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Complementing Cognition: The Relationship between Language and Theory of Mind

Jill G. de Villiers
Smith College

Jennie Pyers
Smith College

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Smith College

1.0 Coincidence of language developments and false belief

de Villiers (1995) among others (Astington & Jenkins, 1995, Tager-Flusberg, 1993) noted that the sophisticated use of sentence forms involving mental verbs and their complements coincides roughly in time with the child's successful performance on false belief tasks that make relatively light linguistic demands. A most reasonable proposal is that understanding of beliefs and states of mind is prerequisite for using the linguistic forms correctly, the usual orthodoxy of cognitive determinism. However, Perner (1991a,b) and others argue that the mature theory of mind requires a certain representational capacity, in fact, the ability to represent propositional attitudes about belief, thoughts, feelings and so forth. When examined closely (Segal, 1996), what is required is a rich system of interlocking propositions of the same semantic precision as that found in natural languages. A significant form of representation that natural languages permit is that of the embedded complement construction, by which means a false proposition can be embedded under a verb and the whole sentence nevertheless remains true:

1) He thought <u>he saw a unicorn</u>.

We argue that this form of representation is uniquely suited to the psychological representation of other's false beliefs, and we hypothesized that the representation of false beliefs in other minds (presumably couched in a "language of thought ") may be parasitic on the linguistic form. If so, then the correlation among different performances at age four or so achieves a new interpretation: perhaps mastery of the linguistic forms of complementation provides the representational structure for handling false belief reasoning, i.e. a strong form of *linguistic determinism*. Our proposal is then that such language provides the representational analog for other's false belief. Until children can represent the grammar and semantics of an embedded complement, they have no system to represent and reason about other's false beliefs. Complex sentences of different forms won't suffice, because each individual proposition is true (or irrealis), for example in *to*-complements, relative clauses, *if-then* clauses, or conjunctions and adjunctions of other sorts. Why could the child not entertain other's false beliefs using imagery, rather than via propositions? Olson (1996) argues that the fundamental problem with pictorial or non-symbolic forms of mental representation is that they fail to represent negation, a point made also in arguing for a propositional account of mental representation (Fodor, 1975). It is possible that a child could represent a person having a false belief by means of a picture of the person with a picture of an event different than reality in his head,

but it is not clear that such a picture alone could support prediction or reasoning about how that person will then act.

Hence, language is the key for representing false beliefs. However, we put forward the strong hypothesis that the critical trigger is not just mastery of any complex language, nor just the vocabulary of mental terms, but specifically, the ability to use mental state verbs with sentential complements that could be false.

2.0 Longitudinal study

We are conducting a longitudinal study of 3 to 4 year old children to test the order of key language and false belief developments. The study involves testing 3 year olds four times over the course of one year with varying versions of the same tasks. Here we present the analysis of data from the first three rounds of data collection from the first cohort (collected in October, January, and May).

2.1 Subjects

The subjects in the first cohort are 19 children in local preschool or daycare centers, average age 3;4 (range 3;1-3;9) at the start of the study. There are 10 boys and 9 girls in this cohort. One of the children had some exposure to another language before learning English, and another was bilingual, but all were normally fluent in English for their age by the time we tested them.

2.2 Tasks

The tasks used were a collection of false belief tasks and language tasks. Except where specified, the tasks each had four variants with different content, divided into sets A,B,C and D. So that no particular time of testing would be associated with one set of materials, each child received a different order of these sets across the testing periods. Here we focus on the two critical sets of tasks: false belief and language tasks, though the study includes additional tasks that are not yet analyzed fully. Each round of testing required two or three short sessions with each child in a separate room, and all sessions were videotaped for later checking against the on-site coding.

2.2.1 False belief tasks

a) <u>Unexpected contents task</u> (Perner, Leekam & Wimmer, 1987).

For example, children see a familiar candy box, say a Smarties (M&M) box, which they then open and find to be full of pencils. Then they are told that a classmate (say, Sarah) will be brought in, and are asked e.g. "What will Sarah think is in the box?" In this standard unexpected contents task, three-year-old children are prone to say that Sarah will think there are pencils in the box, apparently failing to understand that the other person's beliefs may be false. Furthermore, children are often unable to report what <u>they</u> first believed was in the candy box (Gopnik & Astington, 1988).

We used four different containers with unexpected contents, one in each round of testing, and asked both about the child's own prior belief and their friend's likely belief, for a total of two points.

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, e.g.:

Story:

This boy Bobby and his Daddy bought a nice cake for after dinner. But Bobby wanted to go out to play so he put the cake away until after dinner. He put it in this cupboard for later. Then he went out to play. While he was out, the Daddy thought that the frosting would melt, so he took the cake out of the cupboard and put it in the refrigerator. Then he went out to get some tomatoes for dinner.

Memory check questions: Where did Bobby put the cake? Where is it now?

False belief question: Now Bobby is tired of playing and he's coming home. He remembers where he put the cake. When he comes in the kitchen, where will Bobby first look for the cake? (Siegal & Beattie, 1991)

Explanation question: Why will he look there?

"Failers" say he will look in the refrigerator, that is, where the cake really is, but "passers" say he will look in the cupboard. However, we also ask the question "why will he look there?" and find like other reports that children may correctly identify the place the character would look without giving appropriate explanations. The problem lies in interpreting this answer, because chance is 50/50 for identifying the right place. We therefore also 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 also.

c) Explanation of action (Bartsch & Wellman, 1989)

The final false belief task used was an amalgam of the other two in which a puppet is deceived. The child is shown a puppet who is then put to sleep out of sight. While the puppet is away, the child is shown a familiar box, say of eggs, and the eggs are removed form the container and hidden in another neutral box. The puppet is then brought onto the scene 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.

False Belief tasks 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.

2.2.2. Language tasks:

a) Memory for complements in described mistakes:

On each round, children received 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. The subject's task was to report what the content of that mistake was. Previous work had shown that children have difficulty in answering such questions when the lower or embedded proposition is false (de Villiers, 1995). There were 12 such events, half involving 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.:

2)He thought he found his ring, but it was really a bottle cap.
What did he think?

3)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:

4) 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; criterion for passing was set at 10 or more out of 12.

b) Spontaneous speech

In rounds 2 and 3 we collected and transcribed the spontaneous speech of the children as they talked to us in the test sessions, while playing computer adventure games with us, and after watching amusing silent videos when they spontaneously offered their own experiences.

Spontaneous language was coded in several ways. We derived MLU scores, and also derived a total IPSyn score (Scarborough, 1990), an index of the range and complexity of the grammatical forms used. Within the IPSyn scoring are several subtotals that we also derived for analysis, including the total Sentence 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). In this way we could separate the critical feature, namely

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.

3.0 Data analysis

3.1 Analysis 1: Correlations

For this analysis we simply show in Table 1 the intercorrelations among performance on individual tasks at round 2, chosen because that was when there was the greatest variance on all tasks:

Table 1
Spearman Rank Order Correlations

	Pred.	Cont.	Expl.	Mem.	MLU	IPSyn no comp
Prediction	1.000					
Contents	**0.455**	1.000				
Explanation	**0.753**	0.434	1.000			
Memory for Comps	**0.502**	**0.605**	0.308	1.000		
MLU	**0.451**	0.278	0.115	0.437	1.000	
IPSyn No Comps	0.327	0.128	0.165	0.317	**0.833**	1.000
IPSyn Comps	**0.681**	**0.499**	**0.580**	**0.597**	**0.611**	**0.565**

The correlations in bold are significant, and those above .56 are significant at the $p<.01$ level. Notice the higher values for the correlations between the False Belief tasks with the IPSyn complement measure rather than the more general language measures. However the correlations also make clear that the language measures do share some variance, which we will attempt to tease apart for their value in predicting False Beliefs in the analyses below.

3.2 Analysis 2: Coincident Change over Time

Figure 1 shows the growth in percentage correct of each type of test item across rounds. We collapsed across the various verbs in the memory for complement task as there were no significant differences. It should also be remembered that we scored the Prediction measure conservatively, in that it counts not just the choice of where the character would look, but also the providing of a reasonable justification for that choice. Scoring it this way made that measure fall much more cleanly in line with the other two false belief tasks than if we just counted where the character would look.

Figure 1 demonstrates that all these abilities change and grow within the same time frame, but the order of influence is not clear from such a pattern. We analyzed the data in a slightly different way to determine order of effect. We claim that the false belief tasks have as a prerequisite that the child be able to represent linguistically complements that are false. But children who fail false belief tasks can be developing the ability to represent complements.

Figure 1

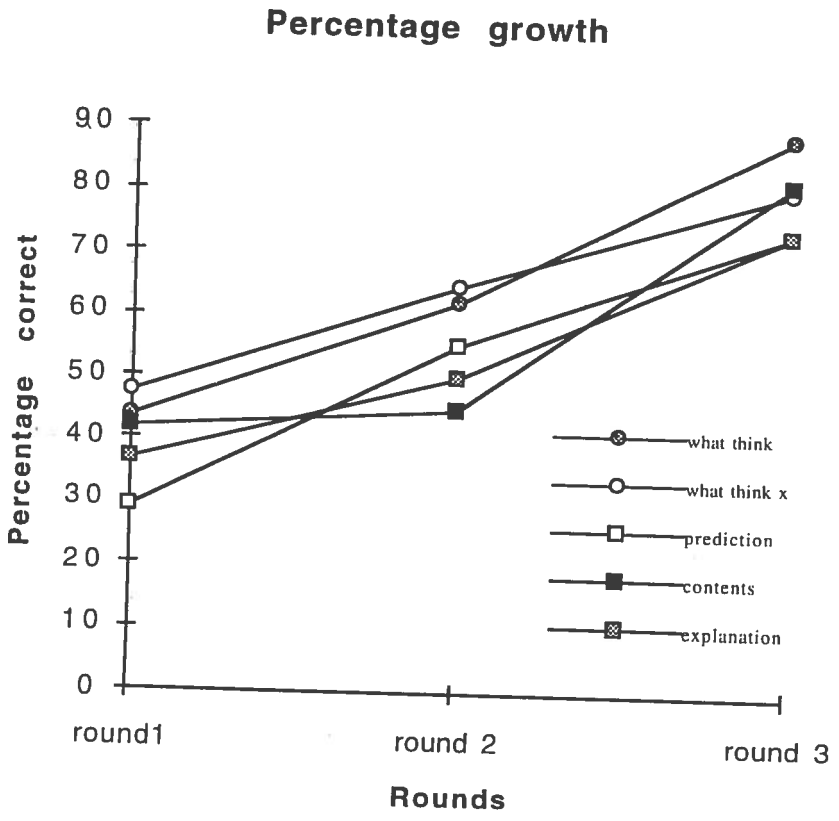
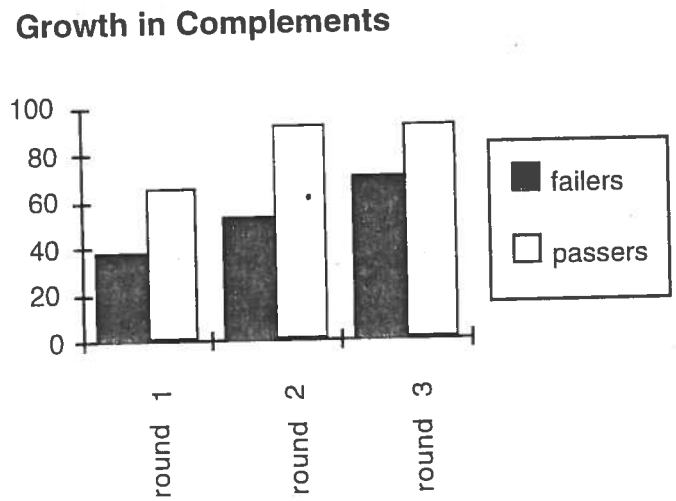


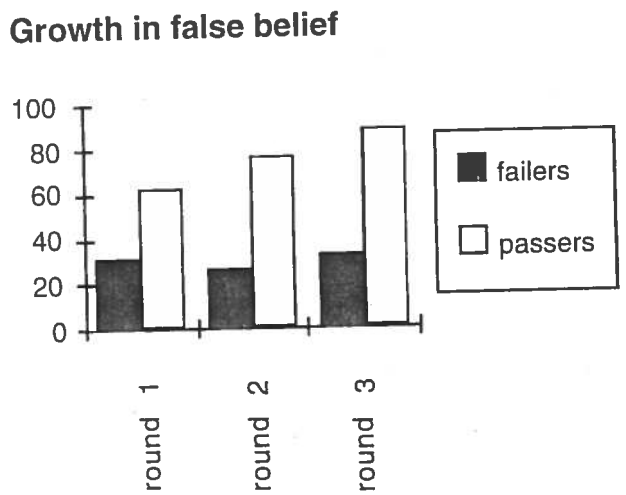
Figure 2 demonstrates that growth: the failers on false belief are developing in their linguistic representations over this time period. Ignoring the first session, the passers of false belief succeed on complements. Figure 2 shows changes across rounds in the success on language (memory for complements) task as a function of passing or failing the false belief tasks.

Figure 2



But we must make the further prediction that there should be *no* growth in passing false belief tasks from the children who fail the memory for complements task. The passers on complements should increasingly pass the false belief tasks. The data shown in Figure 3 support that claim. Figure 3 shows changes over rounds in success on false belief tasks as a function of passing the language (memory for complements) tasks.

Figure 3



It is evident that children who fail to remember false complements, suggesting they cannot yet represent that structure, make no progress on false belief tasks. Notice that in both Figures 2 and 3, the groups constituting the "failers" are not made up of the same children over rounds, rather they are steadily shrinking groups.

3.2 Analysis 3: Simple regressions

We next performed 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. As a predictor variable we used Memory for complements at time 2. The percentage of variance accounted for was a respectable 32.1% ($p<.01$).

Next we tried the reverse, namely trying to predict complement syntax (Memory for Complements) at round 3 on the basis of False belief measures at round 2. The outcome measure was passing (10-12 out of 12) or failing (<10) on memory for complements. 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.)

This asymmetry also supports the conclusion that a certain level of mastery of complements is prerequisite for false belief, not vice-versa.

3.3. Analysis 4: Stepwise Regression: ruling out general language ability.

Which language measures predict a significant percentage of variance in false belief? Children who have, say, larger vocabularies or longer sentences, may have advantages in following the cognitive demands of tasks. We do not want to confound our specific claim with that general advantage. Stepwise regression allows a test of which language measures contribute most strongly, given that they have high intercorrelations. The theory predicts that the key is complementation, not overall length of utterance or other kinds of complexity.

A stepwise regression in SPSS was perfomed, 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-comp) (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.

A stepwise regression in SPSS predicting "passing" false belief at round 3, the next round, on the basis of language measures at round 2 reveals that the most significant predictor variable is production of sentential complements (IPSyn-comp) at Round 2. (29% of variance, $p<.01$). The entire set of language measures at round 2 predict 38% of the variance in later False Belief.

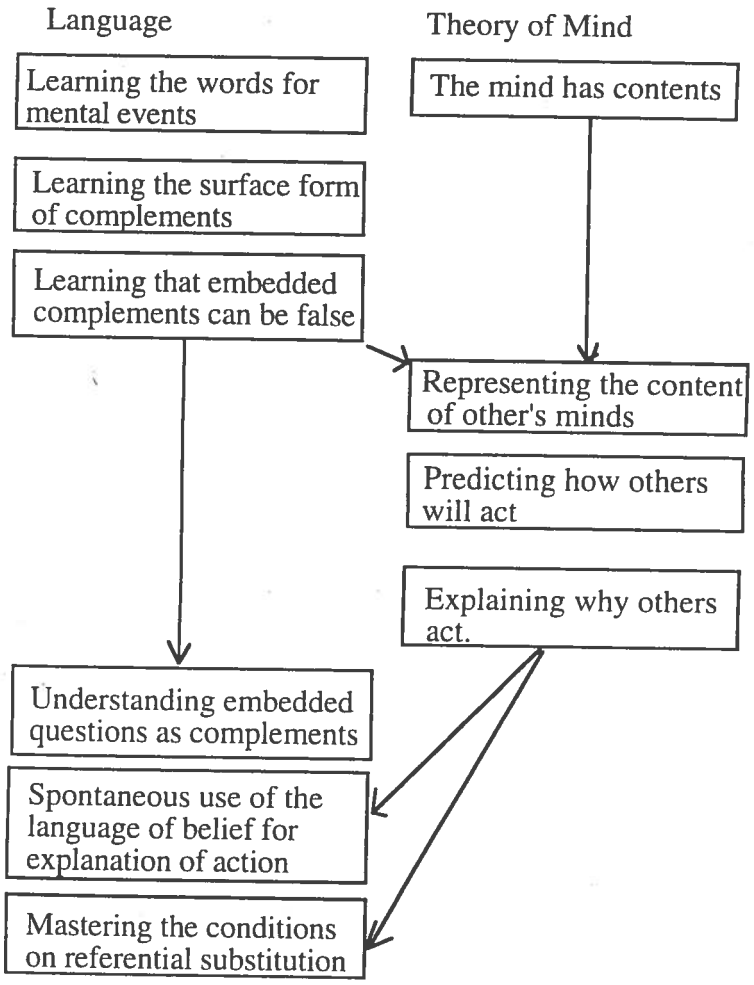
4.0 Conclusion

In previous work we have made the claim that deaf children should fail on even non-verbal false belief tasks to the extent that they lack sufficient command of complex language, and presented initial evidence in support of that hypothesis (Gale, de Villiers, de Villiers & Pyers, 1996). Our ongoing work continues that investigation, but in this study we return to normally-hearing children. The current results with hearing preschoolers bolster the earlier results that suggested that the language of complementation is the critical prerequisite for false belief reasoning in deaf children.

However, it would be a mistake to make a more generalized claim that "a Theory of Mind depends on language". We provide a very rough outline of our current thinking about how these developments interrelate in Figure 4 below. The model tries to make clear that in the present study we are specifically referring to the false belief understanding critical for the classic tasks of unseen displacement and unexpected contents. There is a burgeoning literature suggesting some theory of mind developments come in at widely disparate times, and they each deserve their own analysis in terms of representational requirements (Astington, 1992; Gopnik, 1991; Leslie, 1994; Perner, 1991a; Wellman, 1991). Furthermore, we do not rule out the possibility that some developments in theory of mind actually make possible new understandings of linguistic tasks (cf. Perez, 1996). In our own battery of language tasks we find some that lag behind false belief tasks, suggesting that these language tasks have mastery of false beliefs as prerequisite, for example, acquiring the rules of referential substitution (de Villiers & Fitneva, 1996). Of course, some of these tasks may have further prerequisites beyond passing false belief tasks. It is also becoming evident that children can remember events that have been described to them in more sophisticated ways than they will spontaneously recruit in the description of an entirely non-verbal event. Understanding linguistic complements may not necessarily be sufficient for spontaneously using those forms to describe the actions of characters.

With the addition of an extra cohort of children being followed this year, we hope to disentangle some of these possibilities and make the tentative model in Figure 4 more precise.

Figure 4: a tentative model of interrelationships.



Endnotes

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