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Linguistic Determinism and the Understanding of False Beliefs

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1.0 Introduction

We intend in this chapter to put forward a radical proposition about the relationship between language and the understanding of false beliefs. We begin by contrasting the roles that language acquisition might play with respect to the development of theory of mind reasoning, separating out the language-for-the-task from the social constructivist view of language as one of several facilitators of social cognition, and both of these from the strongest position that certain linguistic structures make available a representational format for false beliefs. We then present empirical data from a longitudinal study of normally developing preschool children and from our work with language-delayed oral deaf children, to test among the rival hypotheses for the role of language in the development of false belief reasoning. The empirical data make a surprisingly coherent story, though many pieces remain to be worked into the puzzle. The empirical story is at least suggestive enough that it forces us to examine the strongest theoretical position seriously, and ask, is it viable?

2.0 Overview of general theoretical positions on language of mind

2.1 Coincident development in language and theory of mind

Several researchers have noted that mastery of false belief reasoning tasks is closely related to measures of language ability, in both normally developing and autistic children (Happe, 1995; Tager-Flusberg, 1993, 1996; Tager-Flusberg & Sullivan, 1994). For example, Jenkins & Astington (1996) found that general false belief understanding, summed across four standard tests of false belief reasoning, was significantly correlated with measures of syntactic and semantic maturity on the Test of Early Language Development (TELD), even when the effects of age were partialled out. More specifically, the sophisticated use of sentence forms involving mental state verbs and their complements coincides roughly in time with the child's successful performance on standard false belief tasks (Astington & Jenkins, 1995; Bartsch & Wellman, 1995; de Villiers, 1995a; Tager-Flusberg, 1996). The usual proposal to account for this relationship is that the understanding of beliefs and states of mind is prerequisite for correctly using the linguistic forms that express those concepts -- the standard orthodoxy of cognitive determinism of language development (e.g. Cromer, 1991 ; Tager-Flusberg, 1993). Hence in many cases the emergence of children's talk about mental states, using verbs such as "want", "need", "think", "know", and "remember" has been taken as a marker of their growing underlying conceptual understanding of a variety of mental states in themselves and others (Bretherton & Beeghly, 1982; Shatz, Wellman & Silber, 1983; Wellman, 1990; Bartsch & Wellman, 1995).

However, there has recently been increased interest in examining which particular aspects of language may be fundamentally involved in theory of mind development and in specifying more clearly the precise nature of the relation between language and theory of mind. "We will make little progress in understanding how theory of mind is acquired unless we investigate more closely how development of a theory of mind relates to development of language." (Bartsch & Wellman, 1995, p. 209)

2.2 What aspects of language might be involved?

As Astington and Jenkins (1995) point out, in exploring this issue researchers have focused on several different features of language. Thus several have suggested that an understanding of people's mental states -- their intentions, desires, beliefs and states of knowledge or ignorance -- is both a prerequisite for and emerges out of the pragmatics of conversational communication (de Gelder, 1987; Shatz, 1994; Peterson & Siegal, 1995; Harris, 1996). Reading an interactor's communicative intentions is a fundamental component of conversation, as is the adjustment of one's own utterances to fit the listener's states of knowledge and belief (Grice, 1975; Sperber & Wilson, 1987). Breakdowns in communication serve to focus attention on differences in the assumptions and beliefs of the interactors.

Others have focused on the semantics of mental terms and the emergence of these lexical items in the language of the child to refer to both their own and others' mental states. Olson

(1988) argued that theory of mind development requires a language for talking about the mind, a metalanguage based on the semantic understanding of terms such as “think” and “know”. Bartsch and Wellman (1995) believe that children’s use of these words provides a window on the child’s growing understanding of the concepts that underlie them. Similarly, Gopnik and Meltzoff (1997) propose that conceptual and semantic development may go hand in hand: at particular periods of development when the child is actively engaged in solving specific conceptual problems (such as those to do with a theory of mind) their attention may be drawn to learning words that are relevant to those problems.

Still others have argued that there is a relation between theory of mind understanding and language at the syntactic level. Feldman (1988) sees the link at the level of the topic-comment structure of languages and the process of linguistic recursion by which comments are turned into topics. She argues that a similar recursion rule is needed for the child to be able to reflect on their own and others’ mental attitudes in a mature theory of mind. Thus the mastery of recursion underlies both the linguistic advances of the child and their emerging thinking about thinking during the third and fourth year of life. Both de Villiers (1995a, 1995b) and Tager-Flusberg (1995, 1997) have noted that verbs of communication (e.g. “say” and “tell”) and mental state (e.g. “think”, “believe”, and “know”) are the two primary classes of verbs that take embedded sentential complements. The syntactic process of complementation allows for the embedding of one propositional argument under another proposition, as is needed for the expression of propositional attitudes such as beliefs and states of knowledge. Furthermore, in these sentential complement structures a false proposition can be embedded under a verb of mental state and the whole sentence nevertheless remain true, so the syntax of complementation may be uniquely suited to the conceptual representation of false beliefs.

2.3 What role does language play in theory of mind development?

The nature of the relation between language and theory of mind development has also been conceptualized in several different ways (Astington & Jenkins, 1995).

1. <u>Conceptual understandings of the mind develop first and are the basis onto which language maps.</u>

For a long time the dominant view has been that cognitive development leads the way, with a conceptual understanding of mental states emerging out of the interaction between maturing cognitive capacities and social awareness from interaction with others. More cognitive theories of ToM development have differentially stressed innate modules and the role of maturation (Leslie, 1994), the cognitive development of different levels of representation (Perner, 1991), or more general cognitive skills such as working memory (Olson, 1993; Mitchell & Lacohee, 1991; Freeman, 1994) and executive function (Frye, Zelazo, & Palfai, 1995; Russell, 1996). More social theories have stressed the child's active participation in social interaction and the interpersonal context as the basis for the emergence of both concepts about other minds and language about the mind (Hobson, 1994; Shatz, 1994).

2. <u>Conceptual understandings of the mind develop first but the child's underlying competence may be masked in theory of mind tests by linguistic complexity and pragmatic features of the language of the task</u> (Freeman, Lewis & Doherty, 1991; Siegal & Peterson, 1994).

This is a "weak" hypothesis about the role of language in theory of mind development. Language is seen as simply one of several possible performance variables (such as working memory limitations) that may constrain or limit the child's task performance. Language acquisition plays no fundamental or causal role in the conceptual changes taking place in the child's theory of mind: at best it has an indirect or peripheral effect through its impact on performance.

Many of the standard tests of reasoning about mental states involve the child in following and integrating a verbal narrative, often supported by pictorial or dramatic representation of the events. These are followed by questions posed by the tester. The language in which the false belief questions are posed has a significant effect on whether three to four-year-old preschoolers pass the standard tasks or not.

For example, key questions assessing the child's understanding of false beliefs are sometimes put in the form of multi-clause sentences with "think" and an embedded complement clause, such as:

Where does Johnny think his candy is? or

Before she looks inside, what will Sarah think is in the box?

Obviously to answer these questions correctly, the child must have acquired sufficient language to comprehend such embedded complement structures with verbs like "think" and "know", and there is bound to be a strong relationship between their language skills and their performance on these tests.

More subtly, the wording of the question may communicate particular conversational presuppositions about how it should be answered. So in the usual task in which an object's location is changed, Siegal & Beattie (1991) changed the test question to "Where will Jane look <u>first</u> for her kitten?" Simply inserting the word "first" in this way significantly increases the percentage of three-year-olds who answer correctly in terms of the character's false belief (see also Leslie, 1994). This is because the conversational pragmatics now communicate to the child that the question should not be taken to mean "Where will Jane find her kitten?" or "Where should Jane look for her kitten?". Rather the insertion of "first" indicates to the child that Jane may be wrong at first but still look in the "right" place eventually.

Even when the language of the task does not itself involve an understanding of complex language about the mind, the child's language skills can be a major constraint on their performance. Thus Lewis (1994) has demonstrated that children's ability to recount the narrative in standard false belief tests, and so to organize their memory for the events in verbal form, contributes to successful performance on the subsequent false belief reasoning questions posed by the tester.

3. Language facilitates social cognition and development of a theory of mind by focusing attention on the mental explanation of behavior (Dunn, Brown, Slomkowski, Tesla & Youngblade, 1991; Bartsch & Wellman, 1995).

It is possible that access to language about mental events scaffolds the child's understanding in a more expedient way than observation of social interaction alone. Human children do not need to learn simply by observation, because the people around them structure that understanding through talk. Dunn et al (1991) demonstrated a relationship between the amount of talk about feelings and causation of behavior in various families and the children's understanding about beliefs, emotions, and desires 7 months later. Astington and Jenkins (1995) consider as one explanation of their data the "social constructivist" view that ToM is mediated by talk within the family. Similarly, Peterson and Siegal (1995) in a study of deaf children's ToM development, entertain the idea that "communicative fluency" is what engenders the social relationships necessary to build a ToM. Adults and other children use language to refer to such states of desire and belief from the time the child is quite young, and provide a discourse about other persons that might serve as a vital experience in the child's conception of others' minds. In the extreme, language could merely highlight pretense, desire, and false belief events without explicitly representing them. Imagine a mother sits down with her child and in front of his eyes, pours salt into her tea. She might groan and say, "Oh no! I wanted the sugar!" or, "OOPS! I made a mistake!" It seems plausible to suggest that language provides a marking that highlights unusual behavior that has no surface explanation, i.e. behavior that requires the development of a "folk psychology" of intention, desire and belief, thus children as young as three and four are brought more rapidly to that understanding. On this account, there is nothing particularly special about the structure or the content of language, as long as it serves to draw the child's attention to the odd event. However, the facts suggest that the child does not just hear exclamations of distress, but rather begins to learn the way we talk about such events in our culture.

4) The language of complementation provides a representational structure for embedded propositions.

In the example above, the language event provides a marking but not an explicit representation of the mother's false belief, which would still need to be inferred and represented, as something like: "Mother thought she was pouring sugar in her tea." But we have been driven to ask: in what form is that representation, and could language facilitate that representation more directly? If one believes that the representation of false beliefs is not propositional at all, perhaps being mediated by identification or empathy, then linguistic complementation would play no specific role in enhancing it (See e.g. Gopnik, 1993, for discussion of alternatives). However, we continue to find the representational position more persuasive, or at least less disruptive of our other philosophical commitments.

We have argued that a child who becomes capable of the language of complementation, namely embedded propositions, might have available a new representational capacity for propositional attitudes. That is, perhaps the complex syntax that is used for describing mental events makes possible the representational changes that allow for understanding false beliefs. The language for discussing mental events provides the child with a formal means of embedding propositions, and thus provides a necessary ingredient for representing false beliefs. This theory would impute a much more significant role to language development than is currently discussed.

Consider some special properties of sentences involving mental states that might provide this representational means. Sentences involving mental states require an embedded proposition called a **complement** in linguistics**:** He thought it was a lion. Complements appear under verbs of desire (want), communication (say, ask) and mental state (know, think, forget). Some of these verbs can take a simple NP (She wants a ride) but they can also take a whole embedded proposition (We forgot that he lost the key). Complements provide a way to discuss lying or mistakes:

He said he had salad for lunch (but he really had pizza)

He thought he left the door open

Notice that the overall sentence can be true, though the embedded complement can refer to a proposition that is false, e.g. in this latter case he shut the door. Thus complementation provides a means of representing someone's mental world, and that mental world could be distinct from our mental world. On this account it is not just that language provides the discourse within which children reach an understanding of mind, it is critically that it also provides structures of the right semantic complexity and power for the representation of false beliefs.

de Villiers (1995a) speculated about the stages of development necessary for the child to reach false belief understanding, and traced its development to the emergence in language of complements that express mental state and communication verbs, summarized in the following model:

> Step 1: the child masters the basic sentence forms: a simple sentence is mapped onto a simple event. The child encounters true sentences that match reality.
>
> Step 2: the child first encounters discrepancy between sentences and reality: the child learns to recognize pretense as well as mistakes.
>
> Step 3: the child masters the first embedded structures under verbs of communication/mental state/desire: child acquires the fundamental syntax of embedding but makes no accommodation of meaning within that structure. That is, the complement retains its truth value as a simple sentence independent of the matrix verb. So, if the child hears a sentence such as "Jim said he ate the broccoli", the child thinks it is true both that Jim said something, and that he ate the broccoli.
>
> Step 4: the child first notices occasions with verbs of communication that suggest the complement can be false when embedded e.g. reports of lying, mistakes. For example, the child notices that what Jim said he ate is not what he really ate. Because statements are overt and can be compared to reality, the semantic accommodation is made evident.
>
> Step 5: the discovery about semantic accommodation mastered with the complements of verbs of communication can now be extended to verbs of mental states, e.g. beliefs. The child can then understand a statement such as "Jim thought he ate broccoli", to imply that

Jim had a false belief. The "thought" is not overt, so it must be inferred from actions or statements, but the analogy with communication structures allows the sentence to be understood, thus the possibility of other minds with thoughts that do not map onto one's own reality is given expression.

This model attributes a significant role to the child's exposure to sentences and events containing acts of mis-speaking (lying, mistakes) as the stepping stone to the mastery of sentence complements, which then become available for representing the invisible thoughts and beliefs of others. The position taken in this model is a variety of linguistic determinism: linguistic complementation allows the representation of "propositional attitudes" such as needed in a Theory of Mind framed in a language of thought. The model tries to capture how the development might be bootstrapped by linguistic structures in domains less opaque than mental states.

de Villiers (1997) elaborates the claim that young children below the age of about 3 and a half years mis-represent the structure of embedded complements such as:

He said he drank milk.

We have consistently found that children younger than about age 4 years do not represent complement structures, even about communication verbs, in a completely adult fashion. In particular, children have a difficulty with questions such as:

What did he say he drank?

if the character said he drank something other than what he really drank. The strong tendency is for young children to respond as if they were answering instead the question:

What did he drink?

(see also Wimmer & Hartl, 1991; Riggs & Robinson, 1995). Having tried several alternative linguistic and non-linguistic interpretations of the problem, it is clear that it cannot be reduced to one in which children simply don't process the matrix verb, nor can it be written off as a purely cognitive limitation. de Villiers concludes that the problem is a linguistic one: that young children have an "under articulated" clause structure that lacks some crucial feature, namely, whatever it is that allows the embedded proposition to be false without disturbing the overall truth value. Interestingly, only embedded complements have the property that they can be false yet the sentence that contains them can still be true. In all other instances where propositions combine to make sentences, if any of the propositions is false then so is the whole[i]. Compare:

He fell after he drank milk.

If he drank cider, the sentence is false.

He fell and drank milk.

If he drank cider, the sentence is false.

He liked that milk he drank.

If he drank cider, the sentence is false.

But:

He said he drank milk.

If he drank cider, the sentence is still true. The lower clause is embedded in the first, it is crucially not an independent clause such as a conjoined sentences. The claim is that only complements of mental and communication verbs can be "false" propositions (vis a vis the "real world", i.e. our point of view) and not upset the truth of the entire sentence. This special property of dependence "opens up" possible worlds, that is worlds different than the world in which the proposition is false. The special semantics of complements allow the possibility of talking about a fundamental distinction between things in the world and things as they are represented in someone's mind.

There must be some feature in the clause to distinguish these cases from other clauses - adjuncts, matrix clauses - whose truth is judged with respect to "the real world". In essence we subordinate the truth value of the complement to the truth of the matrix clause. In linguistic theory, factive complements are usually considered to have some unique marking, but on the current analysis it is the non-factive complements of mental and communicative verbs that have the more distinctive characteristic. Where might such a feature be marked? In current linguistic treatments (Chomsky, 1981, 1995) all clauses are headed by a "functional category"[ii] CP, that is normally the site for complementizers (*that, which, where, how, for*) in embedded clauses and also for wh questions and perhaps other Operators in matrix (main) clauses. In one recent treatment (Rizzi, 1995) the CP is multiplied into several functional sites to accommodate e.g. focus, topic and wh-questions. Other linguists prefer the idea of a single structural position with features that must be checked for particular semantic and functional purposes (Kratzer, 1997). Whatever the correct formulation, de Villiers (1997) suggests that there is some feature in the CP subcategorized for a particular verb that says that the proposition in its complement can be false. This feature must take one value in the CP of mental and communicative verbs, and a different value in the matrix CP, the CP of factive verbs, or in the CP of relative clauses attached to head nouns, which are obligatorily true if the sentence is true. The complements of mental and communicative verbs are marked by this feature as intensional clauses, i.e. their propositions describe "possible worlds" with truth relativized to those worlds. Until the point that this feature is established in the child's grammar, the child has no way to express anything but "real world" semantics.[iii] The "possible world" semantics expand the child's repertoire of linguistic representations, and via those representations, new ways of reasoning become a possibility.

When young children lack that feature in CP, or have it "set" to the default form, then they will not be able to represent reports of lies or mistakes. When children can finally represent that feature, it is only the first of a series of features in an articulated CP feature set that eventually must accommodate at least tense perspective (c.f. Hollebrandse, 1997), speaker beliefs / referential opacity (de Villiers & Fitneva, 1996) and factivity (de Villiers, Curran, Philip & DeMunn, 1997). In other words, it is argued that the full articulation of linguistic structure eventually accommodates all the other special semantic features of certain propositional attitude reports.

2.4 Do other linguistic forms connect to mental state knowledge?

The question then returns to the representation of other propositional attitudes, such as those of desire: want, like, need, and those of pretense: imagine, pretend. For instance, several researchers have reported earlier understanding of other's desires before false beliefs (Gopnik, 1993). The structures necessary in language to represent desire do not typically involve a full, tensed that clause in English (see also Perner, 1991b), but rather a to-clause that represent an event that is "irrealis" rather than true/false:

He wanted to go home

or a simple NP:

He likes apples

In fact, these kinds of structures enter children's language well before full tensed complements (Bloom, Lifter and Hafitz, 1989). Whether or not those language forms play any particular role in the ability to represent those propositional attitudes about another person remains to be investigated. A similar point may be made about some forms of pretense, in that the linguistic forms for pretend also can involve a to-complement that is irrealis:

She pretended to be a dog

However, pretend can also take a that tensed complement in striking similarity to the structures for mental verbs of false belief:

We pretended that the rug was a desert island

Now clearly, there are important differences still to be explored concerning the parallelisms of pretense and false belief representations. Perhaps some of the controversy over the age at which children genuinely understand pretense has to do with the kind of underlying representation, paralleling the two linguistic forms (Perner, Baker & Hutton, 1994; Lillard, 1993). However, Custer (1996) reports an experiment in which all else is held constant about the scenario except for the use of the verb think versus pretend versus remember, all with that-complements, and found that three year old children did show better performance based on the verbs pretend and remember. The conclusion Custer reaches is that only think involves a genuine conflict with reality. Since we have not yet worked on pretense, we leave these issues for the future to resolve.

Finally, there is the interesting work on counterfactuals discussed by Riggs and Robinson (this volume; 1995). Do counterfactuals provide an alternative encoding of the structures necessary for the representation of mental state knowledge, one that need not involve the use of mental verbs such as think, know? . From the linguistic standpoint, counterfactuals are not found in young children's speech until after at least age four or so (Cromer, 1968,1971;Kuczaj & Daley, 1979), and are probably understood later than mental verbs with complements. Even if they do provide the appropriate semantic structures for representing false belief reasoning, it is less clear that the linguistic forms could be the bootstrap for false belief representation.

3.0 Empirical data to distinguish the positions

We next discuss the empirical data we have gathered on the relationship between language and theory of mind that attempts to tease apart the four positions outlined above. These data come from two sources: work on normally developing preschool children, and work on language-delayed orally-taught deaf children, who provide us with a most important means of teasing out cognitive and linguistic developments that are usually intertwined.

3.1 Longitudinal study of normally-hearing preschool children

de Villiers and Pyers (1996) report the initial results of a longitudinal study of children aged 3 to 4 years old which tested the order of development of key language and false belief achievements. The three-year olds were tested four times over the course of one year with varying versions of the same tasks, and what follows summarizes the analysis of data from the first three rounds of data collection from the first cohort of 19 children (collected in October, January, and May of one year).

The tasks used were a collection of standard false belief tasks and language tasks.

False belief tasks

a) Unexpected contents task (Perner, Leekam & Wimmer, 1987).

On each round of testing we asked about a different familiar container: a CRAYOLA crayon box, a Playdo container, a Cheerios cereal box, and a small milk carton, and asked both about the child's own prior belief (Gopnik & Astington, 1988) and their friend's likely belief, for a total of two points. [iv]

b) Unseen displacement (Wimmer & Perner, 1983).

In this type of task, a child is told a story which is acted out in front of her, and in the story a character comes to hold a false belief about the whereabouts of an object. The child must then predict where the character will first look for that object. [v] The problem lies in interpreting this answer, because chance is 50/50 for identifying the right place, given that only two places are usually highlighted in the story via the memory check questions. We therefore also ask the question "why will he look there?" and gave a point for a suitable explanation for the character looking in the wrong location. This explanation did not have to use mentalistic vocabulary, so saying "because he put it there" counted as a perfectly adequate answer. An answer that did not count as adequate might be saying "because the Dad moved it". Thus this task gave a total of two points.[vi]

c) Explaining action (Bartsch & Wellman, 1989)

The third false belief task used was a combination of the above two scenarios in which a puppet is deceived. While the puppet is asleep, the child is shown a familiar box, say an egg carton with eggs, and the eggs are removed from the container and hidden in another unmarked box. The puppet is then woken up and the child is told "You know what he likes to do when he wakes up? He likes to eat eggs!" The puppet is then made to manipulate the (empty) egg box and the child is asked, "Why is he looking in there?" and "Why isn't he looking in that (other) box?" Mental explanations are again not necessary for points on this task: saying, "because they were in there" is coded as a satisfactory explanation. These three False Belief tasks thus each had a maximum score of two, for a total of 6 each round. The "passing" criterion was set at 5 or 6 out of 6.

Language tasks

a) Memory for complements in described mistakes:

Previous work had shown that children have difficulty in answering such questions when the lower or embedded proposition is false (de Villiers, 1995). On each round, children received 12 sets of photographs or drawn pictures of brief stories in which a character was described as making a mistake, telling a lie, or having a false belief. Half the scenarios involved acts of thinking (verbs *think*, *believe*) and half involving acts of communication (verbs *say* and *tell*). For half of the events, the question asked for a report of the contents of the character's belief/statement, e.g.:

He thought he found his ring, but it was really a bottle cap.

What did he think?

She said she found a monster under her chair, but it was really the neighbor's dog.

What did she say?

For the other half, the question asked for a report on the object of the character's believed or stated action, which required simply an noun rather than the whole propositional content:

This girl saw something funny at a tag sale and paid a dollar for it. She thought it was a toy

bird but it was really a funny hat.

What did she think she bought?

Memory for Complements had a total possible score of 12 and the criterion for passing was set at 10 or more out of 12. Notice that we regard this task as a relatively pure measure of the child's understanding of the linguistic representation, unconfounded by the ability to make the appropriate false belief attribution. In this task we provide the attribution, and the child just has to be able to represent it in memory and repeat it. Oddly enough, this does not just involve parroting; instead children seem to "fix" the sentence to have a true complement if they have not reached the point of allowing false complements under a verb.

b) Spontaneous speech

In Rounds 2 and 3 the spontaneous speech of the children was transcribed from a variety of situations inside the test sessions, for example while playing computer adventure games with us, and after watching silent videos of odd mistakes, when the children often described similar things that happened to them.

We derived MLU scores, and we also used the Index of Productive Syntax (IPSyn) (Scarborough,1990) to derive a quantitative measure of the grammatical complexity of the children's language. The IPSyn codes the emergence in children's spontaneous language of a set of grammatical types that were selected on the basis of the considerable normative research on syntactic development in preschoolers over the past 30 years. The IPSyn demonstrates good reliability for child language corpora of as few as 50 utterances, and is more discriminating of normal syntactic development between the ages of 24 and 48 months than is mean length of utterance (MLU). Furthermore, the IPSyn captures persistent syntactic differences between normal and language-delayed preschoolers in longitudinal studies (e.g., Rescorla & Schwartz, 1988). From the IPSyn scoring we created several subtotals such as the total Sentence Structure score (SS), the total complex sentences (total complex IPSyn), the total score for complements (IPSyn comps), and the total complex minus complements (IPSyn complex no comps). These last two scores allowed us to separate the critical feature of sentential complements with mental/communication verbs from other forms of complex sentence that play no role in our theoretical argument, such as relative clauses and if-then clauses. In this way we hoped to separate out the general role of language as a facilitator, or as an index of general maturity, from the more specific role we attribute to the appropriate representation of complements.

Several different analyses were conducted to explore the relationship among the language and theory of mind tasks. The most crude is of course intercorrelations among performance on individual tasks. Table 1 shows the intercorrelations at Round 2, when there was the greatest

Table 1 here

variance on all tasks. [vii] At this point the average age of the children in the study was 3 years 8 months, with a range of 3;4 to 4;1. There are higher values for the correlations between the False Belief tasks and the IPSyn complement measure rather than the more general language measures. As expected, the language measures also correlated with each other, so more refined analyses are needed to separate the contributions.

If it is true that the false belief tasks have as a prerequisite the representation of false complements in language, then we expect growth in the ability to represent complements among children who fail false belief tasks. However, children who pass false belief tasks should show no continued growth in this aspect of complementation. Figure 1 shows changes across rounds in the success on language (memory for complements) task as a function of passing or failing the false belief tasks. The results partially support that argument, at least for rounds 2 and 3. The converse,

Figure 1 here

namely that children who pass complement tasks might still be developing the consistent use of them for false belief reasoning, is supported by the growth patterns in Figure 2. However, children who fail on complement representation should show no growth in false belief ability, as also confirmed in Figure 2. [viii]

Figure 2 here

A further analysis used simple regressions to try to predict False Belief at Round 3 on the basis of language at Round 2. The outcome variable was passing (5 or 6) or failing (<5) on Round 3 False Belief tasks and the predictor variable in language was Memory for Complements at Round 2. A respectable 32.1% ($p<.01$) of the variance is accounted for with this direction of analysis. The opposite analysis is to attempt to predict complement syntax (Memory for

Complements) at Round 3 on the basis of False Belief measures at Round 2. The outcome measure used was passing (10 to 12 out of 12) or failing (<10) on memory for complements and the predictor variables were the subscores on False Beliefs: prediction, contents, explanation. However, the percentage of variance accounted for was only 9.5% (n.s.). The fact that the results are asymmetrical in this way lends credence to the argument that mastery of complements is prerequisite for false belief.

The final analysis goes one step further to investigate whether the mastery of complements can be teased out as a variable beyond the contribution made by general language development. For our theory, the critical mastery is complementation, not overall length of utterance or other kinds of complexity. For these analyses we used the measures derived from the spontaneous speech analyses, that separated out the score on complements from other kinds of complex syntax as well as gross developmental indices such as MLU. The "memory for complement" measure does not allow that separation, so only the spontaneous measures can contribute to that question. Of course these speech measures have significant intercorrelations - a child who develops complementation and uses it frequently will also have a high MLU and undoubtedly other signs of complex syntax such as relative clauses or if-then clauses. Stepwise regression allows a test of which language measures contribute most strongly.

We first tried to predict "passing" False Belief at Round 2 on the basis of language measures in that same round. It revealed that the most significant predictor variable was production of sentential complements (IPSyn comps) (47% of variance, $p<.001$). No other language measure added significantly to the variance accounted for by this complement measure. The entire set of language measures at Round 2 predict 55% of the variance in false belief on that round. But it would be more convincing if we could predict not simultaneous, but future performance in false belief. So we then performed a stepwise regression to predict "passing" false belief at Round 3 on the basis of language measures at Round 2. Once again, the analysis revealed that the most significant predictor variable was the production of sentential complements (IPSyn comps) at Round 2. (29% of variance, $p<.01$). The whole set of language measures at Round 2 predict 38% of the variance in later False Belief, thus the other measures add only slightly to the predictive power of complements.

Consider a major criticism of the interpretation of the empirical findings of the longitudinal study. It could be argued that the language measures of complementation themselves involved false-belief understanding, but that some tasks were sufficiently simple (e.g. memory for complement just involved remembering what was said) that they inevitably preceded success on the more demanding tasks of false belief reasoning. Thus, our direction of effects are trivially true: easier tasks precede harder tasks, but the same thing is involved in all of them, namely, the representation of false beliefs. On that view, either conceptual development is independent of linguistic development, or is facilitated by language via one of the weaker mechanisms suggested above. In partial defense, we do find evidence that the spontaneous use of complements in speech is predictive of false belief reasoning. This covers communication verbs as well as verbs of mental state, so the complements used do not necessarily involve reference to either true or false beliefs, but sometimes just to acts of speech. We have argued above (and de Villiers, 1997)that we cannot be sure that complementation in child language is <u>genuine</u> until the second clause <u>can</u> be false, but the individual tokens we count in spontaneous speech do not have to be false, and neither do they have to be about mental events .

We will return to interpretation after exploring another source of evidence, namely our work with deaf children. We hope to demonstrate with these data that the critic who dismisses the significance of the coincidental development of complements and false belief reasoning in normally developing children should find it troubling that deaf children should be delayed in ToM, if language is not causally relevant. Those theories that might attribute the intercorrelations of language and false belief reasoning to some more general underlying cognitive change in development, such as the maturation of an innate ToM module (Leslie, 1994), would not predict a delay in nonverbally-tapped false belief reasoning in intellectually normal but language-delayed children.

3.2. Empirical data on standard and non standard ToM tasks from language-delayed deaf children.

Most profoundly deaf children have hearing parents, many of whom decide to raise them in an oral environment, and send them to school to learn English and lip-reading. Even with the best and earliest intervention with hearing aids and special teaching, the first few years of language development for such a child are known to be significantly delayed compared to the normal case (Mogford, 1993; Paul & Quigley, 1993). However, with some variation, orally-taught deaf children test in the normal range on non-verbal tests of intelligence, at least up to age 6 (Marschark, 1993). Furthermore, although caregiver-child interaction can be disrupted for deaf children with hearing parents (Meadow, Greenberg, Erting, & Carmichael, 1981; Montanini-Manfredi, 1993; Lederberg, 1993); deaf children can also be socially active, tuned in to the family and their peers, and even inventors of rich systems of gestures to convey simple and even embedded propositions (Goldin-Meadow, 1982; Goldin-Meadow & Mylander, 1984; de Villiers , Bibeau, Ramos & Gatty, 1993). So unlike autistic children, deaf children are interested in and motivated by social interaction and actively seek it out. This is not to claim that oral deaf children are completely unimpaired in the area of social functioning. Several researchers have reported more egocentrism and delayed role-taking abilities in situations in which the deaf child needs to predict the feelings of others (Greenberg & Kusché, 1989; 1993). Greenberg & Kusché (1993) show that these deficits are primarily predicted by the language skills of the children, and are much less noticeable in non-verbal, game-like tasks. Thus any subtle social deficits in deaf children seem to be causally tied to their development of language and communicative skills. Much of the socio-emotional development of the deaf child depends on the development between the child and the caregiver of fluent and easy communication, in whatever modality. However, with an orally-taught deaf child not exposed to Sign, the limited speech, vocabulary and syntax typically present at age four years is insufficient to support elaborate mind- talk, especially reference to other's beliefs. It is not yet clear that the subtleties expressed in mind-talk can be accomplished with a non-conventional gesture system, unless the listener has rich contextual support.

For all these reasons, it becomes very interesting to study the development of ToM in oral profoundly deaf subjects, who can be argued to be normally developing both cognitively and socially in non-verbal realms, but lack access to talk and expression about the states of mind of other persons. If we are wrong in attaching importance to language as a catalyst for developing false belief understanding, then deaf children will succeed at these tasks on the basis of their nonverbal understanding of social interaction, which might be acute, given their dependence on it rather than language for predicting other's behavior. Indeed, it could be that such an essential ingredient for proper social interaction is a "robust" module of mind, buffered against the vagaries of cultural and biological accidents, and hence accessible by a variety of developmental routes, much like language itself.

Since we wished to test the hypothesis that access to a rich language is a necessary ingredient in establishing the mature ToM on a normal timetable, we needed to demonstrate that young oral deaf children have limited access to language of sufficient complexity to capture false belief statements, and that they fail traditional, language-based false belief tasks. However, that failure could be due to the lack of language for the tasks. We needed in addition to find tasks to demonstrate tested understanding of ToM without the associated use of language. We needed to show first that these tasks were equivalent in difficulty and representational demands for normally-developing 3 to 5 year olds. We then endeavored to test whether oral deaf children would fail these same nonverbal tasks of false belief or knowledge inference.

In Gale, de Villiers, de Villiers & Pyers (1996) we report the results of an initial series of studies that begin to tease out these possibilities with orally-taught deaf children. We are engaged in a much larger enterprise that examines the language and theory of mind abilities in other groups of deaf children exposed to American Sign Language at different ages, but that data collection is in its very early stages and we will not discuss it here.[ix]

The children that serve as the subjects in our work must meet certain criteria to be included, such as having a normal non-verbal IQ, showing active social interaction, and being moderate- to profoundly- deaf. As a result of the latter, the subjects have varying degrees of delay in language acquisition, with especially delayed complex syntax (such as complementation), but also reduced vocabulary.

Consider first how such children fare on standard theory of mind tasks, adapted to accommodate their difficulties in speech comprehension, and compared to their language competencies. Gale et al used the following tasks:

Unseen displacement

A standard unseen displacement story was modified for use with the 23 deaf subjects aged between 4 and 9 years. Two modifications in the way the task was administered made the procedure more accessible to the deaf children. First, our pilot testing with oral deaf children revealed that acting out the events with dolls while telling the story was very distracting for deaf children trying to follow the narrative by lip-reading, whether the narrative was simultaneous with or sequential to the actions. Therefore, an artist depicted each event in the scenario in water-color pictures which were placed in a three-ring binder in the form of a flip-up book. The narrative was told with the book held just below the experimenter's chin, a procedure familiar to the deaf children from the way their teachers read them picture book stories.[x] Second, as in the longitudinal study with hearing children, the word "first" was inserted into the crucial question about where the character would look for the moved object -- namely, "where will the boy first look for his cake?" As in our studies with hearing children, control questions were asked before the crucial "where look" question to make sure that the child remembered where the object had first been placed and then where it had been moved to.

False Belief Reasoning -- Unexpected Object in a Familiar Container

In the standard unexpected contents task using a CRAYOLA crayon box the deaf children were asked about their own prior belief and a friend's likely false belief about the contents of the box.

For the unseen change in object location story we consider only the data from the 20 deaf children who could answer the "memory check" questions. Only eleven of the twenty children (55%) correctly answered the false belief question by indicating that the boy would first look in the cupboard where he had put the cake, not in the refrigerator where the cake now was.

For the unexpected contents task the children each received a score out of two, one point for correctly reporting their own initial false belief and one point for giving the same answer for their friend's likely false belief. Only eight of the 21 children (38.1%) answered both of the questions correctly. 10 children (47.6%) correctly reported their own previous false belief and 12 children (57.1%) correctly answered the question about their friend's initial false belief.

The average age of passers on the tasks was 7.41 years (unseen displacement), and 7.25 years (unexpected contents), that is, 3 years older than the normally hearing preschool children who we tested on precisely the same tasks. This would suggest that language delay can have a significant impact on false belief reasoning, but we must also demonstrate that the deaf children's language was predictive of their performance on the false belief tasks.

Language tasks

Explanation of Action -- Elicited Language about the Mind

To elicit language that might include language about mental states, the 18 deaf children above the preschool level[xi] were shown several short videotape clips taken from Charlie Chaplin silent films and from Loony Tunes cartoons. All of the videos were shown without sound. Each video clip included events involving mistakes or deception that could be satisfactorily explained only by referring to the characters' desires, lack of knowledge, or false beliefs.

For example, in one Tom and Jerry cartoon Tom the cat ties Jerry the mouse onto his fishing line and casts him into a pond as bait. Unseen by the cat, the mouse swims underwater to a dock on which a big dog is asleep in the sun. Carefully he ties the fishing line to the dog's back leg and then tugs on the line to fool Tom into thinking that he has caught a fish. As the cat excitedly reels in the "fish" (still underwater and so unseen by him), Jerry hands him a club with which to stun it. Tom wades into the pond and begins beating the underwater “fish” with the club, only to have it emerge from the water as a large, irate dog.

After viewing a video clip twice, the child was asked to describe the events: “Tell me all about what happened.” Following this spontaneous narrative, one or two digitized still pictures from the video were shown to the child, one at a time. These pictures captured key moments in the scenario at which inferring the character’s cognitive state was essential for understanding the events. For each such picture the experimenter pointed at the key character in the event and asked the child: “What is happening in the story here?” If this open-ended picture description did not elicit a mental explanation of the action(s), E again pointed at the pictured character and asked two increasingly specific prompt questions: “Why did/is X ....(action)?”, and “What is happening in his head when he ....(action)?”

Each child saw 8 video clips and 12 still pictures. The testing session was videotaped and the children’s spontaneous and prompted utterances were transcribed for later analysis.

Relationship between Language and Verbal False Belief Reasoning

The children’s spontaneous and prompted explanations of the characters’ actions on the video clips were transcribed and scored for whether they contained references to cognitive states such as beliefs, thoughts, knowledge, or ignorance, or to other mental states such as desires and emotions. Points were assigned on the basis of the spontaneity and developmental sophistication of the explanations given. Thus a child received 3 points for producing at least one spontaneous explanation referring to the character's cognitive state, two points if cognitive state explanations were only given following prompts, and only one point if they made reference to desires or simple emotions but not to thoughts or knowledge (see Bartsch & Wellman, 1995, for developmental data). Giving a cognitive explanation of action in this task of necessity involved producing an embedded complement construction.

The children's performance on the two standard false belief tasks was combined into a verbal false belief reasoning score and then correlated with the explanation of action score, the children's age and degree of hearing loss, and with their PPVT-R verbal mental age (which served as a more general measure of language ability). Producing complex sentences with cognitive state verbs like think and know was by far the strongest predictor of the children's false belief reasoning on the standard verbal tests. The correlation between the verbal explanation of action scores and verbal false belief reasoning was +.70 (df=16; p<.001); however, none of the other three variables -- age, hearing loss or PPVT -- was significantly related to performance on the standard false belief tests. Furthermore, the correlation between explanation of action and false belief reasoning remained significant even when the effects of the other three variables were partialled out (partial r = +.59, p<.01).[xii]

These data suggest that it is the language of these deaf children that is responsible for their delays in standard false belief performance. However, the standard tasks themselves place demands on the children for language comprehension: how can we be sure that it is not language-for-the-task that is responsible for these tight interconnections? To address this issue, we have undertaken studies using nonverbal (or less-verbal) procedures to tap false belief reasoning with oral deaf children, to see if their performance is enhanced if language demands are lessened. In this case, it is possible that deaf children could show appropriate age performance, if language development is only relevant as a task demand.

The critical data, come from the oral deaf children with language delay. However, we have first demonstrated that normally developing preschool children show roughly equivalent performance on the nonverbal or less verbal tasks that we discuss below, compared to their performance on standard verbal false belief tasks (Gale et al, 1995; de Villiers,de Villiers, Pyers, Frey & Gale, in preparation). They have not shown us earlier or better mastery on the nonverbal procedures.

<u>Sticker-finding Game</u>

In Gale et al (1995) we describe a task we call the sticker-finding game, a modification of the procedure used by Povinelli and deBlois (1992) with 3- and 4-year-olds (and with chimpanzees). Its basic purpose is to see whether children can understand that seeing leads to knowing, and that knowledge leads to good advice. It is thus not strictly a false-belief task, more of a seeing-knowing task, but as we report in Gale et al (1995), it is highly correlated with performance on the standard false belief tasks, and is mastered at the same age (around age 4;4 in our sample of preschoolers). The child plays a game in which she must find stickers hidden by the experimenter in a series of boxes, and clues are given by pointing. However, the people who give the clues are either a confederate of the experimenter who has watched where the sticker was hidden (the knower), or a confederate who has been blindfolded and therefore cannot know (the guesser). Obviously the child should go with the reliable advice given by the knower, but she has to figure out the contingencies herself by observing and extrapolating points-of-view.

Only eleven of the 23 deaf children (47.8%) succeeded in choosing the knower's box significantly more often than expected by chance over the course of ten test trials. Ten of these children fulfilled both criteria that we set for success: at least seven of the last eight trials correct and a run of at least six consecutive trials correct. The average age of these passers was virtually identical to the age of deaf passers on the standard theory of mind tests, that is, 7.31 years. Scores on the standard verbal tasks and the mostly nonverbal game were highly correlated [$r (18) = +.60$, $p<.01$]. As for the verbal false belief tasks, correlational analyses revealed that having the language to explain actions in terms of cognitive states was the strongest predictor of performance on the sticker-hiding game ($r = +.61$, $df=16$; $p<.01$).

Thus Gale et al demonstrated that oral deaf children were equivalently delayed in their mastery of verbal and nonverbal theory of mind tasks tapping their reasoning about their own and others' cognitive states. This argues against an explanation of the delayed theory of mind performance of deaf children merely in terms of the language-of-the-tasks. Nevertheless, the degree of delay in the individual deaf children's theory of mind reasoning was closely related to their language ability, particularly their production of complex language about the mind.

The above studies still have several limitations. In particular, the non-verbal task was really a test of the children's reasoning about the relationship between seeing and knowing, rather than more closely tied to the understanding of expectations and false beliefs being tested in the standard verbal tasks (though it is clear for both hearing preschoolers and the deaf children that there is a close relationship in development of the concepts of knowledge/ignorance and true/false belief). Second, the explanation of action measure that was used in Gale et al (1995) might be considered as much a highly verbal measure of theory of mind reasoning as it is a measure of language development (see Bartsch & Wellman, 1995, for the use of linguistic expression as a measure of theory of mind development). So it is not surprising that the explanation of action measure should emerge as the strongest predictor of performance on the standard verbal false belief tasks, though perhaps a little more surprising that it should also be so predictive of the non-verbal sticker-hiding game.

So we carried out a further study of 27 oral deaf children using a different less-verbal procedure more closely related to the standard unexpected contents test of false belief and a more linguistic analysis of syntax development (the IPSyn scale for spontaneous speech that was used in de Villiers & Pyers, 1997).

What face? Surprised or not Surprised

This relatively nonverbal procedure is basically a version of the unexpected contents concept, involving a familiar container that leads one to expect it to contain certain items. The trick of it as a nonverbal procedure is that rather than verbally reporting what someone thinks is in the box, the child must predict whether a character is surprised or not when they see the unusual contents. They do this by choosing the right facial expression to stick on the character's blank face[xiii]. The character has either seen the unexpected item being placed in the container (so will not be surprised), or has seen only the closed container (surprised).

A pretest established that the children knew the facial expression corresponding to surprise, or more specifically, our artist's rendition of it. Next came a warm-up or “training” phase in which the general idea of the procedure was demonstrated to the child. This consisted of two multi-picture sequences involving characters who were either "surprised" or "not surprised" by an event or object depending on whether they had seen it before or not. Other than the utterances specified below, the picture sequences were not accompanied by a full spoken narrative, relying on the pictures to tell the overall story. In the warm-up phase the children were given the chance to complete the character's face as directed, and were given corrective feedback if they chose the inappropriate expression.

There followed a series of six test picture-sequences, in the first picture of each a character was shown finding or manipulating an object (e.g., finding a dollar on the ground). After the picture was placed in front of the child E pointed to the focal object and made sure that the child knew what it was called. In picture 2 the character emptied the usual contents out of a familiar container, i.e. one that predisposed the viewer to expect particular contents (e.g., a CRAYOLA crayon box, an egg carton, or a Bandaid tin). Again, after picture 2 was placed in front of the child E pointed to the contents being emptied out and made sure that the child knew what they were called. In picture 3 the character put the object from the first picture into the familiar container. Two different versions of pictures 2 and 3 were drawn. In each of these a friend of the character is shown: in one version (the "not surprised" condition) they are closely watching the character's actions as the usual contents of the container are removed and the unusual contents are substituted, but in the second version (the "surprised" condition) they are engaged in another activity, turned away from the action, and do not see the substitution. In picture 4 the friend is shown with the closed familiar container, about to open it. Motivation for obtaining either contents is supported by objects present with the container. So in the CRAYOLA crayon box picture-sequence there is a coloring book and a lockable treasure chest shown on the table with the crayon box in picture 4. Thus the pictured person could either be wanting a crayon or the key that the box now contains. Finally in picture 5 the friend opens the box and its unusual contents are revealed. In this picture the friend is drawn with only an outlined blank face. The child was asked to choose which face to put on the last picture (see

Figure 3). On the first two test trials, before asking which face should be placed on the picture, E pointed at the friend in pictures 2 and 3 (when the object substitution took place) and said: "S/he saw." or "She did not see." However, on the remaining four test trials, E simply pointed back at the friend in pictures 2 and 3, then pointed to the final picture and said: "What face? Is s/he surprised or not surprised?"

Figure 3 here

In the test phase each child saw three picture sequences in which the key character did not see the object substitution and thus the "surprised" face should be chosen and three sequences in which the friend watched the substitution and so the "not surprised" face should be chosen. No correcting feedback was given on any of these six trials.

How do normally developing preschoolers fare on this task? de Villiers et al (in preparation) tested 28 three and four year old children on this task and on standard false belief tasks. A score of five or six out of six was taken as a passing score (p=.10, binomial test), for the "what face" task. According to this criterion, 10 out of 18 of the four year olds and 2 out of 10 three year olds passed the task. On the standard verbal tasks ,children who correctly answered both questions on an unexpected contents task (own belief and other's belief) and also answered correctly about where the character would first look in two displaced object stories, counted as passing, i.e.scoring 4 out of 4. Table 2 shows the average ages of the passers and failers on the standard verbal false belief tasks and the less verbal "what face?" task. There was a significant average age difference between passers and failers on the "what face?" task, but not on the standard verbal tasks.

Table 2 here

The less verbal task seems to have been a little harder for the preschoolers than the standard verbal tasks. Fifteen of the 28 preschoolers (53.6%) passed the standard tasks, but only 12 of them (42.9%) passed the "what face?" task. Furthermore, whereas three children passed the verbal false belief tasks without passing the less verbal surprise task, for no children was the reverse true. Nevertheless, children's total score on the standard false belief tasks was significantly correlated with their score on the "what face?" task [$r (26) = +.61, p< .001$].

Having demonstrated that the "what face" task is roughly equivalent to more verbal standard theory of mind tasks for normally-hearing preschoolers, we can now ask how language-delayed deaf children perform on this task. de Villiers et al (in preparation) tested twenty-seven moderate to profoundly deaf children in the elementary grades of a prominent oral school for the deaf. None of them had been formally exposed to sign languages in their education. Their ages varied from 5:2 to 10:1, with a median of 7:0 years.

All of the children received three unseen object displacement stories in which they were asked both where the crucial character would first look for the moved object and why s/he would first look there. The stories were administered in the same picture-book format described in the Gale et al (1996) experiment. The deaf children received one point for each of the "where will s/he look?" questions that they correctly answered. Verbal false belief reasoning scores therefore varied between 0 and 3, with 3 correct answers considered "passing" the verbal tasks. In this group of oral deaf children, fourteen of the 24 children (58.3%) who passed the "memory control" questions passed all of the "where look" questions.

The "what face?" task was administered and scored in the same way as for the normally hearing preschool subjects. Two of the deaf children could not correctly identify the "surprised" and "not surprised" faces in the pretest, so only the data from the other 25 children are considered. Taking as the criterion for passing the task five or six correct choices out of six sequences, eight of the 25 deaf children (32%) mastered the "what face?" task. All of them had scored 3 out of 3 on the questions following the standard unseen object displacement stories. So the less verbal "what face" task was harder for the deaf children than the standard verbal unseen displacement test of false belief understanding. Six children who answered correctly all of the "where look" questions did not pass the "what face" task.[xiv] However, across all the children there was a close relationship between performance on the verbal false belief tasks and performance on the less verbal "what face?" procedure: a significant Pearson product moment correlation was obtained between scores on the "what face?" procedure and scores on the standard unseen object displacement stories ($r = +.58$, $p<.02$)

We can again ask whether the deaf children's language ability was related to their performance on the false belief tasks of all varieties, and whether we can tease apart general language ability from the specific mastery of mental state complements. The relationship between language and theory of mind performance was examined for the 23 deaf children who met the following criteria: they had passed the memory control questions for all of the unseen object displacement stories; they had correctly identified the "surprised" and "not surprised" faces in the pretest of the "what face?" task; and they had produced at least 50 utterances during the testing sessions and while chatting about things happening in the school to allow scoring of their spontaneous speech.

Measures of the children's syntax production were determined from the language samples. These samples varied in size from 51 to 111 utterances, with a mean of 67. The Index of Productive Syntax (IPSyn) was used to derive a quantitative measure of the grammatical complexity of the children's language (Scarborough, 1990), paralleling the work of de Villiers and Pyers (1997) described above. Our IPSyn scoring of the language samples from the deaf children focused on the Sentence Structure subscale. We concentrated on this subscale for two reasons. First, it does not rely on subtle morphological features of English. Oral deaf children are particularly inconsistent in supplying inflectional morphemes in their speech even when their sentence-structuring syntax is well-developed, and even the accurate transcription of such morphemes in oral deaf speech is problematic. Second, it enabled us to separate out the critical feature of syntax that we were interested in, namely the production of sentential complement structures with verbs of communication or mental state. Thus we derived two separate scores for each deaf child from the Sentence Structure (SS) subscale of the IPSyn: productive use of sentential complements (IPSyn SS-Comps), a score varying from 0 to 4; and the remainder of the Sentence Structure items (IPSyn SS-Other), a score varying from 0 to 36. Pearson product-moment correlations revealed that the children's IPSyn SS-Comps and IPSyn SS-Other scores were strongly correlated with each other [r(21) = +.75, p<.001]; and each of the IPSyn SS scores was significantly correlated with the PPVT-R . However, none of the other background variables -- age, non-verbal IQ, and hearing loss -- was significantly related to any of the language measures.

Table 3 shows the correlations between the children's performance on the theory of mind tasks and several possible predictors of that performance. All of the language measures were significantly related to the children's theory of mind performance, though the strongest relationships were with the production of sentential complements with verbs of communication and mental state (the IPSyn SS-Comps). Of the other background variables, only age showed any significant relationship with theory of mind performance -- correlating with scores on the "what face?" surprise procedure.

Table 3 here

Multiple regression analyses allowed us to test the independent effects of the predictor variables on theory of mind performance, carried out for each of two dependent measures: 1) total verbal false belief reasoning score on the three standard stories ("where look?" questions only); and 2) score out of six on the "what face?" scenarios. Six predictor variables were entered into each regression: IPSyn SS-Comps, IPSyn SS-Other, PPVT-R verbal mental age (i.e. vocabulary), TONI-2 nonverbal IQ, aided hearing loss, and age. The results for each of the regression analyses is shown in Table 4.

Table 4 here

For the verbal false belief reasoning tasks, the children's IPSyn complement score emerged as the only significant independent predictor of performance, separable from the contribution of the more general language measures and background variables like IQ, hearing loss and age. For the less verbal "what face" task, both the IPSyn complement score and age made significant independent contributions to the variance in the children's performance on the theory of mind task.

3.3 Summary of Empirical Data

In sum, we have demonstrated the following:

a) A predictive relationship over time for normally developing hearing preschoolers between control of complement syntax in comprehension and production and performance on standard false belief tasks, with syntax at an earlier age predicting later theory of mind performance (not vice versa).

b) Oral deaf children with normal IQ and active social intelligence are significantly delayed in both standard verbal false belief tasks and much less verbal theory of mind tasks. Performance on both verbal and nonverbal tasks are delayed to the same degree and highly intercorrelated, so it is not just the language of the tasks that leads to delay.

c) Both verbal false belief reasoning and nonverbal ToM reasoning in deaf children are best predicted by complement production with verbs of communication or mental state, not just by general language ability.

4.0 The continuity objection

Before we consider the theoretical ramifications of the empirical data, we must digress briefly to consider the objection to the strongest position based on the continuity of development in both linguistic and cognitive domains. This objection goes as follows: the acquisition of theory of mind is a continuous process, not an all-or-none development, as is the acquisition of complementation. How can one trigger or provide computational resources for the other if both are continuous developments, not breakthroughs?

We fully accept that development is most likely continuous and context- and resource-dependent. However, it might also be true that there is a point when something is achieved reliably, and that point is reached sooner for the language representation than the false belief tasks. We consider the point of reliable performance to constitute some "permanent" change in the representation, that presumably makes it impervious to further assaults of resource or context changes or limitations. In the false belief literature that change is usually referred to as the acquisition of the "theory"; in the language acquisition literature, researchers would agree that the structure has been acquired. In both domains however, there are persuasive advocates of the position that the skill/structure/capacity can be seen much earlier, and that the earliest point at which it is achieved should be regarded as the point of acquisition, with subsequent ups and downs being regarded as the usual vagaries of performance, or computational limitations. We have not studied the onset points of either false belief or of complementation, because we are concerned that "chance" performance is so often near 50% on all these standard tasks that we may be seriously misled into mistaking success for mastery. For example, consider the graph of change in Figure 4, from de Villiers and Pyers (1997).

Figure 4 here

Obviously at the first point of testing, the children are occasionally getting some questions right in the battery of false belief tasks, and some questions right in the complement comprehension task. However, their performance does not stabilize for months thereafter, so we feel more confident setting the usual statistical criteria for successful performance and judging them to "pass' when that point is exceeded. Unless one does a study with sufficient exemplars at each testing point, it is very hard to determine the appropriate criteria, and errors of attribution are very likely to be made. Nevertheless, the question is an open one for empirical inquiry, and the rich anecdotal literature would seem to bear out the claim that children get "glimmers" of success in both linguistic and cognitive domains for several months prior to reliable mastery on the standard tasks. That does not alter the significance of the findings that we report here, though it leaves room for other interpretations of direction-of-effect for normally developing children. What those other interpretations do not explain is the delay in false belief understanding in language-delayed deaf children.

In language acquisition there are also serious arguments for the Continuity Hypothesis, namely, that children's grammars are the same as adult grammars in all essential respects. Learnability considerations in language acquisition lead to an assumption that since children cannot learn grammars from the inadequate environment and exposure (the so-called "poverty of the stimulus"), their grammars must be present fully-formed from the beginning. What the child's task is then is to learn (no, actually fix) the parameter settings that define her particular language (See e.g. Hyams, 1986;Cook & Newsom, 199). On this account is also unthinkable to propose that children have less-than-adequate complementation until they are approaching four years of age, since their grammars must contain all the relevant structures from the beginning. In extensive work on the development of complex syntax in children speaking several different languages, we (de Villiers (1995), de Villiers (1996), Roeper & de Villiers (1994)) have argued that there is developmental change in grammar throughout the age period 3 to 6 years, and especially that the domain of complementation and clause combining is an area fraught with lexical specificity - of both verbs and connectives- that could not be fixed prior to learning a particular language. Penner (1996) draws a similar conclusion about the acquisition of Swiss German, following an extensive diary study of one child. That is, it is not necessarily the case that we must attribute the apparent delay in acquisition of the structures to insufficient computational power , or a cognitive system that is inadequately developed. Instead, it could be that the evidence necessary to fix the subtle properties of clauses embedded under and adjoined to verbs has to be amassed over a prolonged period of time, and awaits just the right combinations of context, intention and clearly structured talk. This is traditionally called learning, though it is learning of a highly constrained sort.

5.0 Theoretical variants of the strong position

The data presented above, while far from conclusive, are compatible with the position that says that acquiring the language of complementation is prerequisite for being able to reason about false beliefs. It behooves us therefore to examine the theoretical position carefully. How could it be true? There are several alternative positions within this claim of linguistic determinism, and we need to unpack them to see which ones are plausible. The following set may not be exhaustive, but even sorting through these possibilities will take considerable theoretical and empirical work, involving considerable innovation.

First take the arguments on behalf of a separate, propositionally-based language of thought. Fodor makes several relevant claims in his 1975 Language of Thought:

a) Thinking requires a language of thought. Imagistic representations are not sufficient to serve as a medium of propositional attitudes, though they may stand for "referents". Pictures are not the kind of things that have truth value, but thoughts must have.

b) That inner language of thought can not be, for example, English, because it is prerequisite for the acquisition of a natural language that you have a language of thought in which to entertain and form concepts in advance of learning the words and expressions of your language. So natural language is parasitic on a language of thought that is as rich in its conceptual and representational power as a natural language.

c) Therefore, natural language cannot add to the representational power of the inner language of thought.

Taking this proposal seriously, let us examine the possible variants of how the representation of complements in natural language might relate to the representation of false beliefs within a language-of-thought. These fall naturally into two classes: one which stands in contradiction to c) above, because natural language does add to the representational power of the language-of-thought , and a second class that doesn't contradict c) because it just credits language with improving computational efficiency. These are important theoretical distinctions, but we do not wish to take a stand in favor of any of the alternatives until there are clearer empirical ways to tease them apart.

Class 1. The linguistic development of complementation makes possible a new form of representation in the language of thought.

a) Development in language triggers the corresponding representational structure in cognition.

This possibility is the most vague, but has the virtue that it preserves the distinction between the representational structures in natural language and those in some more abstract, propositional language of thought. On this account, the structure exists already in an innate language of thought but is dormant until triggered by the equivalent development in natural language. This is a possibility that sounds attractive, as it preserves the idea that our representational structures are present without learning (Fodor, 1975, 1992). But like many triggering notions, it is hard to get beyond the surface of the metaphor. Notice, however, that the prediction of this altenative is that an adult who lost the grammatical structures in their natural language, say in aphasia, might be able to preserve the equivalent representational structures in the language-of-thought. This possibility is ruled out by most of the remaining hypotheses.

b) The cognitive component is parasitic on the results of the specialized linguistic system of representation: it borrows the output.

This position might be dismissable out of hand if it is agreed that TOM is a module (Leslie, 1994) and that under modularity, each system is supposed to have its own fast, encapsulated processing of a specific type of stimulus input (Fodor, 1983). However, there is no agreement yet on either conjecture. If TOM uses general-purpose cognition, then there may be less restriction. Why couldn't language-of-thought use the resources of any developed module? The perception of 3-d forms is meant to be modular, though surely our reasoning makes use of the products of that perception. Furthermore, there are domains in which the specialization of the procedures is such that it does not make sense to duplicate its representational capacity elsewhere: take for example, visual imagery, and the claim of a visuo-spatial "scratchpad" that could feed its output to other modules (e.g.Kosslyn, 1994). A good argument can be made that the semantic specificity and detail needed to represent propositional attitudes can only be done within a linguistic system (Segal, 1997): if so, why duplicate the functions and structures, since they are needed for natural language anyway?

c) Reasoning in this case is bound to language: there is no separate "language of thought" for false belief reasoning.

Suppose the language of thought *in this instance* is the logical form substrate of natural language, that is, give up for this function on a separate language-of-thought, and conclude that language is the medium necessary for false belief reasoning. Fodor dismisses the idea that thought in general is reducible to natural language for obvious reasons rehearsed in elementary psychology and philosophy classes: animals and infants can be shown to do things that we count as thinking, these forms of thought cannot just be imagistic but must be propositional, because images cannot have truth value. However, the possibility arises that certain specific forms of thought, perhaps those involved in false belief reasoning, do use natural language as the representational system . After all, infants and animals do seem to be capabale of very clever thinking, but as yet no-one has proven that they understand others' false beliefs. It is a revolutionary thought to have language as the medium for thought in just this instance, but perhaps one should not rule it out.

Class 2. The linguistic representation of complementation facilitates computation in the language of thought.

a) By providing mnemonic structures via natural language that reduce the load on processing capacity.

In addaiiton to the claimns a)-c) above that natural language could not add to the representational capacity of the langauge-of-thought,, Fodor argues

d) Even so, natural language could serve to enhance thinking performance, because it could serve as a mnemonic advantage to collect together heterogeneous examples under a symbol for the purposes of using them in higher computations.

So if one agrees with Fodor, advantage of linguistic complementation can be regarded as a useful mnemonic device for computational efficiency. Fodor (1992) has claimed that the child who acquires a theory of mind does nothing of the sort: she just gets rid of some awkward performance limitations to reveal what she knew all along. For Fodor, then, this role of language would be akin to several other performance "enhancers": the child should get better under any of a number of conditions, even without the role that language plays. Many such performance enhancers have been demonstrated: reducing the salience of "reality" as a distracter (e.g. Fritz, 1991; Zaitchik, 1991) providing other mnemonics (Mitchell and Lacohee, 1991), improving the child's investment in the answer (Chandler & Hala, 1995), highlighting and engaging the child in the trickery (Avis & Harris, 1991; Sullivan & Winner,1991), lessening the response demands by measuring initial direction of gaze (Clements & Perner, 1994). None of these studies measured the language status of their subjects, so we do not know if these devices are sufficient on their own, or just close a gap between mastery of complementation and mastery of false beliefs. We have not yet attempted ways to improve the performance of our oral deaf subjects, so the question must remain open.

b) By providing mnemonic structures via natural language that make possible a quantum step up in processing capacity.

This version sets a higher premium on what is achieved via the linguistic representation. It is not just computational efficiency, but a major step up in the ability to do the computation at all. For instance, it may be equivalent to the computational power achieved by gathering multiple instances together under a single symbol, which can then participate in higher order processes. One can imagine instances in which the multiplication and duplication of machinery and computation in the absence of such a symbol is so great that it strains the resources beyond capacity to attempt them.[xv] The position is not incompatible with Fodor (1975) though it may well be with Fodor (1992), because the change in performance is so radical that we would be unable to distinguish it from a change in capacity. And, nothing else would do: no other lessening of performance limitations would be enough to open the door.

These alternatives may not be easily distinguished using the population of normally developing young children that has traditionally provided the empirical data for previous research on theory of mind developments. Our ongoing work with deaf children promises to allow us to separate more definitively among some of these alternatives: however, they may not all may be empirically distinguishable.

6.0 Conclusion

Our empirical results have pointed us down a path for which we had some unique preparation: we have done most of our work in psycholinguistics. One of us had done detailed work on deaf children's language; the other, on how children handle complementation in the late preschool years. Perhaps it was inevitable that we should attribute causal powers to the phenomena we know the best.

We have been careful not to make the more general claim that "a Theory of Mind depends on language". We are specifically referring to the false belief understanding critical for the classic tasks of unseen displacement and unexpected contents. Some theory of mind developments seem to emerge at different times, and each task deserves a critical analysis of its representational requirements (Astington, 1992; Gopnik, 1993; Leslie, 1994; Perner, 1991a; Wellman, 1990). In addition, it is clear that conceptual developments in theory of mind may also facilitate later language developments. Thus, it has become strikingly evident in much recent work that developments in theory of mind, including false belief understanding, may be a prerequisite for understanding in complex linguistic tasks such as using the subjunctive in relative clauses (Perez, 1997), substitution in referentially opaque contexts (de Villiers & Fitneva, 1996) and interpretation of embedded tense (Hollebrandse, 1997). The overall process is undoubtedly one of mutual facilitation between language and theory of mind, but the critical piece for us is the relationship between mastery of the fundamental syntax of complementation and false belief understanding. The direction of that effect is the focus of our empirical interest.

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[i] Conditional and counterfactual sentences complicate the simplified picture here, as do performative utterances of various kinds whose truth value is not evident.
[ii] Functional categories are distinct from lexical categories (NP,VP, PP) in that they play mostly grammatical roles in sentences, such as IP for tense, CP for questions and sentence connectives (see de Villiers, de Villiers & Hoban, 1992; Cook & Newsom, 1996).
[iii] Except in pretense, which must be considered as a separate case that does not violate truth conditions in the same way. To go into the details of how pretense differs from false belief would take us far beyond the present discussion, and is explicitly addressed in other contributions in this volume.
[iv] We explicitly marked the child's prior belief with the following question form, "Before, when you were sitting over there, what did you think was in the box?"
[v] As suggested by Siegal and Beattie, 1991, we used the form of the question "where will the boy <u>first</u> look for the cake?"
[vi] It has since been pointed out to us that the scale created by this analysis has some unfortunate properties, since the child can only gain the second point by gaining the first. We have changed the scoring in our subsequent work to count as "passing" only if the child gets both points. However, since we wish to report on the earlier work in de Villiers and Pyers (1997) we have left the coding in place for this report. We checked and found that new coding would not in fact effect the coded status (pass/fail) of any of our subjects, because this is a sum across several tasks.
[vii] In Round 1, performance was at floor with only one child passing false beliefs at all, so there could not be correlations of any significance there, and by round 3, the majority had passed.
[viii] In both Figures 2 and 3, the groups constituting the "failers" are not made up of the same children over rounds.

[ix] There are two other published studies of false belief reasoning in deaf children from total communication backgrounds (simultaneous signing and speech) - Peterson and Siegal (1995) and Steeds, Rowe, and Dowker (1997). Both of these studies showed significant delays in ToM reasoning in their subjects though they differ in the degree of delay. However, both studies used only standard verbal ToM tasks and neither had any measures of the language levels of the children in either of their communication modalities..
[x] We have confirmed that the narrated picture book format is essentially equivalent to the acted out dolls house scenario for hearing preschoolers in terms of their understanding of the key character's false belief.

[xi] The five preschool deaf children in this study were only using one and two-word sentences, so we did not attempt to elicit spontaneous speech from them.
[xii] Tager-Flusberg & Sullivan (1994) similarly reported high correlations between explanations of actions by reference to desires and cognitions and hearing preschoolers' performance on standard false belief tasks.

[xiii] The version we used was modified from one first proposed by Ron Frey in unpublished dissertation research at the Ontario Institute for the Study of Education in Toronto.

[xiv] Note that the "what" face task requires the child not only to compute that the character has a false belief, but then make an additional inference about emotional state based on that belief. This may be harder than computing action based on belief, which is what is required for the "where look" task (Tager-Flusberg, p.c.).

[xv] Bickerton (1995) comes close to arguing this with respect to the power of language in thought in the evolutionary process.

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Table 1. Pearson product moment correlations between measures of language acquisition and performance on the three types of false belief tasks at Round 2.

	Unseen Object Displacement	Unexpected Contents	Explaining Actions
IPSyn Complements	.68***	.50*	.58**
IPSyn No Comps	.33	.13	.17
MLU	.45*	.28	.12
Memory for Complements	.50*	.61**	.31

* = p<.05 ** = p<.01 *** = p<.001 (two-tailed)

Table 2 . Mean age and number of preschoolers passing or failing the verbal and less verbal theory of mind reasoning tasks. Also shown are the results of t-tests on the difference between the ages of passers and failers.

	Passers	Failers	
Standard Verbal False Belief Tasks	4.33 (n=15)	4.05 (n=13)	t(26)=1.49, ns
"What face?" Surprise Task	4.46 (n=12)	4.01 (n=16)	t(26)=2.63, p<.02

Table 3 . Pearson product moment correlations between predictor variables and performance on the verbal and less verbal ("what face?") theory of mind tasks for 23 oral deaf children.

	Verbal False Belief (“Where look?”)	**“What face?” Surprise Task**
IPSyn SS-Comps (Embedded Complements)	.73***	.74***
IPSyn SS-Other (minus Complements)	.66***	.58**
PPVT-R Verbal MA	.55**	.57**
TONI-2 Nonverbal IQ	.15	.16
Hearing Loss (Aided)	-.32	.01
Age	.16	.43*

df = 21 * = p<.05 ** = p<.01 *** = p <.001 (two-tailed)

Table 4. Multiple regression analyses of language and background measures as predictors of performance on the standard verbal false belief stories and the less verbal "what face?" procedure.

	Verbal False Belief (“Where look?”)	**“What face?” Surprise Task**
Multiple Regression	$R^2 = 62.2\%$ F (6,16) = 4.39 p<.01*	$R^2 = 67.0\%$ F (6,16) = 5.42 p<.005
Significant Predictors	IPSyn SS-Comps t = 2.34, p=.032	IPSyn SS-Comps t = 2.73, p=.015 Age t = 2.31, p=.035
Non-significant Variables	IPSyn SS-Other PPVT-R Verbal MA Nonverbal IQ Aided Hearing Loss Age	IPSyn SS-Other PPVT-R Verbal MA Nonverbal IQ Aided Hearing Loss

*Values of p are all two-tailed.

Figure 1.

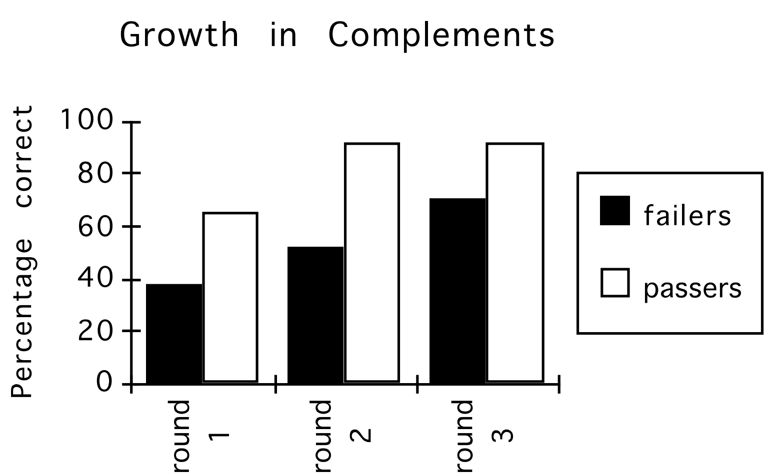


Figure 2

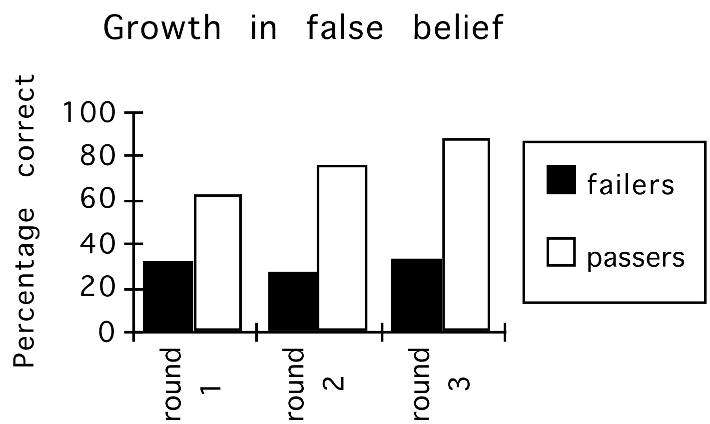
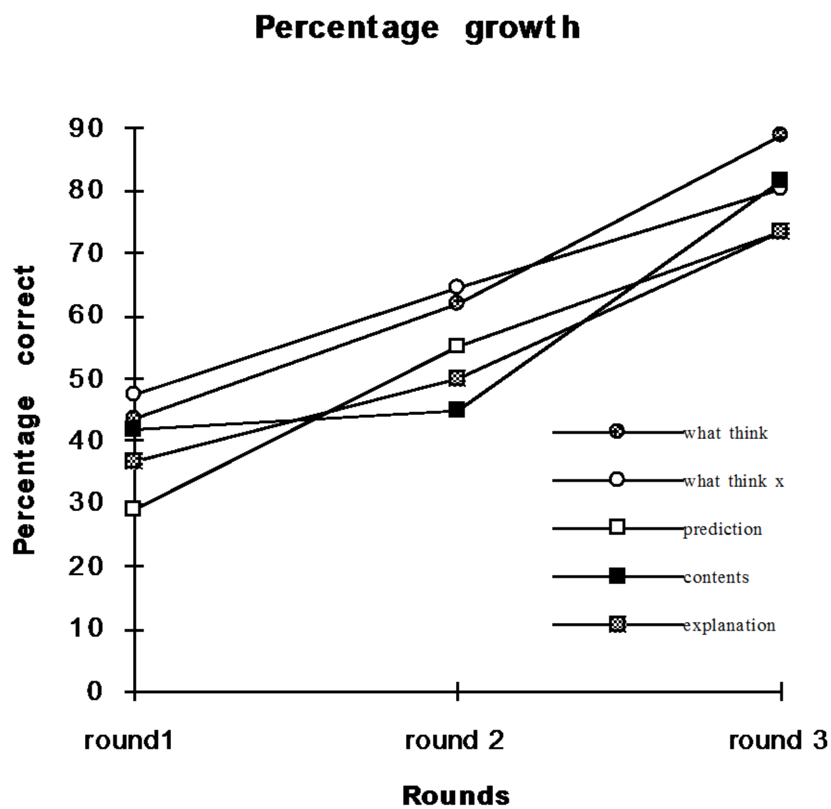

Growth in false belief
Percentage correct
100
80
60
40
20
0
round 1
round 2
round 3
failers
passers

Figure 3.

Figure 4.


Percentage growth
Percentage correct
90
80
70
60
50
40
30
20
10
0
round1
round 2
round 3
Rounds
what think
what think x
prediction
contents
explanation