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Author
Pietarinen, Ahti-Veikko

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A Conceptual Complexity Account of Theory of Mind Development

Matthew Phillips (phillips@sci.ccny.cuny.edu)
Department of Biology, The City College of CUNY,
Marshak Science Building J526, Convent Avenue at 138th Street,
New York, NY 10031 USA

Abstract:

Experiments published by Wimmer & Perner (1983) appeared to show that young children, relatively fluent in the language of belief attribution, did not have the concept of *false belief* as applied to other people. Since the publication of these results there has been an enormous amount of research dedicated to understanding the cognitive and biological apparatus underlying our capacity for *mentalizing,* i.e. for attributing mental states to other individuals, and how this apparatus develops in children. The False Belief task has been the predominant, though by no means the only, experimental paradigm through which this task has been studied. Many theories of Theory of Mind (ToM) development have arisen from this research. In this paper, I will consider two influential such theories, namely those of Josef Perner et al. (1988, 1991, 1995), and Alan Leslie et al. (1987, 1994, 2005). I will observe some problems each view faces (drawing these problems in two cases from the literature), and then I will offer my own explanation of the developmental data. This explanation is motivated by past and contemporary investigations into the semantics of propositional attitude attributions. It holds that, for the sorts of ToM tasks considered in the literature such as the False Belief task, when children of a particular age fail at these tasks it is because the representations required for success are too conceptually *complex* for those children at that age. Finally, I will describe a direction for further experimentation for testing Leslie's theory as well as my own.

1. Perner and Leslie

In False Belief (FB) tasks, the subject predicts the behavior of an agent who within the course of the experiment has come to have a false belief (usually about the location of an object). Typically, children younger than 4 fail on these tasks, whereas older children (and adults) succeed. (E.g. Wimmer & Perner 1983.) In order to explain these results, Perner (1988, 1991) holds that children undergo significant conceptual change around age 4. In particular, children acquire the capacity for *metarepresentation*, that is, the capacity to represent an agent as having an internal representation or *model* of the world, and moreover to represent the *semantic relation*, truth or falsity, between that person's model and the way the world is. That is, 4-year olds represent the agent's representation, the world, and the semantic relation between the two. Being able to represent agents' mental states in this way is the essence, Perner claims, of being able to understand that people *use* their representations of the world, true or false, to guide their actions. Armed with such an understanding, 4-year-olds are able to successfully predict the behavior of someone acting on a false belief.

Three-year-olds, on the other hand, are restricted to being able to represent another agent as entertaining a model of a situation in the world, even when the model isn't veridical, according to Perner. Thus children of this age can understand when a belief is out of step with reality, and counterfactual situations generally. Strictly speaking, however, children at this age do not have the concept of belief at all; rather, they "associate" representations with other agents, without truly understanding how the association figures into the agent's practical reasoning. When confronted with an FB situation, 3-year-olds, not receiving any cues that the agent (e.g., Maxi) is pretending that the chocolate is in the non-actual location, the child bases its prediction off of reality.

By characterizing 3-year-olds this way, Perner is potentially able to explain a lot of the facility with mental states that 3-year-olds do have. For example, he explains the fact that children do successfully use mental state vocabulary correctly on many occasions. (Bartsch & Wellman, 1995) He can also explain 3-year-olds' ability to use physical models to draw inferences about a real, perceptually available situation. (Perner, 1988, 1991) Most impressively, perhaps, he can explain the fact that 3-year-olds do not appear to be able to clearly distinguish between belief and pretense. (Perner et al. 1994, Perner 1995)

One difficulty with Perner's view is that he provides no direct evidence for the existence of a conceptual leap of the relevant sort at any point in development, and what evidence there is which bears on the question seems to point in the other direction. It has been found, for example, that simply adding the word "first" to the instructions in a FB task ('Where will Maxi look *first*') pushes the age of success down significantly. (Siegel & Beatty, 1991, and especially German et al., 2005: 65ff.) If younger children simply don't have the *concept* of false belief, however, such a change should not help. This consideration encourages us to look for a more parsimonious account of childhood development.

The theory of Alan Leslie and his collaborators avoids the concern raised against Perner's view. According to Leslie and collaborators, the developmental pattern with respect to ToM exhibited by children is a result of the collaboration of two mechanisms. The first is an innate "Theory of Mind

Mechanism" (ToMM), which embodies ToM knowledge as well as representational structures needed to mentalize. The ToMM is to be understood as closely analogous to the mechanism which embodies linguistic competence, as described by Chomskyan linguistic theory. The other mechanism is a gradually maturing "Selection Processor" (SP), which, when the child is induced to predict behavior or attribute attitudes, chooses from multiple "competing alternative representations" of the agent's mental states. (Leslie et al., 2005: 48) The SP is thought to perform an essentially executive function, modulating the activation levels of the different representations in ToMM. In particular, the SP serves to *inhibit* the *default* (prepotent) representation which ToMM offers: namely, the representation of the agent's mental states which is identical to the subject's own. I.e., the SP's job is to overcome the subject's reality bias, where appropriate. In young children, the SP is typically not able to deliver enough inhibition to do this; in older children it is. Moreover, since the SP is by hypothesis cognitively penetrable, situational factors can serve to make one or another alternative representation more "salient" than another. Explicitly bringing the non-default representation to the attention of the subject, for example, might make it more salient and therefore easier to select.

This view, ToMM-SP theory, has considerable explanatory power. It explains why 'look *first*' instructions increase FB task success rates; doing so brings to the attention of the child the location where the transferred object *was* first, and this makes the prepotent reality attribution easier to inhibit. Leslie's view also appears to very nicely explain the dissociability exhibited by autistic children between mentalizing, and reasoning about representations more generally. Autistic children, as reported in Leslie & Thaiss (1992), fail spectacularly at attributing false beliefs, relative to their normal verbal-age-matched counterparts. They do this despite performing *better* than matched normals on false map and outdated (Zaitchik) photograph tasks, both of which presuppose possession of the concept of misrepresentation. Finally, Leslie's view is currently the only one which explains the sharp falloff in performance in both FB and True Belief (TB) tasks when an *avoidance* desire (e.g., wanting to *avoid* putting the sick kitten in with the food), is substituted for the standard *approach* desire (e.g., wanting to eat the chocolate).

However, it is not clear that ToMM-SP theory can explain the substantial developmental asymmetry that exists between belief and desire concept acquisition. Children use desire vocabulary a year before belief vocabulary (ages 2 and 3, respectively). (Bartsch & Wellman, 1995: chapter 2) They also understand contrastive (i.e., not-own) desires at age 3. (1990, 218ff.) Leslie et al.'s (2005) own results illustrate this phenomenon, in that TB-avoidance desire tasks prove to be easier for children than FB-approach desire. In discussion of this, they write:

> [Our results show] that a desire target-shift is easier to produce than a belief target shift. A weaker inhibition may shift a desire target while a stronger inhibition is required to shift a belief target. Perhaps this is because a belief, but not a desire, inhibition must overcome a default. (2005: 75)

The claim that there is no default in desire attribution, however, seems suspect. Certainly, the natural assumption to make would be that just there is a bias towards our own beliefs in belief attribution, there is a bias towards our own desires in desire attribution. This bias is the default. Moreover, even if the inhibitory threshold is lower for desire, there is still no explanation of why the child acquires desire psychology earlier than belief psychology.

Thus, both views considered here have problems. I turn now to my own view, which avoids these problems.

2. Conceptual Complexity explains ToM development as well as semantic data

In light of the difficulties which face the views discussed in the last section, it is reasonable to look for alternative hypotheses which explain the data. The one I will offer derives from research done in the formal semantics of propositional attitude ascriptions as well as on the event-based semantic structure of all natural language. It has the virtue of explaining both developmental as well as linguistic data. It is similar in many ways to the account of de Villiers (2003), but also crucially different in one respect which I will mention below.

Following Scheffler (1954), I will suppose that the *complementizer clause* which typically follows a verb of propositional attitude contains, in effect, an *operator* which serves to 'cordon off' or, to use language from Leslie (1987), to 'decouple' or 'quarantine' the part of the sentence which constitutes the metarepresentation. This operator turns the embedded sentence into a predicate, which is a predicate of an internal argument that is also an argument to the mental state verb. Put in psychological terms, I propose that to a first approximation, when a person hears and understands a sentence like 'Sally thinks that the ball is in the red box', she represents the utterance to herself as follows, where '(∃x)' denotes the existential quantifier, and [] … [] is the operator which 'quarantines' the metarpresented component:

(1) (∃x)(BELIEVES(Sally, x) & []the ball is in the red box[](x))

'x' is basically an abstract object, such as a proposition. The above reads, 'there is an x such that Sally believes x and according to x, the ball is in the red box'. The boxes prevent the hearer of this utterance from confusing Sally's belief with any of her own.

This semantic analysis, then, generalizes to thought; the proposal is that any time someone *thinks* 'Sally thinks that the ball is in the red box'—as, presumably, one must in order to pass an FB task—a similar sort of representation exists.

We can analyze the above representation further, by exposing its event-based structure. A cardinal insight of semanticists since Davidson (1967/1980)—who I will interpret here as being engaged in the psychology of language comprehension and deductive reasoning—is that every natural language sentence can be seen as describing an *event* (where this concept is understood broadly, so as to include states). The verbs and adverbs in the sentence describe this event, and the objects picked out by the nouns bear thematic relations to it. Thus, for example, we can analyze 'John kissed Mary tenderly' as

(2) (∃e)(AGENT(e, John) & KISSING(e) & PAST(e) & OBJECT(e, Mary) & TENDER(e))

In (2), 'e' is an event variable; in the example, e is a(n event of) kissing, e occurred in the past, and e was tender. John was the agent involved in e, and Mary was its object.

Thus, event semantics renders English sentences in such a way as to make explicit, and to isolate, all of the pieces of information in them, while retaining intelligibility. What's more, applying the logic of conjunction elimination to (2), we can in effect use it as the basis of a psychological model of deductive reasoning. We all know that if John kissed Mary tenderly, then it follows (trivially) that John kissed Mary. Correspondingly, we can formally derive (3) from (2):

(3) (∃e)(AGENT(e, John) & KISSING(e) & PAST(e) & OBJECT(e, Mary))

Further logico-linguistic evidence supporting event-based semantics is legion. Event semantics elegantly explains inference and ambiguity data involving compound adverbial modification, causative and resultative verbs, verbs of perception, quantification over and reference to events, and many other topics. For reviews, see Parsons (1990) and Pustejovsky (1995).

There is also considerable psychological evidence in favor of the claim that high-level cognition is event-based. For example, in the domain of developmental psychology, Wynn (1996) reports that 6-month-old infants—as yet incapable of speech, qualitative object discrimination, and complex physical action—are able to *enumerate* events. After being habituated to scene in which a puppet jumped some fixed number of times (2 or 3), infants were 'surprised' in test trials where the puppet jumped a number of times different from the number in the habituation trial (3 or 2, respectively). That is, infants stared at the scene for a longer period of time before looking elsewhere.[1] This result was persisted under variation of the amount of time between events (.5 to 1.5 sec), and even persisted, in weakened form, when the puppet is in continuous motion in between jumps. Wagner & Carey (2003) also discuss data which shows that children are able to individuate events at a very early age.

In the domains of perception and memory, Zacks et al. (2001) and Zacks & Tversky (2001) discuss evidence that memory representations encode event structure and that perception is sensitive to event boundaries. In the experiments they discuss most thoroughly, subjects were instructed to view a videotape of an actor making a bed or performing other familiar tasks. Subjects were indicate through tapping on a recording device how the video decomposed into "natural and meaningful units"; in distinct trials, they described both "small" and "large" such units. The segment boundaries subjects assigned in the coarse-grained version of the task ("large units") had a significant tendency to match up with boundaries they assigned in the fine-grained version ("small units"). This effect—the "alignment effect"—indicates, as Zacks and his coauthors claim, that perception has a hierarchical, event-based structure; the video segments picked out in the fine-grained version of the task are subevents of the segments picked out in the coarse-grained version. Interestingly, the ratio of fine-grained to coarse-grained segments was typically 3:1, suggesting that the fine-grained segments divide the coarse-grained events into a beginning, middle, and end. (Cf. Zacks et al. (2001: 34).)

The Conceptual Complexity account of ToM development arises when operator-based accounts of propositional attitudes and event semantics (again, with event semantics is understood as a psychological theory about the structure of conceptual representation) are combined. The full, combined analysis of 'Sally thinks that the ball is in the red box' is as follows:[2]

(4) (∃x)(∃e)(AGENT(e, Sally) & BELIEVING(e) & PRESENT(e) & OBJECT(e, x) & (∃e*)[]SUBJECT(e*, the ball) & PRESENT(e*) & IN(e*, the red box)[](x))

This is pretty symbol-heavy, but if you consider all the entailments that are possible from the sentence 'Sally thinks

[1] Looking time, along with sucking frequency and galvanic skin response, are the three chief behavioral responses that infants are capable of which are recorded by developmental psychologists. It is taken to be a measure of the extent to which an infant finds a stimulus 'interesting', and it is assumed that infants find novel or unexpected stimuli to be particularly interesting.

[2] 'Full' here and elsewhere must be taken with a grain of salt. Much structure, irrelevant for current purposes, is suppressed.

that the ball is in the red box', you will see that every piece is doing some work. I note that specifying that the abstract object x is the *object* of the belief addresses an important semantic explanandum; it explains the fact that from 'Sally believes that the ball is in the red box' you can infer that 'Sally thinks something'. This explanation gets interesting linguistically when one considers that although 'John complained that the ball is in the red box' is grammatically just fine, '*John complained something' is not; yet 'John complained *about* something' is perfectly acceptable again.[3]

What's interesting for the purposes of explaining ToM is what occurs between the boxes. Combining event semantics with operator PA semantics allows us to *quantify*, in an approximate way, the amount of conceptual material that a subject is metarepresenting on a given occasion. (NOTE: I use the term 'metarepresentation' to refer to any thought about a thought, not in Perner's richer sense.) In (4), it's two thematic relations and a tense concept (present tense, in particular). Metarepresentations can thus be more or less complex in a way that is made perspicuous by this form of representation. What the Conceptual Complexity view ('CC', henceforth) holds, then, is that what changes through development is *how much* conceptual material the child can metarepresent, i.e. 'put between the boxes'. Metarepresentation takes cognitive energy. The older the child is, the more it can metarepresent.

How this claim translates into an explanation of developmental data is as follows. Consider first the relatively early onset of desire psychology, at age 2. As we've seen, it's not clear how Leslie's view can explain this (or Perner's for that matter). But on CC the explanation falls out immediately from the conceptual structure of desire attribution. Desire attributions are *tenseless*; whereas the embedded clause in a belief attribution is always tensed ('is', 'kissed'), the embedded clause in a desire attribution never is ('Sam wants *to leave*', 'John wants Mary *to kiss* him'. CC holds that this reflects a genuine, quite significant conceptual difference between our representations of belief and desire. We conceptualize belief as a relation to a *particular* event; this event is particular because it has a temporal location, and that is what is picked out by the tense predicate. We conceptualize desire, on the other hand, as a relation to a *kind* of event. There is no *particular* fulfillment event one has in mind for Susan when one thinks 'Susan wants Bob to leave'; for Susan, any member of the class of acts of leaving, undertaken by Bob, will do. On the other hand, there is a particular event we take Susan to be thinking about when *we* think 'Susan thinks that Bob has left'.

The representation of 'Susan wants Bob to leave', then, looks like this, suppressing irrelevant detail in the main clause:

(5) $(\exists x)(\exists e)(\text{WANTS}(e, \text{Susan}, x)$ &
$(\exists e^*)[]\text{AGENT}(e^*, \text{Bob})$ & $\text{LEAVING}(e^*)[](x))$

There is no tense predicate in the embedded clause. Thus (5) is conceptually simpler than (4). This, according to CC, is why desire psychology comes first. Children have all the concepts they need at a very early age, but they don't have the cognitive 'space' or 'energy' to metarepresent tense until around 4.

Now consider the failure of 3-year-olds at standard FB tasks. The CC explanation of this fact is similar in some respects to Perner's. 3-year-olds can't metarepresent tense; that means that they can't do it for belief either, even if they are able to use the language successfully on occasion. Rather, they treat belief as a relation to an event *kind*. In not being able to tie an agent's belief to a particular situation via a conceptualization of the tense of the event which is the subject of the belief, they can not use such a representation to reason about particular situations. Specifically, when asked about e.g. the current situation, children are forced to predict behavior and report mental states on the basis of their *own* primary belief representations (i.e., their own beliefs). These are tensed and thus do refer to a particular situation, in this case the current one.

So, the 3-year-old's version of (4) above is the following:

(6) $(\exists x)(\exists e)(\text{BELIEVES}(e, \text{Sally}, x)$ &
$(\exists e^*)[]\text{SUBJECT}(e^*, \text{the ball})$ & $\text{IN}(e^*, \text{the red box})[](x))$

Again, it is the absence of a tense representation in the embedded clause which prevents the child from relating the belief content to a particular situation.

There are some independent considerations which support this analysis. Hollebrandse (1998) found that False Belief task failers had difficulty representing past tense embedded within a past tense matrix verb. In the scenario, Cookie Monster says 'I will have a banana on my plate', whereupon he receives one. Children are then asked: 'Did Cookie Monster say that he had a banana on his plate?' The correct answer, in Dutch as in English, is 'no'. The temporal location of the embedded event in the question is at or prior to the event of saying, but Cookie Monster referred to an event occurring after, not during or before, his utterance. Hollebrandse found a correlation between incorrectly answering the test question and failing the False Belief task. This supports the idea that FB mastery depends on successfully metarepresenting tense.

Another consideration—though a relatively weak one—comes from a survey of the mental state language used by children reported in Bartsch & Wellman (1995). Although children are able to use tense in embedded clauses complementing verbs like 'think' and 'know', they do not appear to be able to distinguish *conceptually* between the two tenses. That is, the tense of the embedded clause verb is almost always identical to that of the main clause verb.

[3] Space limitations force me to remain coy as to exactly what the explanation is here.

This suggests that notwithstanding language, children can't genuinely metarepresent tense at a young age. This distinction between linguistic ability and conceptual competence is, I note, what sets CC apart from the syntax-based view of Jill de Villiers, and which allows it to avoid objections based on cross-linguistic data to which her view is subject. (Cf. de Villiers (2003:22ff.) for discussion.)

Finally, CC elegantly accounts for the particular difficulty children have with *semantic opacity*—the recognition that, even if the hunting knife is what was used to murder Jones, Sam might think that the hunting knife was on the dresser while not realizing that the murder weapon was on the dresser. Children do not achieve adult-like performance on opacity until significantly after the point at which they succeed on FB tasks; this further development can take years. (E.g. Russell, 1987) Rather, they show a consistent bias toward de re interpretation—if they know that the knife is the weapon, they assume Sam does too. CC accounts for this by making a slight but natural modification to the original representational format; it assumes that, under normal circumstances, only the tense and thematic predicates get 'boxed', i.e. quarantined, along with variables that connect them to the objects and events in the agent's belief.[4] In situations calling for semantic opacity, however, the crucial predicates ('murder weapon') also get quarantined in adult metarepresentations. Where Sam's state of mind is salient, adults will hear 'Sam thinks that the murder weapon is on the dresser' as, roughly, 'Sam thinks that *what Sam believes to be the murder weapon* is on the dresser'. Hearing it this way requires entertaining a much more complex metarpresentation, which children can't do until they get older.

CC can also explain avoidance desire effects and 'look first' effects. Avoidance desires are naturally construed as containing negation at the conceptual level and therefore being more difficult to process. Leslie et al. (2005) claim to have eliminated this hypothesis, as children succeeded as well on FB tasks with the negative desire 'want to give the bone to the dog that doesn't have spots' as with standard FB tasks which employ a positive desire. Unfortunately, this result does not show very much, for two reasons. First, children may have immediately re-conceptualized the desire as the *positive* desire to give the bone to whatever particular dog fit the criterion. In this case CC would predict success as well. Second, Leslie et al. put the negative particle in a relative clause; the true negative equivalent of an avoidance desire, however, would put the negation on the embedded clause verb—e.g., wanting to *not put* the sick kitten in with the fish. It seems quite possible that, as CC predicts, children would find this construction more difficult than positive desire constructions.[5] However, only children's success on a construction like this could constitute a threat to the analysis of avoidance desires as desires which are negative in character, and so conceptually more complex.

CC can also offer a reasonably straightforward explanation of 'look first' effects, which is broadly similar to that of Leslie et al.'s.[6] Saying '… look *first*' makes temporal information more salient to the child, as 'first' designates a temporal location, and the child is at least implicitly aware that task-relevant information is time-dependent (i.e. that the object is in one location at one time and in another location at another time). As the salience of temporal information increases, the 'cost' to the child of metarepresenting time decreases. This makes it easier for a tense predicate to 'fit in the boxes' and thus makes it easier for the child to entertain an adult-like belief representation.

3. Further experimentation

The developmental asymmetry regarding belief and desire discussed in section 1 sets up some experiments that would provide critical tests of ToMM-SP and CC theories, and I will describe them here.

Although there is no such thing as a 'false desire', there are desires so at odds with our own that we would never imagine attributing them to another; the desire to eat spoiled food, for example. If we assume that, in fact, considerable inhibition is required in order to attribute such a desire to another agent, then running FB and TB experiments employing this desire (possessed by the character 'Nasty man', say) would test between ToMM-SP and CC theories. ToMM-SP should predict considerable difficulty for children; CC theory predicts only negligible difficulty.

Of course, without an independent measure of the inhibition required to attribute a particular attitude, the results from such an experiment could not be definitively interpreted. The deeper project, then, particularly for ToMM-SP, is to find a way of independently measuring the

[4] Note that when we ascribe a belief, it's really only the thematic relations and event locations that are quarantined. The various objects involved are, considered separately, typically common ground, even in a case of false belief. The representation involved here is pretty complex; viz. for 'John believes Twain smoked', we have:

$$(\exists!x)(\exists e)(\text{AGENT}(e, \text{John}) \,\&\, \text{BELIEVING}(e) \,\&\, \text{PRES}(e) \,\&\, \text{OBJECT}(e, x) \,\&\, [\text{THE } z\text{: TWAIN}(z) \,\&\, []\text{TWAIN}(z)[](x)](\exists e')[]\text{AGENT}(e', z) \,\&\, \text{SMOKING}(e') \,\&\, \text{PAST}(e')[](x)).$$

[5] If, as suggested in the previous paragraph, noun phrases are not normally quarantined, then children's success with Leslie et al.'s negative desires can be explained without appeal to reconceptualization; viz., the negation in the relative clause is not part of the metarepresentation proper.

[6] I'm grateful to an anonymous reviewer for suggesting this explanation.

inhibition requirement, or the prepotency, of beliefs and desires. Since some beliefs are held less strongly than others, and one's own desires presumably must be prepotent to a certain extent (the nature of many sexual harassment cases often strongly suggests this, I note), if such a measure were found it should be possible to find belief/desire pairs which are matched on their inhibitory requirements, and then to run experiments comparing success across the two cases. ToMM-SP would predict equivalent performance across tasks; CC would predict contrastive desire tasks to be uniformly easier than FB tasks, even in matched circumstances.

How might the inhibition requirement be measured? One way might be to make subjects control the action, instead of simply predict or explain it. Children could be given control of a puppet or computer character, and told to make it behave as they themselves would behave in given situations, modulo discrepancies introduced by the experimenter. Attributing discrepant beliefs or desires to an agent might be easier if the subject is interpreting the agent as, essentially, himself; the child would be, in effect, pretending to believe something it didn't believe or pretending to want something it didn't want. This might prove possible even for children who failed any of the ToM tasks discussed above. If so, the child's resistance to accepting the various mentalistic pretenses could be measured by seeing how well it could maintain the pretense in tasks analogous to traditional FB/avoidance desire tasks. This would in turn allow us to measure the relative inhibition requirements on the corresponding beliefs and desires.

Clearly, the foregoing is highly speculative. Nonetheless, I hope to have provided a strong motivation for pursuing further investigation in this area, as well as some initial suggestions as to how it might go. I hope also, of course, to have introduced a new, viable account of the child's ToM development.[7]

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