is related in a very specific way to the needs of the infant.

The general acoustical properties of individual words may also be important for segmenting and identifying words. Infant-directed speech may facilitate lexical acquisition by exaggerating acoustical properties like the focusing properties of the language. In word-learning contexts with 12- or 14-month-olds, mothers will tend to highlight the target word by placing it an exaggerated pitch peak at the end of the utterance (Aslin, 1993; Aslin, Woodward, LaMendola, & Bever, 1996; Fernald & Mazzie, 1991). Object names in particular tend to be the loudest word and found at the end of the utterance (Messer, 1981).

More controversially, it has been suggested that ID speech may also be helpful for identifying words because of a preponderance of prosodically isolated single words (Brent & Siskind, 2001; Josse & Robin, 1981; Soderstrom, Blossom, Foygel, & Morgan, submitted for publication). Brent and Siskind found that these words cross the spectrum of grammatical categories, and are a better predictor of vocabulary acquisition than the total number of tokens heard by the infant. On the other hand, Aslin (1993) found that in an explicit teaching situation, mothers used the target words in isolation very rarely. This suggests that mothers may not be sensitive to the difficulties of word segmentation, and the isolated words found in the former studies might therefore not be a specific property of ID speech per se.

ID speech also has a low type/token ratio, which is significantly related to infant age (e.g. Henning, Striano, & Lieven, 2005; Kaye, 1980; Phillips, 1973; Remick, 1976). A low type/token ratio indicates that mothers are reducing the number of different word types, simplifying the vocabulary of speech to their infants. In contrast to word segmentation, the lexical complexity of ID speech does appear to be affected by the infant's developmental capabilities.

Another possible role for phonological properties of ID speech is in classifying words by grammatical category. Shi, Morgan, and Allopena (1998) found that phonological and acoustic properties differentiate content and function words in infant-directed speech across a spectrum of languages including English, Turkish, and Mandarin Chinese. Perceptual experiments have shown that even newborn infants can differentiate these word categories (Shi, Werker, & Morgan, 1999). These properties may also differentiate nouns and verbs for infants, particularly for less frequent words, while distributional properties may be more important for highly frequent words (Monaghan, Chater, & Christiansen, 2005). None of these studies differentiated AD from ID speech, however, so the extent to which these cues rely on properties of ID speech in particular has yet to be determined.

In sum, many of the lexical and phonological properties of ID speech seem beneficial for language development. Some of the phonological changes associated with ID speech increase the salience of important phonological properties of the language, and may even be language specific. A simplified lexicon reduces the word-learning load on the infant. On the other hand, these properties are not all ideally suited to language development. Although mothers do produce words in isolation, which would be helpful in the task of word segmentation, they do not do so reliably even in an explicit word-learning task. Furthermore, some characteristics that may be beneficial for language development, such as specific phonological properties of words being associated with specific grammatical categories, have not been shown to be exclusive to ID speech, but may also be found in other ambient speech heard by the infant.

Syntactic properties of ID speech

Most studies of the syntactic properties of ID speech have examined the syntactic complexity by measuring the length of utterances. Like CD utterances, ID utterances tend to be much shorter than adult-directed speech. Indeed, comparisons of infant- and child-directed speech have found little difference in mean length of utterance (MLU) to infants before and after the onset of speech at about 12 months (Kavanaugh & Jirkovsky, 1982; Phillips, 1973; Snow, 1977). However, speech to 24-month-olds and older does begin to show increases in length (Nelson, 1973; Phillips, 1973; Stern, Spieker, Barnett, & MacKain, 1983). Studies examining the length of utterances to younger infants have found inconsistent results. While one study (Sherrod, Friedman, Crawley, Drake, & Devieux, 1977) found a decrease in MLU from 4 to 8 months, another found much longer utterances in speech to toddlers than to infants younger than 6 months (Kaye, 1980). Papousek, Papousek, and Haekel (1987) also suggest that their analysis of speech to 3-month-olds found much shorter utterances than those to infants greater than 12 months as reported in other studies—however, since this study did not themselves examine older infants, this claim must be taken with caution.

Although some of the above studies diverge in their measures of MLU across early development, there is agreement that ID speech is overall shorter than AD speech.

However, Newport, Gleitman, and Gleitman (1977) argued that CD (and by extension, ID) speech, while shorter overall, might not be *simplified* compared with AD speech. For example, since some of the reduced length comes from deletions, this may be viewed as adding complexity to the task of the infant, who must reconstruct the missing elements. Whether ID speech is considered to be "simple" then depends in part on the theoretical position one takes about the nature of the syntactic structure in a child (or infant)'s grammar. If syntax consists of a large amount of underlying structure, as posited by generative linguistics, then a relatively short surface form may indicate a large amount of underlying complexity. However, if the surface form straightforwardly describes the grammar, then a small number of words indicates a simple grammatical construction. While short utterances do not guarantee simplicity, there is reason to believe that ID speech is structurally simpler than AD speech in at least some respects, regardless of one's theoretical position. Much of the reduced length comes from a reduction in the number of clauses per utterance, and a high number of pronoun, rather than full noun phrase, subjects (Soderstrom et al., submitted for publication). Furthermore, ID speech has been found to be simpler using other syntactic measures, such as the number of verbs and modifiers per utterance, the relative proportion of function and content words, and the number of different verb forms across utterances (Phillips, 1973). Together with a reduction in the complexity of utterances, ID speech is highly well-formed, with few examples of disfluency or garbled speech (Newport et al., 1977; Sherrod et al., 1977; Soderstrom & Morgan, in press).

Aside from quantitative differences in length and/or complexity, qualitative differences have also been noted. For example, several studies have found a high level of exact self-repetitions in mothers of very young infants that decreases with age of infant (Kavanaugh & Jirkovsky, 1982; Kaye, 1980; Papousek et al., 1987; Stern et al., 1983). Other qualitative developmental changes in speech to infants include a decrease in contentless utterances (e.g. vocal play, routines), an increase in reference to absent objects, and a decrease in direct reference to the child (Kavanaugh & Jirkovsky, 1982; Snow, 1977). These earlier changes prior to the onset of speech may reflect changes in the infant's non-linguistic response to their mother's conversational overtures (Josse & Robin, 1981; Snow, 1977). Speech to younger infants is also more variable than speech to older infants, and can contain some very long and/or whispered utterances which seem self-directed rather than directed at the infant (Phillips, 1973; Snow, 1977). It is likely this variability that contributes to the different findings across studies with respect to developmental differences in length. Although some differences may be difficult to quantify in terms of MLU or other general measures of complexity, ID speech to very young infants appears to be very different in character from that to slightly older infants.

It is tempting to conclude that speech to younger infants may not serve the same function as that to more vocally responsive infants—that such speech is exclusively for communicating affect. However, such a claim might be an oversimplification. An analysis of the communicative function of speech to young infants (Penman, Cross, Milgrom-Friedman, & Meares, 1983) examined differences in informative and affective maternal speech at 3 and 6 months. Informative speech was more common than affective speech, and increased from 3 to 6 months, while affective speech was less common and decreased (although it was still highly present). Affective speech was found to be more sensitive to the infant's eye-gaze than informative speech. Informative speech did seem to be increasing in response to infant age (and therefore, presumably, communicative responsiveness), but it was present even in speech to 3-month-olds, suggesting that while affective speech plays an important role, early ID

speech likely does not serve solely an affective function. While the informational content of informative speech is obviously not understood by 3-month-olds, this result implies that affect is not the only message being communicated in maternal speech. Structural information may well be accessible to young infants, even if meaning is not.

Another qualitative difference is the large number of questions, particularly yes/no questions, noted by many researchers in ID, as well as CD, speech (Kavanaugh & Jirkovsky, 1982; Kruper & Uzgiris, 1987; Soderstrom et al., submitted for publication; Toda, Fogel, & Kawai, 1990). One exception is a study by van de Weijer (2002), a careful longitudinal study of all speech input to one Dutch-learning infant, which found similar percentages of interrogatives (around 10%) in ID and AD speech. It is possible that mothers who are sensitive to the presence of the microphone will be more inclined to use questions to elicit responses from their infants, while the Dutch family, which was being recorded for a continuous, prolonged period, may better reflect the real input to a preverbal infant. However, whether this difference reflects cultural/linguistic differences, is an artifact of the particular case study, or reflects a more realistic assessment of the use of interrogatives in speech to preverbal infants generally is unclear at this point and requires further study. This question is important because interrogatives are structurally distinct from declaratives. To the extent that they are present in the input, they provide an important source of information to infants about how sentences vary structurally, and may provide cues to the internal structure of sentences.

Whether or not syntactic questions per se are more common in ID speech, the intonational properties associated with questions may play an important role in the early development of infant/adult dialog. One interesting study found that 12-month-olds and their mothers use similar intonational properties—rising intonation for open utterances, such as questions and requests, and falling intonation for closed utterances, like statements and turn termination (Ferrier, 1985). It has been argued that this rising versus falling distinction is crosslinguistic and perhaps innate (Bolinger, 1978). If so, it might provide infants an important clue in differentiating sentence types.

There may also exist more subtle syntactic differences in speech to infants which we have yet to characterize. For example, Remick (1976) found that while pronoun usage was similar between ID and AD speech in a group of infants between 16 and 22 months, pronouns in ID speech primarily had physical referents, while those in AD speech tended to be expletive forms. Such subtle differences could have profound effects on infant's ability to detect the grammatical properties of the language.

In sum, the syntactic properties of ID speech include shorter and less complex utterances, greater well-formedness, and differences in the types of utterances produced, than AD speech. If ID speech has an important role to play in the input to language development, these differences must be taken seriously. The existence of age-related qualitative changes across ID and CD speech necessitates a more nuanced consideration of the input in models of language development. What may be available or salient to young infants may not be to older infants or children, and vice versa.

Implications

This section has described many ways in which ID speech differs from AD speech. While these properties of ID speech seem to be primarily beneficial to the language learner, they are not necessarily so. Importantly, a property of ID speech that might be beneficial

at one age might be problematic at another. For example, the preponderance of subject pronouns might be a positive thing for early grammatical development, because it simplifies the input and highlights verb phrases. At later stages, however, an infant or young child may need access to subject noun phrases in order to form a more complete representation of the grammatical structure of the language. The variety of properties of ID speech found at different ages points to the necessity to consider these properties within a developmental framework. The sheer number of modifications in ID speech from the adult-directed form points to the necessity to consider *how* ID speech might influence language learning. That is the topic of the next section.

Effects of ID speech on language development

The preceding section describes a number of ways that ID speech differs from AD speech, with a focus on whether these differences might support or inhibit language development. This next section explores these possible effects in more detail, and specifically examines evidence for effects of these properties on language development.

Different theoretical perspectives on language development will make different predictions about the extent to which these properties of ID speech will affect language development. A highly nativist theory such as Principles and Parameters theory (Chomsky, 1981) would predict a much smaller effect of input variables on acquisition, since pre-existing, innate, knowledge has a large role to play. On the other hand, input-based theories (e.g. Tomasello, 2000), which rely on characteristics of the input to explain acquisition, would naturally predict a much stronger effect of input variables. Different theories also make different predictions about the kinds of linguistic input that will affect language development. For example, a Principles and Parameters approach depends on particular cues in the input, like the presence of expletive pronouns, to set parameters (e.g. Hyams, 1986). A small number of instances of the needed input might be sufficient to set the parameter. For input-based accounts, a study showing that ID speech facilitates general associative learning (Kaplan, Jung, Ryther, & Zarlengo-Strouse, 1996) is of more relevance. Also, a larger exposure to a particular property of the language would be necessary to learn that property. However, many of the properties of ID speech under discussion are relatively theory-independent. Studies showing that properties of ID speech may make it easier to detect in a noisy environment (Colombo, Frick, Ryther, Coldren, & Mitchell, 1995; Newman, 2003) are important regardless of the particular acquisition theory of how that input is used.

Some effects of ID speech on learning

A study of American adults learning unfamiliar Chinese words lends some credence to the benefits of ID speech in lexical acquisition—the participants learned the words best when they were located in utterance-final position *and* produced in infant-directed speech (Golinkoff & Alioto, 1995).[4] Although an earlier study found spontaneous child-directed speech to be *less* intelligible than adult-directed speech (Bard & Anderson, 1983), this study also found an effect of redundancy which may have been a confounding factor.

[4] Unpublished work with children learning nonsense English words (Golinkoff, Hirsh-Pasek, & Alioto, 1995, 1999) may also support this finding.

Words were less intelligible when they were more redundant, and were more redundant in CD than AD speech, which may explain the difference between the findings. Since the Golinkoff and Alioto study used identical stimuli across speech conditions, their study controlled for effects of redundancy.

Work examining effects of ID speech on infants more directly has found better discrimination of syllable sequences (Karzon, 1985), and better vowel discrimination (Trainor & DesJardins, 2002) when ID speech is used (although some aspects, such as high pitch, may decrease vowel discrimination). Infants also show greater sensitivity to statistical properties of a speech stimulus when ID speech is used (Thiessen, Hill, & Saffran, 2005), possibly because they attend more to the ID stimuli. However, infants *do* also show sensitivity to syllable statistics when AD speech is used (Saffran, Aslin, & Newport, 1996). Similarly, Jusczyk et al. (1992) found that infants' ability to detect acoustic correlates of phrase boundaries in fluent speech was better when child-directed speech was used, but infants still showed sensitivity to these properties of the speech stream when adult-directed stimuli were used.

Correlational studies

Some attempts have been made to test the impact of maternal speech on language development by examining correlations between maternal speech properties and infant/child developmental outcomes. Results have been mixed, from findings suggesting that maternal speech type has no influence on language development (de Villiers & de Villiers, 1973—for grammatical morphemes only; Scarborough & Wyckoff, 1986), to findings that several maternal speech variables correlate with infant development variables (Furrow, Nelson, & Benedict, 1979). The difference between findings like that of Scarborough and Wyckoff and that of Furrow et al. betray a difficulty in using correlational studies, which rely on complex statistical methodologies, to study what may be subtle and intricate interactions between mother and child variables. This is especially difficult because these variables are all confounded with the development of the infant and infant–mother relationship across time (Schwartz & Camarata, 1985). Even assuming that such relationships can be controlled for, subtle effects may be difficult to pin down. Furrow et al.'s statistical tests were more inclusive, and they found several correlations, which may have been spurious (a Type I error). On the other hand, Scarborough and Wyckoff's more conservative statistical technique may well have excluded some legitimate correlations, leading to a Type II error. Making conclusions from such studies therefore can become an exercise in "glass half-empty" vs. "glass half-full" reasoning, when the effects are not strong.

Despite these statistical difficulties, the potential insights from finding such relationships have driven many researchers to continue to pursue this kind of research. Murray, Johnson, and Peters (1990) found that mothers' linguistic adjustment, in terms of MLU, when their infants were 3–9 months correlated with a measure of receptive linguistic development (the REEL score) at 18 months. Harris, Jones, Brookes, and Grant (1986) found that mothers of slower developers in terms of MLU and vocabulary were more likely to be abstract in their reference, talking about things not in the child's attentional focus, and using more pronouns and fewer specific object labels. Others have found effects of maternal vocabulary diversity and amount of input on early lexical development (e.g. Bornstein, Haynes, & Painter, 1998; Huttenlocker, Haight, Bryk, Seltzer, & Lyons, 1991; Pan, Rowe, Singer, & Snow, 2005). The extent to which mothers produce cues to

word boundaries has also been found to correlate with the number of unanalyzed phrases produced by the child (Pine, Lieven, & Rowland, 1997), even when effects of the child on the mother have been controlled for.

One widely-cited study of this type (Gleitman, Newport, & Gleitman, 1984; Newport et al., 1977) found effects of maternal use of yes/no questions on auxiliary development and of deixis on nominal inflection. It is intuitively logical that infants who hear more objects labeled might acquire the grammatical properties of nouns sooner. Similarly, a greater number of yes/no questions, which place auxiliaries in a salient position at the beginning of the utterance, might lead to faster acquisition of auxiliaries. And both of these (deixis and yes/no questions) are considered canonical properties of ID speech. However, there is a puzzle regarding the yes/no question-auxiliary correlation. Most yes/no questions in colloquial speech involve utterance-initial auxiliaries that are greatly reduced, if not completely elided from the utterance. This effect is, if anything, magnified in ID speech. Compare "Is that a pretty baby?" → "'Z' that a pretty baby?" → "that a pretty baby?". Newport et al. do not indicate how they scored such elided utterances. It would be interesting to see how the extent to which a mother elides interacts with her usage of yes/no questions in predicting acquisition of auxiliaries in infants.

Although most studies of this type have examined syntactic and lexical properties of infant development, one study of Mandarin-speaking mother-infant pairs has shown a correlation between maternal speech clarity, as measured by the expansion of the vowel space in ID speech, and infant phonological development, as measured by sensitivity to a consonant contrast using a conditioned headturn task (Liu, Kuhl, & Tsao, 2003). This line of research is promising and deserves further study both crosslinguistically, and in terms of different phonological contrasts and measures. Additionally, Liu et al. did not report whether they found a correlation between infant perception and maternal clarity in AD speech. It is possible that maternal clarity in general, and not ID speech per se, is responsible for their findings.

Despite the difficulties mentioned above in interpreting subtle statistical correlations, this body of findings provides convincing evidence that properties of the input to an infant have important and specific effects on the course of that infant's language development.

Acoustical cues to grammatical structure

The most well-documented properties of ID speech are acoustic ones. Some researchers have proposed that some these properties might function not only to increase the salience of speech input, but might serve a more direct role in language development, particularly in providing information about the syntactic properties of the input (Gleitman & Wanner, 1982; Jusczyk, 1997; Morgan & Newport, 1981; Peters, 1983), although others have challenged the idea on theoretical grounds (Fernald & McRoberts, 1996; Pinker, 1984). This idea has been variously known as the prosodic bootstrapping hypothesis, the phonological bootstrapping hypothesis, or bootstrapping from the signal. Support for the hypothesis came originally from findings that some acoustic properties are associated with syntactic boundaries, and these properties are exaggerated in ID speech (Bernstein Ratner, 1986; Broen, 1972; Kemler Nelson, Hirsh-Pasek, Jusczyk, & Cassidy, 1989). Perceptual studies in the laboratory have also supported the hypothesis, finding that infants use these cues to group words into syntactically-relevant sequences, both at the level of the utterance and the phrase (Mandel, Jusczyk, & Kemler Nelson, 1994; Mandel, Kemler Nelson, & Jusczyk,

1996; Nazzi, Kemler Nelson, Jusczyk, & Jusczyk, 2000; Seidl, Johnson, Redman, & Brentari, 2004; Soderstrom, Kemler Nelson, & Jusczyk, 2005; Soderstrom, Seidl, Kemler Nelson, & Jusczyk, 2003). This result is well-established and uncontroversial for whole utterances. However, the lack of one-to-one mapping between syntactic boundaries and acoustic boundaries, and the shortened utterances in ID speech, which leave little room for utterance-internal phrase boundaries, have caused some to question whether these phrase-level cues are actually useful to infants in the home environment.

However, a small number of findings suggest that these cues do exist in everyday speech to infants. Fisher and Tokura (1996) analyzed maternal speech to American English- and Japanese-learning 14-month-olds. They found strong prosodic cues (pitch changes, vowel lengthening and pausing) at clause/utterance boundaries. They also found some evidence for phrase-level cues, but this was only with the most sensitive statistical technique. Also, the cues differed between English- and Japanese-learning infants. For English-learning infants, differences were found in vowel length between phrase-boundary and non-boundary syllables, while for Japanese infants, the differences were in pitch changes. More recent work showed that speech to younger infants (9-month-olds) also contains such cues (Soderstrom et al., submitted for publication), including syntactic phrase-level cues. Examining declarative and yes/no questions separately found significant effects for the yes/no questions, but not the declaratives. Declaratives and questions have very different prosodic, semantic and syntactic characteristics—it may be that they play very different roles in infant language input.

One question that has not been answered is whether such effects are limited to ID speech. The more exaggerated prosodic characteristics of ID than AD speech, and infants' greater sensitivity to phrase-level boundaries in ID than AD speech in laboratory experiments (Jusczyk et al., 1992; Kemler Nelson et al., 1989) support this idea. However, infants did show reliable sensitivity with AD speech in at least one context (Jusczyk et al., 1992). Since one of the characteristics of ID speech is that it is very short, phrase-level prosodic information might not manifest as readily in ID speech as AD speech. This might account for the weak phrase-level effects found in the two analyses such mentioned. Furthermore, as discussed previously, spontaneous ID speech tends to contain many pronouns, rather than full noun-phrase subjects (Soderstrom et al., submitted for publication). The subject/verb phrase boundary examined in the previous studies is unlikely to occur after a pronoun in a declarative sentence. AD speech, while it is prosodically more reserved, contains a much larger number of non-pronoun subjects, which permit a prosodic break. Prosodic characteristics of AD speech may play therefore play a role in providing cues to these full noun phrase subject boundaries, either concurrently with the prosodic cues in ID speech, or at a later point in development.

Crosslinguistic evidence

Arguments that ID speech plays an important role in language development are bolstered by evidence of its existence cross-linguistically. Although American English is by far the most studied language with respect to ID speech (as well as many other aspects of linguistic theory), there is evidence for properties of ID speech, particularly prosodic properties, in a variety of languages, including French, Italian, German, Japanese, Spanish, Hebrew, Luo, British and Australian English (Blount, 1972, 1984; Blount & Padgug, 1976, 1977; Fernald & Morikawa, 1993; Fernald & Simon, 1984; Fernald et al., 1989;

Kitamura, Thanavishuth, Burnham, & Luksaneeyanawin, 2002; Masataka, 1992b; Morikawa, Shand, & Kosawa, 1988; Niwano & Sugai, 2002; Papousek et al., 1987; Shute & Wheldall, 1995; Zeidner, 1983). The characteristics of ID speech have been found in male as well as female speech (Fernald et al., 1989; Jacobson, Boersma, Fields, & Olson, 1983; McRoberts & Best, 1997; Papousek et al., 1987; Shute & Wheldall, 1999).

However, some cultural/linguistic differences have been found. For example, British mothers had smaller increases in mean and mode frequency than American English speakers (Shute & Wheldall, 1995), and Thai speakers had smaller increases than Australian English speakers (Kitamura et al., 2002). One extreme example is that of Quiché Mayan speech to 2-year-olds (Bernstein Ratner & Pye, 1984; Ingram, 1995), in which mothers were not found to raise the pitch of their speech (it has been suggested that in this culture, raised pitch is used when speaking with a person of higher status). Notably, while the pitch-raising is absent, Quiché Mayan child-directed speech does have some of the other properties noted in child-directed speech (Pye, 1986). In general, the prosodic exaggeration seems more acute in American English than other languages and even other dialects of English.

The importance of considering such modifications within the cultural or linguistic context are also highlighted by the presence of ID intonational properties in a tonal language, Mandarin Chinese, in which affective prosodic and phonological considerations may conflict (Grieser & Kuhl, 1988; Papousek & Hwang, 1991; Papousek et al., 1991). In fact, Chinese speakers may reduce or modify lexical tone information in order to preserve these intonational properties of ID speech (Papousek & Hwang, 1991). In this case, these modifications might cause a distortion of the phonological signal in order to preserve the affective characteristics of ID speech, thereby hindering language development.

A potentially stronger case against the universality of motherese comes from a small number of languages/societies in which mothers appear not to use a special register when speaking with their children, or seem not to speak to them at all (Harkness, 1976; Heath, 1983; Ochs, 1982; Schieffelin, 1985). How such counter-examples should be treated within the discussion of universality is open for debate. Clearly, they should not be ignored. However, if the properties of ID speech are found to be similar across a variety of cultures and languages, this suggests that there is some legitimacy to the idea that these properties are important in some way. Furthermore, one can distinguish the notion that ID speech is universal from the possibility that it has important effects in those cultures in which it does exist. If this is the case, it should be possible to see differences in the developmental timeline of societies in which it is present or absent (or more or less prevalent). Clearly, more research is necessary to determine how widespread such counter-examples are, and to better characterize the nature of the linguistic environment and linguistic development of infants across cultures.

One important source of data regarding the question of universality comes from examining signed languages. Like speaking mothers, mothers communicating in Japanese, American, and British sign languages showed differences in their signing to infants compared with adults, including simpler forms, slower tempos, more repetition and exaggerated movements (Erting, Prezioso, & O'Grady Hynes, 1990; Kantor, 1982; Maestas y Moores, 1980; Masataka, 1992a; Woll & Kyle, 1989). One study also reported preferences of deaf and hearing infants for ID signing over AD signing, similar to infant preferences for ID speech (Masataka, 1996, 1998).

Signing mothers additionally show modality-specific changes not necessarily reflected in spoken ID communication. For example, signing mothers must manage the infant's

eye gaze, since infants must be looking at the mother in order to see the sign, something that is not an issue for speaking mothers. The management of eye gaze is also complicated because the linguistic input and object of discussion share the same (visual) modality. Signing mothers employ a variety of techniques, including orienting their signs to maximize their salience, engaging in repeated cycles of pointing and signing, tapping on the infant, and signing directly on the body of the infant (Erting et al., 1990; Harris, Clibbens, Chasin, & Tibbits, 1989; Kantor, 1982; Maestas y Moores, 1980; Mills & Coerts, 1990; Woll & Kyle, 1989). Some studies report that signing mothers produce fewer utterances than speaking mothers to preverbal infants (Harris et al., 1989; Woll & Kyle, 1989), possibly because of the extra burden of engaging the infant's visual attention. On the other hand, Maestas y Moores (1980) found evidence of signing and also fingerspelling to very young infants. The drive to produce linguistic acts directed at partners who are unlikely to respond linguistically is clearly not limited to spoken language.

In at least one context, signing mothers will sacrifice the grammatical properties of their language in order to preserve positive affect. In ASL, wh-questions are expressed using facial expressions that could be interpreted as negative affect. Until 2 years of age, mothers signing in ASL will avoid making these facial expressions, despite their being obligatory in the grammar (Reilly & Bellugi, 1996). This finding is reminiscent of the modification of Chinese tones in exaggerated spoken prosody, where affective considerations also seem to take precedence over linguistic function. The similarities and differences found in ID signing compared with spoken language support the idea that an infant-directed register is widespread, if not universal. But they also, together with the apparent counter-examples within spoken language, highlight the need to understand this register within the context of the *social* act of communication between adult and infant, and not solely its linguistic characteristics.

Implications

This section has highlighted several studies showing ways in which ID speech affects language development. Some of these have focused on positive effects that ID speech has on the learning process—for example, facilitating the salience and intelligibility of words, and increasing sensitivity to statistical and syntactic characteristics of the input. Others have shown that the properties in question are found across a variety of linguistic and social contexts. We have also examine one specific hypothesis about the role of acoustical properties in determining syntactic structure, and found evidence that for such a role. From a theoretical perspective, these findings suggest ways that the task faced by infants may be made easier without resorting to innate knowledge. While not directly arguing against nativist theories, they may therefore be viewed as an alternative account in some respects. On the other hand, the evidence that some features of ID speech may be universal across languages and even modalities suggests that these features may themselves be "innate".

The correlational studies suggest overall that properties of maternal ID speech influence language development, at least somewhat. However, not all maternal speech is infant-directed, and not all input to the infant comes from the mother. The next section examines the role played by alternate sources of input to the infant than maternal, ID speech.

Beyond "motherese"

So far, the focus has been on maternal ID speech as the major source of input to the infant. Not accidentally, most of the research on input to infants has focused on the mother. However, as previously noted, mothers are not the only speakers in the presence of infants. From the beginning, infants are exposed to speech by fathers, siblings, other caregivers and even strangers. Newborns in a nursery setting will hear speech by doctors, nurses, and even someone with no particular need to interact with the infant, such as a housekeeper (Rheingold & Adams, 1980). Infants in the home continue to be exposed to a significant amount of speech from people other than their mother (Friedlander, Jacobs, Davis, & Wetstone, 1972; van de Weijer, 2002).

"Fatherese"

Despite the inherent gender bias in the term "motherese", there has been an extensive amount of research in the 1970s and 1980s comparing the child-directed speech of fathers with that of mothers (e.g. Berko Gleason & Weintraub, 1978; Kavanaugh & Jirkovsky, 1982; Le Chanu & Marcos, 1994; Lipscomb & Coon, 1983). That little has been said recently on the issue can be attributed to the fact that, despite the large differences in caregiver roles between men and women in the decades in which these studies were done, differences in speech characteristics were relatively minor. Those differences that may exist suggest a generally less successful conversational interaction between father and child than mother and child, which led to the proposal that fathers might act as a "bridge" to the greater conversational community (Berko Gleason, 1975; McLaughlin, White, McDevitt, & Raskin, 1983; Rondal, 1980; Tomasello, Conti-Ramsden, & Ewert, 1990).

The sparser literature on gender differences in speech to younger infants also supports the idea that similarities in character generally outweigh the differences. It is generally agreed that both men and women modify their speech prosodically when speaking with infants (Blount & Padgug, 1976; Fernald et al., 1989; Jacobson et al., 1983; McRoberts & Best, 1997; Papousek et al., 1987; Shute & Wheldall, 1999). Differences between men and women have been less consistently reported. Fernald et al. reported that paternal speech did not contain an increase in pitch range (across several languages, including German), while Papousek et al. found such an increase in German (albeit to a lesser extent than that of mothers). Shute and Wheldall reported no increase in variability (measured by standard deviation of mean f_0) in British English paternal speech, while Fernald et al. found such increases in variability across languages, including British English. Similarly, while Trehub et al. (1997) reported similar raising of pitch by mothers and fathers singing to their infants, O'Neill, Trainor, and Trehub (2001) reported less consistent raising of pitch by fathers in a similar task. The pattern of findings across these studies suggests that men/fathers may make the same prosodic modifications as mothers, but to a slightly lesser extent. It is worth pointing out that since men's voices have a lower pitch on average than women's to begin with, even ID speech by men is likely to be of a lower average pitch than AD speech in women. Even if the modifications are the same, the end result is not.

Gender differences have also been found in other aspects of speech to infants. In an experimental "teaching" setting with 8-month-olds (Brachfeld-Child, Simpson, & Izenson, 1988), fathers spoke more and with longer utterances. Fathers also showed a stronger

gender bias, using more imperatives with girls than boys (mothers showed the same bias, but to a lesser extent). A greater gender bias for fathers than mothers in interacting with their infant was also found in a less structured setting (Kruper & Uzgiris, 1987; Pecheux, Labrell, & Pistorio, 1993), affecting the content of their speech. Both fathers and mothers were more likely to talk about the present with girls and absent people or events with boys, but this effect was stronger with fathers. Fathers may also use more rare vocabulary, although this may not have been examined in speech to infants younger than 18 months (Berko Gleason, 1975; Bernstein Ratner, 1988).

One might suppose that differences in infant-directed speech between mothers and fathers indicate a lack of experience on the part of fathers compared with mothers. Fathers traditionally spend much less time in infant caregiving than mothers. One early study reported that fathers spent less than a minute per day interacting with their infants (Rebelsky & Hanks, 1971). However, studies have not found a relationship between caregiving experience and the use of infant-directed speech characteristics (e.g. Jacobson et al., 1983). On the other hand, the results of laboratory studies can be influenced by parents' beliefs about differing gender roles and the knowledge they are being observed. Parents' linguistic behavior has been shown to be heavily influenced by the presence or absence of an observer, and by the nature of the play or task (Lewis & Gregory, 1987; Lewis et al., 1996). It is important to consider the possibility that at least some of the differences that are found are related to such laboratory effects, rather than real differences between men and women in their own homes.

''Sibling-ese''

Siblings may also play an important role in the linguistic input to infants. Children as young as 4 years old, despite failing classical tests of egocentrism, will modify their speech in characteristic ways, shortening and simplifying, when speaking with 1- and 2-year-olds and in pretend interactions with baby dolls, but not other 4-year-olds (Sachs & Devin, 1976; Shatz & Gelman, 1973). Young children differ from adults, however, in some pragmatics aspects of conversation with toddlers, and may provide a scaffold for social development with young peers, similar to the ''Father Bridge'' hypothesis discussed above (Mannle, Barton, & Tomasello, 1991). While there is little research in sibling speech to truly preverbal infants, such effects have been found in speech to infants at young as 14 months, and by siblings as young as 2 years old themselves (Dunn & Kendrick, 1982). One study also found that 4-year-olds spoke more slowly to a young infant (less than 12 months old), but did not modify pitch or pitch variability as adults do (Weppelman, Bostow, Schiffer, Elbert-Perez, & Newman, 2003).

Another aspect on which young children appear to differ from adults is in the use of questions, which seems to decrease, rather than increase, in conversation with toddlers and infants (Dunn & Kendrick, 1982; Sachs & Devin, 1976). Dunn and Kendrick (1982) suggest that the characteristics of individual sibling speech are sensitive to the nature and quality of the relationship between the siblings. Greater use of questions and affective language result from a closer emotional relationship to the infant. Siblings also make use of a high number of repetitions and attention-getting words, either because they have more difficulty than the mother holding the infant's attention, or in an attempt to control the infant's behavior.

Siblings may also alter the linguistic environment of infants indirectly, by their effect on the speech of the mother. Oshima-Takane and Robbins (2003) found that in a triadic context, with mother, infant and older sibling, both mothers and older siblings spoke more about activities and social exchanges, while mothers used more language about language with the infant alone. Jones and Adamson (1987) found effects on the linguistic development of infants based on their birth order, with later-borns producing more social regulative speech. The linguistic environment of twins may also differ from that of singletons, with each twin receiving less total conversational input and less joint attention, as well as a more directive interactional style from the mother (Tomasello, Mannle, & Kruger, 1986). While such studies have not yet been done with preverbal infants, it is reasonable to suppose that similar kinds of differences will arise.

The importance of the relationship between the infant and a child speaker is highlighted in one study of Nigerian non-sibling "maids" (Nwokah, 1987) interacting with their 12-month-old charges. These children, around 8–12 years old, provide day-time care for the infants of other families, while the mothers are at work. They therefore fulfill the role of "mother" during the day (although some are male), but are not relatives of the infant. Compared with the mothers' speech, maids produced fewer and smaller utterances, more imperatives and fewer declaratives. The greater number of imperatives may, like the repetitions and attention-getters above, indicate an attempt to control the behavior of the infant. Maids also produced more wh-questions than yes/no-questions, while the reverse was true for mothers. The author noted that many of these wh-questions were rhetorical in nature, while yes/no-questions may be more legitimate attempts to engage the infant.

Implications

Comparison of the speech patterns of mother, father and sibling toward the infant suggests strongly that the infant will receive input that is modified in many of the same ways by all three groups. Fathers may be slightly less extreme or successful in their ID modifications than mothers, and siblings even less so, but the nature of the modifications is similar. This difference in degrees between men and women and children, may in itself play an important role in bridging the gap between one register and another (i.e., infant- or adult-directed), as well as between mother and the rest of the world.

Although the empirical study has not been done to directly compare them, it is likely that the speech of men, women and children to others' infants is highly similar to the properties found in the speech of mothers, fathers and siblings. Indeed, some of the studies have explicitly made this assumption, in testing ID speech to stranger infants, rather than ID speech directly to one's own child. It is perhaps safe to assume to that much of the non-familial speech heard by an infant, whether ID or AD, will share the same properties as speech from mother, father and brother/sister. The possibility of significant non-familial input does open up a greater variability in the input, as speech characteristics in general, and ID speech modifications in particular, will vary from person to person. This source of additional input is therefore worthy of some attention.

Summing up: Outstanding questions and future research

The preceding sections have examined the prosodic, phonological, lexical and syntactic aspects of speech to preverbal infants. I have deliberately avoided discussion of equally

important issues such as the affective properties of ID speech (e.g. Fernald, 1989; Kitamura & Burnham, 2003; Singh, Morgan, & Best, 2002) or pragmatic aspects of word learning (e.g. Hollich, Hirsh-Pasek, & Golinkoff, 2000), to focus on the characteristics of speech most directly linguistic in nature. What emerges is a picture of the input rich in variability—dependent on context, speaker, infant age, target listener and social environment. In order to assess the role of the input for the preverbal language learner, these varying factors must be taken into account.

The now-traditional view of infant-directed speech as a simplified register that bootstraps the acquisition process is an important part of this picture. The breadth of studies demonstrating short, simplified utterances, repetition, and the exaggerated prosodic characteristics across a variety of languages, cultures, and modalities, and infant preferences for these characteristics are strong indications of the central role of this register in the infant's linguistic experience. But this picture is incomplete. For one thing, infant-directed speech is not, with a few exceptions, an instrument of teaching. Its purpose is communication, not instruction, even for infants, with whom linguistic interaction is by definition not possible in the normal sense (Newport et al., 1977; Snow, 1977). For another, infant-directed speech is not the ideal teaching tool in many respects. It is not unswervingly grammatical (Aslin, 1993; Chafetz, Feldman, & Wareham, 1992; Newport et al., 1977). And it does not even constitute the majority of the speech environment of the infant (Friedlander et al., 1972; van de Weijer, 2002).

Rather than undercutting the benefits of infant-directed speech, a perspective that embraces variation in the input is good news for the hypothetical language learner. What is beneficial to the novice grammar learner trying to decide the order of subjects, verbs and objects in their language—short, single-phrase utterances—may not be the ideal input to the slightly more mature learner ready to contend with more subtle grammatical properties. This is the essence of the "Less is More" hypothesis put forward by Newport, and in a slightly different form by Elman (Elman, 1993; Newport, 1990). But this idea of starting off with smaller information and working one's way up to more complex input should not be viewed as a single parameter of increasing complexity of infant-directed speech, or of a general development of the infant's capacity to analyze complex input. Rather, the ideal, or best, input at any given time will vary for different levels of linguistic analysis as well as by age.

Vowel lengthening at the ends of utterances or phrasal units may provide infants with valuable information about the syntactic organization of their language, but mask important stress properties of the language, or phonological detail. Exaggerated intonation might increase the salience of speech, but mask important lexical tone information. Syntactically simplified speech may limit the complexity of the input to be analyzed, but also constrains the data to a subset of the underlying grammar, creating a potential problem of underspecification. Viewed from this perspective, it seems a tall order indeed (or a very lucky accident) to rely on the mother to make exactly the right modifications at the right times for the developmental progression of her infant.

Yet mothers do make such modifications, and for the most part they seem to be beneficial, rather than harmful—or at least neutral. Sachs (1977) suggests that such beneficial modifications are no accident, but rather the outcome of natural selection (see also, Fernald, 1992). This may be. But if we take some of the onus off of the mother, and consider what other resources are available to the infant, the problem begins to seem more manageable.

Allowing the hypothetical learner access to multiple forms of speech, as well as a variety of speaker types, increases the likelihood that the learner will find what they are looking for in the input. But it also generates the additional problem of selecting from or ranking potentially conflicting sources of data. For example, the reduced complexity and overall well-formedness of ID speech may be important for the early stages of language development, but it comes at a price. A decrease in complexity suggests that not all sentence forms may be represented, since ID speech contains very few multiclause utterances and few full noun phrase subjects. The idea that the input to infants might underspecify the adult grammar (the Poverty of the Stimulus) is of concern to linguists even with the whole range of speech as input (Chomsky, 1968/1972; Chomsky & Hampshire, 1968).[5] If infants are limited only to ID and CD speech, the problem is even worse. One solution may be that infants initially attend only to ID speech, but later begin to access more adult-directed utterances, as their linguistic understanding begins to mature. Recall that the preference for ID speech found in young infants is less reliable in infants older than 8 months. A recent study found that infants older than 20 months can discriminate fluent from disfluent adult-directed speech based on its prosodic characteristics, demonstrating not only that these older infants can process AD speech in some circumstances, but also that they have a possible means of excluding some ill-formed adult-directed input (Soderstrom & Morgan, in press). However, a 10-month-old age group did not show this discrimination, suggesting infants at this age may be less sensitive to prosodic characteristics of AD speech.

Infants may therefore access different forms of input at different stages in development, depending on their linguistic maturity or age. Two converging findings—infants' initial preference for infant-directed speech and their developing ability to detect disfluency—combine to lead the infant developmentally from simpler, more well-formed input, to more complex, messy input. This is not precisely relying on properties of maternal speech, nor on infants' cognitive limitations, but rather a subtle interplay between the two.

The theoretical position being espoused is one in which "the input" is not a monolithic entity, but is dependent on a variety of factors, such as the infant's current stage of development and the speakers in the infant's environment. Such a perspective adds additional complexity to an already complex developmental picture. Clearly, an important part of demonstrating the worth of this position would be to show that infants are indeed attending to non-maternal and/or non-ID sources of linguistic input in their environment. This is admittedly a tough case to make, given the wealth of data showing preferences of infants for maternal, infant-directed speech. But the two counterpoints from the earlier discussion are worth repeating. First, infant preference has been established for a very young age, but not for older infants on the verge of linguistic maturity. Second, preference for one speech type over another does not indicate that the dispreferred speech type is irrelevant to the acquisition process.

To date we have a very limited understanding of how the infant's attention to different sources of input (ID vs. AD speech, direct vs. indirect, etc.) changes over time. While infants show a clear preference for ID speech until about 8 months, both Hayashi et al. (2001), with Japanese infants, and Newman and Hussain (2006), with American infants, found no preference at 9 months. A decrease in preference for ID speech at 9 months,

[5] See Thomas (2002) for a clear discussion of the development of Poverty of the Stimulus ideas.

given infants' increasing language-specific sophistication by 9–12 months (e.g. Shady, 1996; Werker & Tees, 1984), may imply that AD speech begins to play a role in infants' development before the second year of life. Of course, just as a preference for ID speech does not prove that infants are making no use of AD speech, a decrease in preference for ID speech does not guarantee that they *are* attending to AD speech as a source of linguistic input. The small number of studies directly comparing infants' performance on linguistic tasks with ID and AD speech (e.g. Jusczyk et al., 1992; Thiessen et al., 2005) suggest that in general ID speech is often helpful, but not necessary, for infants to succeed at linguistic tasks. Just how dependent infants are on ID speech, and when infants might rely more heavily on AD speech, will likely depend on the nature of the task and the development of the infant. More research is clearly necessary to tease apart these variables.

Infants may also play a more active role in selecting and influencing the type of input they receive by the way they interact with linguistic environment around them. The conversational model (Snow, 1977) suggests that, from early on, mothers and other adults (at least in Western cultures) attempt to develop a conversational interaction with infants. Before infants are able to respond with mature linguistic conversation, they may gradually begin to participate in the conversation with mouth noises, exchanges of eye-gaze, and babbling. Just as infants are viewed as responding to the conversational overtures of the adult, adults are sensitive to the responses (or lack thereof) of infants. This interactive relationship allows for the possibility that infants might be able to actively influence the input they are receiving.

A small number of findings provide preliminary support for the idea that the input infants receive is influenced by their own behavior. For example, Goldstein and West (1999) found that mothers responded consistently to the vocalizations of an unfamiliar infant, and were increasingly influenced by the infant's vocalizations in their responses as the infant's linguistic maturity increased. Infant vocalizations have also been successfully sorted by pattern recognition software into categories based on their acoustic properties (Papaeliou & Trevarthen, 2006). These categories matched the behavioral classifications of "investigative" and "communicative" based on the infants' own actions, suggesting that infant vocalization intent may be discriminable based on acoustic properties. This in turn suggests that caregivers might tailor their behavior accordingly. Finally, recent work suggests that infants may be unable to learn the phonetic properties of a language from audiovisual input alone, but require exposure from a live linguistic partner (Kuhl, Tsao, & Liu, 2003). A possible explanation for this finding is that infants simply require social cues such as eye gaze in order to acquire linguistic input, and these cues are interrupted by the recording. However, this result is also suggestive that infants learn better when they are able to interact with the linguistic partner, and thereby influence the input they are receiving.

While learning might be better in a socially interactive context, it is still an open question whether infants can learn from such "background" input as television, adult-adult conversations, or interactions with other siblings not directed at the infant. Given that these indirect sources may constitute more than half of the input in the infant's environment, this question is an important one. One case study of two hearing children of deaf parents who did not speak or sign to them (Sachs, Bard, & Johnson, 1981) found that the older child, although exposed primarily to television input and some conversational speech not directed at him, acquired the ability to express semantic relations using English words, but not full mastery of the grammatical structure of English. The younger child

seemed to have learned primarily from his older brother, suggesting that interactions with adults may not be necessary for some level of effective language development. The outcome for these siblings suggests that indirect input may play a role in language development, particularly when other forms are absent, but is not in itself enough for normal acquisition. Conclusions about the necessity of direct interaction must ultimately account for the course of language development in those cultures in which there is little direct linguistic interaction by adults with preverbal and even older infants and toddlers. And of course we have no case studies of the reverse environment, in which an infant is exposed only to ID speech directed towards them, and hears no incidental input. Hoff (2006) argues that while all linguistic environments (presumably with the exception of rare cases such as the case study just described) support language acquisition, differences across environments produce differences in the speed and developmental course of that acquisition.

Obtaining a better understanding of the input as a dynamic relationship between the infant and the environment requires a multi-pronged examination. First, we must expand our understanding of the developing linguistic knowledge of infants. The recent change in focus toward receptive measures of linguistic knowledge has been an important first step in this process, but there is a great deal of work to be done. Evidence suggests that infants as young as 6 months old are beginning to form word-meaning pairs (Tincoff, in preparation; Tincoff & Jusczyk, 1999), and even newborns are sensitive to prosodic and phonological properties of speech (Eimas et al., 1971; Mehler et al., 1988). Increasingly, our view of the grammatical knowledge of infants is being altered to include younger ages (Höhle, Weissenborn, Kiefer, Schulz, & Schmitz, 2004; Santelmann & Jusczyk, 1998; Soderstrom et al., 2007). In order to better understand *how* infants acquire linguistic knowledge, it is important to understand the *when*—to have a complete and accurate developmental timeline of this acquisition.

Second, we must fill in the gaps in our understanding of the linguistic properties of infant-directed speech and speech input to infants more generally. A number of issues remain to be resolved from previous research. For example, under what conditions are questions a substantial part of the input, and what properties of questions are salient to infants at different ages? What properties of the input of benefit in acquisition (e.g. vowel clarity, prosodic differentiation of word categories, prosodic cues to syntactic boundaries) are exclusive to maternal and/or ID speech, and what properties may be found exclusively or also in AD or other ambient input? Advances in linguistic theory and cognitive models of acquisition over the past several decades call for updating our measures of the syntactic and other linguistic characteristics of speech input. Speech forms that seem on the surface very similar may mask important differences across linguistic environments. For example, input containing a large number of expletive pronoun forms may have very different consequences for the language learner than input with a large number of referring pronouns (Remick, 1976), yet few analyses differentiate at this level. Therefore, general measures of complexity like MLU, while an important tool for some purposes, likely mask important developmental features of the input. Increasing awareness of the early underpinnings of grammatical knowledge suggests a more nuanced approach to characterizations of speech input to infants across time, building on the important work of the 1970s and 1980s (e.g. Phillips, 1973; Sherrod et al., 1977; Stern et al., 1983). We must better characterize the real linguistic environment of infants, including adult-adult speech, speech from speakers other than the mother, and the variety of social/physical environments the infant might find herself in—at home alone with mom or dad, accompanying the family on travel, to work, or

at social occasions, or in a daycare setting outside of the home. Many of these important aspects of everyday life have not been characterized with respect to differences in the kinds and amounts of input the infant might experience.

Third, we must examine more carefully the how infants' general perceptual abilities influence their access and interpretation of the available input. For example, perceptual studies suggest that infants use prosodic characteristics of speech to group words in syntactically meaningful ways (Mandel et al., 1994; Mandel et al., 1996; Nazzi et al., 2000; Soderstrom et al., 2003), and transitional probabilities and familiar words to recognize and segment adjacent words from fluent speech (Bortfeld et al., 2005; Saffran et al., 1996). In the domain of speech perception, a number of recent models have successfully incorporated dynamic views of the infants' perceptual mechanisms (e.g. Jusczyk, 1997; Morgan, in preparation; Werker & Curtin, 2005). Such dynamic views could be successfully extended to models of other aspects of language development, such as grammatical development.

Finally, we must incorporate our increasing understanding of the nature of the input and of infant knowledge into new computational models which consider these data from the perspective of the communicative interaction between infant and other speakers. Work in computational models, such as input-based accounts (e.g. Matthews, Lieven, Theakston, & Tomasello, 2005) and connectionist models (e.g. Elman, 1993; Elman, 2005) have increasingly attempted to use ecologically valid input, by using child-directed speech corpora from sources like the CHILDES database (MacWhinney, 2000). Yet these corpora are generally treated as static sources of input—lists of words or utterances to be analyzed by the model. While such static models have generated important insights into the statistical nature of input, more realistic models will require ways to reproduce the interactive nature of infant–adult communicative interaction as the source, and underlying purpose, of infant-directed speech.

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