An increasing amount of research has examined the interface between language and the development of a theory of mind. As noted by Astington and Jenkins (1999), several researchers have reported correlations between language and theory of mind development (see, e.g., Cutting & Dunn, 1999; Jenkins & Astington, 1996), but how to explain such correlations is poorly understood. One way to think about this interface has been to suggest that theory of mind development depends on language. Although several interesting proposals exist arguing for the role of language in theory of mind development, there has been surprisingly little discussion of the relationship between such proposals. In this chapter, I begin with a review of some critical differences in how language is understood and the methodological implications of adopting one or another perspective toward language. In clarifying such differences I also highlight some distinctions in the ways language is said to contribute to theory of mind development.

In comparing the various views adopted toward language, I claim that despite a number of differences among various researchers in the specifics of what aspect of language receives focus, they hold together as a group to the extent that all emphasize symbolic aspects of communication. In the second section of this chapter, I turn to consider an alternative way of viewing language, namely language as indexical, and consider how an indexical view of language differs in its methodological approach from other available approaches. In the final section of this chapter, I propose
how adopting an indexical view contributes to an understanding of theory of mind development, illustrating this view from work that I have been conducting over the past few years.

HOW LANGUAGE INFLUENCES THE DEVELOPMENT OF THEORY OF MIND

In thinking about how language influences mind we can begin by broadly considering how language is viewed and then examine how particular views of language contribute to the ways researchers study the theory of mind–language connection. That is, when one examines a variety of proposals supporting the claim that language plays a critical role in the development of a theory of mind, two main differences become clear. First, the different proposals distinguish themselves from one another in terms of how language is viewed, and second, they differ in terms of how such assumptions influence how one studies the connection between language, mind, and human development.

What Is Language?

At a broad level of analysis, language can be viewed in many different ways, three of which include: (a) language as symbolic, (b) language as iconic, (c) language as indexical (see Duranti, 1997, pp. 204–212). Most developmental psychologists have primarily made use of the first of these three views of language. In viewing language as symbolic the assumption is that these symbols have arbitrary relationships with what they represent (see Saussure, 1959). The association is dictated by convention (Peirce, 1940). Researchers, when adopting a symbolic view of language, have focused on one or another particular subdomain, often excluding other possibilities in their studies. For instance, researchers have focused on the role of the lexicon, or syntax, or pragmatics (see Astington & Jenkins, 1999, for further discussion).

Whereas clearly symbolic approaches to language have had much to contribute to the study of language, there are two other important ways language has been viewed. To some cognitive psychologists language has been viewed in terms of its iconic features. Here emphasis is placed on the relationship between the object and its referent. For instance, particular volume and lengthening of sounds has been associated with the expression of particular emotional states. Another example of focusing on iconic aspects of language is in the case of onomatopoeic words; that is, words that in their expression attempt to represent the object referred to.
Finally, we can turn to a third view of language that rarely has been discussed in psychology—namely, the view of language as indexical. As Duranti (1997) suggested: "An index is a sign that identifies an object not because of any similarity or analogy with it, but because of some relationship of contiguity with that object" (p. 209). Indexicals, or deictic terms (originally a Greek term meaning "pointing" or "indexing"), then, are linguistic forms that anchor conversation in relation to the act of speaking. Those adopting an indexical approach to language take a very different methodological stance toward language. Rather than studying one sub-domain in isolation (i.e., the lexicon), an indexical approach necessarily examines language in terms of a simultaneous analysis of linguistic forms (either lexical items or grammatical constructions) and communicative functions.

In summary, to argue that language influences the development of mind leaves open many questions about how language is defined. Before turning to some specific proposals, first we consider a second related theme, namely the need to clarify the goals of studying language for various positions on the language–theory of mind connection.

Why Study Language?

Two main answers can be offered to the question: Why study language when examining the development of theory of mind? One reason to study language is that it presents the researcher with a remarkable tool for better understanding mind. A second reason, and one less commonly discussed in developmental psychology circles, is that language can be viewed as a tool for the child. That is, rather than simply viewing language as a tool in the research process, one can simultaneously argue that language provides the child with access to a powerful resource that allows the child new entry into the development of a theory of mind. For instance, as we note later, some have argued that language provides a cognitive resource for representing reality in fundamentally new ways, whereas others have argued that language provides a powerful mechanism in socializing cultural ways of being, feeling, and acting. Although both of these reasons provide important rationales for why researchers might examine language, it is the purpose of this chapter to focus primarily on the first of these. I have opted to do this because this is in keeping with much prior work that has gone on in the area of theory of mind that has examined language development (see, for instance, the discussion in Bartsch & Wellman, 1995, Chapter 2 for an illustration of this position). Although much of my own work has centered around the second way of viewing language, that is, language as mechanism for the child, I do not address this issue here (see Budwig, 1999, 2000a, 2000b, for such a discussion).
A Comparison of Some Approaches

The previous discussion highlights the point that the argument that language plays a role in theory of mind development can come in many varieties. We turn now to consider how these approaches differ with regard to the specifics of how they conceive of language and how this impacts on the way they methodologically approach the language–theory of mind interface. We will see that assumptions concerning what domain of language is investigated have significant impact on assumptions about methodological approach. It is hoped that teasing apart these assumptions will pave the way for a consideration of how to better understand the kind of evidence that currently exists and gaps in our understanding.

Semantic Approaches

There have been several studies that have examined a variety of mental-state terms and the path of their entry into the everyday speech of young children (see, for instance, Bartsch & Wellman, 1995; Bretherton & Beeghly, 1982; Dunn, Bretherton, & Munn, 1987; Shatz, Wellman, & Silber, 1983). Bartsch and Wellman's (1995) study is perhaps the most comprehensive to the extent that they examined a variety of English-speaking children and a large variety of lexical vocabulary items. Drawing on the CHILDES database (MacWhinney & Snow, 1985), they focused on the use and development of a range of words referring to both beliefs (think, know, believe, expect, wonder, dream) and desire (want, hope, wish, care, afraid). In addition to tracking the onset of usage, the authors also were interested in capturing a sense of semantic features associated with such usage. Such features included, for instance, whose beliefs and desires were referred to (self; other) and whether the use of such terms actually referred to "genuine references to psychological states" (Bartsch & Wellman, 1995, p. 31). Bartsch and Wellman are quite clear that they are not prepared to provide an answer to the question of the relationship between language and thought by suggesting: "We will make little progress in understanding how theory of mind is acquired unless we investigate more closely how development of theory of mind relates to development of language. Our investigation does not answer these questions, but it does show how language and concepts of mind can be investigated together" (p. 209). Bartsch and Wellman's analysis of language, consistent with several other researchers, involves examination of everyday talk in terms of assessing mental-state verbs in terms of what semantic aspects of their usage reveal about underlying conceptualizations. For them, the real benefit of language is that it provides the researcher with a better (though not perfect) understanding of underlying conceptualizations. "Even though language
development does not map onto conceptual development in any strict sense, an analysis of discourse can nonetheless provide an important window onto conception" (p. 17). This view of language as a window is typical of those examining semantic aspects of mental state talk.

**Syntactic Approaches**

Quite a different view of language and reasons for studying language when considering the development of theory of mind can be found in research focusing on more formal aspects of language. Some researchers (see Astington & Jenkins, 1999; de Villiers, 1995; Tardif & Wellman, 2000) have claimed that growing syntactic ability in children promotes theory of mind development. De Villiers (1995) has argued that the development of complementation provides the mechanism for the child to acquire the representational format considered necessary for false-belief understandings. Similarly, Astington and Jenkins (1999) have argued that the development of syntax allows speakers to represent states other than those that are currently experienced. Astington and Jenkins were a bit more cautious given the observation that children can respond correctly when test sentences make use of complements with particular verbs (pretend), but not others (thinks). They suggested that although complementation is central, "something more than the acquisition of object complementation is required to explain why children can respond correctly in one case but not in the other" (p. 1318). Their own methodological approach has been to assess children's general language ability through a test that assesses both syntactic and semantic skills. Their findings indicate that children's receptive and expressive scores, based on the test requiring children to respond to questions and pictures, predict later theory of mind performance but not the reverse. In summary then, for Astington and Jenkins, certain syntactic abilities are a necessary but not sufficient component of language that accounts for theory of mind development.

Tardif and Wellman (2000) have highlighted the importance of addressing questions concerning the relationship of syntactic development and the development of theory of mind from a cross-linguistic perspective. They noted for instance that because the morphology and surface syntax of languages such as Mandarin and Cantonese are simpler than English, they can offer important information about whether such typological distinctions lead to different paths of development. Tardif and Wellman's approach is similar to others who study naturally occurring language between children and their caregivers. Examining, for instance, the English equivalent for "knowing that" in Mandarin and Cantonese, Tardif and Wellman reported these forms appear almost a full year earlier in the
non-English samples. One possible explanation for this, they claimed, is that Mandarin and Cantonese have easier grammatical solutions to the expression of knowledge verbs given the lack of a complementizer after verbs of knowing. Put differently, English-speaking children's later appearance might be due, in part, to the specifics of English syntax, and not a general cognitive deficit per se.

Although I have noted some important differences in the specifics of the claims researchers examining syntactic aspects of language hold regarding the language-theory of mind interface, they come together in holding similar assumptions about why to study language. Rather than providing the researcher with a window to underlying conceptual categories (as was noted for researchers focusing on semantic aspects of language) the argument is that language plays a causal role in theory of mind development. In studying that causal role, researchers examining syntax have used quite distinct methodologies. Most use experimental paradigms or test assessments of general language abilities, though as we have noted in Tardif and Wellman's work, at times, examination also focuses on an analysis of natural language interactions.

**Pragmatic Approaches**

The idea that language plays a causal role in the development of theory of mind is not limited to those who focus on semantic or syntactic development. Others who have examined pragmatic aspects of language have also argued for the view that pragmatics is fundamentally linked to theory of mind development. Astington and Jenkins (1999), in summarizing prior work that provides evidence for the connection between pragmatics and theory of mind development, argued that by definition, pragmatics must be related to theory of mind development. They argued: “Pragmatic ability underlies the ability to use and interpret language appropriately in social situations, which depends on keeping track of listeners' and speakers' beliefs and intentions” (p. 1312). Astington and Jenkins cited evidence that general tests of pragmatic abilities have been noted to be related to false-belief task performance in autistic children (see Eisenmajer & Prior, 1991). They also noted evidence that specific pragmatic devices, such as the appropriate use of referential forms, are connected to false belief understanding (Charman & Shmueli-Goetz, 1998).

Along similar lines others have argued that pragmatic aspects of language are related to theory of mind development. Here, though, emphasis shifts from an examination of individual competencies to a view of language as embedded in ongoing interaction. This position is spelled out most clearly by Montgomery (1997), who suggested that an understanding of mind can best be understood in light of Wittgenstein's argument about
private language. More specifically, the claim is made that in acquiring a
theory of mind, children are learning language games. To this extent, in
learning to talk, children are simultaneously learning about mind. Kessler
Shaw (1998), in her doctoral dissertation, has empirically tested such a
view, and similarly argued that children’s initial uses of belief verbs (*think*
and *know*) are linked to the initial language games in which they first ap-
pear (see Nelson & Kessler Shaw, chapter 2, this volume for further discus-
sion). Methodologically, Kessler Shaw examined several semantic and
pragmatic features associated with the uses of the particular mental-state
lexical items as they occurred in the natural speech of caregivers and their
children. The analyses revealed that the two mental-state verbs were ini-
tially distinguished by the children in terms of their conversational func-
tion. Although similar to the semantic work reviewed previously to the ex-
tent that focus is placed on children’s actual language productions,
Kessler Shaw (1998) and Nelson and Kessler Shaw (chapter 2, this volume)
claimed that language is more than a window for the researcher to tap into
underlying categories of mind. Rather, as several adopting a pragmatic
approach to language have been noted to argue, it is within actual lan-
guage practices that children come to collaborate in the construction of an
understanding of mind (see Nelson, 1996; Nelson & Kessler Shaw, chap-
ter 2, this volume; and Wootton, 1997).

INDEXICALITY

Language as Indexical

As noted earlier, these views of language, despite some fundamental dif-
fferences, hold together in their view of language as symbolic. One charac-
teristic of symbolic views is that they focus on one of many layers of lan-
guage in developing claims about the role of language in theory of mind
development. That is, symbolic views typically focus on either syntax, se-

tematic, or pragmatic aspects of language. An alternative way of viewing
language comes from indexical approaches. One main difference between
symbolic and indexical views is that indexical views consider language in
terms of multiple levels with a focus both on language forms and semantic
and pragmatic functions. Like the already reviewed work by some who ex-
amine pragmatic aspects of language functioning, the idea that language
is studied in terms of communicative practices is central. A distinction
though is that in indexical approaches, language itself is not only acquired
“in” practices, but also plays a fundamental role in the ongoing interpreta-

tion and construction of context. This sort of indexical approach to lan-
guage draws on the work of several recent linguistic anthropologists who
have been thinking about issues of language and thought (see, for instance, Duranti, 1997; Gumperz & Levinson, 1996; Hanks, 1996). Hanks (1996) summarized this position as follows:

Our starting point is the three-way division of language as a semiformal system, communicative activities as semistructured processes, and actors’ evaluations of these two ( . . . ). These evaluations could be called ideological in the sense of embodying broader values, beliefs, and (sometimes) self-legitimating attitudes. . . . The three elements come together in “practice,” the moment of synthesis. . . . (pp. 230–231)

The point here is not only that language does more than refer to the world; it also suggests that there is a specific linkage between various language functions and linguistic forms. Put differently, language forms can be viewed as one way of grammaticalizing routine communicative practices. Ochs (1996) has referred to this as the indexicality principle:

. . . to index is to point to the presence of some entity in the immediate situation at hand. In language, an index is considered to be a linguistic form that performs this function. . . . A linguistic index is usually a structure (e.g., sentential voice, emphatic stress, diminutive affix) that is used variably from one situation to another and becomes conventionally associated with particular situational dimensions such that when the structure is used, the form involves those situational dimensions. (p. 411)

The form–function relationship between indexicals and situational dimensions is not one-to-one but more complex: “It is important to distinguish the range of situational dimensions that a form (set of forms) potentially indexes from the range of situational dimensions that form (set of forms) actually indexes in a particular instance of use” (Ochs, 1996, p. 418). Indexicals, by providing ways to anchor conversation in relation to the act of speaking, play a pivotal role in constructing meaning. Forms such as personal pronouns (I, You), adverbials (here, now) and other spatial or temporal terms help in the co-construction of contextual meaning.

Language, according to a practice-based view, focuses both on language forms and functions, but even more so on the indexical power of language. As Duranti (1997) suggested:

To say that words are indexically related to some “object” or aspect of the world out there means to recognize that words carry with them a power that goes beyond the description and identification of people, objects, properties, and events. It means to work at identifying how language becomes a tool through which our social and cultural world is constantly described, evaluated, and reproduced. (p. 19)
An Indexical Approach to Language Development

As one shifts from viewing language as symbolic and consequently focuses on its role as a linking process between word and object in the world, one simultaneously shifts in how language development is viewed. As many have noted, the examination of language in terms of form–function linkages described previously, opens up the possibility that development can be viewed as something more than the accumulation of new forms, meanings, or functions. An indexical approach views development also in terms of the changing relations between linguistic forms and language functions. To use a form need not imply that such usage is adult-like. Over ontogenetic time, there is a dynamic relationship between language forms and functions. In my prior work and that of others there has been an attempt to examine the changing ways particular linguistic forms (such as pronouns) change in the way they link up with situational meanings (see Budwig, 1995, for review). Borrowing from Werner and Kaplan’s (1963/1984) discussion of the orthogenetic principle, one can argue that children are not only adding new and more vocabulary and syntax, but rather that old forms are given new functions and old functions are related to new forms (see also Bamberg, Budwig, & Kaplan, 1991; Berman & Slobin, 1994; Slobin, 1985, for further discussion).

The suggestion here regarding language is similar to one that has recently been made for theory of mind development (see, for instance, Gopnik, Slaughter, & Meltzoff, 1994), namely that such development is protracted (see also Nelson, 1996, Nelson & Kessler Shaw, chapter 2, this volume). One implication of this is the following: One cannot assume that early use of a form carries with it adult meaning. This implies the need to examine more than either the frequency or presence or absence of a form, and highlights the need to carefully examine the interrelationship between closely related forms and the functions they serve as parts of linguistic systems.

IMPLICATIONS FOR CONNECTION BETWEEN LANGUAGE AND THE STUDY OF THEORY OF MIND

Let me turn now to discuss the question: What are the implications of adopting an indexical approach to language for the study of theory of mind? I think there are multiple answers to this question but for now I focus on two. First, shifting to an indexical approach brings into relief the importance of looking not only at individual levels of language functioning (i.e., syntax, semantics, or pragmatics), but also at the consequences of
examining the changing relationships between these distinct levels. One implication of this is methodological. Research examining the connection between language and theory of mind would focus on the examination of a wider range of forms including not only mental-state terms, but also potentially a variety of nonlexical forms such as deictic terms (pronouns) and voice alternations (active vs. passive construction usage). In addition, once one moves beyond the examination of forms, one includes examination of the semantic and pragmatic features co-occurring with such forms (see Budwig & Bamberg, 1996).

The second theme already raised has to do with a particular view of development. Here focus shifts away from age of onset of particular words to an examination of changes in the ways forms and functions are related over ontogenetic time. A second theme then involves the examination of the protracted nature of development that implies an emphasis on the changing relationship between forms and functions of the entire linguistic system. Children are not assumed to be passively adapting to an adult system.

We turn now to examine two illustrations of this indexical-developmental point of view, first by examining forms such as desire talk terms that have been studied by theory of mind researchers, and second by looking at some other places children seem to creatively mark similar notions with alternative linguistic devices.¹

Mental State Terms From An Indexical-Developmental Perspective

I first turn to an analysis of how language is examined when it comes to the link between mental state desire terms such as want and theory of mind development. Data reported here stem from a study of 6 American children growing up in Northern California who ranged between the ages of 18 and 36 months and who were just beginning to combine multi-word utterances at the onset of the study. The children were videotaped for approximately 45 minutes twice a month (once with peers and once with mothers) for a 4-month period. The data were collected originally as part of a larger study of the early phases of children’s grammatical development (see Budwig, 1989, 1995). Our analysis consisted of isolating all instances of desire talk forms—for now I only refer to the most frequently used form want—and coding these according to semantic, pragmatic, and discourse features. For the present purposes, I summarize here just a few

¹I should note that my typical method of analysis makes use of crosslinguistic and culturally based comparisons but for our present purposes, I refer now to simply the English data patterns—though I am currently working with German and Hindi samples (see, for instance, Budwig, 2000b).
intriguing patterns found in our analyses of longitudinal differences and analyses focusing on differences in caregivers’ and children’s use of the mental state term want (see Budwig, Moissinac, & Smith, 2000; Moissinac & Budwig, 2000, for a more complete discussion).

General Characteristics of Children’s and Caregivers’ Desire Talk

The starting point of our analysis, as with any functional analysis, focuses on the relationship between forms, meanings and functions in the speech of the children and caregivers. After a brief description of some generalizations about children’s and caregivers’ systems, we turn to discuss some of the specific longitudinal findings (see Budwig, Moissinac, & Smith, 2000 for further details). Characteristic of indexical approaches, our analyses looked at the interface between particular desire forms, and how they linked up with particular semantic and pragmatic features of the utterances in which they were embedded. For instance, the use of desire talk verbs were examined in relationship to specific semantic characteristics such as who was the experiencer of the desire expressed (i.e., the child, the caregiver/others, or joint desire). In addition, desire talk verbs were examined in light of pragmatic aspects of how the utterance containing the desire term functioned (i.e., as an assertion, clarification, permission request, etc.). In examining caregiver and child discourse, emphasis was not on whether or not such talk occurred, but rather on the nature of the interface between language forms, meanings, and functions over developmental time.

In a preliminary analysis, an assessment was made of how frequently desire talk took place. Looking first at a comparison of the frequency of children’s and caregivers’ use of the term want we find that the two groups of speakers use them almost equally (caregivers had 236 uses across the study, whereas their children used the form 218 times). Both groups also used the term want similarly at the semantic level. When using want both children and their caregivers tended to use it in conjunction with a reference to the child’s desire. That is, 90% of all children’s uses were to their own desires, whereas 87% of all caregivers’ uses involved references to their child’s desires as well. Reference by both caregivers and their children to the caregivers’ desires was quite infrequent, making up only 4% of all desire talk.

The real difference in how children and their caregivers used desire talk concerned the pragmatic functions of such talk. A complete listing of coding categories and their definitions can be found in the Appendix. For present purposes, it is primarily important to understand the most general levels of distinction. For instance, at the pragmatic level of analysis at-
attention has been paid to whether desire talk is embedded within assertions, permission requests, clarification routines, and the like. Our analysis reveals that the majority of children's desire talk functioned as action assertions. That is, children used desire talk in ongoing events in conjunction with actions that led to fulfillment of their desires. The next two most frequent functions of children's desire talk were permission requests and internal state assertions. Action assertions were distinguished from internal state assertions in that with action assertions the speaker immediately acts on the desire asserted, whereas with internal state assertions the child asserts the desire but no action on the part of the speaker follows. Permission requests involved using desire talk to seek permission to fulfill their own desire.

We also examined caregivers' desire talk in terms of communicative function. In contrast to the children, the caregivers rarely used assertions at all. In fact, active assertions and internal state assertions only made up a combined amount of 16% of all instances of desire talk. How then did caregivers' desire talk function? Two particularly frequent speech functions of caregivers' desire talk included inquiries (33%) and permission requests (22%), and clarifications made up 11% of all desire talk.

In summary, there was little overlap between the function of caregivers' and children's desire talk. Given the semantic characteristics noted for caregivers' and children's desire talk (i.e., the caregivers' desire talk focuses on the child, whereas the focus of the children's desire talk also focused on themselves) this should hardly seem surprising. Caregivers, with their focus on their children's desires, were more likely to inquire about them and clarify them. The children, more focused on expressing their own desires, were more likely to use assertions. Our general findings suggest that although both children and caregivers cluster the use of desire talk with particular semantic meanings and pragmatic functions, each group of speakers works with clusterings that meet their own communicative needs.

The following example illustrates the basic patterning of caregivers using want to refer to their children's desires in utterances functioning as inquiries, whereas the children used this term to refer to their own desires in assertions.

**Example 1:** Grice (20 months) and her mom are playing tea party.

b. Grice: chocolate.
c. Mom: It's chocolate tea?
d. Grice: yeah.
e. Grice: I (inaudible) some more.
3. A DEVELOPMENTAL-FUNCTIONALIST APPROACH

Note, for instance, how in this example in line 1e, the child makes a general request to her mother that her mother cannot quite understand. Her mother follows this up in in the next line by inquiring, which is then affirmed by the child. A few moments later, after both have been pretending to drink tea, the child again asserts her desire (see line 1i). Such uses are characteristic of the two speakers. When caregivers tended to talk about desires, not only was it the desire of their child, but also typically in sequences where they had trouble interpreting what the child wanted. Language was used in an attempt to clarify or inquire about the nature of the child’s expressed desire. In contrast, the children’s desire talk typically focused not only on their own desires, but also in the context of asserting something about them. Although these patterns describe the overall patterns of caregiver and children’s desire talk, they say little about how individual caregivers’ and children’s systems change over developmental time. We turn now to examine some of the specific longitudinal findings concerning how the children’s and caregivers’ use changed over longitudinal time.

Longitudinal Characteristics of Children’s and Caregivers’ Desire Talk

Younger Versus Older Children. In examining the children’s use of the desire term want we noted that the children underwent a shift in usage about the time they begin using multi-word utterances of over three morphological units (mean length of utterance greater than 3). Although there were some interesting differences in the frequency of the use of want (i.e., the frequency went down over time) the most interesting differences were in the changing set of semantic meaning and pragmatic function linkages children created.

Early on—roughly just before the children were 2 and before they moved to a stage of mean length of utterance (MLU in morphemes) over 3—the children used want to refer semantically to their own desire to obtain objects. In many of these cases it was a caregiver who acted instrumentally to fulfill the child’s desires. In this sense, the dyad had worked out a routine in which the child asserted a state and the caregiver then worked...
to fulfill that desire. If the caregiver could not understand, which often was
the case, then the caregiver would proceed to inquire about the child’s de-
sires until mutual understanding had been achieved. In this sense, many
of the children’s assertions about desire with want functioned pragmati-
cally as requests:

Example 2: Jeffrey (30 months, MLU 2.82) and Mom are playing with
blocks.
Jeffrey: My want something → ASSERTION
Mom: Which — what would you like? . . . → INQUIRY
Would you like the red block? → INQUIRY

This usage contrasts with the later sessions when the children alter the
pattern of form, meaning, and function. Although the children con-
tinue to primarily refer to their own desires, these desires now tend to be
about performing actions and it actually is the child who goes ahead and ful-
fills the desire. As Example 3 illustrates, these utterances are not requests
for the mother to act as an instrument to obtain goods for the child. Rather
the child recognizes that she or he can act to realize her own des-
ires, but instead the utterance functions to seek permission.

Example 3: Jeffrey (33 months, MLU 3.68) and Mom.
Jeffrey: What’s this?
Mom: That’s a little microphone.
Jeffrey: I wanna talk in it. (Permission Request)
Mom: Okay.
Jeffrey: (talks into microphone)

The basic change that we found in the use of want in the usages that
came later in the longitudinal study was not one of a form not being used
to a phase of regular usage, as the form want was used by all children from
the earliest video recordings. Rather the major changes concerned the
semantic and pragmatic contexts in which this form occurred. Although
across all sessions the children were primarily concerned with their own
desires, over time there was a shift from the caregiver fulfilling the desire
referred to, to the child at times acting to bring about change. In addition,
there was a subtle shift in terms of what was being desired in the desire
talk. Early on, the child desired objects that were unavailable or inaccessible
to the child; over time there was a shift on the part of the child to also
verbalize desires to perform actions. The significance of this transition be-
comes clarified when we simultaneously consider pragmatic changes that
have taken place.
At the onset of the study, children's early uses of want coincided with assertions about desires, whereas later on want often functioned to seek permission. What is intriguing about this is that at the later point in development the children had the ability to act on their desires but first chose to verbalize those desires with their caregiver. That is, the child could have physically carried out the action desired but turned first to the caregiver to be sure this was sanctioned. What is most interesting about such cases is that they indicate that the children have a burgeoning awareness that desire alone is not enough to motivate human action. The children have come to recognize the social connectedness of action as well.

Mothers' Versus Children's Use of Want. We can turn now to consider how the children's mothers used want and to discuss the connection between the children's and mothers' uses of this term. Mothers used want less frequently over time just like their children. And also like their children, across the timeframe of the study, caregivers also changed the ways desire verbs linked up with semantic and pragmatic notions. Nevertheless, although changes could be found, the linkages differed in important ways from those used by the children. Early on the moms tended, like their children, to focus exclusively on the child's wants. Their usage primarily functioned as clarifications:

**Example 4:** Jeffrey (31 months, MLU 3.52) and Mom.
Child: My build their house.
Mom: You wanna build their house?

**Example 5:** Megan (21 months, MLU 2.30) and Mom.
Child: My see the fireman.
Mom: You wanna what?
Child: My see the fireman.
Mom: You wanna see the fireman?
Child: Yeah.

Later on the mothers' role shifts from one of providing clarification to one of suggesting or requesting permission to act in particular ways. At the point of this shift the children have begun using conventional want statements rather than the sort of "My + action verb" statements of desire illustrated in Examples 4 and 5, which led the mother to query for clarification. That is, the shift away from mothers using want in clarification queries is in part motivated by the fact that the mothers are better able to interpret the children's expression of desire. Interestingly, at the later points in time, the mothers' use of want appears in scenes in which the
children seem unfocused or are disengaged from playing with the toys. It is at these junctures that the mothers often provide suggests through the use of *want* queries:

*Example 6:* Jeffrey (33 months MLU 3.68) and Mom.
(Child has been adjusting blocks and muttering to himself)
Child: wait wait I haft — no xx xx.
Mom: You wanna build a little house to live in?
Child: Yeah.
(Mom and Child start to build house)
Mom: You wanna live in this little house?
Child: Yeah.

At times the mothers also use *want* in permission requests in which they not only seek permission but also are simultaneously making suggestions for how the child might proceed with the play:

*Example 7:* Megan (23 months, MLU 2.58) and Mom playing with blocks.
Mom: Do you want me to get you red triangles or . . .

These conversational uses often are not particularly tied to the children's desires at all. That is, there is no reason to believe that the mother's permission request in Example 7 is formulated in response to a sense that that is what the child desires. In this sense, the use of desire talk refocuses the dialogue, rather than being used to mirror some expressed desire on the part of the child.

**Summary**

To summarize, the findings reviewed here indicate that by the earliest transcripts (18 months) all children were able to use the mental state term *want*. As is noted in Examples 4 and 5, the children did not always use this terms in ways adults might have (see following discussion for an account of this). At the same time, it is important to note that the developmental changes found were not ones of the development of a new form, and in fact there is evidence that over the course of the longitudinal study the children's use of *want* actually decreased as they added new and related vocabulary items. What did change with development for the children was the range of pragmatic and semantic factors associated with the use of *want*.
Early on, the primary uses of *want* by the children were instrumental: Upon uttering a desire the caregiver acted to help the child gain access to objects or the caregiver provided a rationale to the child for why this was not possible. Later on, the children began using *want* with action verbs in utterances that functioned to gain permission to act in certain ways. As the children turned from the simple expression of *want* + object to include *want* + action utterances, a variation was found in form selection. *Want* was used with mention of objects and the variant *wanna* was used with utterances that talked about actions. This development suggests subtle changes in the recognition that desire alone often is not enough to motivate human action. That is, early on the child’s statements of desire led others to act on their own behalf. As the children developed, they often had the physical capabilities to act on their desires, but came to realize that in some cases they needed to first obtain social permission.

The issue of what led the children to develop these systems cannot be fully answered. The caregivers early on could be said to help their children come to understand conventional ways of expressing desire through clarification routines. As is illustrated in Examples 4 and 5, the mothers’ recasts highlight alternative ways for her child to make desires known. The later uses of *want* by the caregivers are more confusing to think about. The mothers typically appealed to the children’s desires, but actually these could best be viewed as the caregivers’ own desires disguised as those of their children’s. The longitudinal data don’t seem to provide any evidence that the children were confused by such usage. Indeed we see the children using desire verbs with permission requests themselves at around the same time the caregivers use them with permission requests as well.

In summary, research examining language from an indexical perspective strives to examine the ways children and caregivers link forms, meanings, and functions over developmental time. An argument has been made that from the start, children’s usage is inextricably tied to ongoing dialogue, much like what was suggested earlier in our review of prior work on language games (see Montgomery, 1997; Nelson & Kessler Shaw, chapter 2, this volume; Wootton, 1997). But note that a subtle difference between the indexical approach and the research reviewed earlier on pragmatics, is the idea that all uses of desire talk, not just the children’s, are what could be referred to as conversational. That is, rather than viewing development as moving from conversational uses of desire talk to desire talk that refers to genuine psychological reference, from an indexical perspective, all speakers—both caregivers and children alike—are quite tied to sense-making activities that are conversationally tied. Only with further crosslinguistic and cultural comparisons will we be in a better position to figure out the range of factors influencing the particular constella-
Nonlexical Indexes of Desire Talk

I turn now to a second way to approach the connection between language and theory of mind from an indexical perspective. Although most theory of mind research has examined language in terms of words or lexical development, I have found that an examination of alternative linguistic means such as the early and creative use of pronominal forms and voice contrasts (such as shifting from active syntax to either the use of middle or passive constructions) also sheds light on theory of mind issues. Although such uses, at first glance, seem to be part of grammatical development and therefore not clearly linked to theory of mind development, the argument made here is that the use of such linguistic devices can be equally revealing about important milestones in children's development of an understanding of mind (see Wootton, 1997 for a similar discussion of request forms).

Pronominal Reference

In prior work (Budwig, 1989, 1995) I have extensively studied early errors in pronominal usage in the longitudinal sample already described based on the six children raised in Berkeley. The children were noted to creatively contrast between the use of a variety of pronominal forms in subject position. Briefly let me illustrate this difference between two forms: *I* versus *My*. Early on, between the ages of roughly 1½ and 2½ years of age the children alternated between these two forms to mark a distinction between self as experiencer (*I want nuts, I like peas*) and self as agent (*My build the tower, My cracked the eggs*). They also distinguished more refined notions of experience to the extent that both *I* and *My* could appear with mental state verbs such as *want*. Although the utterances *I want the nut* and *My want the nut* seem almost identical, a functionalist analysis revealed that they occurred at distinct conversational junctures. Instances like *I want the nut* were said as a child was en route to picking up a nut; it was a sort of informative statement made by one child to her interlocutor to provide a motive for her departure from the play table. That is, the utterance functioned to inform her partner that she was picking up a nut that had fallen. In contrast, *My want the nut* was uttered by the child as a request for action to her mother when she wanted to get an attractive nut out of a pill bottle with a safety cap top she could not operate. Children seemed to be distinguishing between asserting something about a desire (matching an ongoing state) and attempts to invoke desire to bring about change. Example 8
(as well as the children's productions in Examples 4 and 5) illustrate this contrast:

**Example 8**: Megan (20 months, MLU 2.07) and Mom playing with manipulative toys.

Child: *I* want that one (lifting childproof container with nut inside).

Mom: Oh you want that one, okay.

Child: (tries to open container, fails) *My* open that!

Mom: What?

Child: *My* open that, mommy (handing container to mom).

Mom: Wanna open that?

Child: Yeah.

Mom: (opens container).

Note, for instance, that in her first utterance Megan appears to simply be stating her desire and goes ahead to try to obtain a nut that is inside a childproof container amidst some manipulative toys. After her attempts to open the container fail, she switches to the utterance "*My open that,*" and when her mother doesn't understand, Megan hands the container to her mother. Her mother's question of whether she wants her mom to open it (typical of the caregivers' early clarifying uses of *want* described previously) is responded to affirmatively and the mother complies.

Functional analyses revealed that at the time before the children regularly referred to others, they "borrowed" first person pronominal forms to situate themselves differently with regard to their perspective on their role in ongoing action frames. In addition to using *I* and *My*, the children also drew on a variety of other first person reference forms to mark other ways to situate self including affected agency through the use of *Me*, and use of their own name primarily in the context of referring to self in depictions without focus on intentional stance.

As I have noted in detail elsewhere, the children's systematic use of pronominal forms continued for several months and only gradually faded into a system more similar to adult-like usage (Budwig, 1995). Although there were some individual differences in the ways the children went about reconfiguring their pronominal systems, an overall pattern noticed was one of increasing differentiation and hierarchical integration. Two patterns are illustrated in Fig. 3.1 and Fig. 3.2.

Figure 3.1 depicts Megan's system across four months of longitudinal study. Megan's solution was quite straightforward. She began in Month 1 by differentiating between three different self-reference forms (two pronominal forms and one nominal form), each of which was used with a specific cluster of semantic and pragmatic notions. During Months II and III
Megan referred to herself only in assertions about self as experiencer. She simply avoided the other forms and their corresponding functions. In Month IV several self-reference forms were used, but now with a variety of functions.

Jeffrey created a second type of solution. As is illustrated in Fig. 3.2, Jeffrey also began in Month I with a fairly clean system of one-to-one mapping between form and functions. But for Jeffrey, in contrast to Megan, the process by which I began being used multifunctionally involved a protracted set of interim solutions. In Month II, Jeffrey has arrived at a new functional contrast for I and My. My continues to be used in subject posi-
Month I
Form
- I
- My

Pragmatic Function
- Non-Control
- Control

Semantic Meaning
- Experimenter
- Agent

Month II
Form
- I
- My

Pragmatic Function
- Non-Control
- Control

Semantic Meaning
- Experimenter
- Agent
- Joint
- Personal

Month III
Identical to Month II except WE replaces the functions of MY and MY used as quasi-modal

Month IV
Form
- I
- My
- We
- Will
- Gonna

Pragmatic Function
- Label
- Assert
- Request

Semantic Meaning
- Experimenter
- Agent
- Benefactor

Motives

FIG. 3.2. Jeffrey.

...tion in ways that deviate from adult usage, but the contrast now circles around the issue of motivation for action rather than control per se. If the motive for the action was personal desire, Jeffrey employed My, but if the motive was an interpersonal one based on a prior joint agreement, he switched to I. By Month III, Jeffrey viewed My as being more similar to modal forms. For instance, Jeffrey begins to say things like “I m’ant to build a tower.” At this time, Jeffrey also includes new pronominal contrasts into the system replacing the I/My distinction found in Month II with the...
distinction between *I* and *We*. By Month IV, the distinction Jeffrey draws between personal and joint motivations is marked with modal forms, and *I, My,* and *We* are used multifunctionally (see also Budwig, 1990a). Thus we see for Jeffrey an extremely protracted period of adding new forms of self-reference, reorganizing the functional clusters associated with previously used forms, and adding new forms other than self-reference forms into the system to mark functions previously covered by pronominal forms.

Regardless of the particulars, all the children in the study shared some overlap in the ways they moved from the special use of pronominal forms to adult-like usage. They began with relatively global, contextually restricted uses of forms and moved toward solutions involving hierarchical integration and differentiation. Not only did all the children enter a wider range of communicative situations and need to express an increasingly varied set of communicative functions, but they also drew on a great variety of linguistic resources.

**Voice Contrasts**

In my most recent work I have been examining the development of voice shifts and the situational contexts in which they appear. What this involves is examining the difference between utterances like:

- *I spilled the juice* (Active)
- *The juice spilled* (Middle)
- *The juice got was spilled (by x)* (Passive)

My crosslinguistic work reveals that around the age of 2½, just as children begin using *want* to seek permission, they also begin employing these sort of voice contrasts to index distinct stances on the ongoing context (see Budwig, 1990b; Budwig, Stein, & O’Brien, 2001). Whereas there is a clear preference (as in adult talk) for active voice, the shifts to passives and middles are intriguing. The American children use middles for several months in just one activity context, one that I have summarized as “resistance from the environment.” That is, they appear in contexts when the child has announced particular desires (e.g. *I wanna build the tower*) and then the desire is somehow blocked. It is at these junctures of goal blocking that the middles appear. For instance, as the child attempts to clip on a microphone he wishes to wear and this fails he uses the middle: “*It came off again.*” As another child announces her desire to open the door of a toy helicopter and is unable to do this, she switches to the middle and utters “*The doors won’t open.*” And when attempting to build a tall block tower which fails several children comment with a middle “*That fell over.*”
Whereas at first glance focus on voice contrasts may appear to have little to do with desire talk, I find them to be particularly relevant. Their onset of use is just around the time when these same children begin using *want* in permission requests and when they start using *We* as a marker that highlights actions that are not carried out due to personal desire per se (see Budwig, 1990a, for discussion). The middles mark action sequences that fail despite desires. Taken together, these findings provide converging evidence for intriguing developments in how children complexify the relation between desire and action. Such findings suggest that children recognize that desire is not sufficient to bring about change.

**Summary**

In the last section, I hope to have made the point that careful attention to aspects of language other than mental state terms can be productive for a better understanding of the connection between language and theory of mind development. What both the lexical analyses, as well as the analyses of pronominal and voice contrasts share, is simultaneous focus on multiple levels of language. In each instance, not only were particular words or constructions in focus, but also semantic and pragmatic aspects of such usage were considered.

Simultaneously, I have illustrated that language development itself undergoes subtle and important developmental shifts. This suggests the importance of going beyond measures of “earliest” usage or frequency and moving toward more fine-grained analyses of the relationships between forms and context over longitudinal time.

In particular, I have argued that once one begins to examine multiple layers of language simultaneously (i.e., forms, meanings, and functions), one recognizes some overall patterning best accounted for in terms of Werner and Kaplan’s discussion of the orthogenetic principles and Slobin’s crosslinguistic support for the idea that old forms replace new functions and new forms replace old functions. This complexifies any discussion of the mechanisms pushing understanding of mind, and in particular, the specific links between language, cognition, and development—a theme to which we return in the final section of this chapter.

**CONCLUDING COMMENTS**

In this chapter, I have outlined a developmental-functionalist approach suggesting the importance of looking at the use of linguistic forms embedded in social practices. I have attempted to illustrate that careful examination of the relation between linguistic forms and semantic and pragmatic
features that co-occur with their usage can be a powerful analytic tool for the theory of mind researcher. The view of language that I have been forwarding here is somewhat different than that typically emphasized in developmental research. As I argued earlier, developmental psychologists have focused primarily on the symbolic aspect of language, that is language as representation means. Although representation is clearly an important function of language, I have emphasized the importance of looking at language in terms of indexicality (see also Budwig, Wertsch, & Užgiris, 2000). I have argued here that focusing on language as indexical provides the researcher with an important research tool including analysis of forms other than words "representing mind." I have made the argument elsewhere (Budwig, 1998, 1999) that indexicals not only provide an important tool for the researcher, but simultaneously provide the child a powerful means of socialization. I do not elaborate on this point here, however, my sense is that burgeoning work in the area of language socialization could well be integrated in intriguing ways into developmental work focusing on theory of mind.

A second point I have attempted to make in this chapter is that in examining the relationship between language and theory of mind, we must keep in mind that just as theory of mind has a protracted development, so too does language. Therefore, when examining language forms we must be careful not to assume that early use is equivalent to adult usage. At the same time, children's creative uses and developmental changes in the relationship between various forms and functions provide an excellent resource for better understanding the development of a theory of mind.

In concluding, I would like to return to the issue of the role of language in children's developing understanding of mind. I, like many others, have proposed that language can be viewed as more than a consequence of prior developed cognitive categories. Nevertheless, the particular view of language and the particular view of development lead to some alternative suggestions about how that relationship is best considered. Two that I consider here include (a) the grammaticalization of action, and (b) means–ends relations directing the organism toward increasing differentiation and hierarchical integration.

One central claim about the language–thought relationship is that it is a dynamic one. Following Humboldt's discussion of language as energia (energy, activity) that gives expression to thought emphasizes the idea that the relationship is bidirectional. On the one hand, language is a sort of map of how a speaker apprehends the world. It is one of many interpretations and to this extent plays a dynamic role in contributing to the development of worldview. Similarly, Wootton (1997) has argued that lan-
language, which he viewed as sequentially organized patterns of local understandings, plays a significant role in meaning-making:

In these ways, for the child, the sequential context comes to be the bearer of a new order of information, information that permits more finely tuned forms of calibration with the views of her co-participant. The child's actions can now become contextualized along lines that are commensurate in precise ways, with the understandings which prevail in the local culture to which she is being exposed. (p. 9)

Both within and across utterances, language plays a dynamic role in the build-up of thought activity.

At the same time, I have noted that individuals bring to dialogue a propensity to use symbolic means for communicative ends. Here the bidirectional relation is more immediate. As noted earlier in discussing Werner and Kaplan's view of the orthogenetic principle, children from the start interpret their worlds in terms of certain "formula-like schemata" imposing certain action-models that guide the early development of symbol usage. The imposition of these schemata, which Slobin (1985) and others have shown to be a universal property of early language development (see Budwig, 1995, for review) remind us that any discussion of the role of language on thought must account for the inextricable linkage of conceptualization and language.

In summary, like others in this volume, I have argued that linguistic symbolization plays a fundamental role in concept development. Its role must be viewed, though, both as dynamic and bidirectional. Clearly, developments in language as a system provide important tools for thought. Likewise, development of language as a system of forms, meanings, and function pairings allows for developments in communicative interactions that themselves have been said to impact on conceptual development. Studying the intricate relations of language viewed in this way surely will provide a better view of the complex process involved in the ontogenetic development of an understanding of mind.

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APPENDIX

Pragmatic Coding

_active Assertion_: Speaker asserts a desire and acts on it. This is not limited to actions that realize the desire, but also to actions that emphasize the speaker’s desire or those that point in the direction of desire fulfillment.

Internal State Assertion_: Speaker states desire without acting on it. This differs from an active assertion in that the speaker remains passive and waits for her interlocutor to act to fulfill the stated desire.

Clarification_: Speaker reaffirms the desire or other.

Permission_: Speaker seeks permission to fulfill her own or her interlocutor’s desire.

Inquiry_: Speaker acts on own desire to inquire about other’s desire concerning an object or action in the form of a question, without seeking permission.

Invitation_: Speaker invites other to co-participate in action.

Objection_: Speaker protests/objects to other’s desire/action.

Suggestion_: Speaker suggests an action to her interlocutor. This is usually in statement form but occasionally takes the form of a question.

Other Directive_: A directive that does not fit into above.

Multifunctional Act_: Any combination of above.

Uncodable_: Utterances that cannot be interpreted and pretend talk.

REFERENCES


Relational Language and Relational Thought

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Human cognitive abilities are remarkable. We easily go beyond what is perceptually available to reason about abstract systems. Our cognitive ability to adapt to a vast range of environments, and even to alter our environment to suit our desires, has given our species so great an advantage over other mammals that we are now poised to exterminate most of our former predators, and must use our ingenuity to preserve a few. Indeed, for many theorists, the sophistication of adult human reasoning defies any explanation based on learning.

How do we get so smart? Traditional theories of cognitive development can be grouped into four broad categories. Behaviorist accounts used mechanisms of association and stimulus generalization over perceptual gradients to explain learning, eschewing discussion of mental representations. Current descendants of this view rely on mechanisms such as statistical learning of transitive probabilities. Piagetian constructivism postulated increasingly complex mental representations learned through the child’s interactions with the world and cognitive stages characterized by different representational formats and logical operations (Piaget, 1951, 1955). Another constructivist approach is Vygotsky’s (1962) theory that abstract cognition develops through the child’s interactions with cultural and linguistic systems. The fourth approach, of renewed interest of late, is a nativist approach that postulates that children possess nascent cognitive systems and theories that unfold through interaction with the world.
The theories of Piaget and Vygotsky offer a rich and appealing view of cognitive development. In particular, Piaget's claim that children can represent and reason over structured knowledge schemas and Vygotsky's claim that language and culture influence cognitive development have remained influential. However, Piagetian stage theory has been challenged by demonstrations of early learning. Further, both theories lack specificity in their accounts of how learning occurs.

The inadequacy of learning mechanisms powerful enough to explain the development of abstract cognition is all the more apparent in light of increasing evidence of the sophistication and generativity of early cognition and language (Mehler & Dupoux, 1994). The past two decades have seen many striking demonstrations of very early insight into number (Gelman, 1990; Gelman & Gallistel, 1978), the behavior of objects in space (Baillargeon, 1987, 1991; Spelke, 1988, 1990), and the composition of basic-level categories (Waxman, 1990; Waxman & Kosowski, 1990). Very young children have been found to categorize (Mandler & McDonough, 1993) and/or to differentiate between domains based on functional principles (Gelman, 1989; Hirschfeld & Gelman, 1994; Keil, 1994), and infants were seen to have remarkable early language proficiency (Gleitman & Wanner, 1982; Pinker, 1994). Children's early achievements vastly outstripped the predictions of the available accounts of learning. The inescapable conclusion, to many theorists, was that much of our knowledge is built in: There must be innate domain-specific principles or skeletal systems that frame our later knowledge.

But perhaps we have dismissed learning too quickly. True, purely behaviorist learning accounts, with minimal representational commitments and mechanisms of simple association and perceptual similarity generalization, cannot account for the acquisition of complex knowledge. And true, Piagetian and Vygotskian approaches have not met our current expectations for theoretical specificity. But we maintain that the richness of constructivist theorizing is compatible with current accounts of learning processes. Our proposal draws on insights from cognitive science models of learning. It is aimed at capturing the development of abstract relational thought—the sine qua non of human cognition.

Relational learning encompasses not only how children acquire abstract relational systems such as mathematics, but also how they learn the theory-like relational information that informs their understanding of ordinary concrete entities. For example, children come to know that both tigers and sharks are carnivores, whereas deer and hippopotamuses are herbivores, that tigers prey on deer, and so on; or, that a taxi is not defined as a yellow car but as a vehicle that can be hired (Keil & Batterman, 1984). Table 4.1 shows a sample of relational terms, chosen to suggest the range
and utility of relational language. Many of these terms are acquired in childhood, although not necessarily with their full relational meanings.

To preview the approach, we suggest that much of children's learning prowess stems from carrying out comparisons that yield abstractions. Some of these comparisons are grounded in the child's own experience, as when infants repeat an interesting event over and over in the circular reactions noted by Piaget (1952). Other comparisons are culturally invited, either explicitly by the child's caretakers (e.g., "Look—see how the hawk looks like the eagle?") or implicitly by the fact that two situations have a common linguistic label (e.g., "These are both houses"). These early comparisons are typically based on close, concrete similarity. Later, comparisons among less obviously similar exemplars promote further inferences and abstractions. We suggest that comparison is not a low-level feature generalization mechanism, but a process of structural alignment and mapping that is powerful enough to acquire structured knowledge and rules (Gentner & Medina, 1998; Gentner & Wolff, 2000).

The plan of the chapter is as follows. We first discuss evidence that analogical learning processes can foster the acquisition of abstract relational

| TABLE 4.1 |
| A Sampling of Relational Terms |
| **Spatial Relational Terms** |
| in | bisector | approaching |
| on | symmetric | preceding |
| under | monotonic | increasing |
| between | equilateral | passing |
| across | the limit of | half |
| $y$ as $x \to 0$ | quarter |

| More Relational Terms |
| carnivore | cause | forget |
| parent | incite | expect |
| gift | prevent | remember |
| target | prohibit | intend |
| passenger | engage | persuade |
| weapon | inverse | deny |
| friend | converse | |
| twin | identical | |

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knowledge. We then examine two ways to invite the comparison process: physical juxtaposition, that is, the direct observation of two comparable exemplars; and symbolic juxtaposition, that is, applying common language to two situations. The former is what we typically discuss in the course of studying analogical processing. Yet we think the latter is fundamentally important as well. We present evidence that language both invites specific comparisons and reifies the resulting abstractions. We begin by discussing structure-mapping as a learning process, and then turn to the role of relational language in furthering this process.

Comparison as Structural Alignment and Mapping

According to structure-mapping theory, the comparison process is one of alignment and mapping between structured conceptual representations (Falkenhainer, Forbus, & Gentner, 1989; Gentner, 1983, 1989; Gentner & Markman, 1994, 1997; Goldstone, 1994; Goldstone & Medin, 1994; Markman & Gentner, 1990, 1993, 1996; Medin, Goldstone, & Gentner, 1993). The commonalities and differences between two situations are found by determining the maximal structurally consistent alignment between their representations. A structurally consistent alignment is characterized by one-to-one mapping (i.e., an element in one representation can correspond to at most one element in the other representation) and parallel connectivity (i.e., if elements correspond across the two representations, then the elements they govern must correspond as well). When more than one structurally consistent match exists between two representations, contextual relevance and the relative systematicity of the competing interpretations are used. All else being equal, the richest and deepest relational match is preferred (the systematicity principle). An important psychological assumption—particularly if one hopes to model learning in children—is that achieving a deep structural alignment does not require advance knowledge of the point of the comparison. (If it did, it would be relatively useless as a developmental learning process.) Structural alignment can be accomplished with a process that begins blind and local.

We briefly describe a computer model of structure-mapping theory, the Structure-mapping Engine (SME), to give the flavor of this local-to-global alignment process (Falkenhainer, Forbus, & Gentner, 1989; Forbus, Gentner, & Law, 1995). When given two representations to align, SME begins blindly with a set of local, mutually inconsistent matches and gradually coalesces these into one or a few deep, structurally consistent alignments.

SME carries out its mapping in three stages. In the first stage, it proposes matches between all identical predicates at any level (attribute, func-
tion, relation, higher order relation, etc.) between the two representations. At this stage, there are typically many mutually inconsistent ($1 \rightarrow n$) matches. In the second phase, these local matches are coalesced into small, structurally consistent connected clusters (called kernels). Finally, in the third stage these kernels are merged into one or a few maximal structurally consistent interpretations (i.e., mappings displaying one-to-one correspondences and parallel connectivity). SME then produces a structural evaluation of the interpretation(s), using a cascade-like algorithm in which evidence is passed down from predicates to their arguments. This method is used because it favors deep systems over shallow systems, even if they have equal numbers of matches (Forbus & Gentner, 1989). Finally, predicates connected to the common structure in the base, but not initially present in the target, are proposed as candidate inferences in the target. This means that structural completion can lead to spontaneous unplanned inferences. Thus, the process begins with local matches, allowing the interpretation to emerge from the commonalities. But the final interpretation of a comparison is a global match that preserves large-scale structures.

This process model has important implications for the process of comparison in learning and development. First, because matches at all levels enter into the maximal alignment, the easiest and most inevitably noticed similarity comparisons should be those of rich overall (literal) similarity. Indeed, a concrete match like (1) and (2), in which both the objects and the relations match, is intuitively easier to process than an abstract match like (1) and (3), or yet more challenging, (1) and (4):

1. The mother Husky licks her puppies.
2. The mother wolf licks her cubs.
3. The mother falcon grooms her chicks.

For pairs like (1) and (2), the comparison process runs off easily, because the matches are mutually supporting, yielding one clear dominant interpretation. There is considerable evidence that novice learners and children can perceive overall similarity matches before they perceive purely analogical matches. There is also evidence that adults process concrete matches faster than purely relational matches (Kurtz & Gentner, 1998) and high-similarity matches faster than low-similarity matches (Wolff & Gentner, 2000). Further, there is evidence that rich concrete matches, such as two identical dachshunds, are perceived as more similar than sparse concrete matches, such as two identical circles (Gentner & Rattermann, 1991).
Comparison Can Promote Learning

On this account, there are at least four ways in which the process of comparison can further the acquisition of knowledge: (a) highlighting and schema abstraction—extracting common systems from representations, thereby promoting the disembedding of subtle and possibly important commonalities (including common relational systems); (b) projection of candidate inferences—inviting inferences from one item to the other; (c) re-representation—altering one or both representations so as to improve the match (and thereby, as an important side effect, promoting representational uniformity); and (d) re-structuring—altering the domain structure of one domain in terms of the other (Gentner & Wolff, 2000; Gentner, Brem, Ferguson, Markman, Levidow, Wolff, & Forbus, 1997). These processes enable the child to learn abstract commonalities and to make relational inferences.

Alignment and Abstraction. Highlighting commonalities may seem like a rather trivial learning process, but this is not true in the case of common relations. Here we present evidence to make the case for the importance of relational highlighting. SME's alignment process, taken as a model of human processing, suggests that the act of carrying out a comparison promotes structural alignment and renders the common structure more salient (Gentner & Wolff, 1997, 2000; Gick & Holyoak, 1983; Markman & Gentner, 1993; Wolff & Gentner, 2000). We have found considerable evidence that mutual alignment promotes learning and transfer. That is, when a learner is induced to compare two things—for whatever reason, be it common labels, perceptual similarity, or similar roles in pretend play—the alignment process renders the common relational structure more salient and prompts their re-representation at a more abstract level (Gentner, Rattermann, Markman, & Kotovsky, 1995; Gick & Holyoak, 1983; Kotovsky & Gentner, 1996; Loewenstein, Thompson, & Gentner, 1999; Thompson, Gentner, & Loewenstein, 2000).

In one set of experiments, we studied the effect of making comparisons on 3-year-olds' ability to perform mapping tasks (Loewenstein & Gentner, 2001). We used a version of the classic spatial mapping task developed by DeLoache and her colleagues (DeLoache, 1987, 1989, 1995; Uttal, Shreiber, & DeLoache, 1995). Children were tested on their ability to find a hidden toy in a model room after being shown the location of an identical toy in an analogous model room. The task was deliberately made fairly difficult. First, the "Hiding room" and the "Finding room" were perceptually different: That is, although the objects in the Hiding and Finding rooms belonged to the same categories, they were different in shape and color. Such perceptual differences between the corresponding objects
make the mapping task more difficult for children (DeLoache, Kolstad, & Anderson, 1991; Gentner & Toupin, 1986). Second, the Hiding and Finding rooms each contained not only unique objects—a bed, a desk, and a rug—but also two identical “twin” stools (after Blades & Cooke, 1994). These twin objects made the task more challenging, because such mappings cannot be accomplished purely by matching objects: Children must also attend to spatial relational information to disambiguate the matches. This twin manipulation is particularly informative because it allows us to tell whether children can surpass the typical initial strategy of simply matching objects (Blades & Cooke, 1994; Gentner, 1988; Gentner & Rattermann, 1991; Halford, 1987). To succeed at this mapping task—particularly at mapping between the twin objects—children must note relational correspondences as well as object matches.

The basic procedure was similar to the DeLoache (1987, 1995) standard task. Children aged either 36 months or 42 months played a hiding and finding game in which the experimenter hid a toy in the Hiding room while the child watched. The experimenter explained that the child could find a similar toy in the same place in the Finding room. Before beginning this task, the children were divided into two groups that received different pre-task experiences. The comparison group received a brief introductory experience in which children saw the Hiding room, with another virtually identical room (the Hiding2 room) next to it. The only difference between these rooms was the color of the walls and furniture. The experimenter said “Do you see how these are the same? Let’s see how these are the same.” He then pointed to an object in the Hiding2 room, and asked the child to point to “the one in the very same place” in the Hiding room. The experimenter and the child went through all the objects in the room in this fashion. The experimenter then removed the Hiding2 room and brought out the Finding room, and began the standard hide-and-find task just described.

The second group was the baseline control group, which was not given a pre-task comparison experience. However, to equate the amount of time children were given to study the Hiding room, we asked the control children to tell us the functions of all the objects in the Hiding room (or, in another study, the colors of all the objects).

Once the pre-task experience was completed, the experimenter brought out the Finding room. Both groups were then given the same search task. As predicted, comparing highly similar examples helped children in the subsequent mapping task. Children in the comparison condition (.77) performed better than children in the control condition.