Do infants really understand false belief?

Response to Leslie

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In his Research Focus ([1] this issue) Leslie argues that the idea of an innate theory of mind module (ToMM) has for too long been considered absurd. We do not consider it absurd but simply think current data can be explained equally well by means of an interaction between genetic endowment and the environment, and that exploration of this interaction should not be curtailed by *a priori* restrictions due to genetic over-specification.

In defense of his position Leslie first cites neuroimaging studies in support of neural structures 'dedicated' to theory of mind. The seeming consensus regarding which brain region is responsible for theory of mind [2] is currently being challenged [3,4] such that different areas are considered responsible for different aspects of theory of mind. Furthermore, it is unclear whether involvement of particular neural regions says anything about innateness. The fusiform gyrus was thought uniquely 'dedicated' to face perception until the discovery of its specialization for cars in car enthusiasts [5]. Is specialized processing of cars also innate? For some functions brain areas become specialized by virtue of experience.

Leslie also cites evidence for theory of mind in infancy. However, even some of the authors cited acknowledge that their results have both a mentalistic and a behavioristic interpretation [6,7]. Indeed, we can distinguish four different explanations:

(1) *Low level similarity to previous encodings*. Leslie does not cogently counter our initial argument [8] against Onishi and Baillargeon [9] along these lines; that cells in the brain code for configurations of persons relating to objects, and infants' looking might indicate these codings.

(2) *Behavior rules* (e.g. 'people look for objects where they last saw them').

(3) *Teleological understanding* [7], in which behavior is understood as being due to goals and external circumstance (true beliefs), and a rationality assumption is made that the most efficient means of achieving the goal are taken.

(4) A *mental understanding* that allows for different perspectives of a circumstance, which is needed for understanding false belief.

Leslie questions why infants would evolve behavior rules. Our points are that such rules are potentially used by primates with which humans share a genetic ancestry [10], that such ancestral abilities also form core theories in other areas that are then modified by means of language [11], or that infants' sophisticated statistical learning abilities [12] would also provide ample means for acquiring such rules. Indeed, the parallels to language acquisition are striking; beliefs that syntax must be innate have been tempered by evidence that infants' statistical learning abilities (which might themselves be innate) permit learning about at least some aspects of syntax [12].

Leslie also argues that 3-year-olds do not use behavior rules in the traditional false-belief task but default to answering in terms of reality. This leaves the question of why their looking to the empty location in implicit tasks [13] does not also default to reality. Instead, such looking is consistent with the use of a rule. It is perfectly plausible that children use this rule in an implicit task but when asked explicitly they use a different strategy. The evidence for 2-year-olds is less clear despite Leslie's claim that they show implicit insight. In the study cited by Leslie [14], only 53% of children (aged 2 yrs 1 mth to 4 yrs 1 mth) looked correctly over the true and false-belief tasks – not compelling evidence for 2-year-olds passing the test. In the

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only other relevant study, children less than 2 yrs 11 mth failed the implicit measure [13]. It could be that methodological differences account for the different ages children pass implicit tasks compared with the Onishi and Baillargeon task.

Leslie suggests that younger children (below 2 yrs 11 mth) fail implicit measures because of the verbal demands of the implicit tasks. Yet these tasks follow the same sequence of events as in Onishi and Baillargeon's study. Even without understanding the narrative, the visual details of the events should enable correct eye gaze, provided that infants understand the eye gaze prompt (e.g. '*I wonder where he'll look*?'). Importantly, 2-year-olds do look correctly in response to this identical prompt in other social understanding tasks [15], and ironically also in a study cited by Leslie (Waskett *et al.*, unpublished), demonstrating the verbal demands are within their grasp.

In our view, current data indicate that infants understand much about behavior but whether it includes an understanding of belief is still a wide open question.

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