

# Embodied Social Cognition and Embedded Theory of Mind

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Embodiment and embeddedness define an attractive framework to the study of cognition. I discuss whether theory of mind, i.e. the ability to attribute mental states to others to predict and explain their behaviour, fits these two principles. In agreement with available evidence, embodied cognitive processes may underlie the earliest manifestations of social cognitive abilities such as infants' selective behaviour in spontaneous-response false belief tasks. Instead, late theory-of-mind abilities, such as the capacity to pass the (elicited-response) false belief test at age four, depend on children's ability to explain people's reasons to act in conversation with adults. Accordingly, rather than embodied, late theory-of-mind abilities are embedded in an external linguistic practice.

*Keywords:* embodied and embedded cognition; false belief test; social cognition; social understanding; theory of mind

## 1. Introduction

Recent years have seen the birth of a new conception of the mind, namely, embodied cognition (Varela *et al.* 1991; Steels & Brooks 1995; Clark 1997, 2008; Lakoff & Johnson 1999; Shapiro 2011). Briefly, embodied cognition asserts that our physical constitution, that is, the body, matters to the definition of our mental life. In opposition to traditional cognitive psychology, according to which cognitive activity depends on the manipulation of amodal representations that control motor responses, embodied cognition states that perception and action are constitutive of mental representations. Accordingly, motor as well as sensory processes have a central role in the definition of cognition.

Embodied cognition supports a principle of economy in the definition of cognitive processes: It suggests substituting, until possible, reference to amodal representations with workable hypotheses about the functioning of sensory and motor systems.<sup>1</sup> This is also consistent with evolutionary explanations:

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<sup>1</sup> Consider, for instance, how Barsalou (1999) replaces Paivio's (1986) reference to a symbolic



“[E]volution capitalized on existing brain mechanisms to implement conceptual systems rather than creating new ones” (Yeh & Barsalou 2006: 374). Theoretical economy and evolutionary plausibility thus make the framework of embodied cognition appealing and desirable for the study of cognition. However, economy and plausibility are not compelling reasons to accept embodied cognition. Whether it defines a valuable framework to explain cognitive activity, in general, and more specific cognitive competences, in particular, is an empirical issue, which is worth of consideration.

In this article, I investigate whether embodied cognition is compatible with social cognitive development and, in particular, with the capacity to attribute mental states (such as beliefs, desires, and intentions) to others in order to predict and explain their behaviour.<sup>2</sup> Although investigation on children’s acquisition of this capacity dates back almost thirty years ago (Wimmer & Perner 1983; Baron-Cohen *et al.* 1985), traditional accounts of social cognitive development have never considered the possibility that it stands for an embodied capacity. This came to a reason. On the one hand, modularist accounts of theory-of-mind acquisition (Perner 1991; Baron-Cohen 1994, 1995; Leslie 1994, 1995; Scholl & Leslie 1999) usually referred to sentence-like representations to describe the processing of the cognitive mechanism implementing theory-of-mind abilities; thereby, they assumed an amodal medium of representation that is incompatible with embodied cognition. On the other hand, child-as-scientist accounts (Gopnik 1990, 1996; Carey & Spelke 1996; Wellman & Gelman 1997; Wellman 2002) preferentially focused children’s theoretical understanding of folk psychology and left aside the analysis of cognitive processes.<sup>3</sup>

Recent research however allows rethinking the embodiment of theory-of-mind abilities. Based on evidence from the false belief test (FBT) paradigm, traditional explanations of theory-of-mind acquisition assumed that children acquire the ability to attribute false beliefs to others in their fourth year of life (Wellman *et al.* 2001; Wellman & Liu 2004; Liu *et al.* 2008). Recent results however demonstrated that even infants in their second year of life seem to attribute false beliefs when simplified versions of FBT and behavioural responses are considered (see Baillargeon *et al.* 2010 and Sodian 2011 for updated reviews and discussion about alternative interpretations). Because these recent results demonstrate that theory-of-mind abilities are acquired earlier than previously reported, they raise the possibility that theory of mind is embodied in early

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code for mental representations with reference to a network of multi-modal associations.

<sup>2</sup> The acquisition of this capacity has traditionally been interpreted as equivalent to the possession of a ‘theory of mind’ (Premack & Woodruff 1978). Further evidence however importantly questioned the idea that such a capacity is acquired all in once due to the maturation of one cognitive mechanism. In what follows, I will hence distinguish *early* and *late* social cognitive abilities — I will consciously employ the expression ‘social cognitive abilities’ as a synonym for the more specific capacities manifested in false belief tasks. Whenever the term ‘social cognition’ will be used, it will preferentially refer to early social cognitive abilities, such as those manifested in spontaneous-response tasks. Instead, I will talk about ‘theory of mind’ to refer to late social cognitive abilities as manifested by the capacity to pass the traditional false belief test (see further).

<sup>3</sup> Simulation theory (Gordon 1986, 2007; Harris 1989; Heal 1986, 1998; Gallese & Goldman 1998; Goldman 2006) represents a case apart. I will discuss embodied accounts of theory-of-mind acquisition related to it in the long of this article.

sensory–motor skills. They also suggest that the capacity to pass FBT is not as central as previously thought to the acquisition of a theory of mind — as some had already claimed (e.g., Fodor 1992; Bloom & German 2000). But these results are merely suggestive. They leave open the question of *which* competences underlie the acquisition of this ability and whether *those competences* fit the framework of embodied cognition.

This article is devoted to the exploration of these two perspectives. I will claim that *early* social cognitive abilities are probably embodied inasmuch as available evidence is consistent with their implementation by cognitive processes integrating sensory–motor information. On the other hand, I will argue that *late* social cognitive abilities are embedded in social and dialogical practices — and, in particular, that the ability to pass FBT at age four denotes the acquisition of a minimal capacity to explain people’s reasons to act. Embodiment and embeddedness are two logically distinct hypotheses about the nature of cognition, each appropriate to some cognitive skills, and not to others. Late social cognitive abilities thus fall beyond the borders of embodiment. I will conclude that theory of mind is a composed competence that stands in a complex relationship with the principle of embodiment: It is likely partially embodied, and partially not, but the part that is not is likely embedded.

Section 1 clarifies which conception of embodiment is at stake when discussing whether theory-of-mind abilities are embodied. It also distinguishes embodiment and embeddedness as two logically different principles about the nature of cognition. In section 2, I discuss how the empirical plausibility of an embodied approach to early social cognition is challenged by mentalist interpretations. I argue that embodiment accounts advance a coherent and plausible interpretation that is not dismissed by mentalist pre-theoretical intuitions.

In section 3, I claim that the crucial argument in favor of mentalist interpretations presupposes that early social cognitive abilities develop in continuity with later theory-of-mind capacities. However, I show that empirical evidence disconfirms continuity in social cognitive development. It follows that mentalist interpretations are not in a better position than embodied approaches in describing the earliest forms of social cognition. Empirical investigation should take very seriously the task of deciding to what extent infants’ social cognitive abilities can be accounted for by relatively simple embodied processes and mechanisms.

Section 4 turns on four-year-olds’ acquired capacity to pass FBT and rejects three different explanations of its developmental pattern, one of them being based on the role of the executive function two others on different aspects of language acquisition. In section 5, I propose as an alternative that the capacity to pass FBT depends on a minimal ability to explain people’s reasons to act. I review empirical evidence supporting my proposal, and conclude that late theory-of-mind abilities fit the principles of embedded rather than embodied cognition.

## 2. Embodied, Situated, and Embedded Cognition

Discussing whether theory-of-mind abilities are embodied first requires clari-

ifying which conception of embodiment is at stake. Generally speaking, embodied cognition asserts that our physical constitution, that is, the body, matters to the definition of our mental life. Although this general principle can be refined or expanded in several ways (Wilson 2002; Anderson 2003; Kiverstein & Clark 2009), it minimally requires only that the processes implementing cognitive abilities importantly rely on sensory (e.g., somatosensitive, interoceptive, proprioceptive) and motor representations (Goldman & de Vignemont 2009; Gallese & Sinigaglia 2011).

This formulation may appear inadequate for at least two reasons. First, even traditional cognitivists acknowledge that sensory and motor processes trivially have a role in cognition. By requiring that they must play an ‘important’ role, embodied cognition stresses that sensory and motor processes must be central even to the definition of high-level cognitive abilities. Second, anti-representationalist embodiment theorists (e.g., Varela *et al.* 1991; Thelen & Smith 1994; Steels & Brooks 1995; Chemero 2009) would say that this formulation is too weak because sensory–motor processes sufficiently define cognitive activity without the need of positing inner representations. Still, embodiment as a principle neither requires nor denies the existence of mental representations. I believe that this formulation would be accepted by most of its non-radical supporters. In what follows, I will hence assume that this formulation correctly states a viable minimal definition of embodiment: In order to be embodied, social cognitive abilities need to be implemented by cognitive processes that importantly rely on sensory and motor information.<sup>4</sup>

Before going further, it is important to disentangle embodiment from two close principles. Making this distinction will come at help later when discussing how it relates to different components of theory-of-mind abilities. *Situated cognition* asserts that we cannot artificially separate the body, thereby cognitive activity, from the environment in which it is placed.<sup>5</sup> *Situated cognition* differs from embodiment in that it stresses the role of background information to the processing of any stimulus (Yeh & Barsalou 2006; Barsalou 2009), whereas the latter focuses on the role of the body in actively engaging the organism with the environment.

Embodied cognition has also to be distinguished from *embeddedness*, which highlights the role of external structures in supporting and scaffolding cognitive activity.<sup>6</sup> *Embeddedness* supports a principle of conceptual economy for cogni-

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<sup>4</sup> This is substantially a re-proposal of Goldman & de Vignemont’s (2009) definition of embodied cognition. It is less exposed to anti-representational concerns because ‘representations in a bodily format’ have been replaced by reference to their vehicles, i.e. cognitive processes integrating sensory and motor information.

<sup>5</sup> *Situatedness* is closely related to ecologism (Gibson 1979), which states that behavior cannot be studied independently of the environment in which it occurs. It is also presupposed by enactivist approaches — in both their representationalist (Grush 2004; Noë 2005) and anti-representational versions (Chemero 2009; e.g., Varela *et al.* 1991; Thelen & Smith 1994; Steels & Brooks 1995) — according to which cognition is the outcome of the interaction between the body and the environment so that action, not only perception, is constitutive of cognitive activity. *Situatedness* is however a weaker principle than enactivism, which also assumes the truth of embodiment.

<sup>6</sup> We continuously modify and construct the space around us disseminating information in it to our next benefit. Think about how we re-locate objects in our house not to stub our toe on

tion in a direction opposite to embodiment. Where embodiment points to conceptual economy in the inwards direction of the modal nature of mental representations, which are the inner vehicles of cognition, embeddedness points instead to the outwards direction of the environment, which simplifies cognitive processes by scaffolding cognitive activity.

Moreover, not every form of embedded cognition is situated (and vice versa but I will not pursue this here). Language, for instance, is a powerful tool to discharge the computational complexity of a task (e.g., remembering a long sequence of actions) on an external support (e.g., a piece of paper, or a sentence one can rehearse by the help of auditory memory) (Vygotsky 1934, 1978). However, although language is learned in interaction with the (social) environment, it is later internalised (Berk 1991; Winsler *et al.* 2003), and can be used as a symbolic tool in isolation from the environment (Clark 1998). Language acquisition thus deeply impacts on cognition disregarding the situatedness of the cognizer (Karmiloff-Smith 1992; Clark & Karmiloff-Smith 1993).<sup>7</sup>

## 2. Embodied Cognition and Early Social Cognitive Abilities

I have made explicit a minimal conception of embodiment. I have also distinguished it from the two closely related principles of situated and embedded cognition. We can now start investigating whether the capacity to attribute mental states can be defined in a cognitive system so characterized.

Recent research employing violation-of-expectancy and first looking paradigms recently showed that even infants seem to attribute false beliefs to others in their second year of life. For instance, Onishi & Baillargeon (2005) found that 15-month-olds look significantly longer when they see an experimenter acting incoherently with respect to her false beliefs. Their result, obtained in a violation-of-expectancy paradigm, was replicated considering 25-month-olds' anticipatory looking, which is a clearer index of infants' expectations (Southgate *et al.* 2007). In addition, Surian *et al.* (2007) found that 13-month-olds are already sensitive to one agent's knowledge or ignorance of a situation.

The studies above strictly focused on visual stimulation and responses. Further research investigated infants' processing of others' beliefs obtained through sensory modalities other than vision and showed that infants' social cognitive abilities are not restricted to the exclusive elaboration of visual input. Infants have been found sensitive to one agent's false beliefs induced through

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them; or how we leave post-its on the fridge and knotted handkerchiefs in our pockets to remind of next duties; or how we fill our environment with road and shop signs. These activities allow us to discharge the computational complexity of cognitive processes in the environment. They relieve the cognitive load of memory and simplify both perception and action planning (Kirsh 1995; Clark 1997).

<sup>7</sup> The scaffolding role of language is not limited to cognitive agents in isolation. Thanks to linguistic communication, cognitive processes can be distributed across the members of a group — as the crew of a ship (Hutchins 1995a), or the aircrew of a plane (Hutchins 1995b), or a surgery team — thereby supporting the execution of complex cognitive tasks. Linguistically mediated communication also allows the emergence of important forms of cultural transmission across generations (Dawkins 1976; Latour 1986).

proper communication (Song *et al.* 2008), through incorrect deductions from perceptual cues (Song & Baillargeon 2008), and through tactile perception (Träuble *et al.* 2010). In addition, not only they consider others' non-visually induced false beliefs, but they can also actively react to them (Buttelmann *et al.* 2009; Southgate *et al.* 2010; Knudsen 2011).

According to a first interpretation of these results, early forms of social cognition can be explained by cognitive processes that operate on perceptual input and mostly automatically trigger low-level motor responses (e.g., sustained attention and anticipatory looking). These processes integrate visual information that infants obtain by observing other agents, but they likely involve also motor representations. Extensive data indeed show that processing others' actions involves the activation of pre-motor areas in adults (Wilson & Knoblich 2005; van Overwalle 2009), and the same likely happens even in infants (Del Giudice *et al.* 2009). This first interpretation of early forms of social cognition is thus consistent with the definition of embodiment introduced in section 1 because, on this view, early social cognitive abilities are implemented by cognitive processes subserving both sensory and motor information. Call this the *embodied view* of early social cognitive abilities.

The embodied view is compatible with very different accounts of the capacity to attribute mental states advanced both in the philosophical and scientific literature.<sup>8</sup> For instance, Gallese (2005, 2007; Gallese & Sinigaglia 2011) argues that the same sensory–motor processes (i.e. the mirror mechanism, Rizzolatti & Craighero 2004) implementing one's own mental states — e.g., one's intention to act — are also used when functionally attributing the same mental state to another — e.g., when understanding another's intention to act. Similarly, Goldman (2006, 2009) claims that mirror neurons play an important role in 'low-level' mindreading and support the attribution of mental states to others. According to Gallagher (2008, 2011), interpreting others' mental states depends on perceptual, rather than inferential, capacities that are employed in situated social interaction and rely on low-level sensory–motor associations developed since early infancy. Finally, according to De Jaeger, "social understanding emerges from a dynamical process of interaction and coordination of two embodied subjects coupled to each other" (Fuchs & De Jaegher 2009: 470; see also De Jaegher 2009, McGann & De Jaegher 2009). Accordingly, we cannot disentangle infants' elaboration of a perceptual input from the motor processes driving infants' reaction to it.

These accounts differ from one another with respect to several issues: which kinds of mental states are attributed by the cognitive processes implementing early social cognitive abilities; how often these processes are at work in everyday social interaction; whether they can be interpreted in representational terms; and how they ground or implement theory-of-mind capacities. With respect to the last point, in particular, these accounts provide very different interpretations of the activity of the mirror neuron system when we observe others' actions. According to Gallese, for instance, mirror neurons

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<sup>8</sup> The point is not that all the following accounts embraced the embodied view. Rather, they may agree with an embodied explanation of early social cognitive abilities.

underpin our understanding of motor intentionality. For Goldman, instead, they enable us to enter the same mental states that we observe in another person. Gallagher interprets the mirror neuron system as a neural mechanism supporting 'smart' perception. Finally, De Jaegher is very critical of neurological explanations of social cognitive abilities.<sup>9</sup> Nevertheless, she considers that "this is not to say that the link between action and perception found in mirror neuron research does not play an important role for social understanding" (Fuchs & De Jaegher 2009: 469).

Despite these differences, these accounts are nonetheless unanimous with regard to the following theses: (i) the attribution of mental states to others exploits cognitive mechanisms that are developing since early infancy; (ii) sensory-motor processes such as the mirror neuron system constitute the core of these mechanisms. Call these embodied social cognitive processes. The embodied view explicitly adds that (iii) embodied social cognitive processes ground infants' performance in spontaneous-response false belief tasks.

The embodied view presupposes that manifest behavior encoded through visual processes and processed by the mirroring system constitutes the fundamental source of data that infants process in spontaneous-response false belief tasks. In this sense, the embodied view is sympathetic with those proposals explaining infants' sensitivity to others' false beliefs in the terms of different capacities to track more superficial, observational features.<sup>10</sup> For example, it has been argued that infants' performance on spontaneous-response false belief tasks depends on behavior-reading capacities (Penn & Povinelli 2007; Perner 2010; Butterfill & Apperly 2013), on the capacity to remember others' encounter with objects (Apperly & Butterfill 2009; Butterfill & Apperly 2013), or to create triadic associations (Perner & Ruffman 2005; de Bruin & Newen 2012), or even on sensitivity to affordances (de Bruin *et al.* 2011).

Notably, these (more or less strictly) behavioural accounts and the embodied view may disagree about the *interpretation* of the cognitive processes underlying infants' performance in spontaneous-response false belief tasks. However, they are much more in agreement about the empirical *nature* of these processes. Behavioural accounts indeed argue that (i) infants' performance in spontaneous-response false belief tasks does not demonstrate the capacity to attribute (false) beliefs, and that (ii) the cognitive processes underlying infants' looking behavior primarily process others' motor intentions and goal-directed behavior. Analogously, it is the empirical significance of a minimal interpretation of the embodied view that the capacities to process goal-directed behavior and motor intentions are sufficient to ground the earliest forms of social cognition. The two views are thus minimally consistent: They both stress the importance of processing overt

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<sup>9</sup> These explanations indeed "single out one section only of the whole circle of organism-environment interaction. They fail to address social interaction as a structured and structuring process which in turn influences brain functions" (Fuchs & De Jaegher 2009: 469).

<sup>10</sup> Therefore, Gallagher writes: "What the enactive position adds to the behavioral abstraction position concerns the nature of the meaning that I see in the other's actions. The other's actions have meaning for me in terms of how I may be able to interact with her. [...] I think this is consistent with your [the behavioural abstraction] view, but offers a specification about the meaning" (Gallagher & Povinelli 2012: 154).

behavior to display the kind of expectations manifested in spontaneous-response false belief tasks, and they avoid commitment to strong mentalistic interpretations of early social cognitive abilities. Indeed, it is possible that the attribution of mental states merely globally supervenes on the sensory–motor processes underpinning infants’ basic abilities to process others’ behavior, and is not an explicit independent representational activity.

The alternative to the embodied view, the *mentalist* view, instead claims that infants’ early social cognitive abilities already involve the capacity to attribute mental states such as beliefs. For instance, Leslie (1994, 1995) advocates for the existence, at 18 months, of a Theory of Mind Mechanism (ToMM) that allows the use representations as meta-representations, thus constitutes the basic computational mechanism beyond both pretend and belief representations. Similarly, Baillargeon (Scott & Baillargeon 2009; Baillargeon *et al.* 2010) advances that early social cognitive abilities are provided by the maturation of a new modular component in the infant’s mind in the second year of life, Subsystem-2, which allows infants to hold in mind a separate representation of a scene.

It is a hallmark of the mentalist view that infants’ early social cognitive abilities do not exploit any behavior-reading heuristic.<sup>11</sup> This view rejects both behavioural interpretations of infants’ performance in spontaneous-response false belief tasks and the embodied view, which is minimally consistent with them. And, in fact, mentalist accounts of early social cognitive abilities are often associated with criticisms to the fundamental importance of sensory–motor processes to the ability of attributing mental states (e.g., Csibra 2007; Grafton 2009).

Despite the arguments advanced by mentalist theorists, nonetheless, the opposition between their rich explanation of spontaneous-response false belief tasks and the minimal interpretation defended by both embodied and (more or less strictly) behavioural accounts is far from being settled. Of course, this is an empirical debate, and empirical evidence may provide some reason to assess the contrast. If it were found, for instance, that early social cognitive abilities are not flexible enough to properly match mental state attributions — because, for example, they do not retain attributed beliefs beyond short time threshold, or because they are insensitive to some perceptual modality in the process of belief formation —, this would constitute evidence against the mentalist view. On the contrary, the embodied view is challenged by any result showing the complexity of early social cognitive abilities. In front of a very flexible behavior manifested by infants in a variegated set of false belief tasks, it would be more difficult to explain their performance in the terms of the mere capacity to process sensory–motor information. The choice to treat their capacity as theory-of-mind abilities would be theoretically more parsimonious, thereby also preferable.

Both the embodied and the mentalist view nevertheless have general strategies to explain their empirical flaws. In particular, the mentalist view can always maintain that non-flexible manifestations of early social cognitive abilities

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<sup>11</sup> Adduced motivations are variegated. Leslie claims that ToMM is the essential core of theory-of-mind reasoning because it permits and promotes children’s attention to early intentional insight into the behaviors of others, thereby it allows them to learn about these states. Instead, according to Baillargeon, Subsystem-2 implements genuine theory-of-mind capacities because of reasons of parsimony (Onishi & Baillargeon 2005: 257).



are explained by limitation of the computational resources available to the working of the theory-of-mind mechanism (Fodor 1992; Leslie *et al.* 2005; Scott & Baillargeon 2009). On the other hand, the embodied view can always reduce the complexity of mentalist interpretations of infants' behavior by elaborating behavior-reading strategies of some sort (Perner 2010; Butterfill & Apperly 2013).

I take those principled objections as demonstrating that the opposition between the embodied and the mentalist view is also partially a matter of theoretical preference about how to describe very simple capacities manifested in infancy. Although I acknowledge that solving the dispute is lastly a matter of empirical discussion, I want herein to consider further assumptions not clearly spelled out in the current debate. In defense of the embodied view, I will claim that it advances a coherent and plausible interpretation, which is not dismissed by mentalist pre-theoretical intuitions. It thus defines a concrete proposal, and it should be in the agenda of future empirical investigation assessing to what extent infants' social cognitive abilities can be accounted for by relatively simple embodied processes and mechanisms.

The issue whether (amodal) mental states can in principle be computed by cognitive processes that principally integrate sensory-motor information is particularly relevant to the assessment of the assumptions in favor and against embodied interpretations. With this respect, the embodied view favors that amodality can effectively be reduced to interwoven cross-modal connections (Barsalou 2005; Goldman & de Vignemont 2009; Gallese & Sinigaglia 2011). Accordingly, also the attribution of mental states to others can be implemented by cognitive mechanisms processing sensory-motor information and directly triggering automatic motor responses. Instead, the mentalist view holds that processing sensory-motor information cannot account for the attribution of mental states for the very nature of the modally-non-neutral information that is processed. Nothing less than theory-of-mind processes can account for social cognitive abilities even in infancy.

It is important to note that the embodied view advances a specific claim about the modal nature of information, which can be empirically investigated. The mentalist alternative, on the other hand, merely relies on a principled and, as I see it, unsuccessful objection. Moreover, as discussed above, the embodied view also suggests a viable alternative explanation to data concerning social cognitive abilities in infancy in agreement with (more or less strictly) behavioural accounts. Therefore, if we only consider social cognitive capacities apparent in the second year, the available evidence does not decide between embodied and mentalist interpretations of social cognitive abilities. But if we look more broadly, the evidence supports the embodied alternative. For the sake of parsimony, indeed, there is no need to assume that infants can attribute (false) beliefs if the same cognitive abilities can be explained by more basic capacities to process manifest behavior and motor intentions.

There is, however, a second argument advanced in favor of the mentalist view. Rather than focusing on the second year of life, it hinges on the gradual development of social cognitive abilities from infancy to early childhood. I will assess it in the next section.

### 3. Social Cognitive Development from Infancy to Early Childhood

The argument from the continuity of social cognitive development states that (i) infants' selective behavior in spontaneous-response false belief tasks appears before their capacity to pass FBT at age four, and that (ii) this capacity is usually interpreted as the explicit manifestation of the possession of the concept of belief, and so that (iii) infants' performance in spontaneous-response false belief tasks is the implicit manifestation of the concept of belief.

The argument underlies many mentalist interpretations of early social cognitive abilities. For instance, Poulin-Dubois *et al.* (2009) report data from longitudinal studies finding that children's performance on traditional false belief tasks is predicted by earlier ability to understand goal-directed actions with computer-animated geometric forms (Yamaguchi *et al.* 2009) or to identify behavioural cues of intentional action in an imitation task (Colonesi *et al.* 2008). Hence they conclude that "the current data suggest continuity in social cognitive development that provides support for the hypothesis that the sophisticated social cognitive abilities have their roots in infancy" (p. 91).

Unfortunately for the mentalist view, however, that early social cognitive abilities develop before the capacity to pass FBT does not demonstrate that they are the precursors of this capacity. This conclusion follows only if this capacity is demonstrated to develop in strict continuity with them. Therefore, continuity in social cognitive development is the test bed to decide whether mentalist interpretations of early social cognitive abilities are to be preferred to the embodied view. It is on this issue that I will now turn my attention.

Some empirical evidence attests gradual development in social cognition. Southgate *et al.* (2007) found that 25-month-olds gaze in anticipation towards a location where a person would be expected to search if she had a false belief. This extends Onishi & Baillargeon's (2005) result by relating early social cognitive abilities to a more active behavior (i.e. anticipatory gaze). Still two-year-olds are limited in the kind of stimulation that can enhance their anticipatory-looking response. In Southgate and colleagues' study, infants anticipatory looking was prompted by a visual stimulation, but Clements & Perner (1994) and Garnham & Ruffman (2001) found that it cannot be triggered by verbal prompting until age three.

These studies suggest the following developmental pattern for social cognitive abilities: (i) after 15 months, the cognitive processes responsible for social cognitive abilities can already direct infants' attention at the incongruent behaviour of an agent; (ii) after age two, they also start driving anticipatory looking reactions; (iii) at age three, they start being prompted by verbal stimulation; (iv) finally around age four, they fully integrate with linguistic abilities, thereby also allow children to correctly answer FBT.

Considering this evidence, Baillargeon (Scott & Baillargeon 2009; Baillargeon *et al.* 2010; cf. also Leslie 2005) claimed that young children fail elicited-response FBT because it involves the functioning of at least three different processes. In particular: (i) a process to represent others' false-beliefs, (ii) a process to select the proper response when asked about others' behavior, and (iii) a process to inhibit the tendency to answer the test question based on one's own

knowledge. Since spontaneous-response tasks only tap psychological-reasoning, they are passed earlier than traditional elicited-response false belief tasks. As soon as response-selection mechanisms develop (or interface themselves with psychological-reasoning processes) children's anticipatory-looking starts responding to verbal prompts. Finally, when response-inhibition processes properly develop, children also become able to pass elicited-response tasks.

Important considerations nevertheless reject continuity in the development from early social cognition to late theory-of-mind abilities. A first hint comes when considering a possible double dissociation between early and more mature social cognitive abilities.<sup>12</sup> Senju and collaborators (Senju *et al.* 2009, 2010; see also Senju 2011 for a discussion) found that autistic people are impaired on spontaneous-response false belief tasks while at the same time they pass elicited-response tasks (Happé 1995) — their performance being strongly related to their linguistic abilities (Tager-Flusberg & Joseph 2005). This pattern is opposed to the one of three-year-olds, who are impaired on elicited-response tasks while at the same time they pass spontaneous-response tasks. This suggests that the two tasks map different capacities.

Secondly, if the cognitive processes implementing early social cognitive abilities progressively develop in continuity with more advanced social competence, one would expect cognitive biases affecting late social cognitive abilities to be present even at earlier developmental stages. However, a central bias to the capacity to pass FBT such as the 'curse of knowledge' (Birch & Bloom 2003, 2004, 2007) genuinely affects only four-year-olds' performance on elicited-response tasks, while it spares infants' early social cognitive abilities.<sup>13</sup> This challenges the hypothesis that passing FBT at age four depends on the same processes already in place around age two (Samson & Apperly 2010).

Finally and critically, increasing evidence supports a multi-process theory of social cognitive abilities. On the one hand, empirical findings suggest that beliefs are not automatically attributed in FBT. Apperly *et al.* (2006) reasoned that if this were the case, we should consider others' beliefs even when not requested to do so. They thus probed experimental subjects with unpredictable questions about what was happening in a video; the questions concerned either the location of an object, which participant were requested to track, or a false belief of the main character, which were irrelevant to the task goal. They found that longer response times and higher errors were connected to answers about the character's false belief, suggesting that subjects normally did not track it. Also, explicitly requiring subjects to track the character's belief eliminated the asymmetry between belief- and reality-answers, suggesting that such asymmetry

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<sup>12</sup> Though see Scerif & Karmiloff-Smith (2005) for a warning about the misuse of double dissociations in cognitive neuroscience.

<sup>13</sup> The curse of knowledge refers to the fact that children as well as adults find it difficult to stop considering their own knowledge when asked to assess others' perspectives. That the curse of knowledge spares early social cognitive abilities provides no surprise in the experiment by Southgate *et al.* (2007), where the object that is the content of the false belief is taken out of the scene before infants' response is prompted. No actual knowledge of the object's location thus misleads infants' reaction. This is however not the case in the experiments by Clements & Perner (1994), Garnham & Ruffman (2001), and Onishi & Baillargeon (2005).

depended on the cost of retrieving the character's belief.

Contrary to the case of belief attribution, other findings instead suggest that adults automatically compute others' visual experience even when they themselves have a different view (Samson *et al.* 2010). This result has been demonstrated in six-year-olds (Surtees & Apperly 2012) and, surprisingly, even in seven-month-olds (Kovács *et al.* 2010).<sup>14</sup> However, this capacity is importantly limited in many respects: It does not consider level-2 visual perspective taking (Surtees *et al.* 2011), and it is impaired when the other's perspective includes complex scenarios (Keysar *et al.* 2000, 2003).

In the light of these results, Apperly & Butterfill (2009; cf. also Frith & Frith 2006; Apperly 2010) suggested that adults compute others' mental states by two kinds of cognitive process. *High-level* social cognitive processes develop in early childhood and allow children to pass complex tasks such as elicited-response FBTs. They are highly flexible but cognitively demanding, therefore they do not get automatically employed. In contrast, *low-level* social cognitive processes develop in infancy and have likely been naturally selected. They are cognitively efficient, because they rely on the elaboration of simple features of the perceived input, and explain infants' performance in spontaneous-response false belief tasks. However, the same reason why they are cognitively efficient also makes them inflexible. Indeed, they are very limited both in the kind of information they can process and in how their outcome can influence other cognitive processes. That is, they are *encapsulated* and *impenetrable*: They are activated only by some specific available input, and are of no help to solve general domain problems (Fodor 1983; Coltheart 1999).

Importantly to the present discussion, empirical investigation indicates that early and late social cognitive abilities are provided by completely different cognitive processes. Accordingly, cognitive development does not progress continuously from infancy to early childhood. This rejects the mentalist theorist's argument that the cognitive processes underlying early forms of social cognition must be interpreted in strong mentalistic terms because they represent the early roots of mature theory-of-mind abilities.

In light of the empirical inadequacy of the argument from the continuity in social cognitive development, and considering that mentalist interpretations about early social cognitive abilities inconclusively oppose embodied accounts, we must thus leave it open how to interpret infants' performance in spontaneous-response false belief tasks. Given the severe limitations of infants' early social cognitive abilities, adopting the full vocabulary of folk psychology to describe them may be incorrect, whenever misleading (cf. Kagan 2008 for the same argument against very young infants' possession of the concepts of number and object).

Concluding, it is up to future empirical investigation deciding to what extent infants' social cognitive abilities can be accounted for by relatively simple embodied processes and mechanisms. However, theoretical reflection

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<sup>14</sup> Interestingly, Kovács and colleagues interpret their result in the terms of the capacity to consider others' *beliefs*, although what they really assessed is the subject's capacity to recall what other agents *saw*. This is a good example of over-interpretation of experimental evidence.

demonstrates that we are not committed to interpret them in a strong mentalistic vocabulary. Consistently with the embodied view, the cognitive processes underlying early social cognitive abilities may be the outcome of a minimal capacity to attribute motor intentions and goal-directed behavior. Coherently with (more or less strictly) behavioural accounts, they may even depend on less sophisticated embodied competences that do not have a direct translation in the vocabulary of folk psychology. Inasmuch as these two interpretations do not mutually exclude but agree about the empirical nature of the cognitive processes underlying early social cognitive abilities, rejecting strong mentalist accounts paves the way to an alternative interpretation coherent with the embodied view.

#### 4. Explaining Theory-of-Mind Acquisition in Early Childhood

If early social cognitive abilities already reflected the capacity to attribute beliefs to others, learning to pass FBT at age four would not be a milestone in children's social cognitive development. This would constitute *a priori* reason not to investigate whether this ability is implemented in embodied cognitive processes. However, the discontinuity between early and late social cognitive abilities attests that elicited- and spontaneous-response false belief tasks are rather distinct. Passing elicited-response FBT thus identifies an autonomous competence in child development.<sup>15</sup> Accordingly, it is still worth investigating whether this ability fits the framework of embodied cognition. In this section, I discuss and reject three explanations of the acquisition of the capacity to pass FBT. This will clear the field to my alternative proposal.

A first attempt to explain children's acquisition of the capacity to pass FBT has appealed to the maturation, around age four, of several components of the executive function:<sup>16</sup> in particular, the capacity to inhibit stimulus-dependent answers (Carlson & Moses 2001; Jacques & Zelazo 2005; Sabbagh *et al.* 2006), cognitive flexibility (Carlson & Moses 2001; Müller *et al.* 2005; Guajardo *et al.* 2009), and visual perspective taking (Harris 1992; Gopnik *et al.* 1994; Farrant *et al.* 2006; Bigelow & Dugas 2008). This explanation of four-year-olds' acquired capacity to pass FBT is also provided by contemporary modularist accounts of the theory of mind — namely, those accounts supporting the mentalist view of early social cognitive abilities (sections 2 and 3).

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<sup>15</sup> And indeed, the capacity to pass FBT has been demonstrated extremely robust and unlikely depending on minor changes in previous cognitive development. Allowing children to respond by sticking surprised or non-surprised facial expressions (de Villiers & de Villiers 2000), or proper thought (Wellman *et al.* 1996; Woolfe *et al.* 2002), as well as hide and retrieve tasks (Call & Tomasello 1999; Figueras-Costa & Harris 2001) did not improve four-year-olds' performance in any sensitive way, while only mild improvements were found when allowing children to respond by appropriate hand-gesture (Carlson *et al.* 2005), betting coins (Ruffman *et al.* 2001) and lying by deceiving pointing rather than explicit verbal communication (Perner *et al.* 2002).

<sup>16</sup> By 'executive function', cognitive psychologists refer to the suite of cognitive functions supporting goal directed behavior and cognitive control across conceptual domains, including inhibitory control (or response inhibition), working memory, error monitoring, rule representation and use, planning, behaviour organisation, cognitive flexibility, and attentional control (Zelazo *et al.* 2008).

Several findings nevertheless suggest that the executive function really provides only a marginal contribution to the development of theory-of-mind abilities. Firstly, although autistic children do not pass FBT, they normally perform on executive function tasks when tested by a computer rather than by a person (Ozonoff *et al.* 1991; Ozonoff 1995). Secondly, language delayed deaf children raised by hearing parents are not at all impaired in executive function such as non-verbal working memory, inhibitory control, and conditional rule following; still they fail FBT (P.A. de Villiers 2005). Finally, children in Asian countries manifest earlier competence than their Western peers at executive function tasks, the effect perhaps being due to their education more inclined toward self-control. Nevertheless, early improved executive function does not translate into superior performance in FBT (Sabbagh *et al.* 2006; Liu *et al.* 2008; Oh & Lewis 2008; Lewis *et al.* 2009).<sup>17</sup>

Language acquisition constitutes a better candidate than the maturation of the executive function to account for children's late acquisition of theory-of-mind abilities. Meta-analyses showed that the capacity to pass FBT relates to linguistic competence, the correlation from linguistic abilities to social understanding being stronger than the opposite (Astington & Baird 2005b; Milligan *et al.* 2007). Still, even when focusing on the contribution of language to FBT passing, many different aspects of language acquisition may be relevant (Astington & Baird 2005; de Villiers 2007: 1869–1871). Investigating the embodiment of late social cognitive abilities thus depends on assessing their different contribution.

One explanation that may account for the correlation between language acquisition and FBT passing is that younger children lack the representational capacity to store others' (false) beliefs (Leekam & Perner 1991; Perner 1995; Leekam *et al.* 2008). Accordingly, FBT would measure children's meta-representational abilities. Language acquisition may thus impact children's capacity to pass FBT because, by enabling new representational formats (Karmiloff-Smith 1992), it enables and/or improves the representation of the mental states.

This explanation is strongly supported by de Villiers and collaborators' finding that syntax acquisition, and, in particular, the mastery of sentential complements — i.e. the sentences introduced by a 'that' in mental propositional attitudes (e.g., "he thinks *that-p*") as well as reporting attitudes (e.g., "he says *that-p*") — is predictive of children's ability to pass FBT (de Villiers & Pyers 2002; de Villiers & de Villiers 2003; J.G. de Villiers 2005, 2009).<sup>18</sup> On de Villiers' original interpretation, this was considered evidence that the mastery of sentential complements reshapes children's cognition by providing a new representational format to store meta-representations, therefore also to attribute beliefs to others.<sup>19</sup>

<sup>17</sup> Cf. also Sabbagh *et al.* (2010) for an extended criticism of the role of the executive function in promoting late social cognitive abilities.

<sup>18</sup> The result has been confirmed by comparative studies on different populations of deaf children (Peterson & Siegal 2000; Garfield *et al.* 2001; P.A. de Villiers 2005; Pyers & Senghas 2009; Schick *et al.* 2007), and by training studies, where children were trained in FBT, a Test for Complements and other relevant tasks (Hale & Tager-Flusberg 2003; Lohmann & Tomasello 2003; Lohmann *et al.* 2005).

<sup>19</sup> This proposal shares with embodied cognition the focus on cognitive development to explain social cognitive development. Nevertheless, it does not agree with embodied cognition on the representational format encoding belief attributions. Indeed, it supposes

Several findings nevertheless reject de Villiers' analysis that representing others' beliefs is the main problem in FBT. Indeed, according to de Villiers, there must be one moment in which children learn how to represent sentential complements. However, several studies demonstrated that children start mastering complementation at different ages depending on the context in which it occurs. This is revealed by considering sentential complements selected by desire verbs in German (Perner *et al.* 2003), by pretence verbs (Garfield *et al.* 2009), as well as relative clauses (Smith *et al.* 2003).<sup>20</sup> Moreover, de Villiers' proposal advances that children's difficulty with FBT depends on the general understanding that verbs of thought select either true or false sentential complements. However, the mastery of complementation likely predicts FBT passing only because it requires children to understand that verbs of thought can specifically select *false* complements (Cheung *et al.* 2004, 2009). And indeed, although the mastery of sentential complements is sufficient to pass FBT, children's difficulty also partially depends just on the comprehension of the deceiving character of the false beliefs (Lohmann & Tomasello 2003; Lohmann *et al.* 2005). Therefore, providing the right representational format to represent others' beliefs is unlikely the exclusive reason why language acquisition supports late social cognitive development.

A second attempted explanation of the correlation between language acquisition and FBT passing is that FBT requires children to master not just the representational format of attributed beliefs and desires, but also belief–desire reasoning, that is, the capacity to inferentially combine attributed mental states to make predictions about others' future actions. This proposal is largely shared among supporters of both the modularist and the child-as-scientist view of the theory (cf. the introduction), who advanced that passing FBT require children to develop (either implicit or explicit) inferential abilities. Accordingly, language acquisition would improve the capacity to pass FBT by bolstering children's belief–desire reasoning capacities.

Despite its popularity, we should be cautious to adopt this solution: In fact, several reasons suggest that belief–desire reasoning is really not needed to pass FBT. A first weak argument is that we do not consciously perform belief–desire reasoning very often (Gallagher 2007). Secondly, folk psychology apparently works differently across different cultures (e.g., Lillard 1998; Vinden 1999); this should lead to the conclusion that passing FBT is culture dependent — a result for which partial evidence has been provided (Wellman *et al.* 2006; Liu *et al.* 2008; Shahaieian *et al.* 2011). Third, passing FBT by belief–desire reasoning poses a typical inverse problem (Csibra & Gergely 2007) which requires solving an abductive inference. This makes unlikely that children rely on belief–desire reasoning to pass the test (Apperly 2010; cf. also Ratcliffe 2007; Perner & Roessler 2010; de Bruin *et al.* 2011 for related discussion).

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that others' beliefs are encoded in sentence-like representations, that is, in an amodal representational medium that is very different from sensory and motor representations.

<sup>20</sup> J. G. de Villiers (2005) opposed that *only* the mastery of that-clauses selected by verbs of thought is predictive of children's ability to pass FBT, and proposed that such a competence is scaffolded by their experience with verbs of speech (e.g., *saying, telling*). However, there is no evidence in the literature for a developmental gap between the mastery of verbs of speech and the mastery of thinking verbs.

Of course, denying that the mastery of belief–desire reasoning is not necessary to pass FBT requires explaining why belief–desire reasoning is apparently so pervasive in everyday life (Spaulding 2010). However, note that folk psychology and the attribution of mental states are often employed to *explain* past actions rather than to *predict* future ones. Therefore, the pervasiveness of belief–desire reasoning may well depend on its relevance in rationalizing people’s behavior by reporting their reasons to act.<sup>21</sup> If that is the case, we can abandon the idea that passing FBT requires the mastery of belief–desire reasoning.

I have rejected three explanations of four-year-olds’ acquired ability to pass FBT, one of them being based on the role of the executive function two others on different aspects of language acquisition. In the next section, I will introduce my alternative proposal. We will hence be in position to judge whether late theory-of-mind abilities fit the framework of the embodied cognition.

## 5. Embedded Cognition and Theory-of-Mind Acquisition

My previous analysis rejected two explanations of the correlation between language acquisition and four-year-olds’ acquired capacity to pass FBT. However, it has not refuted the main idea that passing FBT depends on language acquisition. My proposal carves out an alternative explanation for that.

I suggest that passing FBT demonstrates the acquisition of a minimal capacity to explain people’s reasons to act. Since the very early infancy, children are continuously exposed to stories and narratives that clarify the reasons why people acted in the way they did. Although full reasons defined by belief–desire pairs are rarely provided, these stories identify relevant constituents of these reasons (e.g., beliefs, desires, intentions, behavioural traits, personality features) and acquaint children with the domain of folk psychology (Hutto 2008; Nelson 2009). I claim that children’s acquaintance with these narratives, and in particular with those stories focusing false utterances, the deceiving aspect of things, and lying behaviors, promotes their understanding of the reasons beyond (unsuccessful) action and improve their capacity to pass FBT. I also propose that dialogical exchanges where people’s behavior is explained by the attribution of (false) beliefs trigger the acquisition of explanatory capacities in the domain of folk psychology. Accordingly, language acquisition affects children’s capacity to pass FBT because linguistic interaction in the social environment, and, in particular, specific dialogical exchanges where false beliefs are the matter of discussion, provide the main evidence necessary to them to pass FBT.

Before further discussion, let me introduce empirical evidence supporting my proposals. First of all, although I opposed de Villiers’ claim that children younger than four lack the representational capacity to store others’ (false) beliefs, her finding that the mastery of sentential complements is predictive of children’s ability to pass FBT is in itself significant and requires explanation. According to my proposal, children must understand that false beliefs sometimes are good reasons for action before they can pass FBT. Now, sentential complements are the syntactic structures normally employed to report false belief

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<sup>21</sup> A similar point has been suggested by Slors (2012) and Van Cleave & Gauker (2010).



attributions. It comes to a reason that children need to master complementation before they can pass FBT.

A second piece of relevant evidence comes from studies assessing the frequency of mental state lexicon in parental conversation. According to my proposal, understanding people's reasons to act is developed in specific dialogical exchanges where people's behavior is explained by the attribution of mental states. Accordingly, children who have more chances to take part to those dialogical exchanges should be expected to pass FBT earlier. On the contrary, finding that the amount of dialogical exchanges involving psychological discourse does not correlate with the ability to pass FBT would oppose my analysis.

Considering the empirical literature, many studies extensively showed that the frequency of mental terms in parental conversation predicts children's ability to pass FBT (Dunn *et al.* 1991; Furrow *et al.* 1992; Moore *et al.* 1994; Sabbagh & Callanan 1998; Ruffman *et al.* 2002; Meins *et al.* 2003; Dunn & Brophy 2005; Taumoepeau & Ruffman 2006). In addition, some evidence also suggests that this does not depend on the mere presence of mental lexicon in parental conversation, but on the quantity of discourse related to people's mental states even when mental states are not mentioned (Turnbull *et al.* 2008).

The third evidence for my proposal comes from studies about the quality of the conversation between the child and the caregiver. My proposal states that children should advance in their understanding of the mental domain proportionally to the quality of the conversation about the psychological domain they have with their caregivers. Accordingly, children whose caregivers tend to entertain more prolonged exchanges of such a kind and to provide more feedback should be expected to pass FBT earlier. On the contrary, evidence opposing my model would be that the caregiver's availability to converse with the child did not correlate with children's ability to pass FBT.

In the empirical literature, several indices have been advanced to assess the quality of parental conversation. Ontai & Thompson (2008) shaped an *elaborative discourse* index, which assesses the parental disposition to elaborate children's utterances by filling the gaps, providing explanations, and in general enriching the child's utterances. Similarly, Ensor & Hughes (2008) developed an index that they call *connectedness*, which assesses how much parental answers continue the child conversational contribution or whether they just push conversation further. Both studies found that those indices of the quality of the parental conversation correlate with the child's ability to pass FBT.<sup>22</sup>

My proposal is very close to Hutto's hypothesis that *folk psychological narratives* have a fundamental role in fostering "an understanding of the *forms* and *norms* of folk psychology" (Hutto 2007: 53), that is, "our everyday practice of making sense of intentional actions (i.e. our own and those of others) in terms of reasons" (Hutto 2009: 10). In particular, we share the same idea that dialogical interaction with the caregiver is the most important factor for the acquisition of

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<sup>22</sup> While evidence reported above about the quantity of the conversational input was obtained through both correlational and transitional studies, evidence in this case is only correlational, therefore less significant. However, it still suggests that the more that adults are prone to elaborate children's utterances, the earlier the capacity to pass FBT is acquired.

the concept of belief while cognitive development only plays a minor role.

Although I am very sympathetic with Hutto's approach, there are nevertheless also substantial differences between his and my view. In particular, Hutto claims that "children's nuanced folk psychological skills only develop securely after ages four and five" (Hutto 2008: 26) and denies that passing FBT marks an important step in children's mastery of folk psychology.<sup>23</sup> Against this, I advance that passing FBT denotes an important improvement in children's mastery of folk psychology, because it marks their acquisition of an ability to explain people's behavior in folk psychological terms.

The dispute is partially theoretical and partially empirical. As for the theoretical facet, I believe that children's acquired capacity to explain others' reasons to act, which is manifested when they pass FBT, only denotes a minimal understanding of folk psychology, which needs time to be turned into a mature social competence. Therefore, Hutto does not really oppose my view when he claims that folk psychological skills fully develop only after age five or six.

However, against Hutto, I also advance a more specific empirical claim and propose that children start passing FBT because they learn to explain others' behavior by reporting their reasons to act. This makes a definitive claim about the timeline of children's acquisition of the capacity to pass FBT: Explanatory abilities in the domain of folk psychology should be acquired earlier than the predictive ability necessary to pass FBT. Therefore, my proposal would be supported by findings showing that explanatory capacities come in place earlier than the time children pass FBT. On the contrary, if it were found that children can pass FBT without still being able to express people's reasons to act, that would constitute opposing evidence to my model.

Referring to empirical evidence, several studies have already tested the correlation between traditional *predictive* FBT and a modified *explanatory* version, where children are asked to explain the behavior of a main character who just acted on the basis of a false belief. Many studies found that the explanatory version is as hard as the traditional one (Moses & Flavell 1990; Wimmer & Weichbold 1994; Wellman *et al.* 1996; Wimmer & Mayringer 1998; Perner *et al.* 2002; Atance & O'Neill 2004). This does not explicitly contradict my proposal, although it neither supports the presumed role of explanatory abilities in promoting the predictive abilities assessed by FBT. Notably, it nevertheless shows, against Hutto, that four-year-olds start manifesting important folk psychological competences: Not only did they correctly predict others' behavior that depends on the attribution of a false belief, but they also justify their predictions by correct explanations.

Evidence supporting my proposal comes instead by a few studies specifically finding that theory-of-mind predictive capacities are anticipated by explan-

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<sup>23</sup> "There is a fairly widespread tendency to conflate the latter sort of ability [to understand and attribute beliefs] with a capacity to understand and attribute reasons. This mistake stems from assuming, as is commonly done, that children are already in the possession of the bulk of their theory of mind at the point at which they begin to pass false-belief tests. Hence, success on these tests is taken to be the mark of their having acquired the final piece of the theory of mind puzzle. Having mastered the core concept of belief, it is supposed that they have mastered the full set of folk psychological principles" (Hutto 2008: 25).

atory capacities (Bartsch & Wellman 1989; Bartsch *et al.* 2007). Careful looking at the methodology of these studies shows that they are flawed in the way in which they assessed children's psychological explanatory abilities.<sup>24</sup> Nevertheless, we should notice that finding a transitional period for the acquisition of abilities is always difficult: You can fail because either you look at too old children, or because you do not employ fine enough tools. Furthermore, all studies reported above always looked at explanatory ability as a yes-or-no competence and did not consider that there can be many levels of certainty in reporting one's reasons to act. Serious investigation instead would require keeping those levels separated. Future research, more respecting of the ecological validity of prompting answer methods and of the gradual acquisition of explanatory abilities in the domain of folk psychology, may bring clearer results about children's earlier capacity to pass explanatory rather than predictive versions of FBT.

Summarizing, predictive and correlational relations between children's capacity to pass FBT and (i) children's mastery of sentential complements, (ii) the quantity of parental conversation involving mental concepts, (iii) the quality of parental conversation, and (iv) children's explanatory capacities in the domain of folk psychology all support the claim that four-year-olds' capacity to pass FBT depends on their acquisition of a minimal capacity to report others' reasons to act.

This constitutes a significant improvement in our knowledge about social cognitive development and its triggering factors. It also leaves us in position to judge whether late social cognitive abilities fit the framework of the embodied mind. It follows indeed from my analysis that theory-of-mind capacities manifested by the ability to pass FBT are acquired by being engaged in a proper conversational context. The linguistic competence necessary to pass FBT is thus not localized and depends on the whole activity of a brain immersed in its natural and social (dialogical) environment. Accordingly, sensory and motor processes play a very peripheral role in the capacity to pass FBT: Late theory-of-mind abilities do not particularly fit the framework of embodied cognition.

Even though the capacity to pass FBT does not respect the strictest principles of embodiment, it is nevertheless compatible with the closer principles of situatedness and embeddedness. Indeed, according to my proposal, children's capacity to predict others' behavior depends on the mastery of an explanatory practice that children refine in conversation with their caregivers. This is a clear example of how the embeddedness of cognition in the child's social environment supports high-level cognitive processes such as social understanding.

## 6. Conclusions

Although theory of mind has been interpreted for a long as a unified capacity in

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<sup>24</sup> Indeed, Bartsch & Wellman's (1989) method to prompt explanations was all but ecologically valid. Bartsch *et al.* (2007) used a more ecological prompting strategy, but their result depends on considering passers children that passed just one out of four explanatory false belief tasks: if at least two out of four trials are requested, their result is no longer significant.

the empirical literature, careful consideration of its development really demonstrates that it stands for a composed competence, which stands in a complex relation with the principle of embodiment. Available evidence does not exclude that early social cognitive abilities, which are manifested in spontaneous-response false belief tasks, depend on the activity of embodied cognitive processes. This challenges the mentalist view, according to which they must be interpreted in the terms of a capacity to attribute false beliefs.

Instead, late social cognitive abilities, such as the capacity to pass FBT, are the outcome of a process of enculturation: Children learn how to use at their own benefit and for predictive purposes the dialogical competence they have developed in conversation with their caregivers about others' reasons to act. This makes late social cognitive abilities not depending on the principles of embodied cognition. They are nonetheless compatible with it by falling within the borders of socially embedded cognition.

The present analysis acknowledges that embodied cognition indicates a 'unifying perspective' for psychology (Glenberg 2010). However, it suggests that embodiment alone is not sufficient to account for all forms of cognitive competences. Whereas the investigation of earlier forms of cognitive activity (e.g., infants' performance in spontaneous-response false belief tasks) requires pursuing research on the underlying embodied neural circuitries, expanding our knowledge about more advanced forms of comprehension (e.g., social understanding) needs to consider how social practices scaffold cognition and genuinely expand our cognitive competences.

With respect to the case of social understanding, a comprehensive explanation of the capacity to attribute mental states needs an analysis of the dialogical and social interaction between the child and the caregiver, which allows the former entering the 'community of minds' (Nelson 2009). The present analysis thus raises skeptical doubts about the empirical investigation of the neural circuitries underlying late social cognitive abilities such as the capacity to pass FBT (e.g., Saxe *et al.* 2004). Rather, it points to the study of the mechanics beyond dialogical exchanges (e.g., Pickering & Garrod 2004; Ruiter *et al.* 2006; de Ruiter *et al.* 2010) as a more promising field to start clarifying children's development of social understanding. Some research has already chosen this direction (Fernyhough 2008): It is my hope to have contributed to address further investigation along this path.

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