

Sensitive Caregiving Fosters the Comprehension of Speech: When Gestures Speak Louder than Words

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Despite a variety of theoretical arguments to the contrary, sensitive caregiving makes an important contribution to the comprehension and emergence of speech. This research, informed by social ecological realism, documented that during the pre-linguistic and one-word periods, caregivers routinely provided additional perceptual structure to their infants following communicative breakdowns. This sensitive adjusting of subsequent messages to infants contributed significantly to reaching a common understanding. Caregivers also modified their verbal messages in subsequent turns by making them more specific. In contrast, however, these elaborations did not contribute to achieving a practical consensus regarding ongoing events. These results suggest that the social ecological realist approach informing this research has important implications for theory, reviewing past empirical findings and future research. © 1996 by John Wiley & Sons, Ltd.

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Sensitive caregiving makes an important contribution to the comprehension and emergence of speech, despite a variety of theoretical arguments to the contrary. Infants comprehend what others say before they produce speech themselves (Bates *et al.*, 1988; Benedict, 1979). Few would dispute the accuracy of this well-documented developmental milestone. Although the lexicon must be learned (no one claims otherwise), the implications of this pervasive finding have sparked little research into

the interactive origins of speech comprehension during the pre-linguistic period. How caregivers sensitively make speech comprehensible to infants during the second half of the first year of life as well as during the one-word period remains relatively unexplored. Among the exceptions, Harris *et al.* (1983) and Messer (1983) document the close coupling of caregiver speech and actions prior to and after infants' first words. Another body of research provides some suggestive clues. Many researchers have confirmed that caregiver methods for focusing the attention of their infants during the one-word period and beyond contribute to the emergence of the lexicon (Adamson *et al.*, 1988; Tomasello, 1988; Zukow, 1989, 1990). Combining these results with social ecological

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realist theory, I present empirical evidence supporting the view that caregivers educate their infants' attention to promote the infants' comprehension of speech (Zukow-Goldring, 1997a). Caregivers make themselves understood by educating their infants' attention to the organization and structure of ongoing events as well as to the relation between what is said and done as events unfold. These caregiver practices foster the emergence of the lexicon.

OTHER APPROACHES

Emphasis on Infants' Autonomous Achievements

Many theoretical approaches to language development concentrate largely on processes internal to the child. Debates converge on the core of built-in abilities and the set of mental processes hypothesized to support language. Singly or in tandem, innate endowments and gradually acquired cognitive abilities provide the building blocks that underlie the child's acquisition of language (Piaget, 1962; Pinker, 1984; Schlesinger, 1982; Wexler and Culicover, 1980). Depending on the perspective, 'triggers' from linguistic experience and the child's hypothesis-testing spur further development. Not surprisingly, then, much research investigating language development derived (totally or in part) from these theories concerns itself with the production and inferred knowledge of the individual child (Barrett, 1985; Bloom, 1993; Dromi, 1987; McShane, 1980; Moore & Dunham, 1995; Schlesinger, 1982).

Research proposing the potential importance of social interaction for lexical development almost exclusively studies how caregivers' verbal messages affect the language production of children many of whom have already begun to speak (Lock, 1980; Nelson, 1985; Snow *et al.*, 1987). A good many early studies examined the extent to which caregivers served as effective feedback devices, recasting unintelligible or poorly realized utterances of the child (Nelson *et al.*, 1973). More recent work has investigated the emergence of communicative intent (Ninio, 1992), intentional communication (Bloom, 1993), levels of symbolic expression (Dore, 1985), semantic functions (Zukow, 1990; Zukow-Goldring and Ferko, 1994), first words (Harris *et al.*, 1988), frequency of word classes (Bridges, 1986) and teaching-learning strategies (Moerk, 1985). This research

documents that aspects of caregiver speech relate to children's subsequent production. One study by Harris and her colleagues (Harris *et al.*, 1995) looked at comprehension of speech somewhat prior to the onset of speech. They reported that children's early production correlated highly with the activity and settings in which they first comprehended those same words. These studies confirm the important relation of caregiver speech to children's early production.

Even though most agree that caregivers sensitively shape their turns during familiar routines (Bruner, 1983; Snow *et al.*, 1987),¹ hypothesized processes within the child explain what is noticed and eventually learned. That is, infants' cognitive strategies somehow sift through communicative interactions and extract the pragmatic, semantic and affective relations between what is said and what is going on (Bloom, 1993; Nelson, 1985; Ninio, 1992). Perhaps, then, cognitive explanations have obviated the need to elaborate how caregivers may deftly adjust their speech and actions as their infants change and grow. Arguments from another position may have dissuaded researchers from pursuing such investigations as well. Proponents of this perspective assert forcefully that caregiver practices cannot logically make a difference. Specifically, some claim that even if caregiver practices are made explicit, little will be gained but vagueness and ambiguity.

Ostensive Definition and the Ambiguity of Reference

Various (mis)renderings of St Augustine (1945/397) and Quine (1960) have perpetuated the notion that people cannot avoid ambiguity when gesturing as they speak (cf. Bloom, 1993; Erneling, 1993; Nelson, 1988; Reed, 1993; Zukow, 1990). That is, when a caregiver orients or points to, say, a rabbit while naming it, the infant-hearer has no way (in theory) of determining what the caregiver is talking about (Dockrell and Campbell, 1986; Markman, 1989; Schlesinger, 1982). According to these arguments, the hypothetical target of the speech might be the rabbit, its fur or colour, its action, and so on. Empirical evidence does not confirm the ambiguity predicted by these arguments. Instead, appeals to the presumed imperfections in what caregivers say and do find no substantiation when research examines actual interaction (Nelson, 1988; Zukow, 1990; Zukow-Goldring, 1997a).

The emphasis on the autonomous achievements of each child, the bias towards studying child production and the presumed underdetermined nature of caregiver messages may have diverted scholars from investigating the ways that the pre-linguistic caregiving environment prepares the child for learning language, including the early lexicon (Nelson, 1985; Ninio, 1992; Zukow, 1990). However, surmounting these objections rests on theory and empirical evidence. My approach delineates how caregivers educate infants' attention, specifying the perceptual structure that can and does reduce ambiguity.

ATTENTION: THE KEYSTONE OF EARLY CAREGIVER-INFANT INTERACTION

A range of studies conducted during the first year of life and the early months of the second year suggests that caregivers guide attention to enlarge what infants notice and do. This sensitivity to the developing abilities of their infants may cultivate later language learning. Caregivers continuously provide practice as they adjust activities to the shifting interest and changing abilities of their infants. Early pre-attunements gradually differentiate into effective behaviour as caregivers treat infants' inadvertent and awkward participation as culturally appropriate (Ryan, 1974).

Infants gradually learn to initiate, sustain, terminate and avoid interaction (Stern, 1977) as well as detect the form, function and timing of turn-taking and intonation patterns that may set the stage for future dialogue (Papoušek and Bornstein, 1992; Snow, 1977). Propagating shared attention to mutual affective states may provide a key to sharing a practical understanding of events, and finally to the relation between world and word (Bruner, 1983; Stern, 1985; Tamis-LeMonda and Bornstein, 1989; Zukow-Goldring, 1997a). A substantial body of research attests to the relation between a common focus of attention during mundane daily activities and the emergence of the lexicon (Adamson *et al.*, 1988; Bruner, 1983; Tomasello and Farrar, 1986; Tamis-LeMonda and Bornstein, 1989; Zukow-Goldring, 1997a). The following section presents a theory that illuminates these empirical findings.

SOCIAL ECOLOGICAL REALISM

I have proposed a social ecological realist approach to document how caregivers assist infants in

becoming proficient members of their cultures (Zukow-Goldring, 1997a). This approach emphasized the contribution of perception (E. Gibson, 1969, 1997; J. J. Gibson, 1966, 1979), social interaction (Cole, 1989; Vygotsky, 1978) and communicative methods or practices (Garfinkel, 1967; Goodwin, 1994; Macbeth, 1994; Moerman, 1988). Extending this work, I flesh out caregivers' methods for educating their infants' early pre-attunements. These incarnate/embody practices may promote infants' eventual adept participation in daily events. I briefly sketch J. J. Gibson's theory of direct perception as it relates to educating attention and illustrate the potential of this approach by summarizing how this process relates to the emergence of the early lexicon.

Social ecological realism provides a theoretical basis for investigating how caregivers sensitively guide infants to notice, participate in and communicate within events. According to J. J. Gibson's ecological realist theory (1966, 1979), the world is directly perceived.² For instance, caregivers and children detect the perceptual structure that specifies the unchanging, invariant aspects of ongoing events ('the something that something is happening to') as well as the structure specifying transformation and change ('the something that is happening') (Michaels and Carello, 1981). People have evolved to detect functionally significant opportunities for action, perceiving higher-order patterns of light such as an object, not the stimuli of physics such as wave length. As individuals move, they detect perceptual structure in the flow of light that specifies surfaces, edges that occlude one another, texture, rigidity, and so on. This perceptual structure specifies emerging opportunities or affordances for action. Such cycles illustrate the inextricable linking of perceiving and acting.

The Duality of Perceiving and Acting Cycles

When caregivers educate attention, they propagate (cultural) knowing. This approach views development as a process of perceptual differentiation arising from cycles of perceiving and acting. Perceiving and acting do not develop separately, but together as a unitary system (Turvey and Fitzpatrick, 1993). People act to perceive and perceive to act. For instance, as an infant crawls across a floor, he or she sees more perceptual structure specifying the location of things in his/her immediate pathway. The infant can also detect/feel change or continuity from the

texture and slope of the supporting surface with feet and hands. The emerging visual and tactile structure guides the infant's subsequent movements, and so on.

Extending this view, I suggest that cycles of perceiving and acting entail an inseparable reciprocity in which the perceiving and acting of the caregiver reflexively inform the perceiving and acting of the infant. For instance, 15-month-old Carol and her mother Evelyn sat on the living-room floor playing with a shape-ball. Evelyn continuously monitored Carol's acting and perceiving. Noticing which block was in Carol's hand, she tapped the cross-shaped opening on the curved ball with her index finger as she said, 'That one goes in here'. Carol tried to put the cross-shaped block into a different, but equally accessible opening. Evelyn rotated the appropriate opening towards Carol, making the aperture 'seeable' and more available for action, repeating 'That one goes in there'. Carol attempted to push the block into that opening, but did not have the edges aligned properly. Noticing, Evelyn moved the shape-ball so that the edges of the opening mirrored the orientation of the block Carol held. Simultaneously, she said, 'But you gotta turn it around—I'll turn it around'. Carol pushed the block in as her mother sensitively adjusted the placement of the shape-ball. In this vignette the caregiver and infant continue to adjust to each other's perceiving and acting, attesting to their continuous reciprocity.

Effectivities and Affordances

Just as perceiving and acting are inseparably linked in cycles, acting itself is informed by the body's capabilities as well as what the environment affords for action. Caregivers frequently display the effectivities of a body like ours for action and what the environment affords for action with such a body. In this example, a 7-month-old learns that kicking legs (effectivity) propel kickable balls (affordance). Bruce's mother, Connie, first put him through the motions, helping him to embody kicking. She clasped him by the shoulders, picked him up and swung him like a pendulum. As his feet made contact with the ball, Bruce saw, felt and heard that the ball rolled away. A few seconds later, Connie made another effectivity apparent. She patted the ball, asking him to look. Next Connie propped Bruce against her knees as she crouched on the floor and then positioned boy and ball. Connie cocked his leg,

subsequently kicking his leg so that the foot and ball met soundly. In this sequence, Bruce's mother sensitively provided practice that embodied for him the relation of his body's momentum, the configuration of ball and boy, and the articulation of his leg for kicking. This unceasing monitoring and modulating of practice provided by caregivers to infants may relate to disambiguating misunderstood messages.

Re-viewing Ambiguity

Wittgenstein (1961) made explicit a presupposition basic to linguistic communication that clarifies how people come to see eye-to-eye. He asserted that people cannot 'say' or 'explain' in language what a meaning relation might be. In this view, an individual cannot teach in words what is meant. That is, the hearers' ability to understand such an explanatory verbal message presupposes that hearers already know the meaning relation (Erneling, 1993; Hintikka and Hintikka, 1986). If words cannot explain something new, how do people see what is meant? Wittgenstein (1961, 4.1212) answered this seeming dilemma by arguing cryptically that 'what *can* be shown, *cannot* be said'. That is, individuals receiving messages can directly grasp meaning only through the 'saying and showing' of the person expressing the message. Caregivers can assist infants in perceiving what is meant by routinely providing examples of behaviour in context.

If everyone lives in a sea of ambiguity, the view for the infant-novice must be even murkier. How do caregiver and infant ever understand each other? The answer, from a social ecological realist perspective, is that caregivers educate attention by making events audio-visible. They reduce ambiguity by marking the relation between what is happening and what is said, so infants can see and hear an event as it emerges and unfolds. Caregivers find what to say, and do 'on demand', sensitively adjusting messages to the infant's fluctuating attention and emerging effectivities. Infants depend on the audio-visible character of talk to find out what it affords in local settings.³ (For adults, see Goodman, 1994; and Macbeth, 1994.)

Cultivating the Comprehension of Speech

Empirical evidence

My previous research confirms that caregivers propagate knowing by making the effectivities of

the body and the affordances of the environment prominent, and sketches how this process cultivates the emergence of the lexicon. Rather than assuming that messages occur as frozen frames, caregivers *in situ* use gestures dynamically to make perceptual structure prominent. Parents, siblings, babysitters and others make evident whether the target of their speech is a whole object by rotating it around its horizontal axis, some part by tracing its topography, a property by demonstrating its function, or action by moving the self, others and objects (Zukow-Goldring, 1997a; Zukow-Goldring and Ferko, 1994). Caregivers use these methods at home and at school, in the United States and in Central Mexico, in urban and rural settings, in working- and middle-class neighbourhoods and in English and Spanish (Zukow, 1989; Zukow-Goldring, 1997a; Zukow-Goldring *et al.*, 1994). These possibly universal practices 'grow' or propagate within the caregiver-infant environmental system and do not reside within any one individual (Ingold, 1991; Zukow-Goldring and Dent-Read, 1997).

Present Study

This study focuses on how caregivers reduce ambiguity when the infant does not initially understand the caregiver's message. To achieve a practical consensus or mutual understanding of events, I propose that caregivers modify their messages as a function of infants' level of participation in ongoing activities. Given the foregoing arguments, I predict that providing the infant with more perceptual structure will assist caregiver and infant in reaching a working consensus. In contrast, additional or more specific verbal information should not enhance the understanding of the infant during either the pre-linguistic or one-word period. To test these hypotheses, I examined data from a naturalistic, longitudinal study of five caregiver-infant dyads from the middle of the infants' first year through the one-word period.

METHOD

Participants

Five middle-class Euro-American families participated in this 2-year longitudinal study from the infant's sixth month through 30 months of age. We contacted and interviewed parents of newborns whose birth announcements appeared in a local community newspaper as well as circulated

announcements at local universities. The sample included two first-born daughters and one second-born as well as two first-born sons. All the parents had attended college for several years; some had professional degrees.

Procedure

Naturalistic videotapes of everyday interaction were collected in the home to document the most representative language learning environment of the infants. Great care was taken to preserve the ecological validity of these interactional settings. Twenty-minute videotapes and simultaneous audio-recordings were made each month. The audio-recordings of the caregiver-infant conversations were transcribed according to conventions established by Sacks *et al.* (1974) and Zukow (1982). We collected detailed caregiver interviews to ensure that the researchers' interpretations of activities agreed with those of the caregiver. We re-viewed the videotapes with the caregiver immediately following each home visit. In cases of disagreement, the caregiver-expert's interpretation of events and utterances took precedence. The coders used protocols developed to differentiate various aspects of attention-directing in conjunction with the transcripts of the videotaped interactions Cohen's *k* ranged from 85.5% to 95.3%. In addition, caregivers made entries in a diary of the infant's lexicon that documented the participants, the details of the interactive setting, the activity and the prior and subsequent speech. We discussed new entries with the caregivers each month.

Attention-Directing Interactions

The collection of interactions selected for investigation display situations in which caregivers direct infants to notice one specific element, relation or event over the myriad other possibilities available at any one time in any one place (Zukow-Goldring and Ferko, 1994; Zukow-Goldring, 1997a). Attention-directing interactions consist of all instances of perceptual imperatives uttered by caregivers, such as 'Look!', 'Listen!', 'Touch!', 'Smell!', 'Taste!', etc., their accompanying gestures and the gestures alone.

Target of Attention-Directing

The target (topic) of attention, such as non-dynamic person/object ('Look at the doll'), agent-action-object-recipient sequences ('Look, Brian

throws the ball to Cathy') or possession ('Look at Brian's ball'), location ('Look in the bucket!'), repetition ('Look, again!'), in the caregiver's speech is a step or two ahead of the semantic level expressed in the infant's speech. There is a shift in the complexity of the caregiver's speech over time with a complementary change in the infant's ability as well (Zukow-Goldring, 1997a).

Attention-Directing Gestures

Five attention-directing gestures that accompany caregivers' verbal messages were coded: embody show, demonstration, point and look. Based on an ethnography of attention-directing (Zukow, 1989, 1990), these gestures vary on a continuum of caregiver- to infant-regulation of attention to the effectivities of the body and the affordances of the environment. Caregivers assist infants to detect how the infants' perceiving and acting relate to the routine expression of words. As infants develop, caregivers focus at first more on the effectivities of the infants' bodies and gradually on progressively more complex affordances of the environment (Zukow-Goldring, 1997a).

Caregivers *embody* infants by putting them through the motions of some activity (caregiver pulls infant up as s/he says 'up'). The infant can perceive the shared effectivities/capabilities of her/his body and that of the caregiver as the caregiver embodies the infant and/or the infant shadows an activity as the caregiver moves. (Our bodies complement action or do the same actions.) In shows, the caregiver controls the infant's line of sight with a translational movement in which s/he looms an object towards the infant (saying 'Ribbit' while looming a frog). As a caregiver shows, the infant can notice familiar effectivities of the caregiver's body and new affordances of the environment for perceiving/acting as the caregiver makes perceptual structure prominent. (My body can do what your body can do.) In demonstrations, an infant who is monitoring the caregiver must detect or pick up in the perceptual flow the action to be repeated or completed (saying 'Hi' when catching gaze, smiling and greeting) or an infant may be invited to see/feel/say the texture of bristles in a broom while the caregiver says 'Sticky'. When the caregiver demonstrates, the infant can monitor the caregiver enacting familiar effectivities of the body and affordances of the environment for perceiving/acting. In a supporting demonstration, the caregiver provides a portion of the effectivity/

affordance cycle. After demonstrating, the caregiver invites the infant to act. In points, the infant must detect the intersection of a gesture's trajectory through space to the place where it intersects with some target of attention (the caregiver pointing to and saying 'Over there'). Points provide opportunities for following a trajectory through time/space to notice familiar effectivities of the body and affordances of the environment for perceiving/acting. Finally, in looks, words direct the infant to coordinate her/his attention to that of the caregiver (saying 'Look' with no accompanying gesture). (See Figure 1 for photographs of the gestures.)

Sequences Containing Initially Misunderstood Caregiver Messages

We searched the corpus of attention-directing interactions for sequences in which the initial message was misunderstood. We evaluated all subsequent messages which had the same target of attention to determine whether caregiver and child reached a practical consensus. We assessed the messages in these sequences on the basis of two continua: the relative amount of perceptual structure/information provided by attention-directing gestures and the degree of linguistic specificity expressed.

Consensus

We determined whether or not caregivers treated their infants' response to each message in a sequence as adequate. Coding of the caregiver's assessment of the infant's understanding was informed by classroom studies of students and teachers (Edwards and Mercer, 1987; Newman *et al.*, 1989; Tenenbergs, 1988; Zukow-Goldring *et al.*, 1994). For instance, for lack of consensus the caregivers repeated or revised messages, gave up and/or made statements, such as, 'You don't want to'. In contrast, caregivers displayed reaching consensus by saying 'Yeah!', 'Good!', 'You did it!' or by elaborating the activity.

Perceptual Structure

We scored each message for providing (+) or omitting (-) additional perceptual structure. Messages unaccompanied by gesture often initiated a sequence, such as 'Look, peel it' as the caregiver looked at an orange. In the next message, she might point to the orange. We would code that message as perceptual structure = '+' and gesture = point. Then, the caregiver might pull a bit of peel



(a)



(b)



(c)



(d)

Figure 1. Attention-directing gestures: embody (a), show (b), demonstration (c), point (d)

away from the orange (+, demonstration). Finally, she might place her hands on the infant's hands and help the infant pull the peel off the orange (+, embody). Alternatively, the caregiver might repeat

by pointing at the orange again (–, point) or omit perceptual structure as she gazed at the orange and said, 'Peel the orange' (–, look). If the caregiver provided more perceptual structure in

any one message within a sequence, we scored the sequence overall as adding perceptual structure.

Linguistic Specificity

We assessed each sequence, message by message, for increases or decreases in linguistic specificity. Linguistic messages in ensuing turns can contain more or less explicit expression of nouns and verbs and previously ellipted lexical items. In the orange-peeling sequence, a caregiver might begin with expressing the verb explicitly and the object with a pronoun, such as 'Look, peel it'. In a subsequent utterance, she might say 'Look, peel the orange'. We coded such utterances as adding linguistic specificity (+). In contrast, the caregiver might express the message less explicitly using only prowords, such as pronouns and proverbs ('Do it!'). The latter would be coded as providing less linguistic specificity (-). If the caregiver provided more linguistic specificity in any one message within a sequence, we scored the sequence overall as adding linguistic specificity.

Infant's Expressive Level

We examined the re-visions of caregiver messages at two levels of development: the pre-linguistic and lexical levels.

Pre-linguistic Level

At this level, caregivers treated two or less of their infant's vocalizations as lexical items.

Lexical Level

One of two criteria identified an infant as having reached the lexical level. Either an infant expressed one exemplar in each of three categories within the first level of the one-word period or the infant produced three different exemplars within one category. Diary data and verbalizations during videotapings comprised each infant's corpus of utterances. At the first level, the doing of the infant and the saying of the word are undifferentiated.

That is, infants express 'indicative objects' by pointing at and saying 'nana' (banana), 'volitionals' by reaching and whining while saying 'ki' (cookie), or 'performatives' by saying 'down' while falling or throwing down. We classified the infant as beyond the one-word period when the infant produced more utterances with multiple morphemes than single morphemes. (The lexical categories are based on Greenfield and Smith, 1976; Zukow *et al.*, 1982.)⁴ Table 1 lists the ages of the infants at each expressive level.

RESULTS

The primary purpose of the following analyses was to test whether providing more perceptual structure significantly related to achieving a practical consensus and whether its absence related to a lack of consensus. A series of nested models was generated to test the significance of various associations between the variables studied. To demonstrate the interdependence of five variables—perceptual structure (P), linguistic specificity (L), consensus (C), expressive level of the infant (E) and subject (S)—the observed frequencies in Table 2 were subjected to a multivariate frequency analysis, BMDP4F (Dixon, 1983), using log-linear methods. A series of models was generated to test various hypothetical relationships between the variables.

The 30 models of conditional independence as well as the simplest model of independence listed in Table 3 provide the basis for constructing specific hypotheses (Wickens, 1989). In simple situations with few variables [P][C] expresses the simple independence of the two variables P and C, whereas [PC] represents dependence. In a more complex circumstance with five variables, a model of simple independence [L][E][S][P][C] would be compared to a model introducing dependence of just two variables, as in [L][E][S][PC].

Table 1. Ages of infants at each expressive level

Expressive level	AB	CB	Infant JJ	KJ	ZR
Pre-linguistic	6-11	6-10 ¹	6-11	6-11	6-12
Lexical	12-20	12-19	12-21	12-21	13-20

¹No data available for 11 months.

Table 2. Observed frequencies of infants' expressive level, consensus, linguistic specificity and perceptual structure across subjects

	More	Perceptual structure Equal/less	Total
<i>Pre-linguistic</i>			
AB			
<i>Consensus</i>			
More linguistic specificity	2	2	4
Equal/less linguistic specificity	4	0	4
Total	6	2	8
<i>Lacking consensus</i>			
More linguistic specificity	1	3	4
Equal/less linguistic specificity	1	1	2
Total	2	4	6
CB			
<i>Consensus</i>			
More linguistic specificity	1	0	1
Equal/less linguistic specificity	1	0	1
Total	2	0	2
<i>Lacking consensus</i>			
More linguistic specificity	0	0	0
Equal/less linguistic specificity	0	0	0
Total	0	0	0
JJ			
<i>Consensus</i>			
More linguistic specificity	4	0	4
Equal/less linguistic specificity	6	0	6
Total	10	0	10
<i>Lacking consensus</i>			
More linguistic specificity	1	3	4
Equal/less linguistic specificity	4	4	8
Total	5	7	12
KJ			
<i>Consensus</i>			
More linguistic specificity	4	0	4
Equal/less linguistic specificity	6	2	8
Total	10	2	12
<i>Lacking consensus</i>			
More linguistic specificity	1	3	4
Equal/less linguistic specificity	1	4	5
Total	2	7	9
ZR			
<i>Consensus</i>			
More linguistic specificity	1	0	1
Equal/less linguistic specificity	8	0	8
Total	9	0	9
<i>Lacking consensus</i>			
More linguistic specificity	2	0	2
Equal/less linguistic specificity	0	0	0
Total	2	0	2
<i>Linguistic</i>			
AB			
<i>Consensus</i>			
More linguistic specificity	3	1	4
Equal/less linguistic specificity	11	1	12
Total	14	2	16
<i>Lacking consensus</i>			
More linguistic specificity	3	0	3
Equal/less linguistic specificity	2	1	3
Total	5	1	6

(continued)

Table 2. (continued)

	More	Perceptual structure Equal/less	Total
CB			
<i>Consensus</i>			
More linguistic specificity	2	0	2
Equal/less linguistic specificity	8	1	9
Total	10	1	11
<i>Lacking consensus</i>			
More linguistic specificity	0	1	1
Equal/less linguistic specificity	0	2	2
Total	0	3	3
JJ			
<i>Consensus</i>			
More linguistic specificity	11	0	11
Equal/less linguistic specificity	26	0	26
Total	37	0	37
<i>Lacking consensus</i>			
More linguistic specificity	2	0	2
Equal/less linguistic specificity	7	4	11
Total	9	4	13
KJ			
<i>Consensus</i>			
More linguistic specificity	12	2	14
Equal/less linguistic specificity	4	2	6
Total	16	4	20
<i>Lacking consensus</i>			
More linguistic specificity	4	2	6
Equal/less linguistic specificity	2	3	5
Total	6	5	11
ZR			
<i>Consensus</i>			
More linguistic specificity	3	0	3
Equal/less linguistic specificity	21	2	23
Total	24	2	26
<i>Lacking consensus</i>			
More linguistic specificity	0	0	0
Equal/less linguistic specificity	5	0	5
Total	5	0	5
Total			218

In more complex situations, however, the test of unrelatedness may occur in the context of several variables that may affect an observed association. Excluding these effects makes for a much more stringent test of the association PC. To eliminate these context variables, L, E and S, the researcher investigates the conditional independence hypothesis (P not related to C, given LES), rather than the simple independence model expressed above. In this more conservative approach, the model [PLES][CLES] expresses the conditional independence hypothesis. To reject this hypothesis, the

association of P and C, must be greater than their common association with L, E and S. To test this hypothesis, a second model is [PLES][CLES][PC].

The use of difference testing allows examination of the adequacy of two related models. In difference testing, the null model composed of specific associations is compared with an alternative model that contains the same terms as well as introducing the association which is to be tested. The difference between the overall goodness-of-fit statistic G^2 for the two models constitutes the test statistic. The term ΔG^2 expresses this difference. As

Table 3. Models of conditional independence

Model	Association introduced	G ²	df
1. [E][S][P][L][C]	(Simplest model of independence)	151.13	67
2. [PCES][LCES]		12.89	12
3. [PCES][LCES][PL]	[PL]: perceptual structure, linguistic specificity	12.50	11
4. [PCES][LCES][PLC]	[PLC]: perceptual structure, linguistic specificity, consensus	12.46	10
5. [PCES][LCES][PLE]	[PLE]: perceptual structure, linguistic specificity, expressive level	9.50	10
6. [PCES][LCES][PLS]	[PLS]: perceptual structure, linguistic specificity, subject	8.04	7
7. [LPES][CPES]		16.09	13
8. [LPES][CPES][LC]	[LC]: linguistic specificity, consensus	15.87	12
9. [LPES][CPES][LCE]	[LCE]: linguistic specificity, consensus, expressive level	15.08	11
10. [LPES][CPES][LCS]	[LCS]: linguistic specificity, consensus, subject	12.99	8
11. [PLES][CLES]		51.14	14
12. [PLES][CLES][PC]	[PC]: perceptual structure, consensus	21.60	13
13. [PLES][CLES][PCE]	[PCE]: perceptual structure, consensus, expressive level	19.38	12
14. [PLES][CLES][PCS]	[PCS]: perceptual structure, consensus, subject	7.10	6
15. [LSPC][ESPC]		22.61	14
16. [LSPC][ESPC][LE]	[LE]: linguistic specificity, expressive level	22.07	13
17. [LEPC][SEPC]		48.80	23
18. [LEPC][SEPC][LS]	[LS]: linguistic specificity, subject	30.64	19
19. [LEPC][SEPC][LSE]	[LSE]: linguistic specificity, subject, expressive level	20.36	15
20. [CSPL][ESPL]		14.67	12
21. [CSPL][ESPL][CE]	[CE]: consensus, expressive level	13.86	11
22. [CEPL][SEPL]		35.77	26
23. [CEPL][SEPL][CS]	[CS]: consensus, subject	32.15	22
24. [CEPL][SEPL][CSE]	[CSE]: consensus, subject, expressive level	29.58	17
25. [PSCL][ESCL]		15.37	12
26. [PSCL][ESCL][PE]	[PE]: perceptual structure, expressive level	13.10	11
27. [PELC][SELC]		44.71	28
28. [PELC][SELC][PS]	[PS]: perceptual structure, subject	28.37	24
29. [PELC][SELC][PSE]	[PSE]: perceptual structure, subject, expressive level	23.92	17
30. [PLCE][PLCS]		32.44	24
31. [PLCE][PLCS][SE]	[SE]: subject, expressive level	27.59	20

an example, turn to models 11 and 12 in Tables 3 and 4 to determine whether the association between perceptual structure P and consensus C, λ_{PC} , makes a significant contribution.

$$\begin{aligned} [\text{PLES}][\text{CLES}] & G^2(14)=51.14 \\ [\text{PLES}][\text{CLES}][\text{PC}] & G^2(13)=21.60 \end{aligned}$$

$$\lambda_{PC} \quad \Delta G^2(1)=29.54, p < 0.001$$

The difference between models 11 and 12 (51.14 – 21.60 = 29.54 on 14 – 13 = 1 degrees of freedom) is significant ($p < 0.001$), indicating that the λ_{PC} association is necessary.⁵ (See Wickens, 1989, for careful explanation and discussion of model testing.) Difference testing of these models confirmed that increasing attention to perceptual structure overwhelmingly related to achieving a

practical consensus, whereas failing to do so was associated with a failure to achieve consensus (See Figure 2.) Both vignettes in the introduction, placing a block in a shape-ball and kicking a ball, illustrate the sensitivity and effectiveness of caregivers as they provide infants with more perceptual structure.

Results from the entire model-fitting procedure tabulated in Table 4 demonstrated that three two-way associations were necessary. In each case the changes in ΔG^2 were substantial, indexing solid significance. The other sources of dependence, LS and PS, indicate that caregivers varied considerably in the amount of linguistic specificity they expressed and that provision of perceptual structure varied as well. Several of the caregivers rarely recast their utterances by amending them with greater linguistic specificity. However, all care-

Table 4. Tests of specific hypotheses

Models tested	Associations	df	ΔG^2	Relative change (%)
Model 2-model 3	$L\lambda_{PC}$	1	0.39	0.3
Model 3-model 4	λ_{PLC}	1	0.04	0.0
Model 3-model 5	λ_{PLE}	1	3.00	2.0
Model 3-model 6	λ_{PLS}	4	4.46	3.0
Model 7-model 8	$L\lambda_{LC}$	1	0.22	0.1
Model 8-model 9	λ_{LCE}	1	0.79	0.5
Model 8-model 10	λ_{LCS}	4	2.88	1.9
Model 11-model 12	$L\lambda_{PC}$	1	29.54***	19.5
Model 12-model 13	λ_{PCE}	1	2.22	1.5
Model 12-model 14	λ_{PCS}	7	14.40*	9.5
Model 15-model 16	$L\lambda_{LE}$	1	0.54	0.4
Model 17-model 18	$L\lambda_{LS}$	4	18.16**	12.0
Model 17-model 19	λ_{LSE}	4	10.24*	6.8
Model 20-model 21	$L\lambda_{CE}$	1	0.81	0.5
Model 22-model 23	$L\lambda_{CS}$	4	3.62	2.4
Model 23-model 24	λ_{CSE}	4	2.57	1.7
Model 25-model 26	$L\lambda_{PE}$	1	2.27	1.5
Model 27-model 28	$L\lambda_{PS}$	4	16.34**	10.8
Model 28-model 29	λ_{PSE}	7	4.45	2.9
Model 30-model 31	$L\lambda_{SE}$	4	4.85	3.2

* $p < 0.05$; ** $p < 0.005$; *** $p < 0.001$.

givers produced a preponderance of messages in which they made more perceptual structure available and prominent to the infant, leading to reaching a practical understanding of ongoing events (PC). Some simply provided more perceptual structure. The other two-way associations (PL, LE, CE, PE and SE) did not reach significance. Of special note, the behaviours of infant and caregiver did not change appreciably with the shift from

pre-linguistic to one-word levels of expression. That is, the expressive level of the infant did not significantly relate to linguistic specificity, achieving a common understanding, perceptual structure or subject. As predicted, the provision of a more specific linguistic message LC over the course of a sequence did not contribute significantly to reaching a practical consensus. Note in Figures 3 and 4 that neither increases nor decreases in linguistic specificity affect consensus. Achieving consensus related only to increased perceptual structure.

The significant three-way association PCS indicates that some pairs rarely achieved consensus unless the caregiver provided more perceptual structure. In some dyads, providing perceptual structure was slightly less effective some of the time. The significant three-way association LSE may point to one dyad in particular (KJ). This caregiver revised her messages to include greater linguistic specificity more frequently during the one-word period than during the pre-linguistic level. However, those messages were usually accompanied by greater perceptual structure as well.

Assessing the importance of an association requires both statistical significance and accounting for a large increment in fit (Wickens, 1989). Calculating the increment in fit achieved by the various models assesses the magnitude of

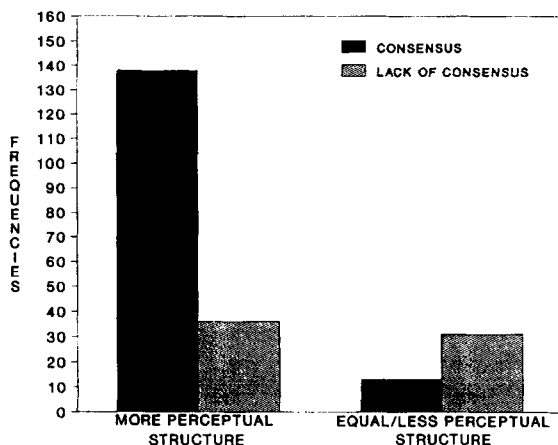


Figure 2. The relation between perceptual structure and consensus, PC.

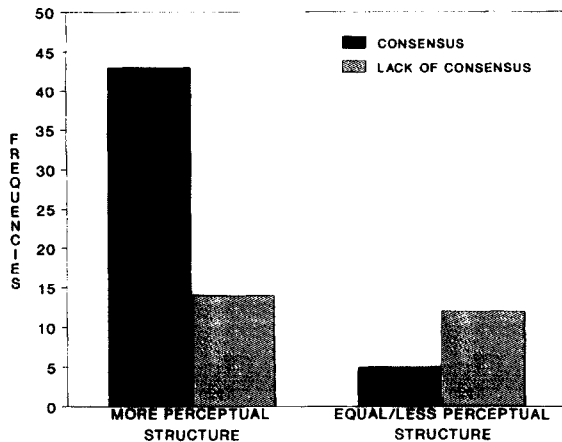


Figure 3. The relation between perceptual structure and consensus, PC, given more linguistic specificity, L.

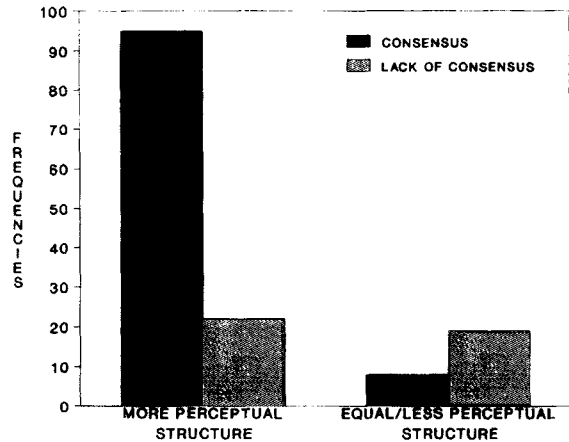


Figure 4. The relation between perceptual structure and consensus, PC, given equal or less linguistic specificity, L.

each association. The terms of $\Delta G^2/G_1^2$, where G^2 is the value for the simplest model (model 1), express the increment in fit or degree of relative change. For example, consider the addition of λ_{PC} to model 12. In this case, $\Delta G^2/G_1^2 = 29.54/151.13 = 19.5\%$ of the relative change possible. According to the complete analysis of relative change, summarized in Table 4, PC accounted for the largest increase in fit, 19.5%. LS, PS and PCS explained much smaller changes of 12.0%, 10.8% and 9.5%. The contribution of LSE was modest at 6.8%. In sum, the strongest effect, PC, demonstrates positively that providing perceptual structure after an initial misunderstanding enhanced the probability of caregiver and child reaching a practical understanding of ongoing events. The next largest effects, LS, PS and PCS, indicate that methods for modifying subsequent messages varied somewhat between caregiver-child pairs. LSE provided minimal support for the possibility that more specific linguistic messages begin to appear more often during the one-word period following an initially misunderstood message.

DISCUSSION

When caregivers resolve ambiguity for infants, gestures do 'speak louder than words'. This research documented that during the pre-linguistic and one-word periods caregivers routinely provided additional perceptual structure to their infants following communicative breakdowns. This sensitive adjusting of subsequent

messages to infants contributed significantly to reaching a common understanding. Caregivers also modified their verbal messages in subsequent turns by making them more specific. In contrast, however, these elaborations did not contribute to achieving a practical consensus of ongoing events. Preliminary analyses from a study investigating a Spanish-speaking, working-class sample of Latino families robustly confirm these findings (Zukow-Goldring, 1997b). These results suggest that the social ecological realist approach informing this research has important implications for theory, reviewing past empirical findings and future research.

This research provides support for Wittgenstein's position (1961) that language cannot tell what a person does not know. Extending this argument, greater linguistic specificity should not facilitate disambiguating initially misunderstood messages. Supporting this view, all the caregivers worked much harder at getting their infants to perceive what was happening than at attempting to tell them what was going on. This relative omission of more precise utterances following a lack of understanding makes logical and practical sense. Apparently, the caregivers see that more speech or even more specific speech appears to be an exercise in futility. Verbal explanations hold little explanatory value if the child cannot comprehend speech. If infants do not 'know' what is happening, infants cannot understand verbal messages about ongoing events. Clearly, infant-novices often do not know the organization and structure of everyday events,

nor do they already know what or how words mean. That is what they are learning, and what their sensitive caregivers educate them to notice.

These findings yielded solid evidence that caregivers set aside language training when communication breaks down. Instead, they first establish an understanding of what is happening. As predicted by social ecological realism, caregivers provided and directed attention to perceptual structure that made prominent the relations among animate beings, objects and their actions. These dynamic relations specify the organization and structure of the most mundane daily activities. Caregivers introduce their infants to new effectivities or bodily capabilities and affordances for action and interaction on a daily basis. As caregivers educate attention, infants gradually learn to perceive, act and know in culturally relevant ways (Zukow-Goldring, 1997a). These ways eventually include detecting the amodal regularities in what caregivers say and do that may specify initially the relation of words to world. However, knowing what is going on appears to emerge a step or two ahead of knowing how to relate language to those events (cf. Schlesinger, 1982).

How might the contribution of familiar routines and caregiver sensitivity to lexical development differ? Some scholars assert that infants learn to talk in highly routinized, ritualized or 'over-learned' situations (Bruner, 1983; Ninio and Bruner, 1978; Snow *et al.*, 1987).⁶ However, even the most familiar activities never unfold in exactly the same manner. The particulars of participants and context vary, affecting the organization and structure of daily life. Instead, the groundwork for infants' ensuing speech production may be found in the breakdowns in communication. Such mismatches in understanding appear to occur with naturally occurring variations during familiar events and when caregivers introduce unfamiliar activities and speech. These situations suggest that learning to talk may emerge as caregivers' speech accompanies and mirrors an ever-expanding and increasingly challenging array of activities. The caregiver method for making initially misunderstood activities perceptually available may be what is invariant or habitual rather than a familiar setting or framework.

These practices may eventually succeed in disambiguating speech by specifying the relation between action and talk. Research conducted with older and more advanced children suggests that

caregivers continue to use similar methods of 'building up' and 'breaking down' utterances (Moerk, 1985). Some studies speculate that older children use context to successfully determine the meaning of initially unintelligible speech (Bard & Anderson, 1994). This work implicitly assumes that the child acts and knows autonomously. It is quite likely, however, that the caregivers made the perceptual structure prominent in the ensuing interaction.

Confirmation of the importance of providing perceptual structure to disambiguate misunderstood speech will come from future studies that investigate how the frequency, semantic functions, grammatical structures and pragmatic forms of caregiver speech during communicative breakdowns relate to the emergence of the infant's speech.

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Notes

1. Ochs and Schiefflin (1984) take issue with this position. They assert that 'guessing' what the infant needs to know describes the style of upper-middle-class mothers in technological cultures. According to Ochs and Schiefflin, adult caregivers in many agrarian and Third World nations do not finely tune their utterances to the language abilities of their children. Broadening the caregiving base, Zukow-Goldring (Zukow, 1989; Zukow-Goldring, 1995) notes that older siblings take care of younger sisters and brothers during much of the day in agrarian societies. Her review of sibling caregiving and research provides evidence that sibling caregivers sensitively adjust what they say and do so infants can understand them.
2. Social ecological realism differs from cognitive approaches to social interaction such as Vygotsky's (1978) zone of proximal development and Wood *et al.*'s (1976) notion of scaffolding. According to the latter, the child

learns about the world during social interaction. The culmination of these experiences is the internalization of knowledge in some form of representation and mental mediation. In this view, the world is experienced indirectly through schemas and concepts.

3. Caregiver-child pairs with blind or hearing-impaired members may utilize other perceptual modalities to achieve a common ground for understanding each other's messages.
4. Within the one-word period, infants express what they notice of their own effectivities and affordances of the environment nested in perceiving/acting cycles. At first the infant expresses what is attended to as an inseparable whole/unity. Next, infants express effectivities or actions of the body, who or what affords action and who acts. Finally, the effectivities and affordances the infant expresses expand in space/time, e.g. tools as perceptual extensions of the self (Smitsman, 1997), possessions and parts/whole as relations between persons or person/object or parts of either to the whole through time/space, location as the relation between object or person and some surface(s) or medium over space/time, repetitions as successive perceivings of perceiving/acting cycles.
5. The parameters of the log-linear form of these models are denoted by μ (Bishop *et al.*, 1975) or λ (Goodman, 1970).
6. Ninio and Bruner (1978) suggested that book-reading may be the paradigm case, the interactive setting *par excellence*, that illustrates the 'naming game' hypothesized to fuel the emergence of the lexicon. However, for the vast majority of the world's children living in agrarian sites or Third World cities, book-reading interactions play little or no part in their daily lives. A preliminary analysis of the longitudinal data reported herein of middle-class Euro-American children in a large urban technological centre suggests that book-reading begins in earnest when the children are well into the one-word period.

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