WHEN (AND HOW) IS THEORY OF MIND USEFUL? EVIDENCE FROM LIFE-SPAN RESEARCH

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WHEN (AND HOW) IS THEORY OF MIND USEFUL? EVIDENCE FROM LIFE-SPAN RESEARCH

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Theory of Mind (ToM) or mentalization is the ability to understand and foresee the behavior referring to one's own and others' mental states (Premack & Woodruff, 1978; Wimmer & Perner, 1983). This capacity, which is considered the most representative mechanism of social cognition, is a multifaceted set of competences liable to influence – and be influenced by – a manifold of psychosocial aspects. Studies on typical and atypical/clinical development during life showed that ToM is frequently delayed (e.g. in deafness) or impaired in many clinical conditions (e.g. Autism Spectrum Disorder, Attention Deficit Hyperactivity Disorder, Schizophrenia, Borderline Personality Disorder, Parkinson's Disease, Alzheimer's Disease) and, on the other hand, may not be unequivocally a positive experience. It is therefore possible to consider the existence of multiple kinds of Theory of Mind. In fact, ToM may vary along a quantitative and a qualitative continuum. As for the quantitative dimension, the continuum is constituted by the fluctuation between high and low levels of ToM ability in different clinical conditions. Along this continuum, impairment can mean "not enough" ToM (for example in Autism Spectrum Disorder) as well as "too much" ToM (for example in Schizophrenia and Borderline Personality Disorder). The qualitative dimension – highly interrelated with the quantitative one - regards the shift between adaptive (e.g. prosocial, nice ToM) vs. unadaptive (e.g. antisocial, nasty ToM) mental states content. The issue is discussed in light of recent evidence from outstanding researchers working on typical and atypical/clinical populations along the life-span. Findings from the fields of psychology, neuropsychology and neuroscience enrich the research topic argumentation.

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EDITORIAL
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Editorial: When (and How) Is Theory of Mind Useful? Evidence from Life-Span Research

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The Editorial on the Research Topic

When (and How) Is Theory of Mind Useful? Evidence from Life-Span Research

The Theory of Mind (ToM) paradigm was born almost 40 years ago with the study "Does the chimpanzee have a theory of mind?" by Premack and Woodruff (1978). Several papers (meta-analyses, reviews) have tried to describe the state-of-art, both in general and with respect to specific constructs. From a historical perspective it is possible to identify some relevant turning points in this field of research. ToM, which initially began as a cognitive theory, has subsequently been hybridized to include socio-cultural and/or psychoanalytic perspectives. Within the socio-cultural framework ToM is considered as an outcome of internalization processes in the Vygotskian Zone of Proximal Development; within the psychoanalytic perspective the mentalization process, as ToM is often named, is viewed as a result of the successful relationships with caregivers equipped with a sufficient reflective function. In both cases, intersubjectivity acts as the core concept and the link between ToM and affective relationships have become a new object of investigation. Moreover, there has been increased interest in life-span research from the early stages of life up to the elderly. ToM neural correlates have also been investigated. It has been hypothesized that ToM continues to evolve in a manner that involves both behavioral skills and neural plasticity. Furthermore, the search for novel and more ecological methods aimed to enrich a stronger external relevance. In this regard it has been recognized that "have ToM" and "use ToM" are two deeply different concepts. Furthermore, the use of ToM is linked to the global sphere of social competencies: many studies have tried to understand the predictive role of ToM or at least its connections with other social skills. The present Research Topic (RT) deals with theoretical and empirical contexts with the scope to understand "when" and "how" ToM emerges as a relevant component of social competencies devoted to promoting adaptation and well-being. First, the temporal element, "when," is referred not only to the chronological dimension of developmental, but also to the subjective relational, circumstances of life, i.e., type of affective relationships, typical vs. non-typical or clinical development and so on. Second, "how" is referred to as the phenomenology of this process, namely the behavioral mode or the neural patterns as well as the connections between them. The RT investigates classic ToM constructs, from the initial concept of "false belief" to pretense and storytelling. Moreover, there are several contributions which aim to use the power of the understanding of subjectivity, in which ToM consists, for educational and therapeutic purposes. The relevance of ToM for the clinical view is supported by the DSM V which includes social competencies in the nosographic framework of developmental impairments (i.e., autism spectrum disorders and social/pragmatic communication disorder) and neurocognitive disorders.

It is possible to cluster the manuscripts that compose the RT around a few principal axes. Some papers offer general considerations about ToM construct. The contribution by Shatz directly addresses the issue raised in by Premack and Woodruff (1978). She argues that the several decades

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of research concerning ToM have proved that animals and children have a different ToM, since the latter are able to manage both syntaxes and false belief understanding. Battistelli and Farneti, considering meta-representative thinking as equivalent to ToM, identify two domains in which ToM is useful: the reduction of naïve realism and the promotion of metacognitive awareness regarding one's own and other's ignorance (with concrete benefit regarding for example the learning process).

The central concept of belief and false belief has been discussed in many studies as the most debated and utilized ToM measurement. Airenti broached this matter by analysing the difference between the implicit and explicit comprehension of others and the related issue regarding the comparability of verbal and non-verbal tests. Furthermore, Ghrear et al. examine, also from a methodological point of view, the twist between the understanding of false belief and the curse of knowledge. This twist changes along the life-span, and for this reason, new tools are required to evaluate its nature and subsequently the evolution of ToM beyond the "litmus test" of false belief. Finally, Bellagamba et al. investigate the link between the understanding of false belief and the cognitive and affective inhibitory control mechanisms among pre-schoolers. Their findings argue for a specific connection concerning the cold component of inhibitory control. Results are discussed with regard to the link between delayed gratification and mental time travel (i.e., mental projection of themselves into future situations) based on a set of cognitive skills which includes ToM.

Other contributions explore the relation between ToM and some specific abilities deriving from mental representation: pretense, understanding of stories and artistic artifact and the narrative attitude. Dore et al. jointly analyse ToM and social pretend play and subsequently overturn the widely accepted hypothesis of "Play first." The hypothesis "ToM first" can be supported by naturalistic longitudinal studies. As opposed to the more commonly used training studies, they could investigate both causal directions while monitoring all of the variables potentially involved, with a particular focus on linguistic skills. Through Aesop's Fables, Pelletier and Beatty investigate the bond between the understanding of stories and ToM. Age is positively associated with the ability to infer moral meanings from such stories based on the mental contents of the protagonists rather than on their concrete actions. From an educational perspective, this is important given the role played by the explicit conversation regarding the mental states in the school context. Gilli et al. explore the impact of an interpretative ToM with respect to various issues linked with the representational understanding of the arts. The developmental steps highlight interesting changes in the conceptions about the intentions of both the artists and the art-users, which are progressively included in a more comprehensive view of the respective agency. The understanding of esthetic experience requires critical elements of judgment as well as the recognition of a particular concept of "truth" (artistic artifact vs. fake). Brizio et al. address the social cognition characteristics in adolescence, a period in the life-span which has been scarcely investigated in literature. The classic ToM tasks, suitable for infancy and childhood, are inadequate in this case as they fail to account for the great cultural valence of adolescent social competencies. The latter would be more properly investigated incorporating the narrative tools used by adolescents to cope with challenges and risks of this developmental phase.

Further evidences about the topic are provided by the studies regarding the neural correlates of ToM. Schurz and Perner analyse, on the basis of a previous meta-analysis, nine domain-specific, and domain-general neurocognitive theories and the respective predictions regarding the neural activations while subjects are engaged in six categories of ToM tasks. The failures of the theories in predicting the results are discussed in the context of four critical issues: (1) lack of a clear and shared definition of what is a ToM task, (2) the need for more appropriate knowledge concerning the cognitive processes involved, (3) the need for a more precise anatomical brain mapping, (4) a better understanding of the differences between ToM tasks and Control tasks, which is an emerging topic in this field. Cabinio et al. analyse age-related structural brain changes in relation to a widely used affective ToM task. The negative relation between age and ToM performance is explained by both gray and white matter structural modifications. However, the decline remains within a normal range. The most likely hypothesis is that compensatory mechanisms of brain plasticity aid in maintaining this ToM ability. The study by Marchetti et al. provides both behavioral and neural evidences about Mind Wandering (MW). This study includes the Italian validation of a questionnaire designed to explore the contents of the resting mind. Moreover, the relationship between the ToM contents of the questionnaire and the brain functional connectivity during MW are explored. These evidences show the involvement of areas involved in both affective and cognitive ToM tasks.

The inter-subjective understanding of the subjectivity and the role of attachment process within this dynamic are also addressed in another cluster of papers. Marraffa et al. examine the nativist/modularist theory and the cognitive constructivist theory. They argue that the intersubjectivity promoted by mentalization (named respectively "Mindreading" and "Introspection") comes from a first-person perspective, connected to mindreading; only at a later point does this scheme tie into a socio-cultural frame, in which the attachment elements are included. Rollo and Sulla analyse through a Vygotskian perspective the influence of maternal mental language on cognitive and socio-cognitive skills in pre-schoolers. Also maternal empathy and child's temperament are proposed as variables that need to be investigated. Rosso et al. examine pre-adolescent and mother dyads in order to characterize the link between the maternal reflective function and pre-adolescents' mentalization process. They observe a lack of connection between the maternal security of attachment and the pre-adolescents' mentalistic abilities, in contrast to the one found with the maternal reflective function. This aspect is especially true regarding negative or ambivalent mental states. These evidences are particularly relevant for focused therapeutic interventions. Similarly, other studies deal with therapeutic and psychoeducational applications. Baimel et al. propose a strategy to understand the other's mind based on behavioral synchrony. The social rituals, which support behavioral synchrony by

reducing the psychological distance, can be efficient tools to promote cooperation. The promotion of this mechanism is an implicit way to support ToM as an alternative to overcome the limits of explicit strategies. Bak et al. propose the theoretical basis and application of a Resilience Program. It is an intervention to promote ToM in different contexts for various targets, such as, parents, teachers, and pediatric health care providers. The main characteristic of this program is its flexibility and the possibility to divide it into separate blocks on a case-by-case basis depending on the requirements. Cavallini et al. discuss the results of a ToM training proposed to elderly people. The effectiveness of the training is based on the three fundamental criteria highlighted in the literature for the transfer of acquisitions: (1) repetition, (2) variability of tasks, (3) a learner-oriented approach. From the clinical perspective, Muller and Midgley show the features of the time-limited Mentalization-Based Treatment for Children (MBT-C). It is an adjustment of mentalization-based psychotherapy for borderline patients. Considering mentalization as a set of developing multifaceted abilities allows for a more precise formulation of the various cases. The idea that the development of mentalization is a relational process implies the involvement of parents in different steps of the treatment. This aspect stems from the hypothesis that improved mentalization in parents can strongly produce a similar improvement in that of the child.

Finally, some studies regard ToM in a clinical sample involving participants from school-age to adulthood. Fadda et al. explore the role of ToM in the promotion of moral reasoning in a sample of children with autism spectrum disorder. In these children ToM impairments seem to be connected to a higher proclivity to evaluate actions on the basis of their outcomes. Moreover, they seem more inclined to rigidly comply with moral norms, as in the Piagetian stage of heteronomous morality. Bender et al. investigate the emotive component of ToM with respect to attachment and emotional dysregulation in clinically anxious children. They demonstrate a relationship between the understanding of emotion as mental states and some aspects of anxiety. Ayesa-Arriola et al. analyse whether first episode psychosis patients show a stable ToM impairment over time. In their study, ToM deficits are associated with the neurocognitive status but not with the clinical symptoms. Furthermore, they observe that trait-related mentalizing impairments are found in even in remitted patients.

All contributions presented above elicit some considerations and comments. Developmental researchers appear to remain mostly interested in the quantitative aspect ToM abilities. They study the evolution of these competencies depending on age and specific trainings. Nowadays the qualitative aspect of ToM is more addressed in the clinical field as effects of treatments are also evaluated with respect to the contents of mentalization. In the developmental field the relevance of the ToM quality emerges only in the assessment and training studies where language (i.e., mental language and conversation) is the core of the investigations. Since the beginning of this research paradigm, additional life epochs have been added to both before the original pre-school phase as well as going forward all the way to the elderly one. In the meantime various tasks have been devised to meet these new research requirements as well as to investigate the nascent field concerning ToM's neural correlates. However, there is still a lack of authentic life-span studies performed with cross-sectional methods. On the other hand, longitudinal research is generally performed regarding follow up of clinical and training studies as well as researches on the effects of social relational variables (e.g. security of attachment) on mentalistic abilities in different developmental phases. A relevant future topic of research could concern the long-term developmental patterns of ToM skills in different typical and atypical situations.

AUTHOR CONTRIBUTIONS

All authors listed, have made substantial, direct and intellectual contribution to the work, and approved it for publication.

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OPINION
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A commentary on theory of mind

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Keywords: mind-reading, behavior-reading, children, animals, modularity of mind

THE CHILD AS PHILOSOPHER

"You don't know what I'm thinking," my 3-year-old granddaughter called to me from her car seat. Her out of-the-blue, metacognitive comment confirmed that, despite inconsistent performance on false belief tasks, young children reveal sophisticated mindreading abilities in their spontaneous talk (Shatz, 1994). At the least, she was concerned with knowledge in another's mind. But her statement suggested more: With no prior conversational context, and serving no communicative or behavioral purpose, it seemed to be in the tradition of philosophy of mind. What kind of theory of mind (TOM) lay behind it?

POSSIBLE THEORIES OF MIND

As scientists, we must consider the most economical, reasonable explanations for behavior. Possibly, a minimal TOM, e.g., behavior-reading as clues to intention (Butterfill and Apperly, 2013), could have accounted for her comment. Because I was driving and directing my gaze elsewhere while she sat quietly, she probably knew that I lacked perceptual information about her. (Behavior-reading handles well the findings on animal "mindreading," Lurz, 2011). However, comments about mindreading from competent language users like her may exemplify more, namely, thinking about mind. Possibly she held "the doctrine of opacity of others' minds," the belief that it is near impossible to know what another is thinking (Robbins and Rumsey, 2008).

In numerous Melanesian cultures, talk about others' thoughts is inappropriate, but evidence is lacking that mindreading does not happen (see Keane, 2008). Thus, the universality of mindreading among human adults has not been seriously challenged. Indeed, discoveries with pre-linguistic infants and animals have encouraged the view that, while possibly necessary for mature mindreading, language is very likely subsequent to early TOM skills (e.g., Malle, 2002). Apparently, children in Melanesian cultures still read others' minds, but they must learn not to talk about them (Schieffelin, 2008).

In Western cultures, social experience and family talk about mental states fosters TOM development (see Antonietti et al., 2006). As the younger sibling in an upper-middle class American family, my granddaughter very likely heard much talk about mental states and so would have been unrestrained in talking about our minds. Still, one cannot know for sure whether she held a TOM based on behavioral clues or on impossible access.

To explain improving performance with age, TOM theorists have proposed various mechanisms such as a mindreading "module" with performance constraints, growing representational ability, or social experience and language skill. Nichols and Stich (2003) even proposed a multi-component theory drawing on previous accounts. These authors' efforts, as well as later ones, show that no single mechanism explains all the findings on different-aged humans and animals. The answer to the question of who can read minds, when and how, is not simple.

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WHAT IS MINDREADING?

At the least, mindreading entails entity A assessing an internal mental state of entity B that is not accessible from direct perception. Hence, inference on the part of A is necessary. (See Premack and Woodruff, 1979; They coined the term, TOM.) Being a good reader of others' behaviors apparently is insufficient for "full-blown" TOM (Butterfill and Apperly, 2013). Mature mindreading is not constrained to a single (e.g., competitive) circumstance. To account for mindreading-like behaviors in animals and pre-linguistic infants while not granting them mature TOMs, researchers have proposed various minimal or two-system theories (e.g., Apperly and Butterfill, 2009; Ruffman, 2014). Already their proposals have garnered a variety of criticisms (e.g., Carruthers, 2014; Scott, 2014).

So, years after my granddaughter's remark, and after studying many recent arguments, I cannot definitively answer the question of what kind of theory she had. Lurz et al. (2014) propose "optimistic agnosticism" to address whether animals behavior-read or mind-read, but I am not as optimistic as they that further experimentation will establish the truth for either animals or young children. Lurz et al. say that the evidence already favors an innate module, even in animals, as the basis for TOM. The notion of modularity comes from Fodor's (1983) proposal of it as the mind's organizing principle. His work follows from the idea of an innate human language capacity (Chomsky, 1965).

The language and TOM modules are similar in that both have some innate bases or other, and both require environmental input to achieve mature status, that is, "full-blown" TOM and specific language competence. Nonetheless, the modules and their developmental constraints are critically different. The innate language module constrains syntax, allowing humans to use limited data to develop a specific syntactic system. Thus, the syntax module accounts for various features of a language being packaged together so that when a crucial piece of data is encountered, those multiple features can be acquired simultaneously. In contrast, the mindreading module seems to consist of a score of disparate, (albeit possibly innate) abilities functioning together to produce early TOM-like behavior. As these skills grow, so TOM ability grows, bringing success on increasingly difficult tasks. Animal modularity may be different from human modularity altogether, with entirely different constraints (e.g., limited to competitive contexts; Barrett and Kurzban, 2006). More clarity on the nature of TOM modules is needed to decide which, if any, modules share more than an ill-defined label.

The problem of clarity plagues other constructs in TOM proposals as well. For example, the question of what they represent when creatures mind-read is a conundrum because there is no clear definition of representation. Without clear basic constructs, there can be no determinative testing of modular or any other TOM theories.

Only human children can acquire both false-belief understanding and syntactic language. Several researchers have proposed that language is the human ability that can integrate early skills, leading to more advanced ones, (e.g., Spelke, 2003; Shatz, 2007). Or, humans may have a higher-order cognitive capacity that accounts for both language and "full-blown" TOM (see Penn et al., 2008; Shatz, 2008). Such proposals may be agnostic with regard to whether animals' abilities are the evolutionary precursors to adult human strengths, but they are not so with regard to the "pro-discontinuity" position that humans are basically different from animals.

When my 3-year-old granddaughter said, "You don't know what I'm thinking," my first and lasting impression was that she had marked a crucial difference between us. The grandmother in me credited her with a rather mature TOM. Although, my scientist's head may be more agnostic, it is not at odds with my grandmother's heart. I believe, even after perusing the last decade's work, that young humans have different TOMs from animals. Proof awaits.

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OPINION
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When the theory of mind would be very useful

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Introduction

The theory of mind is certainly necessary. The dire consequences of a missing theory of mind in autism spectrum disorders are a clear proof for it. So, it might be interesting to examine how it is necessary and useful by looking at some specific (and possible) functions in the mind of a child as well as of an adult, beyond the more general comprehension of one's own and others' mental state.

First of all, as the field of the theory of mind is full of different approaches, we want to specify, very schematically, our point of view about this topic.

1. The theory (naïve) of mind is based upon the capacity to think about thoughts as such, to represent the representations regardless of the "objective" reality (meta-representative thought). The analysis of the results of the common cognitive test for studying this topic, the famous *false belief task*, shows that, regarding the representations of others, a correct meta-representation has to desist from reality as well as from one's own representation: "I know X, but I understand that you know Y." In our opinion, the meta-representative thought is the cognitive process that generates the decentralized thought (vs. the egocentric thought); in other words the ability to adopt the cognitive perspective of someone else. However, the meta-representative thought can be pointed not only towards the external world and to other people, constituting the basis of interpersonal relations, but also towards the internal world, i.e., to one's own representations, thus constituting the basis of consciousness and meta-cognition. Summarizing, one could say that the theory of mind is the basis for the representation of the world of subjectivity (we have exposed these concepts more broadly in Battacchi et al., 1998).
2. When talking about everyday thinking, we must remember that people not always reason according to the formal logic, but often activate cognitive processes that are less rational and affected by important biases (heuristics, analogical thinking, etc...). We can apply this well-known principle also to the meta-representative thought. This is certainly a complex thought that we would be able to use, but that we don't necessarily use in every situation of daily life. Indeed it's easy to notice (and even to demonstrate, as had been done in some cases, Keisar et al., 2003; Bloom and Birch, 2007; Keisar, 2007; Ryskin and Brown-Schmidt, 2014) that in daily life people very often violate the properties of the meta-representative thought, as the ones that we have indicated above.

Massaro et al. (2013), for example, investigated the so-called outcome bias and hindsight bias in primary school children and explored the possible predictive function of false belief understanding in reducing these biases.

This is why our basic question should sometimes be: "*How useful would the theory of mind be?*" From this point of view, we believe it could be interesting to address two specific topics: one is what we will call the "*naïve realism*," the other is "ignorance," once more of one's own as well as of others. We belief in fact that the theory of mind, as meta-representative thought, can contribute to reduce the bias of naïve realism and to increase the meta-cognitive awareness of one's own and others' ignorance and that these functions can have relevant social implications.

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The Naïve Realism

Back in 1926, J. Piaget described in a very short passage the meaning of his first, by now almost forgotten studies about infantile representations. When representing the world, a thought (not only of children) can be objective or realistic. It is objective when "*it recognizes (...) the manifold intrusions of the ego into our everyday thoughts and the thousands of illusions that derive from it—illusions of senses, of language, of points of view, of values, etc.—which start to get rid of the obstacles of the ego before venturing a guess.*" On the other hand, a realistic way of thinking "*consists in ignoring the presence of the ego, which is in considering one's own perspective as immediately objective and absolute. Therefore, realism is (...) all the countless illusions that pervade the history of science.*"

The most famous Italian novel of the nineteenth century, *I promessi sposi* ("The Betrothed") by Alessandro Manzoni, contains a very effective literary image of this concept. Manzoni tells the story of plague that haunted the city of Milan in 1630: back then, it was assumed that the epidemic had been caused by some suspicious characters, the so-called *greasers*, who greased walls and doors with a deadly substance. Renzo, the main character of the novel, is mistaken for a *greaser* because of some of his actions; he gets denounced and chased by the bulk. Manzoni then tells us that in later years people started to contest this myth of the *greasers*, and that the passer-by who had denounced Renzo argued that "*one must have seen things.*" By using the verb "to see," Manzoni, a very subtle psychologist *ante litteram*, wants to exclude the fact that in the mind of that alas nameless person there wasn't even the slightest doubt about his representations as well as the slightest awareness of the "*manifold intrusions of the ego into everyday thinking,*" as said Piaget (1926).

It seems obvious that these words can by referred to extremely broad fields of knowledge: from the problems of micro- and macro-social relations (which are right now in some way particularly relevant) to the problems of epistemology (naive as well as scientific). Moreover, the awareness of one's subjectivity is always essential for recognizing the subjectivity of others.

This topic can also be connected to another classical theory of modern psychology: the theory of attribution (Heider, 1958). One of the most important cognitive procedures is without doubt the search for the causes of events and behaviors. We know that we can ascribe the actions of someone (and also of ourselves) to internal causes (abilities, motivations, etc.) as well as to external causes (the characteristics of objects, the behaviors of others, the chance, etc.). We know as well that there is a general tendency to overestimate the internal causes, to see ourselves as governed by ourselves or to prefer internal or external attributions as a means of valorizing and defending the image of ourselves. Today, we have the instruments for measuring the attributional processes and for documenting their importance for a person's adaptation and wellbeing. The most famous example is certainly the concept of *locus of control*. Less known and less documented, but nevertheless highly plausible is the hypothesis of a tendency to belief realistic the representations which regulate the more or less problematic relationships with *the other*, *the different one*, etc. A slightly more sophisticated meta-representative thought would allow us to get aware of the fact that some of our trusted representations (that seem to be completely "objective") are nothing else than the result of our "attributions," based on certain heuristics well known in social psychology. This is why we can ask ourselves if a metacognitive consciousness of the internal components of our representations could be useful to control the social stereotypes which are the basis of the hostile relationships typical of our societies.

The Representation of Ignorance

In our opinion, there is another important topic related to meta-representation which does not get the attention it deserves, maybe because it is a kind of "non-representation." We are referring to "ignorance," i.e., absence of knowledge. Ignorance is a cognitive condition that we experience daily and that we consider as nothing more than a limit that has to be eliminated. If there is something we do not know, we look for information; or if there is someone who doesn't know something, we try to give him the necessary information. But reality is not as simple. If ignorance itself can be seen as something negative, the metacognitive awareness of ignorance can, on the contrary, be considered as an important and very "useful" condition. The philosopher Nicholas of Cusano (1440) referred to this in his famous oxymoron "de docta ignorantia": in front of the immense wisdom of God, we become aware of the limits of our thoughts. In an attempt to secularize this concept, we could say that the awareness of the limits of our knowledge would be a sign of great intellectual (as well as academic) virtue—just in the sense of Socrates and his "knowing to know nothing." On the contrary, the illusion of knowing everything is the royal road to ignorance and stupidity.

Our Ignorance

Even in a metacognitive sense, the awareness of one's ignorance is the necessary condition for every kind of learning (Rohwer et al., 2012). When do we "decide" that we know enough so that we can stop asking and learning? Which is the level of comprehension that we consider as sufficient and that leads us to stop searching? It is obvious that even the most simple of topics can never be studied and known in all of its details. Our meta-decisions depend on our meta-representation of our relative ignorance, as well as on other factors, first of all the necessity of daily routines, but also the image of ourselves, the comparison with others, etc. We can also assume that people differ in their level of tolerated ignorance: there are those who content themselves with fairly superficial skills and explanations in the illusion to eliminate their ignorance as easily as possible, and there are those who use their ignorance as a means to go on looking for a deeper knowledge. And it is exactly in this, until now only partially explored research area that we see a big potential for new studies connected with the topic of meta-representative thought.

The Ignorance of Others

The ignorance of others is part of our everyday life: when we communicate something to someone, we do this mostly because we assume that the other does not know it yet and that we have to consider, in an implicit and maybe unconscious way, his or her ignorance. This means that we are capable of representing it to ourselves. Besides, ignorance is also the specific object of numerous important professions: teachers, journalists, technicians (when they must sharing their knowledge with the novice), etc. The main problem of these professions is a correct representation of ignorance: what is the state of mind of the person who ignores what I have to teach him? What does he know, and what does he not know? What are his cognitive abilities, and which ones does he not have? Representing the mental representation of a person who does not know something is probably one of the most difficult cognitive operations at all. It is all about taking on the perspective of someone else with regard to a topic that we know well, and the first, necessary but not sufficient step is that of ignoring what we know. This is certainly the main difficulty of teaching in every form and at every level. What does a child know about the world that we are supposed to explain? What are his strange representations of it? Many years ago, a boy attending the first year of junior high school, a really good student, could not understand how a river can flow northward; the only way to explain it was to take down the map from the wall, to spread it out on the floor and to allow the boy to walk on it.

It might interesting to remember that Piaget based his research method on the analysis of mistakes.

Are the mistakes of our students false representations that one has to get rid of as soon as possible, or are they a precious source for understanding their relative "ignorance"?

Road signs are another funny example: when a passer-by asks for the right direction, giving him a useful answer implies that we identify ourselves with his ignorance—something that those who are in charge of road signs are not always capable of doing.

Our everyday experience shows that explaining the functioning and use of an instrument to a non- professional is a very difficult task for technicians in every field—we see this by the countless obscure user manuals (Serra Barneto, 1992). Even in this not all too trivial field, meta-representation could be very useful for keeping in mind the ignorance of others.

In conclusion, we can briefly highlight that the theory of mind and the meta-cognition are not only important mechanisms of information processing but they represent overall the essential tools of every kind of interpersonal communication.

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Theory of mind: a new perspective on the puzzle of belief ascription

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The concept of theory of mind (ToM) has considerably changed since its first proposal. The aim of first human studies was to understand how young children acquire the representation of others' mental states, in particular beliefs, and how they distinguish them from their own and from reality. The False Belief Task was designed to prove the acquisition of this capacity. According to children's performance in this test the acquisition of ToM has been attested at around 4 years of age. In last years it has been shown that using spontaneous response tasks also 15-month-old-children could attribute to an agent a false belief about the location of an object. These results have generated the puzzle of belief-ascription: Why do 3-year-old children fail the classical false belief tasks whereas much younger children show the correct expectation in the spontaneous response tasks? In this paper I shall argue that (i) infants and young children, when confronted with the two forms of false belief tasks do not face the same problem and (ii) behind the two testing situations there are different ways to understand theory of mind. I shall propose that what appears in infants is the natural human disposition to intersubjectivity.

Keywords: theory of mind, intersubjectivity, false belief, deceit, irony

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Introduction

The concept of Theory of Mind (ToM) has considerably changed since its first proposal in the paper Premack and Woodruff's (1978). Focusing the interest on humans and in particular on human acquisition has posed methodological problems, which are still at issue.

The aim of first human studies was to understand how young children acquire the *representation* of others' mental states, in particular beliefs, and how they distinguish them from their own and from reality. To test the acquisition of this main conceptual change Wimmer and Perner (1983) designed the False Belief Task. According to children's performance on this test the acquisition of ToM has been shown to emerge at around 4 years of age.

In recent years a new trend emerged: researchers have found ways to verify the capacity of passing the false belief test in much younger children. Clements and Perner (1994) first showed that it is possible to assess implicit comprehension of false beliefs in 3-years-olds monitoring the direction of their gaze. Other researchers, using the violation of expectation paradigm have proven that also 15-month-old-children may attribute to an agent a false belief about the location of an object (Baillargeon et al., 2010).

These new results have generated what Perner and Roessler (2012) call a puzzle about belief. Why do 3-year-old children fail the classical false belief tasks whereas much younger children show the correct expectation in the spontaneous response tasks?

The question I intend to discuss here concerns the very existence of a puzzle. Are implicit and explicit false belief tasks comparable? To discuss this point let us analyze first the relationship between the false belief task and ToM.

The Development of ToM and the False Belief Task

The importance attributed to the false belief task with respect to the development of ToM has been criticized in the past. For instance, Bloom and German (2000) argued that passing the false belief task requires other abilities besides ToM and conversely that ToM cannot be reduced to the ability to pass the false belief task. In a similar vein Apperly (2012) argues that there is more to ToM than having a conceptual grasping of mental states. In his view ToM is also a set of cognitive processes and a social competence attesting to individual variability; then no single task can be considered as the right "measure of ToM" across development.

In contrast, there are authors who still consider that the false belief task is a good indicator of explicit belief understanding. The hypothesis is that false belief comprehension is a step in a ToM scale including what children may know about persons and minds (Wellman and Liu, 2004). Cultural variation would result in differences in the sequence (Shahaeian et al., 2011). Variations in the sequence and acquisition times would interestingly characterize atypical populations like children with deafness, autism and Asperger syndrome (Peterson et al., 2012).

At the core of the present debate one point is central. What are we measuring with the different forms of false belief task that are in use? As we have seen the fundamental distinction regards implicit vs. explicit understanding. Anticipatory looking in young children allows inferring infants' comprehension from their spontaneous behavior, while in the classical verbal tests children are asked to give an explicit answer about the false belief (for a review of the literature, see Low and Perner, 2012). It has been suggested that the implicit capacity shown by young children could have its basis in the human attitude to automatically encode others' beliefs that would be active throughout development. This attitude has been shown both in 7-month-old infants and adults by Kovács et al. (2010) who argued that it could be part of a human-specific "social sense." This work nicely fits in with the standpoint that the implicit and explicit false belief tests tap two different cognitive mechanisms and that perspective tracking is a process that it is often disrupted in various ways in the verbal versions of the task (Rubio-Fernández and Geurts, 2013). Interestingly, it has been shown that also in adults perspective tracking is a continuous process that can be disrupted by false belief questions (Rubio-Fernández, 2013). Thus, there is evidence in favor of the position that early understanding of belief is implicit while the classical false belief task requires explicit reasoning about actors' reasons for how to act. It is the latter task that is not acquired before 4 years of age (Perner and Roessler, 2012).

The existence of two distinct systems was postulated by Apperly and Butterfill (2009). One system, efficient but limited and inflexible, would explain the ability shown by infants to deal with ToM tasks as well as social abilities of some non-human animals. The system constituted of mental concepts (desires and beliefs), would gradually develop in children allowing reasoning about others' minds in a flexible but less efficient way. Adults would be equipped with both systems. This point of view is supported by evidence showing a task specific developmental continuity in false belief reasoning (Thoermer et al., 2012). An important role in the transcription of the first system into reasoning would be played by the emergence of language and executive functions.

Meta-analysis has shown no significant difference for false belief tasks types in their relation to language (Milligan et al., 2007). However, Helming et al. (2014) maintain that the analysis of the pragmatic framework of the test may elucidate the puzzle of belief ascription. Their thesis is that children's second person engagement with the experimenter's communicative action disrupts their ability to keep track of the content of the instrumental agent's false belief. The cooperative perspective would prevail in the verbal task explaining children's failure. Children would transform the experimenter test question into the question "Where *should* Sally look for her toy?"

Through the analysis of the literature it emerges that while at the beginning we had a definition of ToM and the false belief task was intended to ascertain its development now we are questioning the very definition of ToM. Thus the concept of implicit belief becomes central. What is an implicit belief and what is its relationship with ToM? How to avoid the risk of begging the question: ToM is what is measured by ToM tests? There is no demonstration that non-verbal and verbal false belief tests measure the same capacities, and that what we call implicit belief is comparable with explicit belief (San Juan and Astington, 2012).

Intersubjectivity and ToM

My argument is that showing that infants have implicit grasp on others' minds amounts to re-discovering intersubjectivity. Almost 40 years of studies on the development of intersubjectivity have shown that infants deal and communicate with other humans since birth (Trevarthen, 1998). It would be impossible to explain infants' ability to deal with others if they had no grasp at all of what happens in their minds. Yet, this has little to do with what traditionally has been defined as ToM. My claim is that conflating intersubjectivity and ToM suggests a non-existing puzzle. The problem is the centrality attributed to the false belief task on the one hand and on the other hand the purported equivalence posed between the two forms of it, verbal and non-verbal. What Kovács et al. (2010) call a human-specific "social sense" has been shown for years in developmental research under the name of intersubjectivity. The development of the explicit capacity of reasoning about others' mental states, i.e., ToM, is a "specialization" of human "social sense" that since the pre-school years humans *may* use to deal with particularly difficult situations.

One fundamental point of interest for developmental studies is the gap between how brilliant young children appear in some interactive situations and how ignorant of fundamental facts regarding other minds they turn out to be when tested in experimental situations.

Let us consider two cases of controversial interpretation of young children's behavior, namely humor and deceit. The literature on intersubjectivity has shown that children before

2 years of age are able to participate in humorous interactions with adults and to engage in some forms of intentional falsifications of reality (Reddy, 2008). On the contrary in experimental situations these two forms of behavior are not shown to occur before 4/5 years of age. How may we explain this discrepancy? A possible answer is that in studies on intersubjectivity children are observed in the course of interactions and they show their intentionality and proficiency in engaging with others. Instead, in experimental situations children are requested either to explicitly manipulate others' mental states or to have a judgment on the situation, i.e., to show what traditionally are considered as ToM abilities.

I take the case of humor. Young children in interactions with adults share situations of amusement. This means that there is a form of understanding that some acts are not serious: putting a breadbasket on one's head is not the same as putting a spoon in one's mouth. The first gesture makes others laugh while the second does not. Does this mean that young children "really know" what non-serious communication is? In order to investigate this we carry out experiments. For instance, a number of experiments have been made on irony comprehension. What do these experiments test? In general they test if children are able to comprehend that something has been said in a non-serious way, i.e., the real meaning of an ironic utterance but also if they understand the kind of act that has been produced, i.e., what being ironic means. Young children do not succeed in these tasks before 5/6 years of age. Thus the children that we observe in interaction are able to distinguish serious from non-serious situations in a rather appropriate way from a very young age, while in experiments children show that they do not know what being non-serious means till school age. Actually these experimental tasks are ToM tasks in the traditional definition and thus children have the traditional ToM results. In a study we designed an experimental task in which children had only to prove their comprehension of the communicative intention of ironic utterances, i.e., their non-literal meaning (Angeleri and Airenti, 2014). For instance, if a character said to another character who had just broken a plate: "Your mommy will be happy!" children were expected to understand that the intended meaning was that the mother would be upset. The goal was to have a comprehension task not burdened with ToM difficulties. In this condition we were able to show that even children as young as 3 years of age might understand the non-seriousness of an ironic utterance. In a sense we produced a kind of intermediate situation between using a communicative device in everyday communication and being able to explain what happens in another person's mind in an experimental situation.

Thus, I argue that there is no puzzle. The so called explicit ToM is one of the aspects that intersubjective abilities may take in children not before 4 years of age and that evolves until adulthood. Younger children not only—as it is obvious—do deal with others but they do so in an effective manner *without* ToM.

We should come back to the fact that the false belief task has been devised in order to ascertain the development of the capacity of explicitly representing others' beliefs. Designing false beliefs tasks that children may pass relying on those capacities that they normally use in their everyday behavior reverses the problem. But what does it prove with respect to ToM? 15-month-old children may pass the non-verbal false belief task but they are nevertheless unable to carry out or understand a deceit, to a find a good way to overcome a communicative failure, etc., i.e., to plan communicative acts that require representations of others' beliefs. In sum, the problem of the development of ToM remains unaltered with the connected question regarding the role of language acquisition.

Humans are equipped from birth for interaction with others. This implies monitoring and adapting to others' actions and participating in communicative exchanges. This is the *clever* part of young children's behavior. However, some situations demand a more strategic thinking, i.e., reacting only after having reflected upon others' mental states. For some basic interactive behaviors we can imagine two possible versions, one not implying ToM and one implying ToM. This applies for instance to failure. An infant happily communicates with her mother but if the mother just stops the interaction as it has been experimentally provoked in the *still face* situation or—with older children—interrupting a playing sequence, the child's only possibility is protesting, manifesting discontent, diverting attention (Weinberg et al., 2008). Such a situation of unexpected behavior of the interlocutor can be handled by using ToM: Why does mom not smile at me anymore? or Why does mom not want to play with me anymore? The same applies to deceit. Young children may lie but many studies have shown that they do not plan real deceits and do not consider that others may be liars. Deceiving and discover possible liars demands ToM, i.e., reflecting on others' beliefs (Airenti and Angeleri, 2011; Lee, 2013).

Conclusion

In conclusion, the study of ToM was intended to understand how the capacity to represent mental states develops in children. The false belief task was designed to determine when and how this competence appears. Recently, the test itself has become the focus of the investigation. In this way we overlook the fact that the aim of ToM studies was to discover how children become able to perform acts as complicated as deceiving, discovering that others may be liars, or that in some situations lying is considered preferable than expressing real feelings. Actually, we have discovered something that we already knew, i.e., that even very young children have reasonable expectations with respect to others' actions. This finding is consistent with the fact that in natural situations young children are able to deal with others rather successfully but does not improve our knowledge of ToM. I consider that using ToM terminology in this context is misleading. ToM is a particularly refined form of intersubjectivity and it is not intersubjectivity that has to be seen as a form of minimal ToM (Butterfill and Apperly, 2013). The question remains of explaining the mix of cleverness and candor so typical of young children, i.e., how ToM abilities transform early "social sense."

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MINI REVIEW
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Outcome Knowledge and False Belief

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Virtually every social interaction involves reasoning about the perspectives of others, or 'theory of mind (ToM).' Previous research suggests that it is difficult to ignore our current knowledge when reasoning about a more naïve perspective (i.e., the curse of knowledge). In this Mini Review, we discuss the implications of the curse of knowledge for certain aspects of ToM. Particularly, we examine how the curse of knowledge influences key measurements of false belief reasoning. In closing, we touch on the need to develop new measurement tools to discern the mechanisms involved in the curse of knowledge and false belief reasoning, and how they develop across the lifespan.

Keywords: curse of knowledge, theory of mind, hindsight bias, perspective taking, social cognition

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INTRODUCTION

Christmas is approaching. John's 6-year-old sister, Maggie, is very excited about Santa Claus. She has already written three letters to Santa, and is discussing the cookies she plans to leave beside the tree. As an 11-year-old, John cannot understand why his sister believes in Santa Claus. Doesn't she realize that it is her parents who leave gifts under the tree? In this scenario John is influenced by what is called 'the curse of knowledge' or 'hindsight bias' (see Fischhoff, 1975; Camerer et al., 1989): because John knows that Santa isn't real, it's difficult for him to appreciate his sister's more naïve perspective. The curse of knowledge refers to a difficulty ignoring one's current knowledge when taking the perspective of someone less informed. This bias colors our ability to reason about the less informed thoughts of others and even recall our own previously held naïve perspectives. Considering the curse of knowledge's profound impact on perspective taking across the lifespan, it is important to consider this bias's role in social perspective taking, or 'theory of mind' (ToM).

We briefly review the literature on the curse of knowledge. We then discuss how the curse of knowledge relates to ToM, focusing on the most widely used developmental ToM measures—the classic false belief tasks. We then review literature investigating links between the curse of knowledge and ToM across the lifespan. Lastly, we suggest future research objectives that will illuminate issues critical to our understanding of the curse of knowledge and ToM.

THE CURSE OF KNOWLEDGE

The Curse of Knowledge Across Development

Our brains are geared toward *acquiring* knowledge, rather than ignoring it. Although we sometimes unintentionally forget information, it is difficult to *intentionally* 'unknow' something (see Golding et al., 1994). Cognitive and social psychological research has investigated the pervasive

nature of the curse of knowledge and its effects on social cognition and memory (see Lilienfeld et al., 2009; Roese and Vohs, 2012). Typically, researchers investigate the curse of knowledge by using either a memory design or a hypothetical design (Pohl, 2007). In a memory design, researchers ask participants to answer questions. Later, participants learn the correct answers to the questions, and must recall their original answers. Participants' recollection of their original answers tends to be biased toward the newly learned correct answers. For example, Fischhoff and Beyth (1975) asked participants to estimate the likelihood of a set of possible outcomes of Nixon's future visit to the USSR (e.g., 'The USA and the USSR will agree to a joint space program'). Upon learning the outcomes of Nixon's visit, which included a joint space flight, participants had to recall their earlier likelihood estimates of the different outcomes. Participants' newfound knowledge of the actual outcomes to Nixon's visit biased their recollections of their prior estimates.

In a hypothetical design, participants learn the answer to a question, and then estimate how they *would have* answered the question if they had not learned the answer, or how another individual, who had not learned the answer, would respond. For example, Fischhoff (1975) provided participants with descriptions of a historical event involving the war between the British and the Gurka. Some participants did not learn the war's outcome, whereas others learned that 'The British and the Gurka reached a military stalemate.' Subsequently, participants considered several possible outcomes, including the actual outcome. For each possible outcome, participants estimated how likely it would be for a naïve peer to predict that outcome. Compared to participants who did not learn the true outcome, participants who learned the outcome estimated that naïve peers would be more likely to predict the war's true outcome.

In curse of knowledge studies, participants' current knowledge biases their recollections of what they previously thought and/or their ability to predict what someone else would think (Hawkins and Hastie, 1990). The curse of knowledge is robust and widespread. It occurs across a range of time intervals between exposure to the privileged outcome information and the hindsight judgment. More so, the curse of knowledge persists after explicitly warning participants about it, and providing cash incentives to avoid it (Camerer et al., 1989; Pohl and Hell, 1996). Indeed, the curse of knowledge occurs across a variety of paradigms and information types (Bryant and Brockway, 1997; Tykocinski et al., 2002; Blank et al., 2003); across cultures (Heine and Lehman, 1996; Pohl et al., 2002); and has been documented in many applied settings including business, education, and politics, as well as in academic writing and legal, governmental, and medical decision-making (e.g., Harley, 2007; Pinker, 2014). Compared to research with adults, however, the developmental literature has largely overlooked the curse of knowledge.

The Curse of Knowledge and Theory of Mind

We propose that there is a fundamental link between the curse of knowledge and ToM (see also, Birch and Bernstein, 2007). ToM encompasses social perspective-taking abilities that allow us to reason about our own and others' mental states. An important aspect of ToM is the ability to infer the mental states of individuals who lack knowledge about key information and who consequently hold a false belief—a belief that is inconsistent with reality. This aspect of ToM is called false belief reasoning.

Previous research shows notable improvement in false belief reasoning between the ages of 3–5 years (for a meta-analysis, see Wellman et al., 2001). In a classic task, a child observes Sally playing with a ball and placing it in a box. Then, when Sally is away, Anne takes the ball and hides it under a basket. The child is then asked where Sally will look for the ball upon her return (e.g., Wimmer and Perner, 1983; Baron-Cohen et al., 1985). At 3 years of age, children inaccurately say that Sally will look under the basket (the ball's current location). Rather than choosing randomly between the two locations, children are biased in the direction of their own knowledge. By 5 years of age, children tend to respond accurately, and say that Sally will look where she first hid the ball. A new wave of non-verbal false belief tasks has reported success in false belief reasoning at a much earlier age than 3 years. For instance, Onishi and Baillargeon (2005) showed that infants as young as 15 months demonstrate false belief reasoning in a violation of expectation paradigm (discussed shortly).

Why 3-year-olds fail the classic false belief task and its variants is hotly debated (Miller, 2012). One view suggests that 3-year-olds do not understand that minds can *mis*represent reality (e.g., Wellman, 1990; Perner, 1991; Gopnik, 1993). Another view suggests that developmental changes in general cognitive mechanisms (e.g., memory, language, executive functioning, and processing speed) account for the developmental change on this task. That is, 5-year-olds ability to perform the task may reflect maturation of one or more general cognitive abilities rather than a qualitative change in their conceptual understanding of the mind (Zaitchik, 1990; Fodor, 1992; Bloom and German, 2000; for other perspectives on false belief reasoning, see: Penn and Povinelli, 2007; Apperly and Butterfill, 2009; Sabbagh et al., 2013).

A variant of the latter view, the curse of knowledge account, suggests that children do not necessarily undergo a qualitative conceptual change in their understanding of the mind, but that classic false belief tasks pose the additional demand of ignoring one's privileged knowledge—a demand that is especially problematic for young children. Consistent with this view, younger children are more susceptible to the curse of knowledge than older children and adults (Mitchell and Taylor, 1999; Birch and Bloom, 2003). The fact that most classic false belief tasks require that an outcome-knowledgeable child predict the perspective of someone less knowledgeable raises the question of how much the developmental change in the curse of knowledge bias contributes to the developmental change in false belief performance.

Previous research suggests that the curse of knowledge also affects young children's impressions about how long they have known information. Taylor et al. (1994) found that when preschoolers learned new information (e.g., the color chartreuse) they claimed they knew it all along. They were unable to differentiate between knowledge that they learned long ago (e.g., the color red), and knowledge that they learned that day

(see also Sutherland and Cimpian, 2015). Consistent with this, young children also struggle with recalling their own earlier false beliefs. For instance, in another classic false belief task, children guess the contents of a crayon box. After justifiably guessing, "crayons," they learn it actually contains balloons. When asked to recall their earlier guess they claim they knew that there were balloons inside. They aren't just trying to look smart—they also think that someone else will know there are balloons inside. Interestingly, young children sometimes claim that others will share their knowledge regardless of whether the others are peers, adults, or even babies (Taylor et al., 1991; e.g., Caza et al., 2016).

The curse of knowledge is more complicated than simple egocentrism. Egocentrism predicts that an individual will overestimate how widespread his or her knowledge, or ignorance, is on a given topic. In other words, egocentrism predicts an over-attribution of one's own perspective (whether knowledgeable or ignorant) to others. However, children only overestimate how likely other people are to share their knowledge and do not overestimate how likely other people are to share their ignorance. To show this, Birch and Bloom (2003) investigated children's ability to infer another's knowledge of the contents of different toys when the children either knew or didn't know the toys' contents. Three- to five-year-old children saw sets of toys, each containing "a special thing inside." Children learned that Percy, a puppet, had seen what was inside one set but not the other. On half the trials, children saw what was inside both sets of toys; on remaining trials, children did not see what was inside either set, resulting in a 2 × 2 cross between Percy's knowledge (or ignorance) and the child's knowledge (or ignorance). When children knew the toys' contents they overestimated Percy's knowledge compared to when they didn't know the toys' contents (see **Figure 1A**). Interestingly, this bias decreased between 3 and 5 years of age, paralleling the developmental change in children's performance on classic false belief tasks. However, when children didn't know the toys' contents, they didn't overestimate Percy's ignorance compared to when they knew the toys' contents (see **Figure 1B**). Thus, children who didn't see what was inside the toys were more accurate in their judgments of what Percy knew and didn't know.

In another demonstration of the curse of knowledge's role in children's ToM, Lagattuta et al. (2014) tested 4- to 7-year-old children's and adults' ability to estimate a naïve individual's interpretation of pictures. A cover over the pictures revealed only a small, often uninformative, portion of the picture. Some participants saw the pictures before they were covered, and others only saw the covered pictures. Participants who saw the pictures before the cover, and thus knew the pictures' identity, overestimated the likelihood that a naïve individual would correctly guess the pictures' identity (see also Mossler et al., 1976; Chandler and Helm, 1984; Taylor, 1988). Moreover, consistent with earlier research, children were more likely to be biased by their knowledge compared to adults (see also Epley et al., 2004; Lagattuta et al., 2010).

Similarly, Bernstein et al. (2004) found that knowledgeable children and adults were more likely to overestimate their peers' knowledge. In this procedure (a visual hindsight bias task, see **Figure 2** and Harley et al., 2004), 3- to 5-year-old children and adults saw degraded images of common objects that gradually clarified on a computer. In a foresight condition, participants identified an image as it clarified. In a hindsight condition, participants first saw a clear version of the image, and then estimated when a naïve peer would identify the image as it clarified. Participants who had previously seen the clear images of the objects overestimated how early their peers would be able to identify those objects. In a study examining participants from 3 to 95 years of age, Bernstein et al. (2011) found that the bias follows a u-shaped pattern across the lifespan, with preschool children and older adults exhibiting more curse of knowledge bias than older children and younger adults.

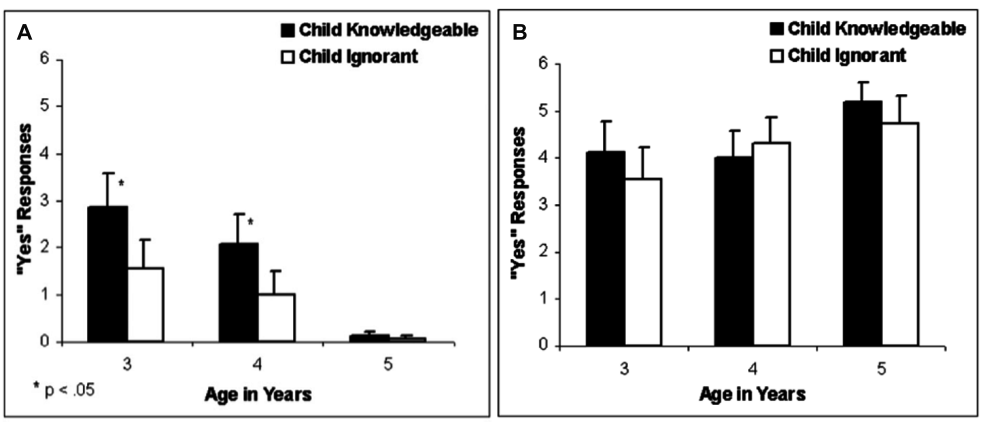

FIGURE 1 | Results from the knowledge assessment task used in Birch and Bloom (2003). Y axis reflects the mean number of 'yes' responses to the question 'Does Percy know what is inside this toy?' across six trials. That is, the Y axis shows the mean number of times that the participants indicated that Percy would know what is inside the toy. **(A)** Shows the results for toys that Percy had not seen before. **(B)** Shows the results for toys that Percy had seen before. Black bars illustrate the performance of children who saw inside the toy (child knowledgeable), and white bars illustrate the performance of children who did not see inside the toys (child ignorant). The asterisks indicate a significant difference between the child knowledgeable and child ignorant conditions. From Birch and Bloom (2003).

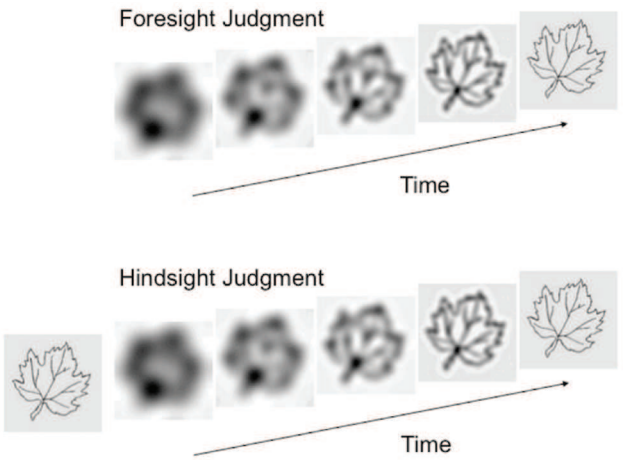

FIGURE 2 | Stimuli from the visual hindsight bias task. In the foresight judgment condition, participants try to identify the object as it clarifies on a computer screen. In the hindsight judgment condition, participants see the object in advance of estimating when a naïve, same-age peer will identify the object. From "Hindsight bias from 3 to 95 years of age" by Bernstein et al. (2011).

Importantly, Bernstein et al. (2007) showed a link between performance on hindsight bias tasks and classic false belief tasks among 3- to 5-year-old children. The researchers presented participants with visual hindsight bias tasks (see above) and verbal hindsight bias tasks. In the verbal tasks, children tried to answer six questions; later, children learned the answers to half the questions, and tried to recall their original answers. The researchers found that performance on both verbal and visual hindsight bias tasks correlated with performance on the classic false belief tasks. This correlation remained significant even after controlling for age, language ability, and inhibitory control.

We are not suggesting that the curse of knowledge and false belief reasoning are the same cognitive process. The curse of knowledge refers to a more general cognitive bias that applies to situations in which one needs to ignore privileged information to reason about a more naïve perspective; thus, the curse of knowledge is not limited to false belief reasoning. Moreover, false belief reasoning doesn't *necessitate* that one have specific outcome knowledge. That is, one can deduce that an individual has a false belief about an event outcome without knowing the outcome him/herself. For example, imagine you know that Sally put her chocolates in the cupboard before leaving. After Sally leaves, her mother tells you, "Sally is not allowed to have chocolates. I'll hide them somewhere." Although you don't know where her mother hid them, you can infer that Sally will have a false belief about the chocolates' location. However, most classic false belief tasks (see Wellman et al., 2001) don't take this approach. Rather, they make the participant knowledgeable of the specific outcome (e.g., Sally's mother moved her chocolates to the basket), unnecessarily requiring the child to infer a false belief *and* overcome the curse of knowledge.

Consider the following study showing that adults, who understand that the mind can misrepresent reality, can be hindered by outcome knowledge when reasoning about a false belief. Birch and Bloom (2007) had adults complete a four-container version of a false belief task. In all conditions participants learned that the protagonist, Vicki, had placed her violin in the blue container before leaving. All participants then learned that the violin was moved to another container in Vicki's absence. One group learned that it was moved to the red container; another group learned that it was moved to 'another' container (but did not know which container). All participants then indicated the probability that Vicki would first look in each container when she returned for her violin. Both conditions require appreciating that Vicki would hold a false belief about her violin's location, yet adults who knew it was moved to the red container rated the probability of her acting on a false belief (i.e., first looking in the blue container) as significantly less likely. These results reveal that even adults, who undoubtedly have a conceptual understanding of false beliefs, can experience difficulty in predicting the consequences of another's false beliefs (e.g., which action Vicki will take) when they have specific outcome knowledge (e.g., it was moved to the red container). This raises the question: how much of children's difficulties with classic false belief tasks is due to their exaggerated curse of knowledge bias instead of a conceptual deficit in false belief reasoning.

We acknowledge that there are developments in children's social perspective-taking abilities besides their decreasing susceptibility to the curse of knowledge. To disentangle these developmental changes, we call for new ToM tasks that reduce or eliminate the curse of knowledge and minimize other task demands. Ideally, these new tasks would employ continuous measures rather than simple pass/fail dichotomies that, by their very nature, can only produce (*seemingly*) qualitative developmental shifts (see Sommerville et al., 2013). In significant ways, the new wave of non-verbal false belief tasks reporting success at false belief reasoning in infancy (e.g., Slaughter, 2015) have made several improvements. Compared to the classic tasks, these newer tasks (a) eliminate verbal demands, (b) use more sensitive continuous measures (e.g., looking time; see Brooks and Meltzoff, 2015), and (c) require participants to make sense of someone's actions *in retrospect,* after watching the scenario unfold (e.g., infants look longer after seeing the protagonist look for the object in a box where she should not know it is), rather than requiring participants to make *a priori predictions* (e.g., "where will Sally look for the ball?"; see Miller, 2012). This latter alteration may reduce the effects of the curse of knowledge bias that to date has only been shown to bias participants' a priori predictions.

CONCLUSION AND FUTURE DIRECTIONS

The curse of knowledge is relevant to ToM. We primarily focused on the classic false belief tasks because of their widespread use, but the curse of knowledge can operate anytime someone possesses privileged information and must predict a less-informed perspective. Thus, the curse of knowledge is relevant to a wide variety of ToM tasks.

More work is needed to illuminate the mechanisms underlying the curse of knowledge and ToM. We predict that the curse of knowledge is not a result of a singular cognitive mechanism such as inhibitory control but more likely the result of two or more cognitive mechanisms and biases working in tandem (e.g., inhibitory control, working memory, and fluency misattribution) that may contribute differential effects depending on the age of the participant (e.g., see Birch and Bernstein, 2007; Groß and Bayen, 2015a,b, for discussion). The curse of knowledge has been studied extensively in young adults, with limited research in children and older adults (see Bayen et al., 2007; Coolin et al., 2015). ToM, conversely, has been studied extensively in young children but less in adults (see Birch and Bloom, 2007; Samson and Apperly, 2010; Miller, 2012; Surtees and Apperly, 2012). Future research examining these constructs across the lifespan from infancy through old age will provide a more complete understanding of the developmental changes in the curse of knowledge and ToM (and how the two relate). We believe that future research would benefit from new continuous ToM measures that can be used *across development* rather than during a small developmental window such as the infancy or preschool period (see Bernstein et al., 2011; Cassels and Birch, 2014). More continuous measures (e.g., Sommerville et al., 2013) would also aid in examining the many social and emotional correlates of individual differences in ToM and assist in identifying individuals that would benefit most from intervention techniques (see Caputi et al., 2011; Schaafsma et al., 2015). We encourage researchers to continue to move beyond false belief reasoning as the so-called 'litmus test' for ToM—as Paul Bloom and Tamsin German aptly noted, "there is more to ToM than false belief reasoning" (Bloom and German, 2000). Moreover, when an assessment of false belief reasoning is warranted we suggest researchers consider a variant that does not 'curse' the child with specific outcome knowledge, such as the aforementioned example where the antagonist hides the object in an undisclosed location or a variant akin to that used in Birch and Bloom (2007).

We, as humans, use ToM in virtually every social interaction. These abilities profoundly affect our social-emotional health, provide the foundation for moral regard and empathic concern for others, reduce prejudice and cultural intolerance, promote prosocial behavior and social competence, and predict academic achievement and better quality of life indices (for reviews see Capage and Watson, 2001; Chandler and Birch, 2010; Smith and Rose, 2011). Unfortunately, our current assessment tools limit our understanding of ToM and its correlates. The first step toward a more nuanced appreciation of ToM is to design and validate better measurement tools.

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All authors listed have made substantial, direct and intellectual contribution to the work, and approved it for publication.

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False belief understanding and "cool" inhibitory control in 3-and 4-years-old Italian children

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During preschool years, major developments occur in both executive function and theory of mind (ToM), and several studies have demonstrated a correlation between these processes. Research on the development of inhibitory control (IC) has distinguished between more cognitive, "cool" aspects of self-control, measured by conflict tasks, that require inhibiting an habitual response to generate an arbitrary one, and "hot," affective aspects, such as affective decision making, measured by delay tasks, that require inhibition of a prepotent response. The aim of this study was to investigate the relations between 3- and 4-year-olds' performance on a task measuring false belief understanding, the most widely used index of ToM in preschoolers, and three tasks measuring cognitive versus affective aspects of IC. To this end, we tested 101 Italian preschool children in four tasks: (a) the Unexpected Content False Belief task, (b) the Conflict task (a simplified version of the Day–Night Stroop task), (c) the Delay task, and (d) the Delay Choice task. Children's receptive vocabulary was assessed by the Peabody Picture Vocabulary test. Children's performance in the False Belief task was significantly related only to performance in the Conflict task, controlling for vocabulary and age. Importantly, children's performance in the Conflict task did not significantly correlate with their performance in the Delay task or in the Delay Choice task, suggesting that these tasks measure different components of IC. The dissociation between the Conflict and the Delay tasks may indicate that monitoring and regulating a cool process (as flexible categorization) may involve different abilities than monitoring and regulating a hot process (not touching an available and highly attractive stimulus or choosing between a smaller immediate option and a larger delayed one). Moreover, our findings support the view that "cool" aspects of IC and ToM are interrelated, extending to an Italian sample of children previous findings on an association between self-control and ToM.

Keywords: false belief, inhibitory control, Italian preschoolers, conflict task, delay task, delay choice task

Introduction

Over the past 20 years there have been significant improvements in research on two milestones of cognitive development, theory of mind (ToM) and executive functioning (EF). In both these domains of cognition, major developments occur between the ages of 3 and 5 years.

Theory of mind is the ability to attribute mental states, such as emotions, beliefs, and intentions to oneself and to other people. Mental state understanding helps the child to make behavioral predictions about how people will act (Perner and Lang, 1999). An important transition in the development of a ToM, emerging around the age of 4 years, is the explicit understanding that a person can be mistaken about the world, that is, the comprehension of false belief and the distinction between appearance and reality (Perner et al., 1987). Before this age, children have difficulties in understanding that a false belief can cause one to search for an object in the wrong place, and children tend not to manipulate other people's behavior by lying or deceiving (Sodian et al., 1991).

Prototypical tests for ToM, including the Deceptive Container task and the Appearance- Reality task, measure the representational nature of mental states, and are failed by most preschoolers at age 3 but are grasped by age 5. The most frequently used measure for assessing ToM at around 4 years of age is the 'False-Belief task.' The standard version requires the unexpected transfer of a wanted object, so that the protagonist has a false belief about the location of the object, and children are asked to predict where the protagonist will look for the object (Perner and Lang, 1999). At 3 years of age almost all children answer wrongly with the actual location of the object, whereas most children of 4 years and older answer correctly. False belief performance shows a similar developmental pattern across various countries and task manipulations: preschoolers progress from below-chance performance to above-chance performance, suggesting that understanding of belief and mind exhibits conceptual change in the preschool years (Wellman et al., 2001, 2006).

Some studies have suggested that having one or more siblings to interact with at home promotes ToM understanding (Perner et al., 1994; Jenkins and Astington, 1996). Children with siblings have access to other children's mind via arguments, reciprocal engagement in pretend play and child-oriented conversation (McAlister and Peterson, 2013). Moreover, many studies have shown that high-functioning children with autism spectrum disorders exhibit deficits in ToM understanding as measured by False Belief tasks. These deficits do not emerge in control groups of subjects with Down's syndrome, general retardation or specific language delays (Sodian and Frith, 1992; Baron-Cohen, 1995).

Executive functioning (EF) refers to higher-order self-regulatory cognitive processes that enable a person to engage in flexible goal-directed behaviors, including the control of attention, and motor responses, resistance to interference and delay of gratification (Carlson et al., 2004a). EF has been frequently associated with the prefrontal cortex, which is one of the slowest developing brain areas; also, EF is generally regarded as non-social and domain general (Hughes and Ensor, 2007). There is a growing evidence that executive function is not a unitary construct, but rather involves a series of distinct processes under the control of the frontal lobe, including working memory, IC, and task switching (Garon et al., 2008; Duckworth and Kern, 2011; Miyake and Friedman, 2012). Important developments in typically developing children in IC occur in the first 6 years of life. The first signs of inhibition (such as the ability to ignore distraction and stay focused, or to resist making a habitual response to produce a new and more adaptive one), are evident by 12 months of age, when infants succeed in the A-not-B and object retrieval tasks (Diamond, 2006). In the preschool period, children make important improvements in self-control over actions, thoughts and emotions (Carlson, 2005; Lewis and Carpendale, 2009). Three-years-old children have difficulty in waiting for a reward, in staying on-task in the face of tempting distractions, and in learning a reverse-reward contingency task (in which they should point to a small amount of candies in order to receive a larger amount). In contrast, 4-year-olds are able to exert more self-control, and in the reverse-reward contingency task they point to the undesired option in order to get the other one (Carlson et al., 2005).

Although EF is considered a domain-general construct, a distinction has been made between the relatively hot affective aspects of EF and more purely cognitive, cool aspects (Metcalfe and Mischel, 1999; Zelazo and Muller, 2002). Whereas cool EF is more likely to be involved in relatively abstract, decontextualized problems, hot EF is required when the regulation of affect and motivation is solicited by the task (Zelazo et al., 2005). Metcalfe and Mischel (1999) formulated the hypothesis of a brain network model in which self-control occurs through the interplay between a bottom–up, affective 'go' system, labeled the "hot system," and a top–down, cognitive system, labeled the "cool system." The hot system develops earlier and is under stimulus control. The cool system develops later and is under self-control. Involvement of the hot system may be related to an over-focusing on visible reward and lower self-control. Garon et al. (2012) used this model to interpret the results of a recent study on the development of future-oriented self-control. The study explored factors underlying 2-, 3-, and 4-years-old preschoolers' capacity to make future-oriented choices using a delay-of-gratification choice task. When choosing between two reward, with the larger being delayed, children have to consider two variables – the quantity of the reward, which implicates the bottom–up system, and the temporality of the reward, which implicates the top–down system. Their findings indicated that children made more choices to delay gratification as the quantity of the reward increased. Looking at age-related differences, Garon et al. (2012) argue that, while 2-year-olds focused on quantity and 3-year-olds showed a mixed pattern, 4-year-olds were able to consider both time and quantity together in making their choices.

Two different classes of tasks have been used to measure IC in the preschool period (Carlson and Moses, 2001). The first class (Delay tasks) evaluates affective ("hot") aspects of IC and includes measures of children's ability to delay, control, or suppress an impulsive response. An example of this class of tasks is the Gift delay task (Kochanska et al., 2000), in which an experimenter tells the child not to have a look while the experimenter noisily wraps

a present. Children's waiting ability on this and other 'delay' tasks gets better across the preschool years. Another classical delay measure is the Delay of gratification task (Mischel et al., 1989). In this task, 4-years-old children waited longer to receive a larger reward (two marshmallows rather than one) when they were encouraged to cognitively transform the reward (for instance, by imagining the marshmallows as fluffy clouds) rather than when they were told to focus on the arousing qualities of the reward (i.e., its taste). A distinctive feature of Delay tasks is that the child must maintain a course of action in the face of continual competition from an available, tempting alternative. In fact, after the initial choice of delaying gratification, the immediate reward remains available throughout the delay; thus, the decision to wait for the preferred reward needs to be sustained during the entire delay, since the child can reverse the initial choice at any time by picking the smaller or less preferred item. This is different from what happens in the Delay Choice task, which is considered a further measure of "hot" IC. In this task, the subject faces a choice between a smaller immediate option and a larger delayed option and, once the choice is made, there is no possibility to modify it (Addessi et al., 2014). The second class (Conflict tasks) evaluates more cognitive ("cool") aspects of IC and requires children to inhibit an habitual response to generate an arbitrary one. An example of conflict task is the Day–Night Stroop task developed by Gerstadt et al. (1994). This task requires children to say 'day' when a black card depicting the moon and the stars is shown and 'night' when a white card depicting a yellow sun is shown; thus, the expected response has to be suppressed. As with delay tasks, children's performance on this and similar conflict tasks improves gradually during the preschool years.

The link between ToM and EF was first noted in the context of research on individuals with autism. Ozonoff et al. (1991) found that high-functioning children with autism were impaired both on measures of ToM and on tasks assessing EF, and suggested that the maturation of the same brain structures that underlie ToM and EF may be the cause of the observed correlations. Later studies strongly supported a general link between ToM and EF in typically developing preschoolers, and highlighted a special connection between ToM and IC (Carlson and Moses, 2001; Perner et al., 2002; Carlson et al., 2004a; Sabbagh et al., 2006; Hughes and Ensor, 2007; Henning et al., 2011; McAlister and Peterson, 2013). The correlations between individual differences in EF performances and ToM tasks in these studies are notable and remain even when factors such as age and verbal ability are controlled. A few studies suggested that the link between ToM and EF may be present even earlier than the preschool years, when measuring these emerging abilities may be challenging (Carlson et al., 2004a; Hughes and Ensor, 2005; Bellagamba et al., 2014; Poulin-Dubois and Yott, 2014). Despite the large number of studies that addressed the relationship between ToM and EF, only a few studies included both delay and conflict components of IC in their measures. Carlson and Moses (2001) examined the relation between individual differences in IC and ToM performance in preschool children of 3- and 4-years of age using a variety of tasks. The ToM battery incorporated measures of false belief, deceptive pointing and appearance-reality. The EF battery (10 measures) included conflict tasks and delay tasks. A multiple regression analysis revealed that the Conflict scale was a highly significant predictor of ToM, holding the control variables (age, gender, and verbal ability) and the Delay scale constant. The Delay scale, however, did not contribute uniquely to variance in ToM over and above the control variables and the Conflict scale. The authors noted that the abilities assessed by Conflict tasks may have been more central to ToM reasoning than those assessed by Delay tasks. In a follow-up study, Carlson et al. (2002) again found a different pattern for conflict and delay measures. The conflict tasks correlated with ToM controlling for age and intelligence. In contrast, the correlation between the Delay tasks and ToM was not significant. The authors hypothesized that the Conflict tasks impose loads on both working memory and inhibitory capacity, whereas the Delay tasks impose a substantial inhibitory load but only minimal working memory demands (Carlson and Moses, 2001; Carlson et al., 2002).

Hala et al. (2003) examined the relation between false belief understanding and executive function including a battery of both conflict and delay tasks. They found no relationship between the gift delay task and ToM, in contrast to a strong association between conflict and ToM scores. Like Carlson and Moses (2001), also Hala et al. (2003) suggest that the difference between conflict and delay tasks is principally in the working memory: conflict tasks demand that children keep in mind the pertinent rules as well as inhibit an impulsive response. Kain and Perner (2005), however, noted that the claim that the delay task poses lower memory demands than the conflict task is not very convincing because in delay tasks children have to keep reminding themselves for some time that they were instructed not to touch a forbidden object. Kain and Perner (2005) suggested that emotional and reward factors could provide another reason why the delay task bears a lower and less robust correlation with ToM tasks than does the conflict task. These authors noted that the delay tasks activate emotional and reward processing, which are known from other tasks (e.g., gambling task; Bechara et al., 1998) to be associated to the orbitofrontal cortex, whereas conflict tasks activate the dorsolateral prefrontal cortex and the anterior cingulated cortex, which are also involved in ToM.

Bellagamba et al. (2014) investigated the concurrent relations between 18- and 24-month-olds' performance on two tasks measuring inhibitory control (IC; a Conflict and a Delay task) and internal state language abilities in 61 Italian speaking children and found that the ability to refer to mental states through language was significantly and specifically related only to performance on the conflict measure of IC, even when vocabulary size was controlled for.

Carlson et al. (2004b) examined the relative contribution of two aspects of executive function – IC and planning ability – to ToM in 3- and 4-year-olds. Children were given two standard ToM measures (Appearance–Reality and False Belief), three IC tasks (Bear/Dragon, Whisper, and Gift Delay), three planning tasks (Tower of Hanoi, Truck Loading, and Kitten Delivery), and a receptive vocabulary test. Multiple regression analyses indicated that only the two conflict inhibition tasks (Bear/Dragon and Whisper) were significantly related to ToM after accounting for age, receptive vocabulary, and planning, while the Gift Delay task

was not. Finally, in a very recent study, Carlson et al. (2015) found similar results, showing that children's better performance on a conflict task (Bear/Dragon) predicted higher scores in ToM tasks that presented both low and high levels of executive demands (Think-Know and Sources of Knowledge were low demanding, in addition to False Belief and Appearance-Reality, which were high demanding). In contrast, once again, the Gift Delay task was not related to either of the two kinds of ToM tasks.

A recent meta-analytic review of 102 studies reported a moderate to strong association between EF and false belief understanding in early childhood (Devine and Hughes, 2014), indicating that among typically developing 3- to 6-years olds there is a genuine association between individual differences in EF and false belief understanding. Also, the correlation between EF and false belief understanding was similar in magnitude from ages 3 to 6, and this consistency is remarkable as this developmental period is associated with rapid gains in both domains. Moreover, Devine and Hughes (2014) noted that false belief understanding is more strongly associated with conflict inhibition than with performance in the Gift Delay task and Sticker Delay task, but that only a very few studies evaluating the relationship between ToM and EF included also measures of delay of gratification in their analyses. Devine and Hughes (2014) also underlined that the Delay task measure cannot be considered equivalent to the Delay of Gratification task, since only the second task presents the child with a choice between a smaller reward now and a larger reward later.

On the basis of the above findings, the main goal of the present study was to examine the relationships between explicit false belief understanding, a delay measure of IC and a conflict measure of IC in a group of typically developing Italian children, controlling for age and receptive vocabulary. To our knowledge, this is the first study analyzing the relation between false belief understanding and IC in preschoolers belonging to this population [although a study by Valle et al. (2015) has recently addressed this issue in adolescents and early adults]. Our understanding of how children develop in ToM and EF is largely based on Anglo-American, French- and German-speaking children, but there is an increasing focus on cultural differences in the development of children's understanding of mind (Lillard, 1998). Culture plays an important role in shaping how parents think and act out their parental role (Bornstein, 1991), which in turn interacts with universal pathways of infant development. Hsu and Lavelli (2005) found both cross-cultural similarities and distinctive differences in social/affective aspects of feeding between Italian and American mothers. In their interactions with their infants, Italian mothers tend to promote the expression of positive affect and social relatedness with others, while American mothers tend to encourage independence and self-reliance. According to Lecce and Hughes (2010), cultural differences in the expression of emotions and in the focus on self-control could contribute to the differences in ToM performances in British and Italian children. Parental education, different styles in maternal use of mental state terms, and differences in the onset of formal schooling – which begins at age 5 in Britain, but at age 6 in Italy – are considered factors that may also contribute to the advantage observed in their study by British children on false belief understanding, compared to a matched sample of Italian children. Also, findings on the relation between ToM and EF from cross-cultural studies appear mixed. Sabbagh et al. (2006) suggested that children growing in two very different cultures, China and the United States, showed considerable cross-cultural synchrony in the association between ToM and EF tasks, suggesting that this relation may be universal and not changed by cultural differences. A later study, involving children from three oriental cultures, instead suggested that the patterns of executive skills and their correlates with standard false belief measures are very different from those found in Western cultures (Lewis et al., 2009). Oriental children tend to outperform Western children on executive function tasks, whereas they do not exhibit these advanced levels of performance in false belief tests. The above study also reports a lack of association between false belief understanding and EF composite measures for Korean, Japanese, and Chinese children. Therefore, as noted by Devine and Hughes (2014), a systematic comparison of the impact of cultural differences is important to understand whether the relation between EF and ToM does vary in strength across different cultures.

Given that previous studies have reported an association between ToM tasks and conflict tasks in children between 3 and 6 years of age (Carlson and Moses, 2001; Perner et al., 2002; Carlson et al., 2004a; Hughes and Ensor, 2007; Henning et al., 2011), we hypothesized that there would be a stronger relation between ToM and the conflict measure of IC rather than between ToM and the delay measure of IC. In line with the proposal of Kain and Perner (2005), we expected false belief understanding to be more strongly related to a task requiring the child to overcome a dominant response and start a conflicting one, than to a task measuring the capacity to delay a response toward an highly attractive stimulus.

Materials and Methods

Data were collected during a study on children's self-control ability, focusing on how symbolic representations of the reward affected performance in a Delay Choice Task (Addessi et al., 2014), and whether displacement activities improved children's performance in the Delay Task (Pecora et al., 2014). Data for the Delay Choice Task, Conflict Task, and Delay Task were partly analyzed in the aforementioned studies, whereas data for the False Belief task are completely original.

Participants

Participants were 101 Italian preschool children, 51 3-year-olds (mean age = 36.13, range = 35.07–37.0; 25 boys and 26 girls) and 50 4-year-olds (mean age = 48.11, range = 47.02–49.0; 27 boys and 23 girls). Children were sourced from kindergarten and were all healthy. They came from middle-class Italian families (as determined by parental educational level) living in Rome. The children's parents signed an informed consent form outlining the aim of the study. The study complied with the ethical guidelines of the Italian Association of Psychology (AIP) and were approved by the Ethics Committee of ISTC-CNR.

Procedure

Tasks were administered to the children in a quiet room by two qualified experimenters, who alternated their role as experimenter and assistant across sessions. The experimenter administered the tasks and the assistant quietly recorded children's performance on the protocol sheet. The entire session was also video-recorded. Each child was given five tasks in one single session and in a fixed order: (a) the Delay choice task, (b) the Peabody Picture Vocabulary Test (PPVT, Dunn and Dunn, 1981), (c) the Unexpected Content False Belief Task (Perner et al., 1987; Gopnik and Astington, 1988), (d) the Conflict Task, a simplified version of the Day–Night Stroop Task (adapted from Gerstadt et al., 1994), and (e) the Delay Task (adapted from Vaughn et al., 1986 and Kochanska et al., 2000). Depending on the parents' preference, the experiment was administered either in a separate room of the kindergarten that the child attended (65% of 3-year-olds, and 78% of 4-year-olds) or at home. Each testing session lasted around 40 min. At the end of the experiment, each child was given a small gift and the parents were given a DVD of the recorded experiment to thank them. Data collection was carried out between November 2009 and May 2011.

Measures

Delay Choice Task

Children were presented with choices between a small option and a large option in three experimental conditions (Food Delay, Low-Symbolic Token Delay, and High-Symbolic Token Delay), in which the smaller option was immediately available, whereas the larger option was delayed by 80 s. Children were also tested in two control conditions (Food Control and High-Symbolic Token Control), in which both options were immediately available. We employed a between-subject design, counterbalancing gender and age. Each subject participated in a single session of six trials, including two familiarization trials (forced choices, with only one option available, presented at the beginning of the session), and four experimental trials (binary choices). In all conditions, the dependent variable was the proportion of choices of the larger delayed option.

In the Food conditions, children chose between visible food amounts, whereas in both Token conditions children were presented with two cards depicting, respectively, two dots and six dots (Low-Symbolic Token condition) or a mouse and an elephant (High-Symbolic Token condition). After choosing one of the two cards, the subject could exchange it with the experimenter for obtaining the corresponding food amount. The food type was previously agreed upon with the parents on the basis of children's preferences and/or diet restrictions. For further details on the methodology, please see Addessi et al. (2014).

Peabody Picture Vocabulary Test

We used the Italian version of the PPVT-R (Dunn and Dunn, 1981, adapted by Stella et al., 2000), a measure of receptive vocabulary. For each item out of a series of 175 items, the child was asked to select from a set of four pictures the one best illustrating the meaning of an orally presented word. Testing continued until the child erred on eight consecutive items.

False Belief Task

We used the Unexpected Content False Belief Task (Perner et al., 1987; Gopnik and Astington, 1988). The children were shown a container of a desirable and highly familiar candy (a Smarties box) and asked to state what they thought was in the container (Control question). The experimenter then opened the container and showed that the box actually contained something unexpected (a pencil). The pencil was then put back into the box and the box closed again. The subjects were then asked the first experimental question about their own former false belief: "When you first saw this box, before we opened it, what did you think was inside?" Then they were asked the second experimental question, about someone else, Mary, who had never looked inside the box: "What will Mary think is in here?" The children were assigned either a 0 (fail) or a 1 (pass) for the three different scores: (1) Self attribution, (2) Other attribution, and (3) Global score (passing both self- and other attribution). Intercoder reliability, calculated on 20% of the sample, was 100% (index of concordance).

The Conflict Task

This task was a simplified version of the Day–Night Stroop Task developed by Gerstadt et al. (1994) and was used to assess the children's capacity to inhibit a prepotent response in order to give a conflicting one. Both Gerstadt et al. (1994) and Waston and Bell (2013) indicate that the Day–Night Stroop task is too difficult for 3-years-old children. We thus employed a simpler version of the task using one set of five red and five blue cards. The experimenter first verified that the child correctly named the color of a red and of a blue card and then said: "Now we are playing a game. In this game, when I show you a red card you have to say 'blue' and when I show you a blue card you have to say 'red,' okay?" Two training trials followed in which the children were shown one of each type of card. If the subject hesitated, the experimenter prompted the subject by saying: "What do you say for this one?" If the subject responded correctly to the red card, the experimenter praised the child and proceeded to a training trial with the blue card. If the subject responded incorrectly or did not respond at all on either of these trials, the experimenter immediately reminded the subject of the rule. On the two training trials, the experimenter gave feedback and repeated the question as needed (up to three times). The experimenter then proceeded to the eight test trials without feedback in a fixed random order. The experimenter reminded the subject of the rule of the game after the first four test trials. The dependent variable was the total number of correct responses in the test trials. Intercoder reliability, calculated on 20% of the sample, was 100% (index of concordance).

The Delay Task

This task was adapted from Vaughn et al. (1986) and Kochanska et al. (2000), and was used to assess the children's capacity to delay responding to an attractive stimulus. The experimenter showed a musical box to the child, with a carillon inside that turned on once the box was opened, and explained that the experimenter would have to leave the room for a short time. The child was then instructed not to touch the box in the experimenter's absence. The experimenter and the assistant left the room and waited for 3 min,

but the child could interrupt the trial at any time before the 3 min elapsed. During the delay period, the child received four yellow toy ducks to play with.

Five different scores were derived from this task: (1) *Latency to touch the box*: total time from task onset until the subject touched the box, (2) *Latency to open the box*: total time from task onset until the subject opened the box, (3) *Frequency of touching the box*: number of times the subject touched the box during the 3 min (or until the end of the trial if the child interrupted the trial earlier), (4) *Frequency of opening the box*: number of times the subject opened the box during the 3 min (or until the end of the trial if the child interrupted the trial earlier), and (5) *Time to interruption*: total time from task onset until the subject interrupted the trial or the 3 min elapsed. All measures were scored from videotapes. Intercoder reliability was calculated on 20% of the sample (*Latency to touch the box*: Spearman $r_s = 1.0$, $N = 19$; *Latency to open the box*: Spearman $r_s = 0.99$, $p < 0.0001$, $N = 19$; *Frequency of touching the box*: index of concordance: 91%; *Frequency of opening the box*: index of concordance: 95%). Intercoder reliability was not calculated for *Time to interruption* since most of the children (72%) waited until the end of the task.

Results

Descriptive Statistics for All Tasks are Presented in **Table 1**.

Delay Choice Task

All 101 children participated in this task (51 were 3-year-olds and 50 were 4-year-olds), 20 in each condition, with the exception of the High-Symbolic Token Delay condition in which there were 21 children. For analysis purposes, data were transformed by calculating the arcsin squareroot of proportions of choices of the larger option. As reported in Addessi et al. (2014), a factorial ANOVA with gender and age as between-subject factors revealed a main effect of condition, but no significant effect of gender and age, nor any significant interaction. Here we do not discuss the effect of condition since this was the focus of Addessi et al. (2014).

Peabody Picture Vocabulary Test

All the children participated in this task, but data for one 4-years-old are not available because of video camera failure. We performed a factorial ANOVA with the children's standardized score on the PPVT as the dependent variable and with gender and age as independent variables. There was a main effect of age: $F_{1,96} = 53.9$, $p < 0.001$, $= 0.36$, with 4-year-olds ($M = 90.8$, SD $= 10.5$) performing better than 3-year-olds ($M = 77.6$, SD $= 7.19$). Gender did not significantly affect performance ($F_{1,96} = 1.01$, $p = 0.32$), nor was there any significant interaction between gender and age ($F_{1,96} = 1.21$, $p = 0.27$).

False Belief Task

Ninety-eight children participated in this task (48 were 3-year-olds and 50 were 4-year-olds). Three children did not participate because they did not answer the experimenter's questions (two 3-year-olds) or did not have any experience with the candies (Smarties) used in the task (one 3-years-old). All children passed the control question, 42% of the 3-year-olds and 68% of the 4-year-olds passed the first experimental question, 19% of the 3-year-olds and 38% of the 4-year-olds passed the second experimental question, 15% of the 3-year-olds and 30% of the 4-year-olds passed both first and second experimental questions.

For each measure (First experimental question Self-attribution, Second experimental question Other attribution, and Global score), we performed a logistic regression with the children's score as dependent variable, and with gender and age as independent variables. For both experimental questions, age significantly predicted performance in the False Belief task (First experimental question Self-attribution: $z = 2.59$, $p = 0.010$, 4-year-olds: $M = 0.68$, SD $= 0.47$, 3-year-olds: $M = 0.42$, SD $= 0.50$; Second experimental question Other attribution: $z = 2.06$, $p = 0.040$, 4-year-olds: $M = 0.38$, SD $= 0.49$, 3-year-olds: $M = 0.19$, SD $= 0.39$). For the Global score (passing

TABLE 1 | Mean scores, SD, and ranges for all tasks, divided by age.

Task	Measure	3-years-old			4-years-old		
		M	SD	Range	*M*	SD	Range
Peabody Picture Vocabulary Test (PPVT)	Score	77.6	7.19	67–98	90.8	10.5	68–119
False Belief Test	Self-attribution (score)	0.42	0.50	0–1	0.68	0.47	0–1
	Other attribution (score)	0.19	0.39	0–1	0.38	0.49	0–1
	Global score	0.15	0.36	0–1	0.30	0.46	0–1
Conflict task	Correct responses (proportions)	0.45	0.39	0–1	0.78	0.31	0–1
Delay task	Latency to touch (s)	100.0	58.51	1–180	113.7	69.7	2–180
	Latency to open (s)	139.8	54.7	3–180	153.8	46.9	31–180
	Frequency to touch (proportions)	0.007	0.009	0–0.3	0.012	0.020	0–0.080
	Frequency to open (proportions)	0.003	0.007	0–0.3	0.007	0.002	0–0.010
	Time to interruption (seconds)	158	39.06	49.21–180	159.5	41.19	47–180
Delay Choice Task – Food Delay	Choice of the larger option (proportions)	0.70	0.28	0.25–1	0.65	0.27	0.25–1
Delay Choice Task – Low-Symbolic Token Delay	Choice of the larger option (proportions)	0.57	0.29	0.25–1	0.67	0.31	0–1
Delay Choice Task High-Symbolic Token Delay	Choice of the larger option (proportions)	0.50	0.24	0–0.75	0.48	0.07	0.25–0.50

both first and second experimental questions), there was a non-significant trend of 4-year-olds ($M = 0.30$, SD $= 0.46$) to perform better than 3-year-olds ($M = 0.15$, SD $= 0.36$; $z = 1.79$, $p = 0.074$). For all measures, gender did not significantly predict performance (First experimental question-Self attribution: $z = 0.15$, $p = 0.88$; Second experimental question Other attribution: $z = -0.57$, $p = 0.57$; Global score: $z = -0.20$, $p = 0.84$), nor was there any significant interaction between gender and age (First experimental question Self-attribution: $z = -0.16$, $p = 0.87$; Second experimental question Other attribution: $z = -0.96$, $p = 0.33$; Global score: $z = -1.36$, $p = 0.17$).

Conflict Task

Eighty-one children participated in this task (36 were 3-year-olds and 45 were 4-year-olds). Twenty children did not participate because they failed to recognize the colors (seven 3-year-olds and two 4-year-olds), did not answer the experimenter's questions (six 3-year-olds) or were tested when this task had not yet been introduced in the present study. Since one child had some invalid trials, we converted the number of correct responses into proportions. For analysis purposes, data were transformed by calculating the arcsin squareroot of proportions. As reported in Addessi et al. (2014), a factorial ANOVA with gender and age as between-subject factors revealed a main effect of age, with 4-years-old children ($M = 0.78$, SD $= 0.31$) performing better than 3-years-old children ($M = 0.45$, SE $= 0.39$). Gender did not significantly affect performance, nor was there any significant interaction between gender and age. The children's proportion of correct responses in this task did not significantly correlate with their total latency to respond (combined for the eight trials), controlling for chronological age and receptive vocabulary ($r_p = 0.19$, $p = 0.091$, $N = 80$).

Delay Task

Ninety-eight children participated in this task (48 were 3-year-olds and 50 were 4-year-olds). Three children did not participate because their caregiver was present during the task (two 3-year-olds) or because of video camera failure (one 3-years-old). Since the children could interrupt the trial at any time before the 3 min elapsed, we converted frequencies of touching and opening the box into proportions. Data were transformed by calculating the logarithm of latencies and the arcsin squareroot of proportions. We performed a MANOVA with, as dependent variable, the five measures scored during the Delay Task (*Latency to touch the box*, *Latency to open the box*, *Frequency of touching the box*, *Frequency of opening the box*, and *Time to interruption*). Gender and age did not significantly affect performance (Gender: $\lambda = 0.97$, $F_{5,90} = 0.59$, $p = 0.71$; Age: $\lambda = 0.92$, $F_{5,90} = 1.53$, $p = 0.19$), nor was there any significant interaction between gender and age ($\lambda = 0.94$, $F_{5,90} = 1.09$, $p = 0.37$).

Relations between Tasks

First of all, we examined whether there was a correlation between our IC measures and, if so, whether this relation would remain after we controlled for age and receptive vocabulary. As for the Delay Choice Task, we analyzed only data for the experimental conditions (Food Delay, Low-Symbolic Token Delay, and High-Symbolic Token Delay).

As shown in **Table 2**, performance in each experimental condition of the Delay Choice Task was not significantly related to any of the measures scored for the Delay Task, nor to children's performance in the Conflict task. Similarly, measures scored for the Delay Task were not significantly related to performance in the Conflict task.

The next series of analyses was aimed at specifying the relative contribution of cool IC (as measured by the Conflict Task) and hot IC (as measured by the Delay Choice Task and by the Delay Task) to ToM. As shown in **Table 2**, the correlations between the Other attribution and Global score measures of the False Belief Task, respectively, and performance in the Conflict task were significant, whereas the correlations between ToM and (i) performance in the Delay Choice Task and (ii) measures scored for the Delay task were not. Importantly, the relations between ToM and performance in the Conflict Task remained significant after controlling for effects due to age and receptive vocabulary. Therefore, individual differences in cool IC, but not hot IC, were related to ToM performance.

Table 2 also reports the relations between the variables measured in each task and, respectively, chronological age and receptive vocabulary.

Discussion

The present study investigated the relations between performances on a task measuring false belief understanding and three tasks measuring cognitive versus affective aspects of IC in a sample of Italian preschool children.

Considering the range of variations in responses within each task, and the correlation found between ToM and the conflict measure of IC, the performances of 3-and 4-years-old Italian children in the current study can be considered similar to those reported in previous studies conducted with children growing up in Western cultures. Similarly to what has been reported in previous studies, 4-years- old children performed better than 3-years-old children in both the False Belief and the Conflict task, and these measures were positively associated even after controlling for age and receptive vocabulary. A direct comparison with the study by Lecce and Hughes (2010) reporting an advantage of British children over Italian children on ToM tasks is not possible, since their study tested children of a different age group (5- to 6-years-old). The conflict task that we used was slightly different from the classical Day–Night Stroop task employed by Gerstadt et al. (1994). While in the classical Day–Night task the child has to say 'day' when shown a card with the moon, in our modified version of the task the child had to say 'red' when a blue card was shown. In the first case the child is required to inhibit a symbolic categorization, whereas in the second case the child has to inhibit a perceptual categorization.

As in previous studies (Hala et al., 2003; Carlson et al., 2004b, 2015), the children's performance in the Delay task did non-correlate with ToM measures. Moreover, we did not find any effect of age on children's performances in the Delay task.

TABLE 2 | Pearson correlations between behavioral measures.

Measure	1	2	3	4	5	6	7	8	9	10	11	12	13	14
(1) FB Self-attribution	–	0.298**	0.486**	0.213	0.083	−0.072	−0.035	−0.072	−0.061	0.124	0.351	−0.208	0.275**	0.259*
(2) FB Other attribution	0.274**	–	0.851**	0.308**	0.033	0.023	0.067	−0.163	−0.156	−0.164	−0.094	−0.258	0.218*	−0.004
(3) FB Global score	0.494**	0.837**	–	0.303**	−0.051	−0.007	0.070	−0.150	−0.137	−0.146	−0.149	−0.258	−0.190	−0.050
(4) C Correct responses	0.087	0.259*	0.267*	–	0.126	−0.030	0.079	−0.014	0.009	−0.023	0.193	0.095	0.406**	0.307**
(5) D Frequency to touch	0.007	0.003	−0.084	0.072	–	0.195	−0.622**	−0.231*	0.083	−0.321	0.281	0.059	0.177	0.216*
(6) D Frequency to open	−0.009	0.065	0.042	0.048	0.264**	–	−0.224*	−0.553**	0.061	0.224	−0.165	0.016	−0.232*	−0.184
(7) D Latency to touch	−0.041	0.048	0.055	0.023	−0.632**	−0.228*	–	0.470**	0.406**	0.035	0.066	0.211	0.085	0.059
(8) D Latency to open	−0.083	−0.178	−0.159	−0.079	−0.233*	−0.560**	0.445**	–	0.718**	−0.251	0.199	0.069	0.131	0.053
(9) D Time to interruption	−0.035	−0.151	−0.125	−0.036	−0.029	0.059	0.370**	0.709**	–	−0.298	0.082	0.080	0.015	−0.069
(10) DCT-FD	0.156	−0.146	−0.155	0.053	−0.299	0.187	0.013	−0.237	−0.311	–	§	§	−0.097	−0.038
(11) DCT-LSTD	0.340	−0.150	−0.244	0.234	0.270	−0.095	−0.009	0.136	0.080	§	–	§	0.180	−0.045
(12) DCT HSTD	−0.213	−0.324	−0.324	0.092	0.105	0.031	0.237	0.051	0.066	§	§	–	−0.089	−0.302
(13) Age	–	–	–	–	–	–	–	–	–	–	–	–	–	0.597**
(14) Receptive vocabulary	–	–	–	–	–	–	–	–	–	–	–	–	–	–

*Bivariate correlations are reported over the diagonal, partial correlations (controlling for age and receptive vocabulary) are reported below the diagonal. *$p < 0.05$; **$p < 0.01$. FB, False Belief task, N = 98; C, Conflict task, N = 81; D, Delay task, N = 98; DCT, Delay Choice task (FD, Food Delay, N = 20; LSTD, Low-Symbolic Token Delay, N = 20; HSTD, High-Symbolic Token Delay, N = 21); §Correlations were not performed since these were different conditions of the same task (between-subject design).*

Since only 23% of the 3-year-olds and 46% of the 4-year-olds waited for the entire delay (180 s) without touching the musical box, we can exclude that there was a ceiling effect. However, it cannot be excluded that factors such as fatigue (the Delay task was administered at the end of the session) or experimental setting (kindergarten vs. home) may also have had an impact on children's performance.

A different developmental pattern emerges from children from non-Western cultures, with studies reporting a lack of association between false belief understanding and composite scores of EF (Lewis et al., 2009). Oh and Lewis (2008) reported that Korean preschoolers tend to be 1 year ahead in executive tasks (including both conflict and delay tasks) in comparison to British children, whereas they are at chance level on false belief measures at 4 years of age. For instance, in the Delay task (Gift delay) the majority of children (72.5%) waited for the entire delay (150 s) to touch a present. As noted by Oh and Lewis (2008), Korean children may be very skilled in delay inhibition probably because their culture places emphasis on patience or because impulsive behavior tends to be punished in Korea. These authors also noted that far Eastern countries such as China, Japan, and Korea have a long tradition of Confucianism. Holding parents, teachers, elders, and authority figures in high respect is an important aspect of Confucianism and this may contribute to young children's self-control and obedience.

Research on the development of IC has differentiated between cognitive components of self-control, assessed by conflict tasks which demand inhibition and some additional cognitive load (e.g., activate a novel response), and affective components, such as affective decision-making that is measured by delay tasks, which require inhibition of an impulsive response (Carlson and Moses, 2001; Perner et al., 2002; Carlson, 2005; Prencipe and Zelazo, 2005). In the present study, we did not find a correlation between the Conflict task and the Delay task. In our view, one important difference between conflict and delay tasks is that they set different challenges to the child during inhibition. Conflict tasks need a relatively abstract and decontextualized type of inhibition, while delay tasks, which activate emotional and reward factors, require a more affective and context-bound type of inhibition. Our results are in line with Kain and Perner's (2005) proposal that emotional and reward factors could contribute to the reason why delay tasks are not as strongly associated to ToM tasks as conflict tasks. According to these authors, there is some evidence that the areas of activation in the prefrontal cortex during conflict and ToM tasks may overlap in childhood and not be the same as the neural basis of emotional and reward processing involved during delay tasks (Kain and Perner, 2005). Similarly, we did not find a significant correlation between performance in the Delay Choice task and the Delay task, in agreement with those studies in which only a weak correlation between delay choice and delay maintenance measures (or a lack thereof) was reported for the same population (Schwarz et al., 1983; Duckworth and Kern, 2011; Addessi et al., 2013).

On a theoretical level, alternative reasons have been proposed to explain the developmental link between self-control and ToM (see Perner and Lang, 1999 for a review). With respect to expression views (Hughes and Russell, 1993), good performances

on standard ToM tasks demand some level of executive ability to inhibit the true state of affairs and reflect on mental states. With respect to emergence views, there is a functional and ontogenetic relationship between EF and ToM, but several proposals have been put forward for the developmental direction. According to Perner and Lang (1999), an understanding of mental states as causally effective representations is necessary for the development of self-monitoring and IC. On the other hand, Russell (1996) and Carlson and Moses (2001) hypothesized that a certain level of executive control could be essential for the acquisition of mental state concepts. There is not yet definitive proof backing the expression or the emergence view (Henning et al., 2011; Devine and Hughes, 2014) and testing the different theoretical accounts of the relation between IC and ToM is clearly beyond the scope of our work.

Our study, even with its limitations (including not using a wide battery of EF and ToM tasks, and the concurrent measurements that precludes clear causal statements) supports the results of those studies that found a significant relation between the ability to understand false beliefs and the conflict (but not the delay) measures of IC. Moreover, in the present study, delay and conflict measures were not associated, suggesting that these tasks measure different components of IC. The dissociation between the Conflict and the Delay task may indicate that monitoring and regulating a hot process (not touching an available and highly attractive stimulus) may involve different abilities than monitoring and regulating a cool process (as flexible categorization), and that only the latter component of IC is developmentally linked to false belief understanding. Also performance in the Delay Choice task and in the Delay task did show a lack of correlation, probably because these two tasks tackle different aspects of delay of gratification ability. Whereas in the Delay Choice task the initial choice cannot be reconsidered during the delay, in the Delay task the subject can modify her choice at any time.

The lack of correlation between ToM and "hot" IC, observed in previous studies and replicated in the present study, has important implications on the alleged link between delay of gratification and so-called "mental time travel" (MTT). MTT is defined as the ability to mentally project oneself in some future situation (Atance and Meltzoff, 2005; Suddendorf and Corballis, 2007), and it is increasingly conceptualized as continuous and complementary with the ability to remember episodes on one's past (episodic memory; Busby and Suddendorf, 2005; Addis et al., 2007). MTT has often been suggested as a key element for planning (Atance and Meltzoff, 2006) and delayed gratification: as Atance (2008, p. 297) argued "were an organism not able to conceptualize a time other than the present, then delaying would make little sense." In turn, MTT is typically described as a complex faculty that relies on a variety of cognitive processes, including ToM, IC, and working memory (Suddendorf and Corballis, 2007). According to this view, (i) ToM and "hot" IC should positively correlate, through the mediation of MTT, and (ii) subjects that are unable to mentally project themselves in future situations should demonstrate substantial impairment in delay tolerance. The latter hypothesis is contradicted by recent data on amnesic individuals with hippocampal damage and associated impairments in episodic memory and future imagining (Kwan et al., 2012, 2013): in spite of their impaired MTT abilities, these subjects exhibited the same delay discounting behavior observed in demographically matched controls, thus suggesting that MTT is not a necessary condition for delay tolerance. As for the idea that ToM may facilitate "hot" IC, this is at odds with previous developmental evidence (Carlson and Moses, 2001; Carlson et al., 2002, 2015; Hala et al., 2003; Kain and Perner, 2005; Devine and Hughes, 2014), as well as with the present findings.

The impact of our results on the MTT debate is moderated by the fact that we did not check for MTT abilities specifically, so we cannot be sure that the age-related improvement in ToM observed in our sample also resulted in a similar improvement in MTT skills (although this would be consistent with the relationship between ToM and MTT hypothesized by most MTT scholars). Nonetheless, in the present study ToM did not correlate with performance in either the Delay task or the Delay Choice task: the latter finding, in particular, suggests a lack of role for ToM in "hot" IC. However, as for the Delay Choice task, it cannot be excluded that the small sample size might have played a role, and future studies should evaluate whether performance in ToM tasks and in the Delay Choice task correlates in larger samples. More generally, this discussion shows that (i) the connection between ToM and delayed gratification hypothesized by proponents of MTT as a key aspect of future-oriented self-control (Suddendorf and Corballis, 2007; Atance, 2008) is far from being proven, and thus (ii) a more comprehensive examination of the relationship between ToM and different aspects of IC is urgently needed.

Conclusion

Although we did not test children with a full battery of EF and ToM tasks, our results are stimulating and broadly in line with previous findings. Future research on the relationship between ToM and IC should include several conflict and delay measures and test children in different cultures in order to better understand the role of cognitive vs. affective components of self-control and their specific relation to ToM development. A better understanding of the interdependence between ToM and IC may also come from a thorough investigation of their neural basis and evolutionary precursors, via comparative studies.

Author Contributions

Conceived and designed the experiments: FB, EA, FP. Performed the experiments: VF, GP, VM, BP. Analyzed the data: FB, EA, GP. Wrote the paper: FB, EA, GP, FP.

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How is theory of mind useful? Perhaps to enable social pretend play

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It is often claimed that theory of mind (ToM) is facilitated by pretend play (PP), or by a particular type of PP, social pretend play (SPP). Here we challenge that view, proposing instead that ToM might be useful for driving SPP, rather than the reverse. We discuss background theory, review pertinent studies, and explain why the "ToM first" view is at least equally likely.

The first form of pretend to consider is solitary PP, emerging at 12–18 months, in which one engages in three basic types of transformation: substitutes one object for another, projects imaginary characteristics onto objects, and imagines situations that do not exist (Leslie, 1987). The second form is social pretend play (SPP), which involves the same basic transformations but occurs with others, and emerges around age 3. We address these two forms of PP consecutively.

There is a fundamental similarity, or isomorphism (Leslie, 1987), between PP and ToM. For all three types of transformation just described, PP involves projecting a different reality onto a situation, all while knowing what the real situation is (Lillard, 1993). For example, a child might mentally project a telephone onto a banana, engaging in both of the first two types of transformation. Similarly, understanding false belief—a foundational skill in ToM—involves understanding that someone is projecting a different reality onto a situation, when one knows what the real situation is. For example, a child might see someone as mentally projecting a chocolate bar inside a drawer, while the chocolate bar is actually in the cupboard.

Theoretically, then, the ability to imagine a situation that differs from one's present reality underlies both PP and understanding others' minds, in particular, false belief (Leslie, 1987; Flavell, 1988; Forguson and Gopnik, 1988; Moses and Chandler, 1992). Leslie (1987) argued that the cognitive architecture that enables one to engage in PP also enables one to understand false belief, suggesting that PP should be related to ToM.

Hence it is possible that PP engenders ToM by giving children practice at projecting representations that differ from reality onto that reality. In pursuit of evidence on this point, many researchers have examined the correlation between PP and ToM. For example, Taylor and Carlson (1997) assessed preschoolers' PP sophistication by examining their tendency to use imaginary objects in pretend action sequences (e.g., holding an imaginary toothbrush to brush one's teeth rather than using a finger as a toothbrush). The researchers examined whether this more sophisticated form of PP correlated with children's performance on standard ToM assessments. However, across many studies, findings are inconsistent: Although some observe significant relationships (Suddendorf et al., 1999; Nielsen and Dissanayake, 2000) others do not, even with the same measures and very similar samples (Schwebel et al., 1999; Lillard, 2001b). Even within studies that found that solitary PP and ToM were related, inconsistency was observed among measures. For example, Taylor and Carlson (1997) found that ToM correlated with self- but not object-directed pretense, and Lalonde and Chandler (1995) found a significant relationship for "engages in simple make-belief actions alone" but not for "uses … objects for make-believe activities alone" (p. 395). Cumulatively, these inconsistent findings undermine the idea of a reliable causal relationship between solitary PP and ToM.

This brings us to the second type of PP, social PP. When children engage in SPP, they pretend to be other people with distinct thoughts and emotions. A major theory of how we understand

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others' minds, simulation theory, suggests that pretending to be someone else aids ToM because it gives children practice in simulating others' mental states and imagining oneself in another's shoes (Harris, 1995). If pretending to be others does involve such metarepresentations, it would be expected to predict ToM (Lillard, 2001a).

Indeed, researchers often find correlations between SPP and ToM. For example, Astington and Jenkins (1995) assessed the sophistication of preschoolers' pretend play through coding their explicit role assignments (e.g., "I'll be the mommy") and joint proposals (e.g., "Let's go to the store"). These behaviors were associated with children's ToM. Several earlier studies are also consistent with these findings (Rubin and Maioni, 1975; Connolly and Doyle, 1984; Peisach and Hardeman, 1985; Lalonde and Chandler, 1995). Another type of SPP is having an imaginary companion. When children postulate imagined beings, they must represent those beings' mental states. Indeed, Taylor and Carlson (1997) found correlations between having an imaginary companion and ToM (see also Giménez-Dasí et al., 2014).

However, just as for PP, results are inconsistent (Cole and LaVoie, 1985). Some of the same studies that find positive relationships for certain ToM measures report null results for other measures. For example, in the studies cited above, PP correlated with spatial but not affective perspective taking (Rubin and Maioni, 1975), affective but not cognitive perspective taking (Connolly and Doyle, 1984), and to appearance reality but not false belief (Schwebel et al., 1999). Other research revealed inconsistent relationships between ToM and different pretense measures. For example, although Youngblade and Dunn (1995) found that ToM was related to role enactment, it was not related to explicit role assignments, in contrast to Astington and Jenkins (1995), who found that ToM was related to joint proposals and role assignments but not to a more general measure of social pretense. At the very least, such inconsistent relationships suggest that SPP does not reliably improve ToM.

Nonetheless, a single-time-point correlational study is not an ideal design for inferring causality. Lagged designs, although imperfect, are better, and some longitudinal studies have found evidence for a causal relationship. One found that children's SPP at 33 months predicted ToM at 40 months (Youngblade and Dunn, 1995). Another with four time points and several different measures of PP and SPP found that certain aspects of PP related to concurrent ToM and predicted ToM over time (Lillard and Kavanaugh, 2014). However, not all measures were related at all time points. For example, pretense production at 24 months (in a social situation with the mother) predicted ToM at 48 months but not at 60 months, and sophistication of the child's play narrative with an experimenter at 36 months predicted (at trend-level) ToM at 60 but not 48 months.

However, neither of these studies investigated whether these lagged relationships could be explained differently, namely, whether earlier ToM might foster both SPP earlier, and ToM later. In this case, it might look as if SPP at Time 1 leads to ToM at Time 2, when in fact SPP at Time 1 was simply a by-product of having more advanced ToM at Time 1. We know of only one study that could shed light on this, by also testing ToM at Time 1 (Jenkins and Astington, 2000). In this study earlier ToM predicted later SPP, whereas earlier SPP did not predict later ToM, suggesting that better ToM might enable children to engage in more, and more advanced, PP.

Although these findings are suggestive, the most solid evidence for a causal effect of SPP on ToM would come from training studies, in which some children experience an intervention to promote SPP and then are compared to an otherwise matched control group who did not. Indeed, several such studies have reported that SPP training improves ToM or related skills (Rosen, 1974; Saltz and Johnson, 1974; Fink, 1976; Saltz et al., 1977; Burns and Brainerd, 1979; Dockett, 1998). However, these studies all had significant methodological shortcomings (see Lillard et al., 2013), including unmasked experimenters who may have influenced posttest performance and unequal adult contact between groups. A study designed to rule out these possible confounds found no improvement in ToM for children in a SPP training group (Smith et al., 1981).

In a recent study, Qu et al. (2015) reported that SPP improves ToM, but given the training content, this conclusion is questionable. In four, 45 min sessions, kindergartners were read books with distinctly ToM-related scenarios (e.g., a child has a false belief about where her books are) and then acted out the stories. Controlling for pretest ToM skills, children who had this experience had better posttest ToM compared to children in a free play control group. Although the particular training experience described here appears to be effective in improving ToM, the conclusion that, in general, children's naturalistic SPP leads to better ToM goes beyond the data.

Furthermore, we recently failed to show evidence for the proposed simulation mechanism (Dore and Lillard, unpublished raw data, 2013). We reasoned that if SPP helps ToM by causing children to think about mental states, then SPP should prime mental states, leading to a stronger orientation toward mental states afterwards. In two studies, children played with an experimenter for 10 min. In a doll condition, the experimenter guided children through a partially scripted play session focusing on role play, cognition, and emotions with Playmobil dolls and animals. In a block condition with a Magneato construction set, the experimenter avoided using mental state language and directed play away from any child-generated pretense. Before and after the play session, children were given a task designed to assess their preference for thinking about people in terms of mental states vs. behaviors (Lillard and Flavell, 1990). Children in the doll condition did not describe people in terms of their mental states any more than did children in the block condition. Although null results should be interpreted with caution, this data from two studies we conducted ($N = 100$) failed to support a mechanism by which SPP might improve ToM: by causing children to focus on mental states.

Overall, the evidence described here is not strongly supportive of a causal relationship in which PP promotes ToM skills. (For a more detailed discussion of studies up to 2013, we urge readers to see the Theory of Mind section of Lillard et al., 2013.) Two other possibilities should be given equal consideration: a third variable underpinning both ToM and SPP, and reverse directionality, in which better ToM skills enable SPP—making SPP one reason

why ToM is useful. One longitudinal study finds this reverse relationship (Jenkins and Astington, 2000), as described above, and more studies should be designed to test this possibility.

Given the state of the research, why is it so often assumed that PP helps ToM (Leslie, 1987; Flavell, 1988; Forguson and Gopnik, 1988; Moses and Chandler, 1992; Harris, 2000; Lillard, 2001a; Bergen, 2002; Ashiabi, 2007; Wellman, 2014)? Researchers might be swayed by what Smith (1988) called "play ethos," the strong belief that PP promotes development. When researchers design, run, and interpret their empirical investigations from the perspective that PP must help development, it seems highly possible that their beliefs might unintentionally bias their findings. We note that researchers who have found significant correlations between PP and ToM tend to frame their findings in the context of a positive effect of PP and the training studies described here are clearly designed with this causal direction in mind. Training studies designed to assess the reverse causal relationship might train ToM and examine whether PP, or sophistication of PP, increases. Longitudinal studies in natural settings could be designed to be able to assess both directions of causality, controlling for potentially related variables like verbal ability. Finally, future training studies designed to assess the potential causal role of PP in ToM development can take care to avoid the methodological problems common in this literature.

Why is the relationship between PP and ToM an important one to pin down? Surely, even confidence that the causal view is incorrect should not lead one to conclude that PP does not have value in children's lives in other ways, either to promote well-being (Lillard et al., 2013), for relaxation (Hutt et al., 1989), to promote positive adult-child interaction (Paley, 2005) or even for fun (Power, 2000). However, embracing the idea that PP promotes ToM without solid evidence is not beneficial, and may even be indirectly harmful if such efforts detract from undertakings with better-established effectiveness. More and better research to clarify the relationship between these complex activities will have important theoretical and practical applications.

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Children's understanding of Aesop's fables: relations to reading comprehension and theory of mind

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Two studies examined children's developing understanding of Aesop's fables in relation to reading comprehension and to theory of mind. Study 1 included 172 children from Junior Kindergarten through Grade 6 in a school-wide examination of the relation between reading comprehension skills and understanding of Aesop's fables told orally. Study 2 examined the relation between theory of mind and fables understanding among 186 Junior (4-year-old) and Senior (5-year-old) Kindergarten children. Study 1 results showed a developmental progression in fables understanding with children's responses becoming increasingly decontextualized as they were able to extract the life lesson. After general vocabulary, passage comprehension predicted fables understanding. Study 2 results showed a relation between young children's theory of mind development and their understanding of fables. After general vocabulary, second-order theory of mind predicted children's fables understanding. Findings point to the importance of developing mental state awareness in children's ability to judge characters' intentions and to understand the deeper message embedded in fables.

Keywords: Aesop's fables, reading comprehension, theory of mind

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Introduction

This paper describes a study of children's developing understanding of story characters' intentions and the resulting lesson that one can take away from Aesop's well-known fables. The first study examines how fables understanding changes across grades from Junior Kindergarten (4 year-olds) to Grade 6 (12 year-olds), and the second study examines how "theory of mind" development in Kindergarten is related to fables understanding.

One of the goals of schooling is to bring children to an appreciation of stories: fantasy and fun, escapism, emotional arousal, food for thought, shared discussion and much more. However, many children are slow to or do not develop this appreciation. One reason may be that they do not develop the advanced comprehension skills to make insightful judgments about story characters' mental states, in particular, their intentions and accompanying behavior. Understanding why this appreciation does not happen for some and how it does happen for others should be a concern for educators and researchers. We can begin by asking what reading – or listening to a story – entails. Both in reading and listening comprehension of narrative text, it requires the active construction of meaning by the reader based on a progressive understanding of story schema, and the ability to apply comprehension strategies including the identification of relations among characters, intentions, and actions based on information given in the text and prior knowledge.

This requirement applies to younger children to whom a story is read, and to older children who are able to read for themselves. Indeed, it presents some interesting questions – when do young children begin to acquire an understanding of the intentions of the characters and to what extent do they understand the mental states of all the characters in order to fully comprehend the story?

Reading comprehension research has demonstrated that children develop a story schema through repeated exposure to stories (e.g., Anderson and Pearson, 1984; Paris and Paris, 2003). Most children's stories employ a story structure consisting of a protagonist whose response to an initial event leads to an intention to achieve a goal and whose subsequent actions, relationships, conflicts, and resolutions result in a clearly stated outcome. It has been proposed that the ability to use this story structure schema is fundamental for children to identify, organize, and understand information from narrative text (Anderson and Pearson, 1984; Carrell, 1992; Baumann and Bergeron, 1993; Davis, 1994; Paris and Paris, 2003). Since children's stories often center around a protagonist's intention and the subsequent actions and relationships that develop in order that the intention be carried out, an understanding of characters' mental states is needed for comprehending not only the sequence of events in a story, but also why the events took place and what judgments might be made about them. Indeed children's storybooks are a ripe source of information for exposure to mental states (Cassidy et al., 1998; Dyer et al., 2000; Pelletier and Astington, 2004; Peskin and Astington, 2004). Nevertheless, true mental state understanding requires more than simple exposure to mental state terms (Peskin and Astington, 2004); it also requires personal, social, experiential, and linguistic interpretation (Astington, 1996; Nelson et al., 1998).

Several studies assessing students' retellings of short stories have shown that children in the primary grades tend to recount stories as a list of actions (Carnine et al., 1982; McConaughy et al., 1984). A study by Nezworski et al. (1982) concluded that children in Kindergarten and Grade 3 prefer to tell stories as a series of factual events, rather than to describe "uncertain internal states." McConaughy et al. (1984) found that children are less likely than adults to mention character intentions when recalling a story and claim that children and adults use different story schemata. Children tend to focus on what happened by listing a series of actions that took place, and adults focus on why things happened including statements about characters' thoughts, beliefs and intentions. Other research has shown that young children are able to integrate plot actions with characters' thoughts and beliefs, but only if they have the mental state understanding and mental state language that allow them to link action with consciousness (Pelletier and Astington, 2004). When the main character's intention is explicitly articulated, children from Kindergarten to Grade 6 are able to identify the mental state and related goal of the protagonist but the stories still tend to be retold as a sequence of events rather than as a holistic narrative of interrelationships and goal achievement (Feathers, 2002). Nelson has maintained that while children may hear and use mental state language, it is their increasing experience in the social world that allows them to fully understand the meaning of the term and to give a mentalistic interpretation to behavior (Nelson et al., 1998).

Bruner (1986) described the comprehension of stories as existing on two planes. One is understanding a structure in which characters play out a sequence of events in order to reach a conclusion; this is the action plane. The other is understanding that characters are goal-driven based on intention and act because of their thoughts and beliefs that may or may not be accurate; this is the plane of consciousness (see also Pelletier and Astington, 2004). Fables are a particular kind of story with their own structure and lesson to be learned. To understand fables, it is necessary to understand the story on both of Bruner's levels. Fables are an effective way to assess children's comprehension of character intentions because the positive or negative attributes of a character do not always correspond to that character's outcome. In many Aesop's Fables, the lesson is not that the "bad character" is punished and the "good character" is rewarded. Rather, they are cautionary tales in which (typically) an animal symbolizing a human character flaw (greed, arrogance, stupidity, timidity, naïveté, carelessness) is deceived by another character, inadvertently helping the deceiving character to fulfill his/her intention. In many cases the "good character" can be weak and the "bad character" strong. This kind of characterization sends the message that power and evil can win out over innocence and good will unless thoughtful action is taken (Clayton, 2008). Alternatively, fables may exploit a situation in which a good character attribute is revealed (kindness, empathy, intelligence), resulting in an unexpected positive outcome. An essential component of comprehending the meaning of fables is knowing the relationship of who is tricking or surprising whom, and for what purpose. To that end, children's understanding of mental states may be needed for competence in narrative structure particularly when it involves deception (Sodian et al., 1991; Gamannossi and Pinto, 2014), as is common in Aesop's fables. Second order theory of mind, in particular, has been linked to understanding of deception (Wimmer and Perner, 1983) because it involves beliefs about another's beliefs or intentions.

Fables were used in a study by Shannon et al. (1988), one of the first specifically designed to assess children's comprehension of character intentions. Children and adults listened to or read fables in which character intentions were implicitly or explicitly stated. The results indicated that children found it more difficult than adults to identify and articulate character intentions, even when directly questioned about stories in which the character intentions were explicitly expressed. The authors' conclusion was that elementary students may not automatically put themselves in the place of main characters and try to solve the problems they face, but rather may rely on a comprehension strategy that focuses on characters' actions as opposed to goals or intentions.

Fables are didactic stories that were initially composed and orally transmitted in order to teach a pertinent life lesson and to guide people in how to live a morally upstanding life (Tomasulo and Pawelski, 2012). A structural understanding of the plot must be accompanied by an ability to infer the overarching moral that the author is attempting to convey (either implicitly embedded within the text, and/or explicitly stated at the end). When the moral is not explicitly stated, the reader must consider the outcome of the fable in relation to the intended actions of the characters, and in relation to their understanding of fair

and equitable consequences (Dorfman and Brewer, 1994). As in the research on story understanding and retelling, there are developmental differences in fables understanding. Children in Grade 5 comprehend fables better than their younger Grade 3 peers, but not as well as college students (Narvaez et al., 1998). Dorfman and Brewer (1994) showed that adults find stories that have moral outcomes more meaningful and comprehensible than similar stories that do not have a moral outcome.

Interestingly, Aesop's fables feature animals as protagonists rather than humans. In some contexts, the use of non-humans is meant to illuminate the human experience through "humans in disguise" (Sutton-Spence and Napoli, 2010, p. 442) in a metaphoric way. This kind of anthropomorphism is ubiquitous across cultures (Tehrani, 2013) and is considered acceptable for evoking emotion and appealing to broad audiences (Sutton-Spence and Napoli, 2010). However, behavioral scientists point out some potential drawbacks of anthropomorphism when it concerns teaching children scientific understanding of the natural world (Ganea et al., 2014). Yet Shettleworth (2012), using training tasks inspired by Aesop's fables (for example, the thirsty stork using stones to raise the water level in a pitcher), along with neuroscientific imaging, maintains that animals can indeed show insight. Clayton (2008) argues that anthropomorphism illustrates that hierarchies in the animal world are analogous to human hierarchies in the context of everyday life. There must be similarities between animal and human behavior, otherwise "the animal fable would not exist" (Clayton, 2008, p. 183). Although animals can get themselves into similar situations as humans, all would agree that animals can not use reason to solve a problem. Thus the anthropomorphized life lesson is useful in showing human audiences that they have the advantage of mentalistic reasoning to help them avoid or escape the unfortunate situation.

An understanding of fables requires that the individual take the perspective of the main characters, with an appreciation not only of who is tricking whom, but also with an educational goal of teaching children a life lesson. To date, most studies have compared the poorer understanding of young children to the superior understanding of adults. They have demonstrated that an understanding of both characters' and author's intentions increases the ability to understand the meaning of the fable. Studies have not, however, specifically described the development of the underlying cognitive processes related to intention in fables comprehension.

One theory related to cognitive processes in story comprehension is that children need to be able to conceptualize and construct internal mental states (Bruner, 1986; Pelletier and Astington, 2004; Peskin and Astington, 2004). In order to understand character intentions, children need to be able to conceive that individuals (in stories and in reality) behave in ways that will result in their attainment of a goal, and that behavior is driven by internal mental states such as desire (Gamannossi and Pinto, 2014). Fables add another dimension – the complexity of deception or surprise. In most fables, both of the characters desire something, but one character formulates a deception or surprise based on the desires of the other character and so attains his goal. The reader must simultaneously understand the internal mental states of both characters, and understand that for one character the representation of reality may be inaccurate and thus offer opportunities of which the other character can take advantage. For instance, consider Aesop's story of the fox and the crow, a story that involves deception:

> *A big black Crow was sitting on a branch of a tree with a piece of cheese in her beak when she was seen by a hungry Fox. The Fox walked under the branch, looked up at the Crow, and said, "What a noble bird you are! Your beauty is without equal and the color of your feathers is exquisite. If your voice is as sweet as your looks, then I think you are the Queen of the Birds." The Crow was very flattered by the Fox's compliments and, just to show him that she could sing, she opened her mouth to caw. But as soon as she opened her mouth, the cheese fell to the ground, where it was snatched up by the clever Fox (Hague, 1985).*

In this story, the reader or listener must understand the mental states of each of the characters – the crow's vanity, the fox's hunger, the fox's recognition of the crow's vanity, and the crow's mistaken belief about the fox's opinion of her.

As in a study that employed folktales and fairytales (Ratner and Olver, 1998), it was concluded that children's increasing ability to understand and appreciate fables may be linked to their own growing awareness that there is a difference between reality and the internal representations that each individual has to represent reality, and that these internal representations or beliefs may be false.

Links to Theory of Mind

Numerous studies have described a shift in children's cognitive ability to conceptualize an internal state of mind; typically the development of the "false belief" takes place at about 4 years of age (Astington, 1990, 1993; Wellman et al., 2001). Researchers argue that this shift in understanding constructed by the child – albeit developmentally constrained – develops over the course of the preschool years, and is characterized differently at different ages. That is, at approximately 4 years of age, children come to acquire a "first order" theory of mind understanding (he thinks that × is in the box), whereas between approximately 5 and 6 years of age children come to acquire a "second order" theory of mind (he thinks that she thinks that x is in the box; Wimmer and Perner, 1983; Astington et al., 2002). Theory of mind understanding becomes more recursive as children get older, for example enabling young adolescents to develop a greater understanding of self (Bosacki, 2000). Further, language makes significant contributions to theory of mind understanding and this relationship is interconnected implicitly and explicitly across ages and language group status (Antonietti et al., 2006; San Juan and Astington, 2012; Pelletier et al., 2014).

The fables task used in this study was designed to ascertain whether children's increasing ability to identify characters' intentions is related to their developing theory of mind. In the present study, both first order and second order theory of mind tasks were used, as most of the children were 4 years-old and older. Furthermore, second order theory of mind tasks (but not first order) have been shown to predict children's performance in reading comprehension tasks among second language learners (Pelletier, 2006) and in cause-evidence

distinction tasks (Astington et al., 2002). Cause-evidence tasks tap children's emerging understanding of why an event happened (cause) in contrast to how they know an event happened (evidence). Younger children confuse cause and evidence; for example, "I know the floor is wet because John spilled water" (cause) and "I know the floor is wet because I stepped in it" (evidence).

Given the comprehensive body of research showing that children's theory of mind develops rapidly during the preschool and early school years, we hypothesized that children's understanding of fables would increase from Kindergarten to Grade 6, and that a large incremental shift in understanding would take place between ages 4 and 6 years when children begin to acquire a second order theory of mind understanding. We thought that children's ability to understand fables would be related to general reading comprehension; that is, children who are able to extract the "lesson" of the fables as evidenced by increasingly decontextualized responses, would also perform well on standardized reading comprehension tasks. Typically these standardized tasks measure basic level comprehension skills but do not measure intentional understanding. The fables task goes further in assessing comprehension by linking text comprehension with an understanding of underlying intentions and relatedly, the moral of the story. We further hypothesized that children's developing ability to understand epistemic states as measured by theory of mind tasks at 4 and 5 years of age would predict their ability to understand the intentional states of all characters in the fables task and to articulate the moral of the story based. Thus two separate but related phenomena were being examined: (1) grade level developmental progression of children's understanding of character intentions in children's understanding of fables and its links to general reading, and (2) the relation between children's theory of mind and their understanding of fables between 4 and 5 years of age.

Materials and Methods

Data from two separate studies were used in the analysis. Study 1 data provide information on grade level and ability group differences in fables task performance and the relation to reading ability. Study 2 data provide information on the relation between fables task performance and theory of mind understanding. Both studies were approved by two research ethics boards; Study 1 ethics boards included the University of Toronto and the Institute of Child Study Research Ethics Committees. Study 2 ethics boards included the University of Toronto and the two school board (public and Catholic) external research committees in the Region of Peel, to the west of Toronto.

Participants

Participants in Study 1 include 172 children from Junior Kindergarten (JK- 4-year-olds) and Senior Kindergarten (SK- 5-year-olds) to Grade 6 (12-year-olds) in a private university laboratory school in Toronto, ON, Canada. All children in these grades participated in the study except in cases in which a child moved in or out of the school during the study's duration. Each class had either 21 or 22 children. There were 87 girls and 85 boys. The school population includes approximately 30% from visible minority and lower socioeconomic groups; however, most children are from middle-income families. Due to the generally high academic performance of children at this school, results may reflect higher achievement levels than in public schools in the Toronto area. However, results are useful as indicators of developmental differences.

Participants in Study 2 include 186 children in Junior (4-year-old) and Senior Kindergarten (5-year-old) classes from 5 public schools in the Greater Toronto area. More than 60% of the children spoke English as an additional language and represented a wide range of cultural, racial, linguistic, and socioeconomic diversity. Close to 40% spoke English as a first language. Second language groups primarily include Hindi, Gujarati, Punjabi, Urdu, Tamil, Vietnamese, and Chinese. Children who were judged by their teachers as not able to understand English well enough to fully respond to the questions were not included. There were 101 girls and 85 boys in Study 2; 113 were in Junior Kindergarten and 83 were in Senior Kindergarten. The analyses were carried out with participants for whom complete data were available.

Procedures for Both Studies

All participating children were withdrawn individually from their classrooms to a nearby familiar area and were administered the battery of measures by a trained graduate student teacher candidate. Testing time ranged according to grade level but averaged approximately 40 min per child. Children were not made to participate if they were shy, unwilling or tired. All tasks were administered in counterbalanced fashion by the use of two lists. Theory of mind tasks in Study 2 were also counterbalanced for order of administration of the individual task items. In past research (e.g., Astington et al., 2002) and in the present study, there were no effects of task administration order.

Measures

Vocabulary

The Peabody Picture Vocabulary Test III Revised (Dunn and Dunn, 1997) was administered to all participants following standardized procedures. Raw scores were used and age controlled in the analyses. This measure was given to all children in both studies.

Reading

Two standardized measures of reading were employed to address developmental differences. Standardized procedures were followed. For older children (Grades 2–6), three subtests of the Woodcock Reading Mastery Test (WRMT; Woodcock, 1998) were used in Study 1: Passage Comprehension, Word Attack and Word Identification. These were chosen because they include basic skills (Word Attack and Word Identification) as well as understanding (Passage Comprehension). For younger children in Grades Junior Kindergarten – Grade 1 in Study 1, for whom the WRMT was too difficult, the Test of Early Reading Ability-III (Reid et al., 2001) was employed. Because all children in Study 2 were in kindergarten, the TERA was

administered to all children in Study 2. The TERA includes three subtests: Alphabet Knowledge, Conventions of Print, and Meaning. The first two subtests measure basic early reading skills and the Meaning subtest measures understanding. Raw scores representing the total of the three subtests of the TERA were used in the analyses.

Teacher Ratings of Reading

Each classroom teacher in Study 1 rated each child in reading ability by group: low, medium or high. Teachers' ratings were global subjective measures of reading based on children's skills and comprehension and that teachers felt may have captured a broader picture beyond the standardized tests. Teachers were collaborators in this research and were interested in the relation among the measured skills and comprehension and their own global impressions of children's understanding.

Fables Comprehension

An experimental measure that assesses children's basic story comprehension as well as deeper comprehension of character motivations and the moral of the story was administered to all participating children in both studies. Two Aesop's fables tasks were used (The Fox and the Crow, The Fox and the Goat; fables used from Hague, 1985); for all children and for each task a fable was read by a researcher while the child was shown an accompanying illustration. The child was then asked three basic knowledge and comprehension questions (Questions 1–3), coded as correct/incorrect (0 or 1) and one lesson/moral of the story question (Question 4), coded on a scale from 0 to 5. Examples from the Fox and the Crow are:

Q1 : What did the fox see up in the tree branch?
Q2 : Why did the crow open her mouth to sing?
Q3 : Is someone playing a trick? Who?
Q4 : What is the moral/lesson of this story? (probe: What can you learn from this story?)

The maximum raw score for both fables was 16. The maximum raw score for Question 4 (moral question) was 10 (two fables × maximum five points). Coding for the final question measured children's fable comprehension from recognizing the character's intention to "trick" through to an ability to extract the "life lesson" from the fable in an increasingly decontextualized fashion. Younger children tend to respond within the context of the story ("the lesson is that you should not listen to foxes") whereas older children tend to respond in a more decontextualized fashion ("the lesson is that you should not listen to flatterers"). Coders were trained together until they reached consensus on 100% of trial codes. Ten percent of children's responses in the dataset were then double-coded for reliability purposes and agreement reached 90% as reported in previous studies using this method of training (e.g., Timmons et al., 2015). Any differences in coding tended to be in the distinction between scores 4 and 5. A series of acceptable responses was then developed for a score of 5 (a standard cliché) to reduce this error. The procedure for Question 4 was as follows:

0 = incorrect story fact, nonsense
1 = correct story fact (the fox asked the crow to sing)
2 = reference to trick (the fox wanted to trick the crow)
3 = reference to lesson tied directly to story context (we can learn not to sing just because a fox asks us to do that)
4 = reference to lesson decontextualized beyond the story (we can learn not to show off because then we might lose something)
5 = broad life lesson/cliché (do not trust flatterers/people who just say nice things to get something)

Theory of Mind

Two batteries of theory of mind tasks consisting of a first order and a second order false belief were used with children only in Study 2. Both tasks have been employed in traditional theory of mind studies (e.g., Wimmer and Perner, 1983; Astington and Jenkins, 1999; Astington et al., 2002). The first order false belief task measures children's understanding of a character's mental state (e.g., "he knows that. . ."), whereas the second order false belief task measures children's understanding of an embedded mental state proposition (e.g., "she knows that he knows that. . ."). Children were given four first order stories for a possible total of 10 correct points and if they passed, were given 2 second order stories for a maximum total of 16 points (justification responses are scored from 0 to 4). A more detailed copy of the scoring system may be obtained from the first author.

In summary, Study 1 allowed an investigation of grade level differences in fables understanding and its relation to a number of standardized reading assessment tools appropriate for a range of grade levels. Study 2 allowed an investigation of fables understanding at one time point, in Kindergarten, in relation to theory of mind and early reading ability.

Results Study 1

The following are representative grade-level examples of children's responses in the Fox and the Crow example (the crow who drops the cheese in response to the fox's flattery) to Question 4, "what can you learn from this story?"

JK – "About being a queen"; About foxes
SK – "Not to listen to a fox"; Foxes are mean
Gr1 – "Not to open your mouth when you have something in your mouth to show that you can do it"; Do not just do things when a fox says so
Gr2 – "Not to fall for that kind of stuff"; Do not show off
Gr3 – "Do not be tricked"; Do not think you're such a beautiful bird
Gr4 – "Think before you do something"; Be wary of people who ask for things
Gr5 – "Do not listen to strangers that are really smart"; Be careful of people who always say nice things to you
Gr6 – "Sometimes people flatter to get what they want": Beware of flatterers.

The means, minimum scores, maximum scores and standard deviations are presented in **Table 1**.

TABLE 1 | Means, ranges, and standard deviations across grades in fables task performance (maximum possible score = 16 for both fables).

	JK *N* = 22	SK *N* = 21	Gr 1 *N* = 22	Gr 2 *N* = 21	Gr 3 *N* = 21	Gr 4 *N* = 21	Gr 5 *N* = 21	Gr 6 *N* = 22
Mean	4.73	7.95	9.45	10.10	10.38	10.57	10.81	12.91
Minimum	2.00	1.00	4.00	5.00	5.00	7.00	6.00	8.00
Maximum	9.00	12.00	14.00	16.00	14.00	15.00	15.00	16.00
SD	1.75	3.04	3.17	3.51	2.62	2.56	2.36	2.51

JK, Junior Kindergarten (4 years), SK, Senior Kindergarten (5 years).

A One-Way ANOVA was used to examine grade level differences in children's fables task performance for Question 4 alone (the moral/lesson question). Mean scores ranged between.68 (JK) and 7.0 (Gr. 6) (see **Figure 1**). Findings represent a significant difference by age [$F(7,163) = 11.8$, $p < 0.001$]. A Bonferroni *post hoc* comparison showed the greatest leaps were initially between JK-Grade 1 and again at Grade 6. A Bonferroni correction was not used as Sedgwick (2012) suggests that this test may be overly conservative and can prevent the identification of significant findings when many comparisons are made, in this case grade levels.

The next analysis compared children's fables task performance in relation to teacher reports of whether children were in the high, medium, or low reading groups in the class. Results showed significant differences between teacher rating groups, that is, children in the highest teacher-rated reading groups were those who received the highest scores on the fables task [$F(2,168) = 5.32$, $p < 0.01$; See **Figure 2**]. There were no gender differences.

In order to examine the interrelations among the variables, a partial correlational analysis controlling for age was carried out. It should be noted that two reading measures needed to be used to address developmental differences, the TERA for younger children and the WRMT for older children; thus reading results are reported separately for age groups. The fables task was modestly but significantly correlated with vocabulary [$R(62) = 0.35$, $p < 0.01$, for younger children; $R(85) = 0.41$, $p < 0.001$ for older children] and with the passage comprehension subtest [$R(88) = 0.38$, $p < 0.05$] but less with word identification and word attack skills. Teacher ratings of high, medium or low reading performance were significantly correlated with vocabulary [$R(65) = 0.29$, $p < 0.05$ for younger children; $R(85) = 0.34$, $p < 0.001$ for older children], with TERA performance for the younger children [$R(65) = 0.36$, $p < 0.05$], passage comprehension for the older children [$R(88) = 0.51$, $p < 0.001$], word identification [$R(88) = 0.27$, $p < 0.05$] and word attack [$R(88) = 0.30$, $p < 0.01$], and with fables task performance for all children [$R(168) = 0.24$, $p < 0.005$].

A stepwise regression analysis was used to test the relative contributions of the reading and vocabulary measures to fables task performance. In the first regression, vocabulary, passage comprehension, word identification, and word attack skills were entered. Only vocabulary made an independent contribution to fables task performance ($R = 0.43$, R Square $= 0.19$, $F = 13.24$, $p < 0.001$). In a second regression analysis, vocabulary was not entered. This time, only passage comprehension made a significant contribution to fables task performance ($R = 0.42$, R Square $= 0.18$, $F = 12.2$, $p < 0.001$).

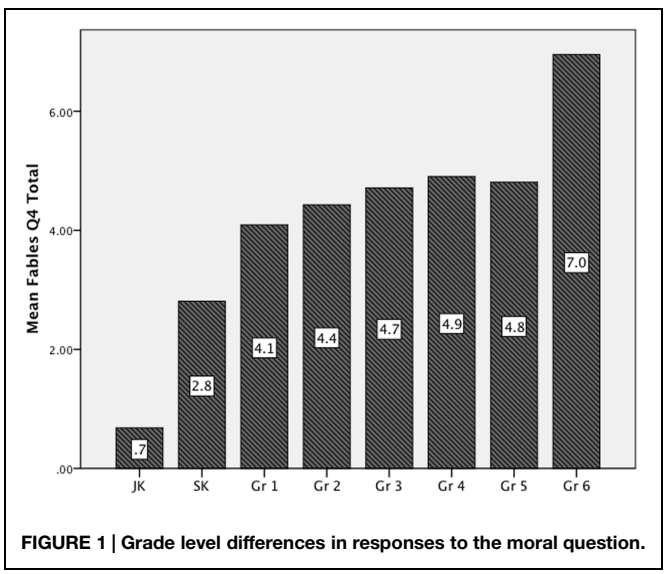

FIGURE 1 | Grade level differences in responses to the moral question.

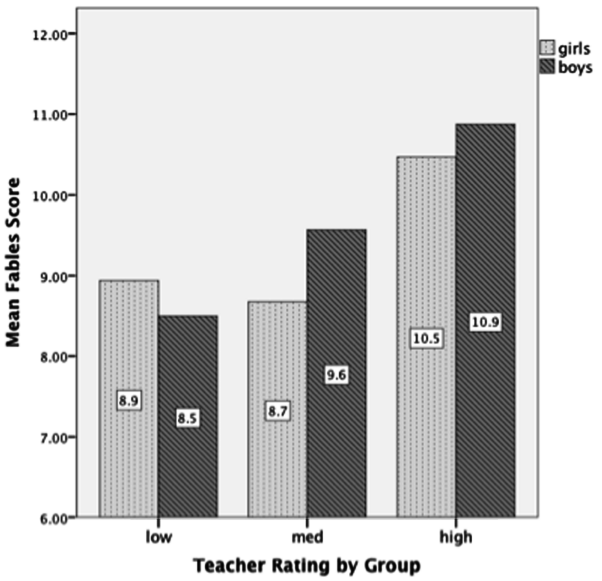

FIGURE 2 | Mean fables total scores for low, medium, and high reading groups.

Results Study 2

The next set of results draws from the data in Study 2. The first analysis presents means and standard deviations for Junior Kindergarten and Senior Kindergarten children on the dependent variables of vocabulary, early reading, theory of mind, and fables task performance. First order theory of mind was administered to all children and second order theory of mind was administered to children who correctly answered all items on the first order task (See **Table 2**).

For all variables, the differences between Junior Kindergarten (JK) and Senior Kindergarten (SK) performance were significant at the.001 level, except for first order Theory of Mind which was significant at the 0.05 level and for second order Theory of Mind which was not significant.

The next analysis examined correlations among the variables partialling out age. Second order, but not first order theory of mind was significantly correlated with fables task performance ($r = 0.40$, $p < 0.001$). Vocabulary was likewise correlated with fables task performance ($r = 0.57$, $p < 0.001$) and with second order theory of mind ($r = 0.33$, $p < 0.01$), but not with first order theory of mind, and only modestly with early reading ability as measured by the TERA ($r = 0.26$, $p < 0.05$; see **Table 3**).

Finally a stepwise regression analysis on the dependent variable of fables understanding (fables total score) with the factors of age, vocabulary, early reading ability, first order theory of mind, and second order theory of mind, showed that vocabulary and second order theory of mind contributed to children's understanding of fables. Vocabulary accounted for 36% of the variance [$R = 0.60$, R Square $= 0.36$, $F(1,67) = 38.1$, $p < 0.001$] and second order theory of mind accounted for an additional 6% of the unique variance [$R = 0.64$, R Square $= 0.42$, $F(2.66) = 22.7$, $p < 0.05$].

TABLE 2 | Means and Standard Deviations for JK (Junior Kindergarten) and SK (Senior Kindergarten) children.

JK or SK		PPVT	TERA	1st order	2nd order	Fables
JK	Mean	48.19	12.17	6.29	6.43	3.94
	N	108	109	103	35	96
	SD	22.18	8.01	2.42	2.44	2.37
SK	Mean	63.56	21.25	7.40	7.05	5.42
	N	79	79	83	43	79
	SD	22.91	9.85	2.33	2.21	2.69

TABLE 3 | Partial correlations controlling for age.

	PPVT	TERA	1st order	2nd order	Fables
PPVTRAW		0.26*	0.22	0.33**	0.57****
TERA			0.21	0.38***	0.27*
1st order				0.19	0.23
2nd order					0.40***

*$p < 0.05$, **$p < 0.01$, ***$p < 0.005$, ****$p < 0.001$.

Discussion

Taken together, the results show that as children age, they gain an increasing understanding of fables. Consistent with the first hypothesis, as children became older their comprehension of text became increasingly decontextualized; that is, their understanding progressed from identifying story facts to extracting a life lesson that was less explicitly tied to the story action and was more implicitly tied to the mental states or intentions of the story characters. In the example of the Fox and the Crow, 4- and 5-year-old children in Study 1 were more likely to think about the Crow as becoming a queen or the Fox as the "bad guy." However, 11- and 12-year-old children in Grades 5 and 6 were more likely to think about a larger life lesson, in this case the dangers of succumbing to flattery. This developing awareness is likewise related to general reading comprehension as measured by standardized passage comprehension tests and to general vocabulary knowledge. Vocabulary knowledge is often used as a proxy for general intelligence and thus it is not surprising to find that only vocabulary predicted children's performance on the fables task; passage comprehension, word identification and word attack skills did not predict. However, when the regression analyses were carried out without entering vocabulary, children's performance in passage comprehension predicted performance on the fables task but other reading skills did not. Interestingly teacher ratings of children's reading ability also correlated with vocabulary and fables task performance but not to discrete skills of word identification and word attack. It is important to note that there was very little variability in the standard vocabulary scores of the Study 1 children. Standard scores were calculated for Study 1 children and all classes were in the above to well above average range. While this fact may reduce the generalizability of the age-related stages, it also reduces error due to variability in verbal intelligence. The age-related stages may simply apply to children in the next grade in other school systems. There were no gender differences in this study despite research showing young girls' higher verbal performance in narrative tasks (e.g., Fivush and Zaman, 2015). However, comprehension of mental state stories, including false belief tasks, may differ from production of mental state narratives. For example, Charman et al. (2002) reported a very slight advantage in false belief task performance for girls which did not hold over time. Thus it is not surprising that gender differences in mental state story comprehension were not found in the present study.

In Study 2, there were also significant differences between Junior and Senior Kindergarten in all measures including first order theory of mind but with the exception of second order theory of mind which fewer kindergarten children (78 rather than 187) were administered due to the level of difficulty. Applying these findings to individual differences among children in classrooms – without an ability to move beyond earlier stages in a taxonomy in which reading moves from simple knowledge of facts to ability to synthesize, apply and judge (e.g., Bloom, 1956), children remain at lower levels of reading comprehension, only having basic knowledge of the facts without understanding the characters' intentions and larger moral "purpose" of the tale. They lack an ability to synthesize what they read, to apply it

to their own and other life experiences, and to think critically about the message of the text. Fables comprehension, while linked to story comprehension, also requires an ability to understand intention. Extracting and articulating a decontextualized life lesson is dependent upon understanding the character intentions that hold the story together. The fables task is thus useful for quickly measuring children's ability to think critically about the intentions of the characters and the overall message of the story. It offers intriguing insights as to how children think about the deeper message of the story. A limitation of Study 1 was the lack of theory of mind data; Study 2 addressed this issue.

The second hypothesis, that Kindergarten children's performance on the fables task would be tied to theory of mind development, was supported in Study 2. In fact, theory of mind understanding contributed most to Kindergarten children's understanding of the fables beyond the contribution of general vocabulary. This is in contrast to research that showed no unique contribution of theory of mind to story comprehension (Strasser and del Río, 2013). In that study vocabulary mediated the effect of executive function in predicting story comprehension. In our study, executive function skills were not included; thus our results should be interpreted cautiously given the lack of executive function data. There are several other points to make here. The first is that more than 60% of the children in Study 2 spoke a language other than English as their first language. Although all children who participated in the study were deemed by their teachers to be competent enough in English to participate, their scores on the standardized vocabulary test were lower than for children who spoke English as a first language. Thus it may not be surprising that vocabulary made less contribution to fables understanding in Study 2 than in Study 1. Another interesting point that has support in previous research (Astington et al., 2002) concerns the greater predictive power of the second order theory of mind tasks than of the first order tasks. Second order theory of mind tasks require children to be aware of the mental states of both characters and to be able to make inferences and judgments about the characters' intentions based on their mental representations. Similarly, fables understanding requires children to keep in mind the mental states of all the characters in order to understand who is tricking whom (if applicable) and to understand the characters' intentions. It is not surprising therefore, that second order theory of mind is important to fables understanding.

In summary, this study has described the relation between fables understanding and story comprehension and has suggested the process by which fables understanding and theory of mind development may be linked. These relations provide useful information for educators: the importance of mental state understanding which may come about through explicit talk about mental states in the classroom, and the value of "getting inside children's minds" to assess the extent to which they truly understand the meaning of what they read and hear in stories.

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How Children's Mentalistic Theory Widens their Conception of Pictorial Possibilities

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An interpretative theory of mind enables young children to grasp that people fulfill varying intentions when making pictures. We tested the hypothesis that in middle childhood a unifunctional conception of artists' intention to produce a picture widens to include artists' intention to display their pictures to others. Children aged between 5 and 10 years viewed a brief video of an artist deliberately hiding her picture but her intention was thwarted when her picture was discovered and displayed. By 8 years of age children were almost unanimous that a picture-producer without an intention to show her work to others cannot be considered to be an artist. Further exploratory studies centered on aspects of picture-display involving normal public display as well as the contrary intentions of hiding an original picture and of deceitfully displaying a forgery. Interviews suggested that the concept of exhibition widened to take others' minds into account viewers' critical judgments and effects of forgeries on viewers' minds. The approach of interpolating probes of typical possibilities between atypical intentions generated evidence that in middle childhood the foundations are laid for a conception of communication between artists' minds and viewers' minds via pictorial display. The combination of hypothesis-testing and exploratory opening-up of the area generates a new testable hypothesis about how an increasingly mentalistic approach enables children to understand diverse possibilities in the pictorial domain.

Keywords: artworks, representation, pictorial theory, theory of mind, intention, exhibition, forgery

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INTRODUCTION

An important part of a conception of the pictorial realm is that it encompasses viewers who want to see pictures, and artists who intend their pictures to be seen. Over much of the life-span, people have repeated practice at spontaneous monitoring of pictorial intentions. Eventually, repetition generates representations available to conscious awareness (Karmiloff-Smith, 1992) which then become everyday assumptions which researchers try to identify (Parsons, 1987). The present investigation focuses on how children rely on their theory of mind to make sense of diversity within the pictorial domain, spanning typical and atypical exemplars. The advantage of acquiring a complex theory of mind in furthering an understanding of diversity was one of the central points made by Wellman (1990; see also Myers and Liben, 2012; Hartley and Allen, 2014). Children learn to understand that human beings "use cultural tools for leaving an intentional trace of their communicative and cognitive acts" (Karmiloff-Smith, 1992, p. 139). In the first part of

the investigation reported below we tested a reformulation of the proposal that children come increasingly to conceptualize artists and viewers as linked in a common communicative endeavor (Freeman, 2000, 2011). Our reformulation is the strong version of that, namely that during middle childhood, the children go beyond (a) representing artist and viewer as linked separate agents, and (b) integrate the two aspects of agency into a representation of someone who intends both to produce and to display pictures. We test that, then present two exploratory studies which serve an advisory function in how to advance on the test in the next round of research to encompass artists who cheat by displaying a forgery.

Mentalistic reasoning is a way of combining interrelated concepts of belief, desire, emotion, and intention which are integral to an understanding of mind. The child learns to extend mentalistic reasoning to encompass a variety of relations between agents and their world (Bloom, 2002). Agents' effects on the world are understandable in the light of how agents' intentions are (a) activated by their desires, and (b) shaped into plans by agents' beliefs about how to fulfill the intentions (Wellman, 1990). Such reasoning is necessary for understanding artifacts that the agents produce (see Keil, 1989, p. 49 on 'The need for intention'). Pictures are ubiquitous artifacts. Mentalistic reasoning by viewers is "an appropriate response to the central fact about art: that it is an intentional manifestation of mind" (Wollheim, 1993, p. 134; also Bloom and Markson, 1998; Freeman, 2000, 2008). Artists produce pictures non-arbitrarily, influenced to varying extents by the artists' conception of viewers' minds. Artists typically do not just intend to produce pictures but to display them to others. It is only through understanding intentions to display that children can come to understand their own everyday pictorial environment. That is, at some point in understanding the world of pictures, the child progresses beyond (a) a unifunctional concept of the typical artist intending to produce pictures, to (b) a plurifunctional concept of the typical artist intending both to produce pictures and to have them seen. It is at present not known when such insight is acquired and integrated with other insights about the pictorial domain. What is known is that the end-state of development, an untutored adult theory of art, does incorporate mentalistic reasoning centering on intention. Pictures often seem automatically to trigger a search for what the artist intended (Jucker et al., 2014), thereby enhancing the viewers' liking for the pictures (Jucker and Barrett, 2011). Presumably the increased liking in turn reinforces the search for intention. Indeed, naïve viewers may be too intention-minded. Rosset (2008) formulated a model in which adults habitually monitor others' actions for evidence of intentions (see also Moore and Pope, 2014) and the monitoring incorporates a positivity bias: when asked to interpret an action, intentions are ascribed more than they should be. It is true that it may be a mistake for viewers to rely too heavily on what artists seem to intend, because some artist intentions may be limited as guides to pictorial interpretation (Beardsley, 1981, 1982; Davies, 2013), and artists may err in their suppositions about how viewers react to the art-display (see Salfner and Voigtmann, 1999). However, identification of artist intentions is useful to viewers even if only to serve to generate useful heuristics for interpretation. A prime task for research is to identify how an understanding of artists' intentions develops.

As is usual in research on mentalistic reasoning, it has been found that important advances in monitoring pictorial intention occur in the preschool years. Preschoolers, when they find a picture unclear, tend to infer what the artist may have intended (Browne and Woolley, 2001). Children as young as 30 months of age spontaneously monitor an artist's gaze while she draws an object; and when taught a name for the drawing ("This is a spoodle!") children map the novel word to the real object the artist had apparently intended to draw (Preissler and Bloom, 2008), see also Preissler and Bloom (2008) on 2-years-old, and Salsa and de Mendoza (2007) and German and Johnson (2009) on 3-years-old. Thereafter, a mentalistic stance on depiction widens to incorporate further insights into agency (Gelman and Ebeling, 1998; Callaghan and Rochat, 2003, 2008; Freeman, 2008, 2011; Hartley and Allen, 2014). Perhaps it is not until at least 7 years of age that children undertaking pictorial interpretation may normally consider the mind of the viewer in relation to the mind of an artist (see Golomb, 1992). Accordingly, we should look to middle childhood to identify the foundation of plurifunctional thinking about intention. We followed the suggestion by Freeman and Allen (2013) of setting puzzles which involve intentions that are contrary to the typical possibilities in the pictorial domain.

Study 1 tested the hypothesis that middle childhood encompasses when children replace (a) a unifunctional conception of an artist as someone who produces a picture, with (b) a plurifunctional conception of an artist as someone who both intends to produce and to display a picture to others. A new method was needed. We adapted the foundational false-belief experiment in theory of mind in which an agent hides something which is subsequently found and removed by someone else. Children watched a brief video in which an artist atypically hides one of her pictures from view, then a friend finds the picture and, unbeknownst to the artist, thwarts the artist's intention by putting the picture on display in a museum (in Italy, *museo* covers both museum and gallery as in The Tate Gallery and the Museum of Modern Art). The child was asked questions, amongst which were three target questions of (a) what people would think of someone who hid her own beautiful picture, (b) whether it is *important* for an artist to display her picture, and (c) whether it is *necessary* for an artist to display her picture. We predict that 5-years-old would unifunctionally judge that the artist had fulfilled her role simply by producing the picture. Ten-years-old would plurifunctionally judge that artists are expected to bear in mind the needs of viewers. An open question is whether the 8-years-old would resemble the younger or older groups.

Study 2 investigated children's conception of what makes a picture worth displaying, asking whether (a) beauty, (b) authorship, or (c) critical opinion were most important in judging a picture. The firm prediction from Parsons (1987) is that 5-years-old' thinking is dominated by the question of how beautiful a picture is. Older children can safely be predicted to move toward a plurifunctional judgment, encompassing both which artist produces the picture, and experienced viewers' opinion that the picture is worth displaying. This aspect of the study is

exploratory, designed to open the area where, interestingly, the typical rate of development has not yet been identified.

Study 3 involved a converse of hiding something, namely atypical display of something misleading. The question is whether deliberate display of a forgery disqualifies an artist from a claim to the role, in a similar way to refusal to exhibit an original. Forgery poses one of the most complex topics for naïve pictorial reasoning that accounts of the domain currently encompass (see Bullot and Reber, 2013). We asked children what is wrong with a forgery, and whether they themselves would put a forgery on display. Children's reasons for their judgments should suggest whether an explicitly mentalistic conception of an authentic display piece arises before the end of middle childhood and facilitate the formulation of a testable hypothesis.

To conclude, the investigation below involved three distinct types of study in a repeated-measures design. Questions were formulated within semi-structured interviews, many of them required yes/no answers, thus facilitating quantitative analysis where the alpha level can be set very high. Another essential part of the approach is to identify mentalistic reasoning irrespective of whether the child answered a question affirmatively or negatively. The overall approach thus employs frequency data and qualitative data in complementary fashion (see Freeman and Parsons, 2001) to identify whether, in the 5-years span of middle childhood, a shift toward mentalistic reasoning characterizes children's approach to the pictorial domain.

STUDY 1: DOES A PICTURE-PRODUCER'S ROLE INVOLVE DISPLAYING PICTURES?

Participants

We interviewed 30 Italian urban children: 10 5-years-old (six girls, four boys), 10 8-years-old (four girls, six boys), and 10 10-years-old (six girls, four boys). The studies were performed under the ethical guidelines of the American Psychological Association and the Italian Association of Psychologists. In accordance with the APA (2010), the participants' parents gave their written informed consent to the experimental procedure. Anonymity of data was also guaranteed. There were no conflicts of interest that could have prejudiced the conduct or presentation of this investigation at any stage.

Procedure

Children began with a session designed to establish rapport and to familiarize the children with the topic of pictorial judgment. First, the experimenter talked informally with the children, asking about their tastes in to drawings, paintings, and color-preferences. The interviewer specified an interested in what the children think about some artistic issues, and that there are no right or wrong answers to the questions that will be asked. Children were then interviewed individually in a quiet room for about 15 min.

The interview began with viewing a purpose-made silent video (duration: 2.10 min) in their classroom. There were two people in the video, neither of whom was a professional actress. In scene 1, a woman sits at a table, painting. She then puts down her brush, looks at her picture with a satisfied expression, then hides it in the drawer of the table, and leaves the room. In scene 2, another woman enters the room and looks around. She opens the drawer, and finds the picture. She looks at it, smiles, and exits taking the picture with her. In scene 3, a building with a sign "Museum" on it is shown. The woman enters and hangs the picture she took from the drawer on a wall in the museum.

The following six questions in colloquial Italian were asked in randomized order:

To be identified as an artist, is it necessary to exhibit your works in a museum?
Must the artist show her works to other people?
Is it important for the artist to exhibit her pictures?
In order to become famous, does an artist have to exhibit her works in a museum?
If I paint a very beautiful painting and I keep it hidden at home, will people think I am an artist or not?
If you create a work of art and you do not show it in a museum, are you an artist or not?

Results

The data of interest in this study were only whether children answered yes or no, not the details of the reasons given by the children. Note that each question wording required a yes or no answer, but the children were free to add spontaneous comments about their reasoning. If the added comments obscured the child's position on a question, the interviewer said that he understood and again asked the question in the manner that someone would who was checking that they indeed understood. For example, after the question "In order to become famous, does an artist have to exhibit her works in a museum?" one 10-years-old child replied: "I do not know, the museum is important, and an artist must exhibit his work there, but can also put it on the internet, or in the street." The researcher then asked: "So do you think the artist must set out her works in a museum?" and the child replied "No, not only in the museum but also in other places." Accordingly, that child's answer was scored as No. Assurance was needed that the answers were consistent with the question; therefore the children's verbalizations were analyzed by three judges. They conducted a preliminary individual analysis on each child's answers, and then, where necessary, discussed the matter until they reached a unanimous decision (Losito, 1993). Note that the interviewer and judges worked blind to the data-plan used for Section "Results" of the present paper; and the person who drafted that plan and the account worked blind to any details of the data-emergence.

The data-analysis below is quantitative, with qualitative issues confined to illustrative status in examples of answers given below for the purpose of information to show how children were expressing judgments.

With Bonferroni correction, an alpha level of 0.008 was set. The two older groups maintained that artists *must* show their pictures to others (19/20 children, binomial $p < 0.001$, whereas

the youngest group denied it by a small majority (6/10 children, binomial chance). The results were identical for a randomly inserted weaker variant question in which it was not asked whether display was necessary but rather whether display was *important*. The data are set out in **Table 1**. The results were identical for the video-related question of whether other people will think that an artist who keeps a beautiful painting hidden is an artist. To give an indication of the reasoning of the most articulate of the children, the 10-years-old, three examples are: "If you paint a beautiful picture and you keep it hidden at home, you are not an artist for others, because artists show their pictures." Again: "To become an artist a person must show his works of art to the others, if he keep them hidden at home, he will never become an artist because [. . .] the others are the ones who can tell whether he is an artist or not." And again: "For example, we went to the seaside and we saw on the street one guy who was painting some poster with spray paint and then he was selling them. He was an artist."

In sum, whichever of the three target questions was asked, the two older groups had integrated the intention to display with that of production. It will be economical to defer to the discussion the question of whether the use of systematically varied repetition of questions bears on how strong those data might be.

Scanning down the columns of **Table 1**, it is evident that the 10-years-old were unanimous for 4/6 questions asked, and showed a majority of 7/10 and 8/10 for the remaining two questions. A score of only five deviations from unanimity over 60 answers exceeds expectations of finding firm effects. Clearly, for the children, whilst it is desirable to put a picture in a museum, all agreeing that it is an indicator of fame, a museum is seen as a vehicle for display not as end in itself. Here, are three representative extracts from the older children to illustrate the type of data sustaining the above summary results on their unanimity: "It is not necessary to show them in a museum, the artist can also show them at home, he can invite some people at home. . .the important thing is to show them." Again; "If you want to become famous, you must show them . . . but it depends: if you want to show them, all right, if you want to show only part of them, all right. . .it's you who decides." And again: "It is not always necessarily a museum, it is possible to exhibit also in an art-gallery or in a private exposition. . .even in the street to show art, to show how beautiful art is, so that more people maybe learn about art. It is to promote art." It appears that here a basic criterion for being an artist concerns the gaze of others, independently of where the communication from artist to viewer actually occurs. Turning now to the 5-years-old, it is evident that their answers are far from unanimity, always being a 6-4 or 7-3 split. The 8-years-old reassuringly present an intermediate state of affairs between the 5- and 10-years-old results.

To sum up, the results are as predicted from the strong version of Freeman's position. That is, the evidence from the very first trial show that children during middle childhood the children integrate artist and viewer as into a representation of someone who intends both to produce and to display pictures. What we could not have predicted was the age at which that integration was evident.

STUDY 2: MAKING AN INFORMED JUDGMENT ABOUT TYPICAL POSSIBILITIES

The next study focused on typical possibilities in the pictorial domain. One topic centered on what is decisive in judging a picture worthy of display, over the span from its origin of production, its quality as a product, and the subsequent mentality of art-critics. Critics are supposed to make up their minds on what is deemed worth exhibiting. The second topic highlighted the question of beauty that is a criterion in everyday naïve esthetics (Freeman, 2004; McManus, 2011). Asking questions about pictorial beauty been used to identify a developmental trend (Parsons, 1987), from the age of 5 years onward (Freeman and Parsons, 2001). The trend is particularly useful for normative purposes to check whether a sample seems to be typical or precocious.

Procedure

After a short break, the child was again interviewed back in the same quiet room for about 15 min. Children were asked five randomized questions (note that the Italian superlative was used in the first three questions listed below, but acts less radically than in English, i.e., is an intensifier of X with the sense of 'extremely X').

What is extremely important when judging a work of art? Is it how beautiful it is?
What is extremely important when judging a work of art? Is it who made it?
What is extremely important when judging a work of art? Is it the judgments of art-critics?
Does a work of art made by a famous artist have more value than one made by an unknown person?
Is beauty the only thing that matters in judging a work of art?

The method of conducting the interview and coding of responses is the same as in the previous study.

Results

Table 2 contains two cells where one of the questions was omitted, because the 5-years-old did not know what the term 'art-critic' meant. Setting those cells aside, scanning the top rows of **Table 2** reveals that all the 5-years-old favored beauty as a criterion for judgment (binomial $p = 0.001$, beyond the Bonferroni-corrected alpha of 0.01), reassuringly in line with Parsons (1987) insistence on young children's prioritization of beauty. As one child commented "It is art because it is beautiful." In contrast, 9/10 of the 10-years-old identified authorship as a criterion for judgment (binomial $p = 0.001$), and divided 7-3 on beauty (binomial $p = 0.50$). Thus a reversal occurred between the youngest and oldest groups. Again, the 8-years-old were intermediate and sometimes made complex judgments, e.g., "When you judge a painting the beauty is important. First of all you see if it is beautiful or ugly. Then it is also important to know who the author is." Using beauty as a criterion, the sample appears developmentally congruent with that of Freeman and Sanger (1995) for this most common of esthetic considerations.

TABLE 1 | Frequency of answers in Study 1.

	Age group (years)		
	5	8	10
In order to be identified as an artist, is it necessary to exhibit your works in a museum?			
Yes, it is necessary for an artist to exhibit in a museum if they are to be considered an artist	4	5	7
An artist has to exhibit but not only in a museum, even in other places	6	5	3
Must an artist show her works to others?			
Yes, it is necessary for an artist to show his works to others	4	9	10
No, the artist is an artist even if he doesn't show his works	6	1	0
Is it important for an artist to exhibit?			
Yes, it is important for an artist to exhibit his works to others	4	9	10
No, it is not important for him to exhibit his works to others, it's	6	1	0
To became famous, does an artist have to exhibit her works in a museum?			
Yes, a famous artist exhibits in a museum	7	7	10
No, a famous artist exhibits not always in a museum but also at home or on the roadside	3	3	0
If I do a beautiful painting and keep it hidden at home, do people think I'm an artist or not?			
If I paint, I am an artist even if I don't exhibit	6	1	0
If I am a true artist I have to show and exhibit my works	4	9	10
If you create a work of art and don't show it in a museum, are you an artist or not?			
If I create a work of art I must exhibit it in a museum to be considered an artist	4	7	8
If I create a work of art I don't have to exhibit it in a museum, to be considered an artist I must be skilled	6	3	2

TABLE 2 | Frequency of answers to What is most important when judging a work of art?

		Age group (years)		
		5	8	10
Beauty	YES	10	6	7
	NO	–	4	3
Authorship	YES	–	6	9
	NO	–	4	1
Judgments of art-critics	YES	–	8	8
	NO	–	2	2

TABLE 3 | Frequency of answers to Is a work of art by a famous artist more valuable than one made by an unknown artist? and Is beauty the only thing that matters in judging a work of art?

		Age group (years)		
		5	8	10
A work of art made by a famous artist has more value than one made by an unknown author?	YES	1	8	7
	NO	9	2	3
Is beauty the only element that matters in judging a work of art?	YES	9	8	7
	NO	1	2	3

The 10-years-old were almost unanimous (9/10, binomial $p = 0.001$) that it is extremely important to know who was the painter when judging a picture: "If you don't know the story of that person, if he was sick. . ., you cannot understand the story of the painting." Turning now to the role of art-critics, in the older two groups 16/20 children (binomial $p = 0.006$) endorsed critics' importance even given the considerations of beauty and of authorship: "When you have to evaluate an artwork, it is important to ask advice from art critics . . .if you do not know it, the picture loses a part of its value." Art critics were described as experts, authorized personnel who can transmit judgments: "Knowing what the art experts think is important because they understand better than you. . .they can help you. I would surely listen to them"; and ". . .they are experts about these things and they know a lot more things than me." The results are not quite as strong as the unanimity that was evident in Study 1 on the basic concept of a viewer. Presumably, extension to informed critical viewer judgment is still in process of formation.

Finally, authorship was again asked about as shown in **Table 3**. The 5-years-old almost all (9/10, binomial $p = 0.001$) denied that it mattered to the value who produced an artwork, but again the older groups lacked unanimity. And when a forced question-form was used, asking whether beauty is all that matters in judging a picture, again the youngest were almost unanimous in judging that it was all that matters (9/10, binomial $p = 0.001$), and the older groups were divided. Examples of older children's reasoning is as follows: "Knowing what the art critics think is important, because with a positive judgment a picture increases its value, whereas with a negative judgment its value decreases." Again: "Yes, knowing who the author is. . . yes, because it lets you know something more about the picture. . .it gets across to you also the story of the picture, since you could also ask for information from the author. Each painting is unique also because the artist transmits his narrative through the painting."

To sum up, the results are as predicted from Parsons' work on children's understanding of art in that the youngest children's thinking was predictably dominated by the question of beauty regardless of authorship; and three-quarters of the older children's reasoning had developed beyond that. What we could

TABLE 4 | Frequency of answers to questions in Study 3.

	Age group (years)		
	5	**8**	**10**
Is it important that a museum exhibit artists' original works?			
Yes, the museum must exhibit only original works	10	10	10
No	0	0	0
Is a fake as valuable as an original picture?			
Yes	0	0	0
No, the original is more important	10	10	10
Would you show a fake in a museum or an art gallery? Why?			
I would exhibit original paintings because the public might lose trust in the museum	1	8	6
I would exhibit original paintings because it's wrong to cheat visitors	9	2	4
Why a fake is not ok? What is the problem with a fake?			
Faking it is wrong because it's cheating to copying what the others made	10	7	6
The forger doesn't prove his ability and creativity	0	3	4

not have predicted was the degree of diversity of thinking in the older children.

The next study forms a converse of the first study, whereby instead of hiding an original picture an artist puts a forgery on display. The technique is to tell the children of a skilled forger, Van Meegeren, then to interview the children about what is wrong with forgery. The aspect of interest is whether the children give unqualified moral reasons (forgery is wrong in some respect) or whether they give mentalistic answers in terms of the effects of forgery on viewers' minds. A conception that it is authentic products that can be displayed in a museum becomes incorporated into a naïve theory of art (Newman and Bloom, 2012; see also Cavanagh et al., 2013; Seeley, 2013). Young children condemn passing off someone else's originality as one's own even if the children themselves like the copy (Frazier and Gelman, 2009). The assumption yet again is that there will be a developmental shift evident after the age of 5 years in the direction of mentalistic reasons being given by the children for their judgments.

STUDY 3: THE PRODUCTION OF FALSITY IN PICTURE-PRODUCTION AND DISPLAY

Procedure

The children were shown images of two paintings (printed in color in A4 format), one original, "The Milkmaid" by Vermeer, and the other one forged (*falso*), "Supper at Emmaus" by Van Meegeren. While showing Vermeer's painting, children were told about the peculiarities of the artist's style. In showing the forgery, children were told in non-evaluative language about Van Meegeren's history, highlighting his intention to copy perfectly the style of another artist, to pretend to be him, and the fact that once the truth came out the picture then lost monetary value. Ten-minute interviews were then individually given, in a quiet schoolroom, with four randomized questions:

Is it important that a museum exhibit the original works of an artist?

Is a fake equally as valuable as an original picture?

Would you show a fake in a museum or an art gallery? Why?

Why is a fake not OK? What is the problem with a fake?

The method of conducting the interview and coding of responses for the first questions was the same as in the previous studies. In addition, for the last two questions, the judges were asked to undertake a content analysis and to create two modal categories, afterward to assign each answer to one or the other category.

Results

With Bonferroni correction, an alpha level of 0.01 was set. We begin with the two questions that served as a check for whether the children had understood the scenario. The children had been told that the picture had lost its monetary value when found to be a forgery, and when the question 'Is a forgery equally as valuable as an original picture?' was asked as a control question, the judges were unanimous that all 30 children passed (binomial $p = 0.001$) as shown in **Table 4**. Secondly, every child affirmed that a museum must show only originals (binomial $p = 0.001$), and the switch from affirmative to negative here rules out simple response-bias as a potential confounding.

Accordingly, given the response agreements, it is now feasible to ask whether the children all give the same reason for why museums avoid forgeries. Is it merely because originals are worth more? Children's answers were clear and the judges easily picked out the same two categories. One category was confidence in the museum that chooses what to display, e.g., an 8 years-old said, "The museum is an important place and the paintings that are there are important and chosen to show them to visitors and those who go there trusting in the museum." The second category concerned the rightful display of only original paintings, representative of the artists' creativity. **Table 4** reveals a cross-over in the reasons offered. Of the 5-years-old, 9/10 took up a moral position, asserting that it was wrong to cheat viewers, whilst the

remaining child took up the mentalistic position that it might cause viewers to lose trust. In contrast, the 8-years-old split in the reverse direction by 2-8 (the cross-over is significant at $p < 0.01$, Fisher test). Clearly some important development was occurring. However, in that light we do not know why the 10-years-old split nearly 50-50, at 6-4. One looks to the final remaining question for possible illumination. The question 'What is wrong with a forgery?' proved interesting in three respects. First, not a single child answered in impersonal terms of the loss of monetary value compared to an original, and the majority, 23/30, confirmed that what is wrong with a fake is that it involves cheating (binomial $p = 0.003$), with all 10 of the 5-years-old asserting that anti-cheating moral position (binomial $p = 0.001$). Secondly, the 8-years-old again were less than unanimous but this time with the majority going in the 5-years-old direction with 7/10 asserting a moral position, so no great development is manifest. The 10-years-old were again split, with 6/10 asserting the moral position, so the 10-years-old split on the previously tabulated question looks less aberrant. Thirdly, the seven non-moral answers from both the older groups, a third of the older groups, are interesting. All seven children asserted that forgery was wrong because forgers disadvantage themselves by not being able to display their skills as an original artist. That reason is of particular interest because the story had made explicit how the forgery had indeed enabled the forger to show skill with the paintbrush. To the best of our knowledge, that aspect of an early view of the importance of originality in artwork has not been documented in the psychological or art-education literature (though see Wolz, 2014, for a pioneering study involving perception of talent in original artists and forgers).

To sum up, the results are exploratory and contain a diversity of children's reasons for their judgments. The use of a transgressive act of picture-display, a forgery, provoked the diversity in line with the suggestion of Freeman and Allen (2013). It will be interesting to use the results to compile a set of forced-choice options to present to children.

DISCUSSION

In Study 1, three variants of a target question probed whether artists intended to show their work to others. The finding was that 8-years-old had replaced (a) a unifunctional categorisation of an artist simply as a picture-producer, in favor of (b) a categorisation of an artist as an agent who is linked to viewers. Previously, Maridaki-Kassotaki and Freeman (2000) had identified the emergence of a critical mentalistic theory of art unifying picture-production and picture-display at preadolescence. The new finding suggests that one should look to even younger children for a conceptual transition. Where Freeman (2004, 2011) had identified the conceptual challenge facing children, we can now add that 8-years-old rise to the challenge by firmly integrating the role of viewer with the role of artist. Study 2 investigated whether (a) beauty, (b) authorship, or (c) critical opinion were most important in judging a picture. The results confirmed the focus on pictorial beauty by 5-years-old predicted from the literature inaugurated by Parsons (1987). Beyond that age, the study served to open the field of possibilities of developmental change, and here, respect for the minds of art-critics emerged in 16/20 older children ($p < 0.001$, binomial), pertaining to one of the highest levels of mentalistic engagement with pictures identified by Bullot and Reber (2013). Again, the majority of 8-years-old were revealed to be mentalistic reasoners. Study 3 found a cross-over in reasons given for why forgery is unacceptable. Five-years-old were unanimous that it is wrong to cheat, whilst the 8-years-old were incorporating a mentalistic concept of viewers losing trust in the authority of the museum. To the best of our knowledge, documentation of that acquisition is not to be found in the experimental literature. Nor is the sign, in a third of the older groups, of awareness of forgery as hampering the artist in demonstrating artistry, despite the preceding briefing on van Megeeren having mentioned his assiduity and skill.

Before discussing implications of the evidence, it is essential to evaluate the quality of the evidence. It will be economical to focus the questions whenever feasible to the particular study they bear on most cogently, rather than repeat the discussion for every detail in the repeated-measures design.

Sample Characteristics

The most general question of all is whether the sample of children had any developmentally atypical characteristics? The concern is whether the complex cultural context within which the sample grew up might make the data normatively of limited value. Might the children have been culturally led into an atypical developmental pathway? The sample was made up of urban Italian children in a country with the richest pictorial art collection in Europe. The context of the investigation is thus one of familiarity with art display. We suggest that the consideration is plausible, but two pieces of evidence ameliorate the concern. First, there is no evidence that Italian children become pushed to any conceptual extreme by their exposure to art: thus, Ruggi and Gilli (1998) found that Italian children still took their criteria for what is beautiful and good from nature instead of from pictures. Secondly, there was the focus on beauty predicted from previous work in other cultures, with both a pictorially representative sample (Parsons, 1987) and a pictorially disadvantaged sample (Freeman and Sanger, 1995) That focus on beauty was shown in the 5-years-old and held up under forced-choice questioning in Study 2: beauty was all-important and authorship was irrelevant. The conclusion is that there seems to be no normative disadvantage in using the sample. On the contrary, there is the advantage that Italian children find it conversationally natural to talk about art and the display of art without floundering. That has three consequences. First, it is easy to establish and maintain rapport over the topic. Secondly, children readily acquire a pictorial vocabulary with which to formulate their judgments, e.g., a distinction between pictures in general (*disegni, illustrazione*) and display-pieces (*quadri*). The availability of the distinction makes it easy to focus on display, which was the target of Study 1. The distinction appears also in Spanish, which would perhaps be first choice for systematic replication. Finally, as was noted previously, it was never necessary to rephrase any of the questions.

Sample Size

The question is whether the trade-off between sample size and lengthy testing may have been too one-sided: sample sizes of 10 per age-group were small. Yet the data in the primary study, Study 1, were compelling in terms of level of probability with Bonferroni-protected p. In particular, given that only 1/20 children in the older groups was an exception to unanimity that an artist must display pictures, we suggest that the data were strong enough for their purpose. Conventionally, $p < 0.001$ is generally acceptable. It would be encouraging if future research found that small samples were adequate to expose robust effects at the level of individuals.

Individual Consistency under Repeated Questioning

In any investigation which relies on extended work with children, the hope is that each child remains in a fairly stable state as a data-generator (e.g., not becoming tired or self-conscious). In that light, there are two procedural points about any investigation, two advantages to repetition and two dangers to be tested for. We shall take these six considerations in order.

One procedural points is to avoid blurring the distinction between new and old questions, so that it should always be discursively clear when one is opening a new topic without any implicit pressure to recall what has already been said in the interview. The other procedural point is to introduce changes in topic if feasible to maintain interest and again to help minimize carry-over effects. Both of these were incorporated into the present investigation, by (a) never having literal repetition of any question, and (b) interpolating Study 2 on non-mental states between the two target-issue studies. We propose that the present investigation conforms to those two requirements.

The first advantage to a long procedure lies in not having repeatedly to establish rapport. It is easy to monitor rapport, once it is established, and with increasing acquaintance with the child it is easy to maintain rapport. We noticed no failure in the process, in particular no drop-out threatened to occur. The second advantage lies in the stability of the sample: is that there is no need to check whether the introduction of each new individual into the investigation is adding noise to the corpus of evidence by virtue of their developmental status or their context (e.g., noisier classroom or anxiety-ridden school). We conclude that the present investigation has those advantages.

We finally consider the two dangers: (a) that an individual's answers may be unstable under repeated questioning, and (b) the converse danger that an uninformative uniformity is inculcated. Let us take these in order. Rose and Blank (1974) proposed that children, if they think that they are being asked a similar question twice because they had given the wrong answer before, will be liable mechanically to change their answer (see Siegal, 1997, for a discussion of five alternative explanations of the effect). Yet in Study 1, the target data went in the opposite direction to the Rose-Blank effect: all the children gave their particular answer each time over the three related questions. Note that the consistency necessarily means that the children gave their particular answer on the very first time of asking, so the judgment cannot be attributed to any unwanted order-effect. However, there is another opportunity to raise the repetition question, in Study 2. The older children's judgments were marked by unpredicted diversity. Might that diversity be an aspect of the Rose-Blank instability of answering, only this time at the sample level rather than within an individual's sequence of answers? Yet there was less reiteration than in Study 1; and if reiteration was not a problem in Study 1, there is no apparent reason why it should obtrude with two of the groups in Study 2. That leaves two possibilities. On the one hand, maybe the diversity is a sign that children were in the process of taking into account disparate considerations, much as Freeman (2000, 2004, 2011) has argued. On the other hand, maybe there is potential unanimity which is obscured by the procedure of enquiring into typical possibilities. Certainly the analytic power of investigating atypical possibilities was the rationale in theory of mind research, leading to the focus on false beliefs. Either way, the primary purpose of Study 2 was only to delimit an area of testable possibilities in children's conception of display.

Lastly, in Study 2, the children might recall Study 1 and come to infer a theme and a core interest of the adult. Might that lead to children giving mechanically compliant answers? Study 1 had been centered on picture-display, so in Study 2 we deliberately avoided posing any question about the importance of display. There was no basis for a desired answer to be inferred about whether it mattered if a picture was beautiful or not. That enabled us to document the predicted beauty-centered criterion in the younger children. In Study 3 after denying the value of a forgery, all the children affirmed that a museum must show only originals. That could be compliance. However, that affirmation was merely a check on whether the children understood the problem. The actual data, the reasons they gave for their judgment, had no basis in priming form Study 1. So those data are suitable to serve an advisory role for the next step in research. We conclude that we can rule out simple compliance as a complicating factor.

In sum, while no method can be perfect, we conclude that the present approach is safe from the major problems of repeated interview, and that it benefits from the commonest precautions. In particular, the crucial target data from Study 1 were consistent right from the very first question, so could not have become weakened by uninformative instability or compliance. It is straightforward to try replication on that. For the rest of the study, we do not suggest attempted literal replication: it would be far more informative to do systematic replication.

Setting the Novelty of the Approach in Context

The most general question is whether it is worth continuing the present approach in future. To answer that it is necessary to consider (a) what continuity there is with previous approaches, set against (b) what innovation is in the present approach. It seemed reasonable to use adopt a common procedure which slowly increased children's involvement. The procedure began with a simple scenario which breaks the norm of an artist's role in displaying pictures by having an artist hide a picture. That formed a single target-question test, rather in the economical way

that a false-belief test does, involving some mismatch with an expectation. That target test was preceded only by the rapport phase. The ease of establishing rapport over the topic means that there is no serious doubt over the complementary worry that children might not have warmed up. The final target study continued the theme of norm-breaking by focusing on displaying a forgery. The data-processing was refocused on whether or not children mentioned any uncued mentalistic considerations. The essential innovation was to center each study on the concept of pictorial display. Whilst the role of an artist is naturally concerned with picture-production, the role of a viewer can only be carried out once a picture is put on display. So, if one is to study the child's conception of relations between picture, artist, viewer, and their world (Freeman, 2008), it is important to investigate the child's conception of a relation between artist and viewer whereby an artist hands over a picture for display which then makes it possible for someone else be a viewer. We conclude that the method seems suitable for extension to child's conception of what intentions a viewer should have if they wish to understand the minds of the artists, and their pictures.

Development of the Method

In that light, it is worth raising the question whether the method should continue to avoid giving mentalistic cues. The protocols were made to contain as few explicit verbal mentalistic cues as feasible, as did Maridaki-Kassotaki and Freeman, 2000 when investigating spontaneous mentalistic conceptions of a pictorial display-piece. It is empirically possible that the children have deeper mentalistic formulations which might be activated by cues. It is, however, important to study spontaneous uncued conceptions because those provide an immediate point of entry for art-educational intervention. There are psychological lessons to be learned from art education attempts to promote and influence children's theory of art (Freeman, 2008; Freeman and Allen, 2013). We suggest that a useful research strategy is to employ the following converse methods. With older children's spontaneous reasoning, it is worth documenting spontaneous reasoning as widely as possible with cues. With preschoolers, where the salience of pictorial intention is documented (Bloom and Markson, 1998), it is worth concentrating on methods designed to identify implicit conceptions below the level of awareness where the preschoolers cannot access them for themselves (much as has been done for false-belief tests: Freeman et al., 1991; Clements and Perner, 1994; Freeman and Lacohée, 1995; Clements et al., 2000; Schneider et al., 2015). Presumably one way forward is to continue the adaptations of a false-belief design as in Study 1 which delivered the crucial yes/no data on children's conceptual integration of artist and viewer.

Theoretical Implications: Mentalistic Reasoning

A viewer may be a passive beholder of a picture or an active agent attempting to become involved in the artist's experience. The issue of artists' and viewers' intentions is hugely important as an aspect of agency. Note that mentalistic concepts are interdependent: one should consider an intention to do something along with (a) a desire to do something, and (b) a belief that something is worth the attempt. The present approach is necessarily not solely about intention to the exclusion of other components of mentalistic reasoning. However, the concept of intention is fundamental because intention is at the origin of action-plans. The agent who implements an action plan and creates an artifact is a key component of everyday reasoning about who has priority in ownership of the artifact (Levene et al., 2015). There is a suggestion from Study 3 about how 8-years-old may distinguish between authentic pieces and forgeries. The issue of forgery becomes interesting here because creation is divided between two agents. One agent creates the original and another agent creates the forgery. The two agents have distinct intentions toward a viewer. We predict that 8-years-old will segregate their intentional concepts of artist and forger, judging that an artist who does not display her picture cannot be regarded as an artist but that a non-displaying forger is still a forger.

A second developmental question is whether young children put too much weight on intention as though it dictated how a picture must be interpreted. Bloom and Markson (1998) argued that for preschoolers, if a picture-producer has the intention of representing a balloon by a circle and line, that shape cannot then represent a lollipop. For preschoolers, intention thus restricts pictorial possibilities. We suggest that it is timely to investigate when the restriction is overcome, and an understanding of intention then becomes a resource for children. It has long been recognized that even very young children have the experience not only of forming clear pictorial intentions, but of changing intentions during the course of drawing (Freeman and Adi-Japha, 2008).

Such issues concern the wider theory in which the present work is embedded. Theory of mind research has energized research into topics in adjacent domains (e.g., Fink et al., 2015, on friendship; Freeman et al., 2000, on numeracy). Pictorial reasoning emerges as a distinct domain which becomes developmentally enriched by mentalistic reasoning. There are developmental differences between the theory of mind domain and pictorial reasoning. Even in preschool, there are empirical differences between passing procedurally matched false belief tests and outdated picture tests (e.g., Peterson and Siegel, 1998). It appears that after the age of 5 years, children begin the conceptual work of incorporating a representation of the viewer into that of an artist. Artists are supposed to show their work to others, and the work is supposed to be genuine lest viewers lose trust. The process of such acquisition may be characterized as one of moving from a fixation on pictorial beauty and moral integrity to a mentalistic conception of the art domain. Possibly, 'Children might call a picture that looks like a bird "a bird" not merely because it looks like a bird, but because its appearance makes it likely that it was created with the intent to represent a bird. In general, appearance – and shape in particular – is seen as an excellent cue to intention' (Bloom and Markson, 1998, p. 203). In that respect, there opens a two-way relation between theory of mind and theory of art: visual communication (Freedman and Stuhr, 2004). Eight-years-old remain an intriguing group in the throes of acquisition, where alongside making predictions about them it is

important to discover hitherto-hidden facets of their reasoning. Whereas, Study 1 and half of Study 2 tested hypotheses, the other half of Studies 2 and 3 were steps in exploring the range of possibilities that the domain affords.

AUTHOR CONTRIBUTIONS

All authors listed, have made substantial, direct and intellectual contribution to the work, and approved it for publication.

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"No more a child, not yet an adult": studying social cognition in adolescence

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There are several reasons why adolescence is interesting. It is in this phase that an individual finds herself fully facing the external world: basically equipped with the kind of social cognition that s/he has acquired at home, at school and through the media during childhood, s/he has now to meet a host of other, diverse views of what "reasonable," "appropriate," or "expected" courses of thought and emotions are, in the wild with friends and peers, romantic or sexual partners, teachers and employers, and the society at large. Furthermore, she is also expected, both at home and in the external world, to have a wholly new degree of control over such courses. While the idea that the development of social cognition still progresses after infancy (and possibly throughout the life span) is clearly gaining consensus in the field, the literature building on it is still scarce. One of the reasons for this probably is that most tests used to study it focus on its basic component, namely theory of mind, and have been mostly devised for us with children; therefore, they are not suitable to deal with the hugely increasing complexity of social and mental life during adolescence and adulthood. Starting from a review of the literature available, we will argue that the development of social cognition should be viewed as a largely yet-to-be-understood mix of biological and cultural factors. While it is widely agreed upon that the very initial manifestations of social life in the newborn are largely driven by an innate engine with which all humans are equally endowed, it is also evident that each culture, and each individual within it, develops specific adult versions of social cognition.

Keywords: adolescence, social cognition, theory of mind, mindreading, metacognition, self-reflection, development

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Introduction

There are several reasons why adolescence—and, more to the point, social life and social cognition in adolescence—is scientifically interesting. It is during this period that an individual finds herself[1] fully facing the external world: basically equipped with the social competences that she has acquired at home, at school and through the media during childhood, she has now to meet a host of other,

[1]Throughout the paper we will use either the feminine or the masculine when referring to unspecified human beings. This is only made for the sake of readability and is not meant to convey any gender-related position or the idea that there may or may not be differences in social cognition between genders. However important, such themes are simply not relevant on the level of abstraction on which our arguments are cast.

views of what "reasonable," "appropriate," or "expected" courses of thought and emotions are, *in the wild* with friends and peers, romantic or sexual partners, teachers and employers, and the society at large. Furthermore, she is also expected, both at home and in the external world, to have a new degree of control over such courses.

Substantially analogous considerations hold when social cognition is viewed in its reflective aspects, that is as a means of self-knowledge. Again, adolescence is a crucial phase in the development of an individual's understanding of herself, of her own feelings and desires, her own ways of reasoning, her own reactions to external as well as internal situations, etc. And, again, both the need and the actual ability to control these courses of thought and emotions change greatly during this period.

However, the literature on social cognition in adolescence is scarce and scattered, particularly if compared with other ages of life, like infancy and childhood, or other domains of cognition: few empirical studies are available and there is no unitary theoretical framework within which to understand them.

Yet, a better understanding of adolescence would be crucial, if only because a quantitatively impressive part of human kind currently falls within such period. The present generation of people aged 10–24 years is the largest in history: at 1.8 billion, it comprises a quarter of the world's population. Nearly 90% of them live in low- or middle-income countries where, due to higher fertility rates, they constitute a far greater proportion of the population than in high-income countries (WHO, 2009).

Still another reason of interest is that several disorders—first and foremost, schizophrenia or substance abuse, but also mood and anxiety-related dysfunctions—have their onset or witness an increase during adolescence and early adulthood.

This makes it all the more interesting to understand what social cognition is in this phase of life, at least within the widely diffused theoretical framework that views a crucial aspect of social cognition, namely *theory of mind (ToM)*, as crucially involved in these disorders (Frith, 1992; for reviews, see Bosco et al., 2009a, and respectively, Bosco et al., 2014a).

This paper will discuss social cognition in adolescence. We will include both a review of the literature available and a theoretical discussion. We are aware that adolescence is, at least in part, a social construction, and that its features may vary between different sociocultural and historical therefore, we will do our best to keep our arguments on a sufficiently general level to allow for these differences. Yet, we are also aware that we are Western researchers, like most of our peers, and that this puts inescapable biases in our analyses.

From Childhood to Adolescence

The social world is the most important realm of interaction of human beings, that within which we spend the whole of our lives. Even when we are alone with ourselves, be it at home or during a walk in the mountains, we are immersed in an environment which is more or less completely made of social artifacts and products; even more crucially, our thoughts and feelings, as well as our actions, are largely shaped by (and generally aimed at) the social world (Clancey, 1997).

Unsurprisingly, a great deal of effort has been devoted within the psychological sciences to investigating into the nature of human social cognition, its evolution in the species and its development in the individual.

As far as phylogeny is concerned, starting from pioneering research on so-called "Machiavellian intelligence" (e.g., Humphrey, 1976; Byrne and Whiten, 1985; Dunbar, 1993), it has been claimed that social cognition is at the very root of the particular evolution of the primates' mind. Technology and a sophisticated use of artifacts would have played less important a role, at least until the appearance of the first hominins, since when the evolution of material cognition appears to have paralleled a further evolution of social cognition. The social life of humans, like that of the other great apes, is highly complex: they form long-term social relationship with others, understand the social relationship among third parties, and recognize that the actions of individuals are driven by their goals and by their perception of the situation (Tomasello and Vaish, 2013).

The phrase *social cognition* generally refers to "the various psychological processes that enable individuals to take advantage of being part of a social group" (Frith, 2008, p. 2033). It is crucial to put an emphasis on words like *cognition* and phrases like *to make sense*, which allow to keep social cognition proper as distinct from the mere influence that an individual's behavior may or may not have on the behavior of other individuals (Bara and Tirassa, 2010), something which instead is universal in animals and even in plants.

An important facet of social cognition in primates is the ability to understand the mental states of other individuals, including their intentions, desires and beliefs, i.e., what is called *ToM*, *mentalizing*, or *folk psychology* (Davies and Stone, 1995; Nichols and Stich, 2003; Goldman, 2006; Blakemore et al., 2007; Hutto et al., 2011). Together with other sophisticated cognitive competences like social emotional processing (Burnett et al., 2009), this capacity enables an individual to understand, explain and predict another individual's actions and thus also allows for the negotiation of complex interpersonal decisions (Crone, 2013). Social cognitive processes include also basic perceptual processes such as face processing (Farroni et al., 2005), biological motion detection (Pelphrey and Carter, 2008), and joint attention (Carpenter et al., 1998).

It is not completely understood if, or to what extent, this particular type of social cognition belongs to species other than ours (Heyes, 1998): it appears, however, that ToM-like competences are more widely diffused among primates than what is commonly thought (Tomasello, 2014). What can safely be said is that, while the social life of great apes is mainly about competition, human societies are vastly more and distinctively structured around and for cooperation (Tomasello and Vaish, 2013), which of course founds on the further evolution of peculiar cognitive competences, among which our special kind of social cognition. In a word, the social life of humans is largely a matter of *intersubjectivity* or *sharedness* (Premack and Premack, 1994; Tirassa, 1999; Tirassa and Bosco, 2008).

As regards ontogeny, there is now a remarkable amount of empirical literature in psychology describing the first years of development of social cognition and mindreading. This body

of literature is far from yielding a univocal sense of what a child's social cognition is or how it develops: rather, it appears to be a multidimensional, highly complex patchwork of different subareas, different theoretical or empirical approaches, and, necessarily, different results.

Most proposals in this area subscribe to a common philosophical framework defined by a set of core assumptions, namely, as stated above, that the primary function of social cognition is to predict, explain, and control the actions of the others, which is made possible by the attribution, and hence the representation, of their mental states. The big issue is whether such attributions are achieved by means of theoretical inference, simulative analogy, or a bit of both (Gallagher and Hutto, 2008; Hutto et al., 2011).

Furthermore, as Hutto et al. (2011) argue, most theories tacitly assume that human adults entertain a fully developed mindreading; consequently, the main question concerns the extent to which the mentalizing abilities of infants (if and when they indeed have any) might compare to those of the adult. However, there is a substantial lack of cognitive models of mindreading in adults (see the review in Apperly, 2013) or of what the phrase *a fully developed mindreading* could precisely mean.

Gallagher (2006) notes that ToM approaches to the explanation of how we come to understand others typically are abstract (third-person when they need to be second-person), mentalistic (starting with the supposition that there are things like minds, beliefs, desires that we have no access to in others, and sometimes even in ourselves), and biased toward theoretical reason (when practical, situated reason is a better way to go: see also Bosco et al., 2009b). Overly intellectualizing what is involved in our basic encounters with others, they tend to forget emotion and our ability to read it not in the minds of others, but on their faces, as well as in their gestures and expressive movements. Yet, if the basic ontology of human social competence is the same from the very beginning of mental life (as has been claimed, e.g., by Tirassa et al., 2006a,b), a more situated, more embodied approach to social cognition should be developed, allowing the more rationally sophisticated abilities to be a precious tool that comes into play when it is necessary rather than the only nature of human intersubjectivity.

These problems notwithstanding, there can be little doubt that crucial advancements in our understanding of the ontogeny of social cognition have been achieved in the last few decades from which knowledge is likely to proceed further, though probably still without a unitary theoretical framework in the foreseeable future.

Much less is known about the ways and directions in which social cognition develops after infancy: despite the increasing interest in social cognition beyond childhood (e.g., Valle et al., 2015) knowledge of how it works in the adult or possibly decays in the elderly still is scarce and scattered. There are several possible explanations for this situation (Dumontheil et al., 2010). Firstly, the tasks that have been used to test ToM in early development are not appropriate for testing older children and adolescents. Since most ToM tasks are passed by 5-years-olds, ceiling effects might be obscuring the observation of any further development. Secondly, tasks typically enquire directly children's representations of another person's mental states; they do not tap into how ToM is used to drive decisions and actions in everyday life.

When a situated framework is adopted, further problems pop up. One is that only one-to-one interactions are normally studied, and even these are framed in terms of a subject who is asked to observe and explain another individual's behavior, rather than truly encountering him; that is, only a third-person perspective, instead of a second-person one, is adopted in practice. Another problem is that only real-time (vs. retrospective), status-free, culture-free interactions are taken into account, thus obliterating most of the complexities of real social life. Not only does the study of ToM in adolescence and early adulthood constitute a methodological challenge, insofar as it requires the creation of new empirical tasks fit to capture age differences (Henry et al., 2013; Moran, 2013; Valle et al., 2015): it also calls for a radical enrichment of the underlying theoretical frameworks.

Still another problem is that the ToM tasks that are normally used with children tend to impose rigid requirements on what the "right" answer is. This might be a reasonable choice, insofar as it can be assumed that all children—or, at least, all children of Western heritage—will basically follow the same developmental trajectories. It is less obvious, however, that the same may be the case of adults. Here, it might be said, "mindreader is as mindreader does": there is no need to assume that a plateau should exist as the final state of the ontogeny of social cognition, and even less to assume that such plateau should be the same for all individuals in all historical contexts.

In line with at least part of the current literature (e.g., Apperly, 2012; Blakemore, 2012; Bosco et al., 2014b), our stance is that the ontogeny of social cognition does not end with childhood; instead, it continues through adolescence and the different ages of adulthood, as biological, social, cultural, educational, autobiographical, reflective, and retrospective changes accrue and become ever more intertwined and stratified.

The whole issue is further complicated by the fact that the psychological literature on adolescence in its turn offers an overwhelmingly ample (and still growing), but fractured, picture. This makes it difficult to achieve a deeper and coherent understanding of it (Moshman, 2005).

In principle, and roughly stated, there can exist three possible frameworks for understanding adolescence, namely as the exit from childhood, the entrance into adulthood, or a distinct stage of human life, a bridge between what comes before and after it but (comparatively) autonomous with respect to both. While each of these views has its merit, we argue that the second is preferable: adolescence as the beginning of adulthood (in agreement with Moshman, 2005).

Of course, this is not meant to imply that there can exist a divide between childhood and adolescence/adulthood: instead, the adoption of a life-course perspective promotes understanding that the factors affecting the individual during childhood can cumulatively affect her as an adolescent and an adult. At the same time, both normative and maladaptive patterns during adolescence shape future trajectories (Sawyer et al., 2012), extending the development of (social) cognition to include issues apparently unrelated like active aging, early determinants of health and risk factors.

Physical and mental health is affected by a complex interplay of individual and social factors at personal, family, community, and national levels (Viner et al., 2012), as well as by individual differences in cognitive abilities (e.g., Romer et al., 2011), attachment history (Bowlby, 1988), and personality traits. As we are discussing throughout this paper, all these factors undergo dramatic modifications during adolescence that tend to slow down and stabilize as the individual becomes an adult—better yet, that adultness begins when these factors begin to slow down and stabilize. Given this framework, it is all too obvious that physical and mental health "leaks" heavily from adolescence into adult life.

The onset of schizophrenia, for example, typically occurs in late adolescence or early adulthood (Häfner and an der Heiden, 1997; van Os and Kapur, 2009; WHO, 2015). Also, the incidence of mood and anxiety-related dysfunctions increases during adolescence (Hankin and Abramson, 2001; Costello et al., 2002).

Adolescence, however, also presents risks and disorders of its own. For example, during this age individuals are probably the fastest, the strongest and the most resistant to disease that they will ever be; at the same time, their chances of dying from putting themselves at risk—through aggression, crime, promiscuity, reckless driving, and drug use—also peak. It follows that precisely such behaviors are the first cause of death in this age group (Casey and Caudle, 2013).

Risk behaviors appear to be caused by diminished self-control, sensation-seeking behaviors and peer pressure. Their determinants are frequently searched in the brain development and neuronal connections (e.g., Steinberg, 2008; Telzer et al., 2013). Several authors have also found a peak in risk taking as evaluated by laboratory tasks involving emotions (Figner et al., 2009; Cauffman et al., 2010) and decision making (Wolf et al., 2013).

A better understanding of adolescence and its features in terms of social cognition would thus have profound implications for protection and prevention. To relate scientific researches and methodologies to real-life issues appears to be crucial in the study of adolescence. Yet, a more critical analysis of the frequency and the contexts of occurrence of risk-taking behaviors in adolescence (Willoughby et al., 2013), an articulated model to understand the evolutionary functions of adolescence (Ellis et al., 2012), and a sound theoretical framework for social cognition during this age, are still needed to complete the picture (and then to develop its implications for protection and prevention).

What is Adolescence?

The rough definition of an adolescent as an individual who is no longer a child but not yet a true adult might seem poor and fuzzy from a scientific point of view, but it is probably the most effective in capturing the complexity and contextual dependence of the phenomenon called adolescence (e.g., Moshman, 2005; Hopkins, 2014).

In discussing adolescence, indeed, not only do we have to consider the high variability between individuals, but we also have to take into account that different societies define adolescence in terms of ages and social roles with comparatively little consistency (Sawyer et al., 2012). Furthermore, most societies throughout human history have not acknowledged the existence of an age called "adolescence," at least as we understand it (e.g., Kett, 1977; Hine, 1999; Hopkins, 2014). Many of the 1.8 billion youngsters mentioned above are likely not, or not fully, considered adolescents within their social contexts.

The beginning of adolescence is commonly identified with puberty, that is a complex biological transition which is universal in the human species, although the age at which it occurs may vary depending on features of both the individual and the context.

The decrease in the age of puberty onset that has taken place since the twentieth century in high-income countries (Sawyer et al., 2012) demonstrates the role of contexts in shaping individual trajectories, whereby the improvement in economic and material conditions like childhood hygiene, nutrition, and health appears to play a major role. At the same time, in those countries, sociocultural conditions like a longer education, possible delays or difficulties in employment, late marriage and childbearing have extended the duration of adolescence and changed its shape (Sawyer et al., 2012).

Adolescence looks different when viewed from one boundary or the other: basically, its beginning depends on biological and material features of the context, while its end depends on cultural and social factors. This also entails that individual differences become more important with age, while the merely chronological data become less important.

Around and with puberty begins a multidimensional and multilayered dynamics that involves every aspect of the individual's life. The young members of several cultures undergo specific rites of passage that take puberty as the symbolic threshold beyond which a child becomes an adult. Many cultures set one or more later thresholds after which the individual will be legally considered an adult as far as her rights and duties of a political, juridical, military, work and otherwise formal nature are concerned.

However, these further thresholds are merely relevant to legal and social norms, so much so that Black's (1990) law dictionary defines adolescence as "the age which follows puberty and precedes the age of majority." Thus, an adult is anyone whom the state legislation says is an adult, by modifying the permissions, obligations and prohibitions that in different ways change her social contexts and spheres of interaction as a member of the community. However, there is no reason to think that these norms depend on clear changes in the individual's cognition, whether social or otherwise.

A chronologically based definition promotes an understanding, typical of Western societies, of adulthood as taking place within the individual, with no concern for the social context: the end of adolescence is determined by law, with exclusive reference to age and not to the individual's interaction with other people and events (Schwartz et al., 2010). We opt for an operational definition of adolescence, instead of a legal/chronological one. Of course, this might turn out to be hardly manageable at the empirical level, where researchers need to have well-defined groups of subjects available; yet, we think that, at least on the theoretical level, this is a more sensible approach.

In fact, there may be different formal threshold ages for the different facets of citizenship, and they may vary from nation to nation or from decade to decade according to the historical context.

In other words, there is no biological threshold after puberty as well as no psychological threshold in a strict sense: the body, including the brain, progressively changes until it slowly reaches a mature stage, but it cannot be said to achieve a literally steady state, nor a state which be clearly distinguishable from adolescence. Its development never really ceases: it just slows down after the fast-paced events ongoing during adolescence proper. The same, of course, holds for cognition in general, and for social cognition specifically.

This makes identifying an end to adolescence a particularly difficult task. A phrase like *coming to terms with adulthood* is vague enough to warrant widely (or even wildly) different interpretations; and anyway, as we have said, adulthood may be differently conceived of in historically different contexts or even in different domains of an individual's life. Thus, for example, in many an affluent country it is comparatively normal to witness a divergence between the age at which an individual is legally and psychologically capable of living an autonomous adult's life and the individual or contextual conditions—like a particularly prolonged education, or the prices of housing and living—that may make this socially or subjectively unaffordable (Sawyer et al., 2012). In other countries or in other socioeconomic situations, of course, things may be hugely different: think, for example, of the many areas, in affluent as well as in less protected environments, where youngsters may legally or illegally be employed or exploited as slave workers, prostitutes, soldiers, or even suicide bombers. In this sense adolescence may be viewed as socially constructed by a society that can and wants to afford it.

A definition of adolescence as *coming to terms with adulthood* may appear to imply that mental life during this age should be viewed as a precursor to that of full adulthood and thus exclusively or prevailingly understood in terms of the latter: the adolescent would then be nothing more than a "future adult." This merits a brief discussion.

There are indeed various ways in which a sort of teleology belongs to this framework. At least some of the environments in which the adolescent participates are explicitly or implicitly conceived and structured so to offer the cognitive, social and cultural tools that will help her to acquire the knowledge, the competencies and the other skills that will be required of her as an adult: schools, professional education, reformatories and military academies are, of course, the most visible, important and formally structured environments of this kind, but there may be others as well. These environments in which the adolescent participates require her to think and act like an adult: many such contexts will be tolerant of "adolescent behavior," but others will not, or not completely. So far, we have a sort of a later-age, probably less tolerant, equivalent of Vygotsky's notion of the Zone of Proximal Development (Vygotsky, 1978; Daniels et al., 2007).

On the other hand, it should be noted that the opposite process may also be at work, whereby typically in the affluent areas of the world adolescents are *teenagers*, that is a specific market segment with features of its own. Of course, this also requires selling the idea that adolescents are *not* adults, that they have a mental and social functioning all of their own, and so on. The coexistence of these two processes increases the complexity of the adolescent's mental and social life.

Furthermore, the adolescent represents herself at least partially in accordance with the psychological, social, and cultural coordinates in which she finds herself. For the first time, she entertains a visible temporal and ontogenic horizon which she may strive to achieve; that is, she represents her own future in a non-oneiric way and may make concrete choices that are, or at least aim to be, consequential. She thus oscillates between two centers of gravity. One such center is the awareness and the expectation that she is soon going to be an adult: she has an idea, however approximate, of what this means, and might work toward such end, e.g., by going to school or by learning the skills that (she thinks) will help her reach her goals as an adult. The other center of gravity is the fears and the other emotions that prospective adultness may ingenerate, and the desire to enjoy the space of freedom which society allows her, in the fear of losing it with passing years.

Thus, teleology in adolescence is different from what it could be during childhood. While in both periods the individual needs be considered in her present time, which she lives with the full autonomy that her age allows for, adolescence is characterized by internal as well as external pressures and tensions between such present and a future which is both the object of representations, expectations and positive and negative feelings, and a set of cognitive, social and cultural tools that offer a scaffolding (again in a Vygotskian sense) which the individual has available to govern her own future, in a circularity whose features are those of a partially self-fulfilling prophecy.

Summing up, adolescence begins with puberty and is characterized by the intertwining of several kinds of changes:

(i) biological and psychological changes that are universal, albeit occurring at different ages;
(ii) socio-cultural and psychological changes that are practically universal, at least in their abstract or symbolical form, called rites of passage;
(iii) socio-cultural and psychological changes that are local and contextual, varying from the status of a young soldier, slave or prostitute to that of a "teenager" in an affluent family;
(iv) the appearance of true autonomy and self-government, with a still budding ability to deal with them and their internal and external sources and consequences.

Adolescence has no precisely identifiable end; it slowly shifts into adulthood as the individual comes to terms with his new state. *Coming to terms with adulthood* may have many different meanings, depending on the groups and the society in which an individual finds himself, of the requests posed by his environment, the resources and the opportunities he finds available, and so on. While puberty is a necessary biological and psychological transition, adulthood is defined contextually; in certain contexts a reasonable level of adultness may be reached at different ages in different domains, and often many years after biological maturity, while in others a distorted adultness ends up to be superimposed

on an individual who is not yet ready to cope with the ensuing set of activities and interactions. Each of this paths may be laden with problems and tensions, which may then relapse on the individual's psychological or social wellbeing.

What Adolescence Requires of Social Cognition

From the subjective point of view, at least in Western countries, adolescence is a time when an individual finds herself confronting the feeling, simultaneously endogenous and exogenous, of becoming an adult. When she has become reasonably able to come to terms with these feelings, this phase ends; or, better, it shifts seamlessly into "full adulthood."

To conceive of adolescence as the beginning of adulthood brings one to also view social cognition during this stage of life as remarkably different from what it used to be during (the various phases of) childhood and more akin to what it will be at later ages. So, what developments in an individual's social cognition characterize this phase?

Changes in social cognition during adolescence are both inward and outward. The latter may be summarized as a further opening toward the world.

Several studies show how social networks change across the life span. Interactions during infancy and childhood normally take place within the family or in quasi-familiar environments like primary school. The global social network grows during adolescence, when the individual gains emotional and behavioral autonomy from parents, and then tends to decrease throughout adulthood (for a meta-analysis, see Wrzus et al., 2013).

An adolescent's social network becomes wider but also more impersonal in some of its zones. Adolescents are involved in situations that require them to take a role in a strict sense, including, e.g., secondary school, working places and other social grounds characterized by formal and formally accountable expectations and behaviors. The types of norms that this requires them to handle are not, or not mainly, behavioral rules in the form of do's and don'ts like those that are learned during childhood; instead, they are complex systems of social positioning and reasoning that establish a certain worldview from which situated social actions should be derived moment by moment. Things are even more complicated, and more challenging for social cognition, insofar as formality often is only part of the situation, a sort of facade that belies complex informal interpersonal, social, and (largely speaking) political dynamics.

On a still more abstract level, this new conception of social worldviews, social grounds, and social roles typically expands to system-wide dynamics. The adolescent begins to interact with and within the society at large and its structures and institutions, e.g., in terms of understanding and dealing with citizenship, or of getting intellectually interested or materially involved in local, national or international politics or economics. This is the age when an individual may begin reading the news, taking a political stance, participating in demonstrations or, in more troubled contexts, more or less voluntarily carrying a weapon in a war. Actually, possibly fueled by a still partial understanding of the relevant dynamics and of their visible and hidden complexities, the civic and political fervor of this period will seldom be found again at later ages. Recent approaches to youth health and development have taken a turn from the traditional view of youths as victims or problems of society and passive recipients of adult-directed interventions to one that portrays them as powerful catalysts to community change by acting as resources and competent citizens in their communities (Makhoul et al., 2012).

We argue that these interests and activities fully engage social cognition insofar as they require understanding social habits and norms, the ways in which different individuals may follow, exploit or violate such norms, the positions that different individuals occupy in groups, organizations and the society at large, how they have reached there and how they tend to interpret such position, and so on.

Within areas more classically acknowledged as relevant to social cognition proper there are at least two other crucial realms that need be considered about social life in adolescence, namely interaction with peers and interaction with romantic or sexual partners. While neither of them appears, strictly speaking, in adolescence, both take on whole new nature and roles with respect to what they used to be in childhood.

Peers may happen to be other individuals, different groups of which the adolescent is or is not a member (including allied or various rival or antagonistic groups), other organizations of which she is or is not a member, and so on. In a different acceptation of interaction, peers may even be the *representations* of the peers that are projected by the various social and cultural contexts in which the adolescent participates, like her family, her friends, the media, or the society at large. Such projections may be descriptive or normative in different ways, ranging from the rules and expectations that are enforced by the family or the group of peers to narratives found in books and movies, marketing and advertising in the media, and so on.

Interactions with peers, like all interactions, require the adolescent to handle habits and norms, hierarchies and statuses, and to understand how arrays of other individuals do the same. At the same time, however, these interactions may be "hotter" than others to adolescents: they are less abstract, more situated, and more emotionally and intellectually compelling. Therefore, these immediate social dynamics cannot be handled with the tendentially formal rules with which the more removed ones discussed above are: dealing with peers thus tends to be *subjectively* more complex, more challenging, and more potentially awkward.

At least in several human societies, even more so may be the other crucial type of interaction that characterizes adolescence, namely the romantic and/or sexual, which may (at least in principle) address the individual toward the construction of a long-lasting relationship. This poses several problems. Courting someone, or letting someone court us, requires a complicated game of showing and concealing one's feelings and intentions. Even more importantly, it requires recognizing, labeling, and wording one's own feelings and emotions (like, "what is it that I feel? Is this what love is? or is it sexual desire?" and so on) as well as those of the partner's. All of this turmoil may often involve further persons on one or the other side of the actual or potential couple,

giving rise to even more complicated problems about cheating, jealousy, rejection, and so on.

Even such a brief outline of the changes that characterize outward social life and social cognition during adolescence makes it clear why an analogously complex change in inward, that is reflective, social cognition is needed. Basically, the adolescent has to devise cognitive tools and ways to deal, on the one hand, with all that is happening in the highly complex, multidimensional space of her outbound social life and, on the other hand, with her own rapidly changing personal identity.

This requires her, among other things, to be able to monitor, understand, explain, predict, abstract from, and, first and foremost, *feel*, her own mental dynamics: the kind of questions she has to answer may take forms like "what is this that I feel? whence do these thoughts and emotions come? how do I explain them? where do they lead me? how do I judge them? are they good or are they bad? how do I control them? how do I share them with other individuals, and how should I choose these individuals?".

Internal tensions concerning this dynamics may easily ensue, due to the sheer difficulty of dealing with such complex questions, accepting their consequences for oneself and for various other persons, and accepting the continuous redefinition of personal identity that they propose. It is in this age that social dynamics as diverse as shame, pride, isolation, rage, rebellion, leadership and others thrive: in several senses, this is the end of innocence. It also comes as no surprise that adolescents are more at risk of deviant behavior as well as of becoming victims of hoaxes, deceits, and so on.

Summing up, an individual's social cognition during adolescence is asked to deal in increasingly complex ways with (and, circularly, her social cognition begins to provide her with the ability of dealing with) different types of contexts:

(i) her own mind;
(ii) other, specific individuals (family, friends, colleagues or classmates, romantic or sexual partners, and so on);
(iii) other, generic individuals (strangers);
(iv) groups and organizations and their individual members acting as such.

This requires an intertwining of social cognition with other "cognitive functions" like planning and organizing one's own actions and recognizing how others plan and organize theirs, processes of education, cultivation, and acculturation, an appropriate management of autobiographical memory, and so on.

Data From Developmental Psychology

ToM is generally considered a crucial part of social cognition and has been extensively studied in developmental psychology.

Children's ability to understand and reason about mental states has traditionally been investigated by testing their accuracy on mentalizing tasks, often based on false beliefs (Dennett, 1978), which are typically passed by 3- or 4-years-olds (Wimmer and Perner, 1983; Wellman and Liu, 2004). As discussed above, these kinds of tests rapidly reach a ceiling effect as the subjects' age increases; a gap thus emerges in the literature after the pre-scholar period. Researches with children older than about four have used more complex ToM tasks (e.g., Happé, 1994; Baron-Cohen et al., 1999); however, precisely these methodological differences make it difficult to highlight continuities or discontinuities in development (Apperly et al., 2011).

In any case, it is hard to imagine that social cognition would not change with adolescence, if only because the individual's general cognitive abilities change, as well as her social experiences do (Blakemore and Choudhury, 2006). In comparison with the large amount of researches investigating mentalizing abilities during childhood, however, only few studies explored the development of these capacities in adolescence and their relations with other life-span developments (Colvert et al., 2008; Apperly et al., 2011; Harenski et al., 2012).

The ability to reason about the mental states of the others and to understand and take into consideration what they think, feel and believe appears to require the ability to take another individual's perspective, which in turn is crucial to successfully manage social communication. Perspective taking is related to first-order ToM, since it involves what another person is thinking; also, it requires the awareness of one's own mental states (first-person perspective) and the ability to ascribe mental states to other individuals (third-person perspective; Blakemore and Choudhury, 2006).

In a study by Choudhury et al. (2006), children, adolescents and adults were tested with a perspective-taking task requiring them to imagine which emotion they themselves (first-person perspective) or another person (third-person perspective) would feel in different scenarios. The results showed that the differences in reaction time between first- and third-person perspective-taking decreased with age, suggesting that proficiency at perspective-taking improves between childhood and adulthood.

Dumontheil et al. (2010) tested the ability of a large sample of children, adolescents and young adults (aged 7–27) to use information received about another person's point of view in a perspective-taking communicative task. Again, the ability to take another person's perspective into account turned out to grow from infancy through adolescence with further improvements in adulthood.

Fett et al. (2014) showed that a greater inclination to take the others' perspectives into account was associated with a stronger pro-social approach toward others and a stronger trust during cooperative interactions. In interactions with an unfair partner, this inclination was associated with a more drastic decrease of trust and less benevolent reciprocity.

Bosco et al. (2014b) assessed the ability to understand and manage mental states in pre-adolescence and adolescence using the ToM Assessment Scale (Th.o.m.a.s.: Bosco et al., 2009a; see also Laghi et al., 2014) and some well-known ToM tasks (namely a subset of the Strange Stories by Happé, 1994). Th.o.m.a.s. is a semi-structured interview organized along four scales, each focusing on one of the knowledge domains in which a person's ToM may manifest itself; it provides a detailed profile of different facets of ToM abilities, namely first- vs. second-order, first- vs. third-person, egocentric vs. allocentric perspective. It also explores different types of mental states involved in ToM, namely beliefs, desires, positive emotions, and negative emotions. The results were that the performance at Th.o.m.a.s. improves with age,

confirming that the ontogeny of ToM continues at least through adolescence.

Furthermore, in agreement with Goldman's (1993) hypothesis that adolescents can better reason about their own mental states than about those of the others, the participants performed better at first-person than at third-person tasks. This appears consistent with the widely diffused perception that a typical feature of preadolescence and adolescence is a tighter focus on the attempt to understand oneself than the others. Also, again in agreement with previous literature (Wellman and Liu, 2004), the adolescents performed better at first-order than at second-order ToM tasks. No significant difference emerged, instead, between the allocentric and the egocentric viewpoint.

The performance at Strange Stories did not reveal any significant age-related difference; however, there is no evidence in the literature that there should be any. While Strange Stories are considered advanced ToM tasks, they were originally developed for children (Baron-Cohen, 1989; Happé, 1994) and thus they too are probably unfit for the study of mentalization at later ages.

Th.o.m.a.s. also investigates the ability to deal with different types of mental states (beliefs, desires, positive emotions, negative emotions). In Bosco et al. (2014b), the participants scored higher at negative emotions than at the others, a result that could be explained with the turbulent psychological and relational changes that characterize adolescence, together with a sort of existential confusion which is likely to lead a person to reflect more deeply on her own negative emotions.

The ability to make inferences about emotions is called *affective ToM* and may be conceptualized as the integration of *cognitive ToM* (inferences about knowledge and beliefs) and empathy (Shamay-Tsoory et al., 2010). In a study by Sebastian et al. (2011), adolescents made more errors than adults in choosing the appropriate ending of vignettes depicting a character's response to a companion's emotions. Vetter et al. (2013) used film clips depicting the manifestation of emotions to investigate affective ToM across adolescence, finding that it develops with age. They also found that it correlates with executive functions (specifically inhibition) throughout adolescence until young adulthood.

The phrase *executive functions* refers to the cognitive processes involved in goal-directed actions, such as those that allow an individual to control and coordinate his thoughts and behavior (Shallice, 1982). These are, for example, selective attention, working memory, decision-making, and inhibition. Several behavioral studies show that the ability to manage tasks like inhibitory control (Leon-Carrion et al., 2004), processing speed (Luna et al., 2004), working memory and decision-making (Hooper et al., 2004) continues to develop during adolescence. A correlation between affective ToM and inhibition has also been found in studies conducted with young adults (Bull et al., 2008; Ahmed and Miller, 2011). In pre-school children, executive functions have been shown to play an important role in ToM performance (Carlson and Moses, 2001), which suggests that they may play an important role in the subsequent developmental stages as well.

Another construct which is commonly held to be closely related to social cognition is metacognition, defined as the ability to think about thinking (Flavell, 1979). Semerari et al. (2003, 2007) view it as composed of an array of independent subfunctions that concur to its overall functioning, namely the abilities to recognize one's own thoughts and emotions, to relate them to the relevant interpersonal events, to understand the mental states of other persons and to keep them distinct from (and possibly different to) those of one's own, to acknowledge that mental states incorporate a point of view and therefore are fallible, to describe mental states modifications in a coherent narrative, and to control and adjust internal states (*mastery*: more about this later). Based on this theoretical elaboration, Semerari et al. (2012) built and validated a semi-structured interview called the Metacognition Assessment Interview (MAI), that has been administered to persons with schizophrenia or personality disorders. What is relevant to our current purposes is the notions that social cognition is a highly complex faculty, far from being reducible to simpler processes, even if complex in their own way like ToM, and that there can be individual or ontogenetic differences in the persons' capacity to handle it.

Metacognitive mastery has been correlated with quality of life (Lysaker et al., 2005) and the complexity of social functioning (Lysaker et al., 2010) in persons with schizophrenia. In general, metacognition appears to be able to influence several aspects of experience (Metcalfe, 1996) such as self-regulating learning (Efklides, 2009) and decision making (Weil et al., 2013). An impairment in the ability to reflect on and to use knowledge about the mental states of one's own and those of the others may hamper the ability to cope with complex psychological and relational challenges and thus lead to dysfunctional reactions to individual or interactional difficulties (Lysaker et al., 2010). Given the dramatic number of new experiences and transformations characterizing adolescence, these issues and their interplay may end up playing a significant role.

Demetriou and Bakracevic (2009) investigated metacognitive ability asking adolescents and adults to assess their own performance on propositional, spatial and social reasoning tasks; this self-evaluation was found to improve from adolescence to adulthood.

Weil et al. (2013) analyzed the development of metacognitive ability from adolescence to adulthood, during a visual task implying decision-making processes. Their results showed that the awareness of one's own perceptual decisions undergoes a prolonged developmental trajectory during adolescence, again suggesting that metacognitive ability significantly improves with age.

Somatic Changes and Brain Maturation

Adolescence brings with itself a vast array of bodily modifications. Some of these modifications, namely those in the brain, are not immediately available to the subject's awareness, while others are external and dramatically important from a subjective point of view.

Adolescence, for example, normally entails a sudden, rapid, and remarkable upgrowth. One finds herself watching the world from about the same level from which adults watch it, sometimes from an even higher one. This alone will obviously yield a difference in how one perceives social relations, hierarchies and statuses,

power (whether social or crudely physical), dependability, and so on. Perspective taking here is laden with an experiential burden that makes it impossible to reduce it to a "cognitive" issue in the classic acceptation of such word. The growth of muscle mass and the increase in agility and physical strength add to this change of one's body image.

Even more the same holds for sex-related morphological changes, like the development of primary and secondary sex characteristics. To find oneself being the agent or the recipient of sexual attention, sexual desire and sex-related activities, as well as *not* being one despite one's desires or needs, has an obvious impact on one's social attitudes. To acquire and to come to terms with the relevant set of thoughts, feelings, emotions, habits and so on, both in oneself and in the others, is a seemingly impossible task that, nevertheless, needs be accomplished with reasonable speed and efficiency.

A completely different set of data and considerations is supplied by other, more classic areas of research.

Several authors suggest that the endocrine changes that characterize puberty influence brain development and restructuring during adolescence (Sowell et al., 2002; Lenroot et al., 2007; for reviews, see Peper et al., 2011; Peper and Dahl, 2013). Functional magnetic resonance imaging (fMRI) studies provide evidence of the plasticity of the adolescent's brain, characterized by a general structural development, a synaptic neuronal reorganization and increase in connectivity (Sowell et al., 2003). Social cognition, particularly the ability to mentalize, is associated with a network of brain regions commonly referred to as the "social brain" (Frith and Frith, 2003). This network appears to be the counterpart of the ability to recognize other persons' mental states like intentions, feelings, emotions, desires and beliefs, and to use such recognition to understand their behavior. The social brain includes several areas: the medial prefrontal cortex (mPFC), the anterior cingulate cortex (ACC), the inferior frontal gyrus, the superior temporal sulcus (STS), the amygdala and the anterior insula (Blakemore, 2008).

Several studies offer empirical evidence of the development of the social brain during the adolescence (for a review, see Blakemore, 2008). Recently this subject has received renewed interest. Mills et al. (2014) studied the structural development of the social brain from late childhood through adolescence and into adulthood. They found that gray matter volume and cortical thickness in the mPFC, the temporoparietal junction and the posterior STS decreased from childhood into the early twenties. The anterior temporal cortex increased in gray matter volume until adolescence and in cortical thickness until early adulthood. The surface area for each region peaks in pre-adolescence or early adolescence before decreasing into the early twenties. The authors suggested that the reductions in gray matter volume may reflect synaptic reorganization and concluded that the social brain network continues to develop structurally across adolescence before relatively stabilizing in the early twenties.

Klapwijk et al. (2013) analyzed the relations of a set of endocrine and somatic pubertal indicators with functional connectivity in the social brain (dorsomedial prefrontal cortex, right posterior STS and right temporoparietal junction) involved in emotion processing in girls aged 11–13 years. Their results suggest that the progress of puberty in girls is related to the functional maturation of the social brain.

Finally, Goddings et al. (2014) found that puberty has a important role in influencing the subcortical development of the brain. They analyzed data from longitudinal magnetic resonance imaging scans of individuals aged 7–20 years, finding an interactive puberty-by-age effect on the volume of the nucleus accumbens, the globus pallidus and the caudate: these regions are involved in reward-seeking behaviors and decision-making processes (Gottfried, 2011). Goddings et al. (2014) also found pubertal effects on the growth of the amygdala, which is involved in emotion processing. Pubertal changes include modifications in the neurobiology of stress and emotions, capable of shaping reactivity to stressors and affective stimuli (Spear, 2009). These modifications may precipitate the emergence of psychopathologies in vulnerable individuals and contribute to the emergence of psychological disorders (Dahl, 2004; Walker et al., 2004).

Globally considered, these modifications appear to be related to several aspects of mind functioning that characterize social cognitive ability (see also Moriguchi et al., 2007). It probably is no coincidence that many of the functions whose cerebral counterparts undergo such modifications are those in which adolescence looks more stormy and potentially unsafe. Yet, brain studies can hardly link brain modifications to a person's social and cultural experience. In this sense, the "social brain" should be viewed and studied as a feature not of the individual, but of the contexts in which the embedded, situated, and embodied individual participates.

Conclusion

Adolescence is an extremely interesting as well as challenging topic for the study of social cognition.

A first issue is that context-free studies can hardly be devised. The social, cultural, educational, economic, and autobiographical situations in which the individuals participate play too important a role in how they experience and enact their social life. For the same reason, it is likely impossible to devise empirical methodologies similar to those that are commonly employed in the study of other aspects of the functioning of the mind or of the social life in infancy and childhood. Not coincidentally, a comparatively advanced ToM task like the Strange Stories (Happé, 1994), differently to the false-belief tasks that are used with children, is built around a narrative infrastructure and its contents are culturally localized.

A second issue is that the empirical methodologies should be adjusted to keep into account the vast differences in social situations, cognition, and actions that exist between different contexts, between different individuals, and between the different domains and activities in which the same individual may participate.

A third issue is that the notions that are generally employed for the study of social cognition, like ToM, are probably insufficient to account for it. In a phenomenological approach such as that adopted, for example, by Gallagher (2006), the notion of a ratiomorphic, purely inferential ToM appears to be far too

simplistic to account for the richness and the complexity of human social experience. The alternative proposed by Gallagher is in terms of a narrative competence, which in its turn would be grounded in the direct perceptual access to the intentions and the feelings of others: in this approach, second-person interactions would replace the more typically studied observations in the third-person; and, of course, the situated, embedded, embodied, autobiographically rich first person would be the center of gravity of the whole narrative.

Theory of mind would then intervene when a breakdown occurs, analogously to how theories in naïve (or non-naïve) physics intervene when our bodily experience, normally grounded in habits and choreographies, encounters a breakdown.

Thus, according to Gallagher and Hutto (2008), it is not the inner life or the mental life of the others that we attempt to access, but their life in its worldly contexts, which is best captured in a narrative form. Life events, including social interactions, happen as stories with a beginning, a development, and possibly an end, that take place in the world and in which we, and the others, may happen to play a part (see also Goffman, 1959).

Adolescence may then be viewed as an age in which the narratives change suddenly and profoundly, opening a world of new possibilities, new promises, new dangers. Cast abruptly in this new world, the adolescent has to wade through it, finding her own way to deal with the new situations in which she wants and needs to find herself. In this task, social life is simultaneously a huge source of problems, opportunities, and resources. That most of us survive this storm to find comparatively calmer waters is one of the most amazing feat of human kind.

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REVIEW
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An evaluation of neurocognitive models of theory of mind

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We review nine current neurocognitive theories of how theory of mind (ToM) is implemented in the brain and evaluate them based on the results from a recent meta-analysis by Schurz et al. (2014), where we identified six types of tasks that are the most frequently used in imaging research on ToM. From theories about cognitive processes being associated with certain brain areas, we deduce predictions about which areas should be engaged by the different types of ToM tasks. We then compare these predictions with the observed activations in the meta-analysis, and identify a number of unexplained findings in current theories. These can be used to revise and improve future neurocognitive accounts of ToM.

Keywords: theory of mind, mentalizing, neurocognitive theories, meta-analysis, task-categories, temporo-parietal junction, medial prefrontal cortex

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INTRODUCTION

For nearly two decades, Theory of Mind (ToM) has been studied in hundreds of functional neuroimaging studies and competing theories about certain brain areas supporting specific cognitive sub-processes of mentalizing exist. Understanding the cognitive processes that are underlying typical ToM, and knowing in which situations they come into play, provides an important interpretational basis for findings of atypical ToM in developmental and psychiatric disorders.

Most neurocognitive theories converge on the following definition of ToM: the ability to make inferences about one's own and other people's mental states. However, very diverse tasks are used to operationalize ToM, and different theories often rely on findings from different studies, which influences the scope of these accounts. Increasing evidence shows that the neural signature of ToM differs for different tasks and stimuli (e.g., Gobbini et al., 2007; Bahnemann et al., 2010; Schurz et al., 2014). Therefore, it was argued (Schaafsma et al., 2015) that ToM should not be treated as monolithic ability in brain research, but needs to be deconstructed into more basic sub-processes which allow a more specific mapping to brain areas. The key for such a deconstruction is to know – or to have a good hypothesis about – which are the underlying sub-processes to look at.

One promising way to define the sub-processes of ToM would be a cognitive ontology, like the cognitive atlas (Poldrack et al., 2011; visit http://www.cognitiveatlas.org). To date, cognitive ontologies are in the build-up, but a definition of sub-processes involved in ToM is still missing. In the present review, we rely on neurocognitive theories that make different hypotheses about the sub-processes of ToM.

We review nine neurocognitive theories on ToM, and summarize which sub-processes (i.e., forms of cognitive processing) are supposed to be engaged in ToM. We also review how these sub-processes are thought to link to brain areas, and formulate predictions about whether these

processes/areas should be engaged by the demands of different ToM tasks. Predictions from theory are then evaluated based on the results from our meta-analysis (Schurz et al., 2014).

For practical reasons, we only address some of the most popular representatives of an immensely large field of published neurocognitive theories and, in addition, we focus our review on two major brain areas for ToM – the temporo-parietal junction (TPJ) and the medial prefrontal cortex (mPFC).

META-ANALYSIS FRACTIONATING ToM

Schurz et al. (2014) looked at the most common tasks in the neuroimaging literature on ToM, and identified six large task groups. We give representative examples for these tasks in **Table 1**. When pooling brain activation over task groups, the meta-analysis found the typical mentalizing network described in the literature (**Figure 1A**). However, after performing separate meta-analyses for each task group (**Figure 1B**), convergence activation across tasks was found only in bilateral TPJ posterior (TPJp) and dorsal mPFC. The task specific activation patterns were then captured by ROI analyses, which are shown in **Figure 1C**. The TPJ ROIs were placed into different sub-areas based on results from a connectivity-based parcellation (Mars et al., 2011, 2012, 2013) of that area: More dorsal/posterior ROIs in the Inferior Parietal Lobule (IPL) and posterior TPJ (TPJp), and more anterior/ventral ROIs in the anterior TPJ (TPJa) and the posterior Middle Temporal Gyrus (pMTG). Furthermore, several ROIs were similarly placed in the mPFC according to a connectivity-parcellation (Sallet et al., 2013): a ventral mPFC ROI (in so-called connectivity cluster #4), and a dorsal mPFC ROI (connectivity cluster #3), as well as a posterior frontal cortex ROI (in connectivity cluster #2). Locations of these ROIs are indicated in **Figure 1C**.

COMPARING PREDICTIONS FROM NEUROCOGNITIVE ACCOUNTS TO RESULTS OF THE META-ANALYSIS

Results from our meta-analysis – with a focus on ROI results shown in **Figure 1C** – will be related to different neurocognitive theories. On the one hand, we will review theories that assume that areas have a ToM-specific function. On the other hand, we will review theories that assume a domain-general function of these areas, which are supporting ToM among other cognitive abilities. The predictions of these proposals and their fit to the data from our meta-analysis are summarized in **Table 2**, and will be discussed in the following sections in detail.

Domain Specific Theories

Theory of Mind Mechanism

Theory. Leslie and Thaiss (1992) argued for the existence of ToM mechanism in the brain (ToMM), which is responsible for "kick-starting belief and desire attribution" (Leslie et al., 2004, p. 528).

Predictions. Leslie and Thaiss's (1992) theory makes no prediction about the location of the ToMM, so we assume it could be found both in the TPJ and in the mPFC. We predict the ToMM to be involved in the tasks false belief, trait judgments, strategic games, rational actions and social animations, because they all implicate processing of beliefs and/or desires. We predict ToMM not to be involved in the mind in the eyes task, as it does not provide any information regarding beliefs or desires.

Evaluation. Both TPJ and mPFC show activation for all five tasks where we predicted it (see **Table 2** for summary). However, TPJ and mPFC also show activation for the mind in the eyes task, which is inconsistent with the ToMM hypothesis.

mPFC for Mental State Reflection

Theory. Amodio and Frith (2006) suggested that any kind of reflection about mental states activates the anterior rostral region of the Medial Frontal Cortex (arMFC), which roughly corresponds to the location of our dorsal mPFC ROI.

Predictions. All six types of tasks should activate the dmPFC.

Evaluation. We indeed find activation for all tasks in the dmPFC ROI.

pSTS for Actions and mPFC for Decoupling

pSTS

Theory. Frith and Frith (1999) proposed a system for representing other person's actions in the posterior Superior Temporal Sulcus (pSTS).

Predictions. Information about other's actions is presented in the tasks rational actions, strategic games and social animations (for the latter, movements trigger the perception of actions), so we expect pSTS involvement here. No clear prediction follows for false belief and trait judgements, since false beliefs may trigger anticipation of mistaken actions, and traits may involve habitual action tendencies. No actions are presented in the mind in the eyes task, so we expect no activation in the pSTS here.

Evaluation. To our knowledge, there is no clear anatomical differentiation between TPJ and pSTS, but it is largely agreed that TPJ is located more dorsal/posterior compared to pSTS. We will therefore use dorsal/posterior ROIs in TPJp and IPL as proxy for TPJ, and ventral/anterior ROIs in TPJa and pMTG as proxy for pSTS. Confirming the predictions, pSTS is activated for rational actions and social animations. Contrary to our predictions, no activation showed in pSTS when it was expected for strategic games, but activation was present for mind in the eyes where it was not predicted.

mPFC

Theory. Gallagher and Frith (2003) suggested that the paracingulate cortex (roughly corresponding to our ROIs dmPFC and vmPFC) hosts the decoupling mechanism proposed by Leslie (1987), which enables keeping separate representations from their ordinary input–output relations. This is necessary for representing anything that is not straight registration of reality, such as pretense, false beliefs, and, presumably, photographs. Note that decoupling actually is a domain-general computational mechanism, so it could be grouped to the theories presented in the next section.

TABLE 1 | Examples from each task-group in the meta-analysis by Schurz et al. (2014).

Author	Imaging	Experimental task	Control Task
		False belief vs. photo	
Saxe and Kanwisher, 2003	fMRI $n = 21$	Read a short vignette involving a person holding a false belief. Answer a question about her belief. e.g., *John told Emily that he had a Porsche. Actually, his car is a Ford. Emily doesn't know anything about cars so she believed John. When Emily sees John's car, she thinks it is a . . .? (Porsche or Ford).*	Read a false-photograph vignette. Answer a question concerning the outdated content in the photo. e.g., *A photograph was taken of an apple hanging on a tree branch. The film took half an hour to develop. In the meantime, a strong wind blew the apple to the ground. The developed photograph shows the apple on the . . .? (tree or ground).*
		Trait judgments	
Mitchell et al., 2002	fMRI $n = 34$	Read an adjective. Indicate whether it can be true for a hypothetical person. e.g., *"nervous" . . . can it be true for "David?"?*	Read an adjective. Indicate whether it can be true for an object. e.g., *"sundried" . . . can it be true for "grape"?*
		Strategic games	
Kircher et al., 2009	fMRI $n = 14$	Play the prisoner's dilemma game (iterated version). You play with a human player for game points. Both players choose a cooperative or defective strategy on each trial. If both players choose defective, they gain almost no game points at all. If both choose cooperative, both gain some game points. If players choose differently, the defective player gains more points.	Play the prisoner's dilemma game (iterated version). You play with a computer.
		Social animations	
Castelli et al., 2000	PET $n = 6$	Watch a video animation of two interacting triangles (e.g., *mother and child are playing*). Explain verbally what was happening (after fMRI).	Watch video animation of two randomly moving triangles. Explain verbally what was happening (after fMRI).
		Mind in the eyes	
Baron-Cohen et al., 1999	fMRI $n = 12$	View photographs of eyes. Indicate which of two words (e.g., *concerned* vs. *unconcerned*) describes the mental state of that person.	View photographs of eyes. Indicate if the person is male or female.
		Rational actions	
Brunet et al., 2000	fMRI $n = 8$	View a cartoon story and predict what will happen based on intentions of a character (no false belief). Choose a logical story ending from several options shown in pictures. e.g., *A prisoner is in his cell. First, he breaks the bars of his prison window. Then he walks to his bed. Participants must indicate what will happen next . . . the prisoner ties a rope from the sheets on his bed/the prisoner shouts out loud.*	View a cartoon story and predict what will happen based on physical causality. Choose a logical story ending from several options shown in pictures. e.g., *A person is standing in front of a slide. A large ball is coming down this slide, heading toward the person standing there. Participants must indicate what will happen next . . . the ball is knocking over the person/the ball is resting on the ground and the person is standing next to it.*

Predictions. Trait judgments and strategic games require hypothetical considerations and thus a decoupling mechanism. So do rational actions and false belief tasks, but here the control conditions used in studies are of particular relevance: for rational action tasks, control conditions require causal reasoning about physical events, and for false belief, they ask about the content shown on an outdated photograph. Thus, both control conditions require hypothetical thinking just as the corresponding experimental conditions of the tasks, so we do not expect to find (relatively increased) brain activation in the mPFC. Finally, for processing social animations and mind in the eyes tasks no possibilities have to be considered, and so no decoupling and mPFC activation is expected.

Evaluation. In keeping with our predictions, trait judgments and strategic games elicited activation the mPFC. Contrary to our predictions, we also observed activation for the other four task groups in the mPFC (at least at an uncorrected threshold in the dmPFC ROI), where we expected to see none.

TPJ for Beliefs and mPFC for Socially Relevant Information

TPJ

Theory. Saxe and Kanwisher (2003; see also Kanwisher, 2010) suggested that right TPJ (which the authors locate dorsal/posterior to pSTS) is representing mental states with propositional content like thoughts and beliefs, but not other mental states without propositional content (like feelings or bodily sensations).

Predictions. False belief and strategic games tasks require reasoning about what another person thinks is going to happen, so we expect them to activate the right TPJ. The case is less clear for most other task groups. Saxe (2006) suggested that belief-desire reasoning is also needed for thinking about true beliefs in connection with intentional actions. If we accept this additional assumption, we can predict that social animations and rational actions also activate the right TPJ. Furthermore, traits can be viewed as habitual patterns of behavior, thought, and emotion.

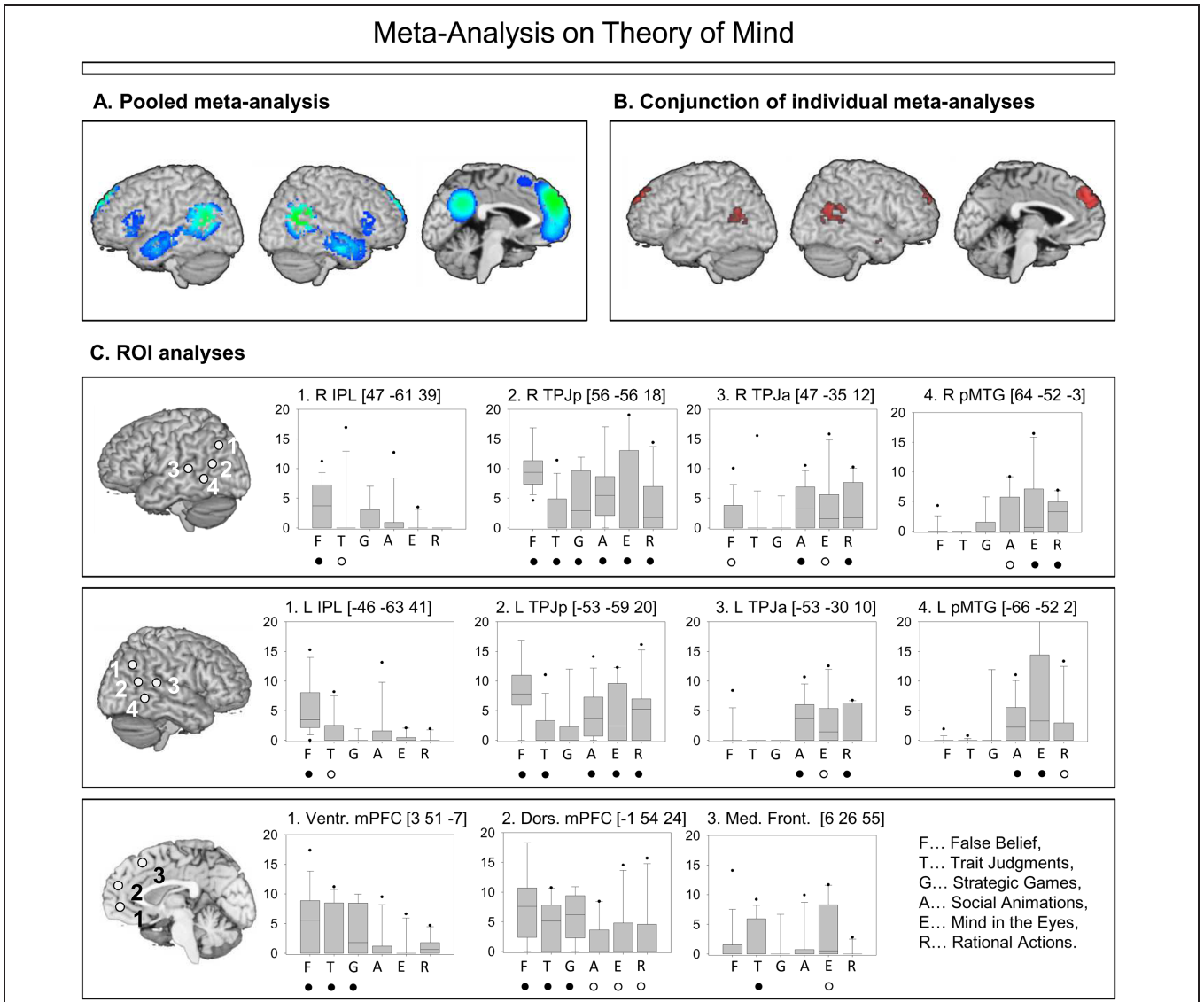

FIGURE 1 | Summary of the results in Schurz et al. (2014). **(A)** Pooled meta-analysis on Theory of Mind (ToM) across all task-groups. Colors represent probability values from statistical permutation testing (*z*-values). **(B)** Conjunction of six meta-analyses, statistically powerful permutation-based overlap analysis (for details, see Schurz et al., 2014). Maps were thresholded at voxel-wise threshold of $p < 0.005$ uncorrected and a cluster extent threshold 10 voxels. **(C)** Regions of interest in posterior temporo-parietal and medial prefrontal areas. Box-plots (median; 25 and 75th percentiles; 5 and 95th percentiles) show the distributions of effect-sizes for the studies in each group. Effect-sizes were weighted by intra-study variances. Significant convergence of effect-sizes above zero was determined by randomization tests; full circles indicate $p < 0.005$ uncorrected, $z > 1$. Empty circles indicate $p < 0.05$, $z > 1$.

From this perspective, we can also expect trait judgments to activate the TPJ. Finally, we predict that the mind in the eyes does not activate the TPJ, as it does not require thinking of beliefs but rather judging about feelings (without propositional content, e.g., judging that the person seems concerned, but not making assumptions about what the person is concerned about).

Evaluation. We found activation in the right TPJ, in particular in the ROI TPJp, for all five tasks were we expected it. However, our prediction of absence of activation for the mind in the eyes task was not fulfilled, as this task also elicits activation in the right TPJ.

mPFC

Theory. Saxe and Powell (2006, see also Saxe and Wexler, 2005) suggested that the mPFC has a less specific role in ToM, and is engaged whenever we are processing socially or emotionally relevant information about others.

Predictions. As all ToM tasks obviously present socially and emotionally relevant information about others, we predict that mPFC shall be engaged in all tasks.

Evaluation. Our meta-analysis fully supports this prediction, as all tasks activate in mPFC, in particular in the dmPFC.

TABLE 2 | Summary of evaluation of neuro-cognitive ToM accounts based on our results.

				Expected activation and confirmation					
Reference	**Theory**	**Area referred to**	**Hemi**	**F**	**T**	**G**	**R**	**A**	**E**
Intradomain fractionation									
Amodio and Frith, 2006	Reflection on mental states	arMFC (ROI dmPFC)	–	+ ☑	+ ☑	+ ☑	+ ☑	+ ☑	+ ☑
Leslie and Thaiss, 1992	ToMM	TPJ and mPFC (Any ROIs therein)	n.a.	+ ☑	+ ☑	+ ☑	+ ☑	+ ☑	– ☒
Frith and Frith, 1999	Other person's actions	pSTS (ROIs TPJa or pMTG)	n.a.	0	0	+ ☒	+ ☑	+ ☑	– ☒
	Decoupling mechanism	Paracingulate area (ROIs dmPFC or vmPFC)	–	(–) ☒	+ ☑	+ ☑	(–) ☒	– ☒	– ☒
Saxe and Kanwisher, 2003	Mental states w. prop. content	TPJ (ROIs TPJp or IPL)	R	+ ☑	(+) ☑	+ ☑	(+) ☑	(+) ☑	– ☒
	Socially relevant information	mPFC (ROIs dmPFC or vmPFC)	–	+ ☑	+ ☑	+ ☑	+ ☑	+ ☑	+ ☑
Gobbini et al., 2007	Covert mental states	TPJ (ROIs TPJp or IPL)	n.a.	+ ☑	+ ☑	+ ☑	+ ☑	– ☒	– ☒
	Overt mental states	pSTS (ROIs TPJa or pMTG)	n.a.	– ☒	– ☑	– ☑	– ☒	+ ☑	+ ☑
Van Overwalle, 2009	Enduring mental states	mPFC (ROIs dmPFC or vmPFC)	n.a.	(+) ☑	+ ☑	+ ☑	(+) ☑	0	0
	Transient mental states	TPJ (ROIs pMTG, TPJa, TPJp or IPL)	n.a.	+ ☑	– ☒	+ ☑	+ ☑	+ ☑	+ ☑
Domain general fractionation									
Perner and Leekam, 2008	Perspectivity	IPL (ROI IPL)	n.a.	+ ☑	(+) ☑	0	– ☑	– ☑	– ☑
	Teleology	pSTS (ROIs TPJa or pMTG)	n.a.	+ ☑	– ☑	0	+ ☑	+ ☑	0
Decety and Lamm, 2007	Comparing predictions to external events	rTPJ (ROIs pMTG, TPJa, TPJp, or IPL)	R	(+) ☑	0	+ ☑	– ☒	+ ☑	– ☒
Corbetta et al., 2008	Attention reorienting	rTPJ (ROIs pMTG, TPJa, TPJp, or IPL)	R	– ☒	– ☒	+ ☑	– ☒	– ☒	– ☒

+... prediction of present activation, –... prediction of absent activation, 0... no prediction follows, ()... prediction only follows when making additional assumptions.
☑... results support prediction, ☒... results do not support prediction.
F, False belief; T, Trait judgments; G, Strategic games; A, Social animations; E, Mind in the eyes; R, Rational actions.

TPJ for Covert and pSTS for Overt Mental States

TPJ

Theory. Gobbini et al. (2007) found that ToM tasks involving false beliefs activate the TPJ more dorsally than social animations and point-light-movement tasks. They hypothesized that this reflects the difference between covert mental states that need to be inferred from what one observes (e.g., beliefs) and more overt mental states, like intention-in-action (Searle, 1980), where one can perceive the mental states in the observed movements.

Predictions. From the theory that covert mental states activate in TPJ/IPL, we predict that false belief, trait judgments, strategic games and rational action tasks should activate the area. All four tasks present covert mental states in the sense that what needs to be represented is not immediately observable from an action. Social animations and mind in the eyes tasks, on the other hand, ask for inference about mental states which manifest in a movement or facial expression, so we predict no activation here.

Evaluation. The predicted activation for the abovementioned four tasks was found. However, predictions of absent activation for social animations and mind in the eyes were not supported. We found also here activation in TPJ, namely right TPJp (but not IPL).

pSTS

Theory. Gobbini et al. (2007) hypothesized that overt mental states activate more ventral areas in pSTS. We take ROIs in TPJa and pMTG as a proxy for that location.

Predictions. Predictions are the opposite from those made above, that is, pSTS should not be engaged by false belief, strategic games, trait judgments and rational action tasks. However, the area should be engaged by social animations and mind in the eyes, as these present overt mental states.

Evaluation. The predicted occurrence of activation for social animations and mind in the eyes tasks was supported by our results. Also in keeping with our predictions, no activation was found for trait judgments and strategic games. However, different from what we expected, also false belief and rational action tasks showed activation in pSTS (in particular in right TPJa).

TPJ for Transient and mPFC for Enduring Mental States

TPJ

Theory. According to Van Overwalle's (2009) model, the bilateral TPJ (including pSTS, TPJ and IPL areas) is engaged in making inferences about transient mental states such as immediate goals and desires.

Predictions. In the tasks false belief, strategic games, rational actions, social animations and mind in the eyes the goal is to infer a transient mental state. For trait judgments, we predict absence of activation, since no immediate goals or desires are involved.

Evaluation. We found activation in the TPJ (broadly defined by the model as pSTS, TPJ and IPL) for all five task groups where this was predicted. However, activation was also found for trait judgment tasks where we predicted no activation.

mPFC

Theory. Van Overwalle (2009) hypothesized that the mPFC is engaged in making inferences about permanent social and psychological properties of others, such as personality traits.

Predictions. Information about enduring mental states is cleary processed in trait judgment tasks, and so mPFC activation is expected. Following Van Overwalle's (2009) reasoning, we also predict activation for strategic games, because each player must develop an impression of the trustworthiness, cooperativeness, or competitiveness of the other. Another prediction following Van Overwalle (2009) is that tasks presenting a rich social context in their stimulus material could lead to spontaneous trait inference, and thus engage the mPFC. Based on this assumption, we furthermore expect activation in mPFC for false belief and rational actions. With respect to social animations and mind in the eyes tasks, Van Overwalle's (2009) theory makes no clear predictions.

Evaluation. In agreement with our prediction, we found activation in mPFC for false belief, trait judgments, strategic games, and rational actions. We also found activation for the two task groups where we made no predictions.

Domain General Theories

pSTS for Teleology and IPL for Perspective

pSTS

Theory. Perner and Leekam (2008) and Perner and Roessler (2010, 2012) proposed two cognitive mechanisms for ToM: teleology and perspective taking (appreciation of perspective differences). Teleology (coming from the greek word *telos* which stands for *purpose* or *goal*) is linked to the pSTS and means applying means-ends reasoning in order to predict others actions, i.e., an agent will do what is needed in given circumstances. No belief-desire reasoning requiring an appreciation of different perspectives is involved in this form of behavior explanation.

Predictions. The social animation and rational action tasks can be interpreted within teleology. Also for false belief tasks, applying the principle of rationality is required (however, it must be put into perspective, see next section). No clear prediction can be made for mind in the eyes and strategic games. In strategic games, this is due to the nature of the control condition: players need to consider what the other player is going to do, which may involve means-ends reasoning. However, this may also take place during the control condition playing against a computer algorithm, where one also needs to figure out the computer's strategy and goals (see also Schurz and Tholen, 2015 for discussion). For trait judgments, no immediate goals, circumstances or actions are relevant, and so no teleology and activation in pSTS is predicted.

Evaluation. Results fully support our predictions: activation was present for social animations, rational actions and false belief tasks (for the latter only in right TPJa), and absent for trait judgment tasks.

IPL

Theory. The second process to understand others is perspective taking linked to IPL (dorsal TPJ). This allows belief-desire reasoning by considering agents' representations and subjective perspectives of what is needed. The mental subjectivity of other people's reasoning can then be captured by teleology within the other's perspective ('teleology-in-perspective'), i.e., in the case of a false belief the other person will do what she would need to do if the world were as she thinks it is. Processing perspectivity is a process that cuts across the domain of ToM to other areas of knowledge such as understanding false signs (Aichhorn et al., 2009), identity (Arora et al., 2015), or level 2 visual perspective taking (Schurz et al., 2013; see also Schurz et al., 2015).

Predictions. No perspective taking is needed for social animations, mind in the eyes, or rational actions, and so no activation of IPL is expected. False belief tasks require means-ends reasoning (teleology) from another person's perspective, so we predict activation in IPL here. For similar reasons as mentioned before in the section on pSTS, no clear prediction can be made for strategic games. Trait judgments, on the other hand, may require awareness of perspective. Traits are habitual patterns of behavior, thought, and emotion. They are characteristic for a person when the person's habits deviate from the norm. For instance, a person is called "anxious" or "nervous" (Mitchell et al., 2002) if she tends to be concerned about situations where one normally has no reason to be anxious. Therefore, many trait judgments are judgments about whether a person habitually takes a different perspective on certain things in life, and so we tentatively predict trait judgments to activate IPL.

Evaluation. Our predictions were fully supported. We only found activation for false belief and trait judgment tasks in IPL, but not for strategic games, social animations, rational actions, and mind in the eyes tasks.

TPJ for Predictions about External Events

Theory. According to Decety and Lamm (2007, p. 583), ToM tasks engage a domain-general "lower-level computational mechanism involved in generating, testing, and correcting internal predictions about external sensory events", which is mediated by the right TPJ.

Predictions. For simplicity, we assume that only generating a prediction about an external event already triggers activation in the TPJ. We expect activation for strategic games and social animations which obviously require generating predictions about an upcoming event. For false belief tasks we can also expect activation, if we additionally assume that participants automatically think of the behavioral consequences of the protagonist's false belief. No activation in TPJ can be expected for mind in the eyes, because they do not refer to external events, and for rational actions because here studies asked participants to predict an external event both in the experimental (e.g., predict what the person will do next) and in the control condition (e.g., predict what will happen due to physical causality). For trait judgments, no clear expectation follows.

Evaluation. Consistent with our predictions we found activation for false belief, strategic games, and social animations. Inconsistent with our predictions, however, we also found activation for mind in the eyes and rational action tasks where this was not expected.

TPJ for Attention Reorienting

Theory. According to Corbetta et al. (2008), the right TPJ is responsible for the detection of salient and behaviorally relevant stimuli in the environment that were previously unattended – a cognitive process called exogenous or stimulus-driven attention. Cabeza et al. (2012, p. 347) extended this idea by proposing the TPJ/IPL to be responsible for guiding 'bottom-up attention by information entering working memory either from the senses or from long-term memory.'

Predictions. We predict attention reorienting in strategic games as players have to reorient attention away from their own goals and movements to focus on what they get to know about the other player. For false belief tasks we predict attention reorienting to take place to the same amount in the experimental condition (reorient away from own knowledge about reality to appreciate the others belief) and the control condition (reorient away from knowledge about reality to appreciate the outdated event shown the photo). Therefore, no (relative increase in) activation is predicted for false belief tasks. For social animations, rational actions, and mind in the eyes, there is no obvious competition between salient versus less salient information. Therefore we do not see any reason for bottom-up attention orienting. Trait judgment tasks often require judging whether a person habitually takes a different perspective on certain aspects of life than it is the norm. However, comparing different perspectives for a trait judgment requires attention to be devoted to two pieces of information simultaneously rather than reorienting from one to the other, so we do not expect activation in the TPJ here.

Evaluation. Consistent with our predictions, we found activation in right TPJ for strategic games. However, inconsistent with our predictions, we also found right TPJ activation for all five other tasks, where the attention reorienting account would not predict it.

CONCLUSION

In this review we evaluated neurocognitive theories of ToM based on results from a recent imaging meta-analysis (Schurz et al., 2014). We checked whether predictions from those theories were met by the results. We made four key observations.

The first observation is that the large majority of failed predictions are due to presence of activation for ToM tasks that are not supposed to engage the cognitive processes in question. This probably shows that authors had different views on what is a ToM task and what is not. The present review is based on a "democratic" definition found in our meta-analysis (Schurz et al., 2014), i.e., we included all studies that were labeled ToM by the authors. Besides adopting such a "democratic" definition, a further strategy for future theory building could be to include tasks based on a refined analysis of specific component processes of mentalizing or teleology, rather than fixating on the umbrella term ToM (see also Schaafsma et al., 2015).

The second observation we made is that theories with best predictive accuracy (e.g., Amodio and Frith, 2006; Saxe and Powell, 2006) are often less specific about cognitive processing. For example, Amodio and Frith (2006) postulate that dorsal mPFC is engaged in all forms of mental state reflection – which is largely equivalent to being engaged in all forms of ToM. Although this claim is fully supported by our data, it does not provide a cognitive explanation of how mental state reflection (i.e., ToM) is implemented.

The third observation is that many theories use loose definitions of the regions of interest they are focusing on. This is the case both for mPFC and TPJ, and probably reflects conclusions from some literature reviews (e.g., Gallagher and Frith, 2003; Amodio and Frith, 2006; Frith and Frith, 2006; Mitchell, 2009) that the ToM network is highly consistent in localization across tasks, methods, and studies. More recently, however, reviews found that brain activation within broad areas such as TPJ or mPFC breaks apart for different ToM tasks (e.g., Gobbini et al., 2007; Bahnemann et al., 2010; Schurz et al., 2014). Thus, the predictive power of theories can be improved by reference to more specific brain anatomy. We speculate that this could also be helpful for ruling out some of the unexpected findings of activation that were not foreseen in cognitive theories (as described in our first observation).

Our fourth observation relates to the role of control conditions. The meta-analysis (Schurz et al., 2014) on which we build this review grouped ToM tasks not only by stimuli and instructions presented in the experimental condition, but also by the kind of control condition employed. Reviewing the ToM theories made clear that some accounts focus exclusively on explaining the processes taking place in the experimental condition (i.e., the ToM condition), without taking into account which processes are controlled for by the control condition. A prominent example for this is the attentional reorienting account of TPJ function in ToM (e.g., Corbetta et al., 2008). This account focuses on the false belief task to re-interpret TPJ functioning during ToM. The argument is that in the false belief task, participants first form a representation of another person's belief and then get to know that the object of that

belief has changed in reality. Therefore, when participants are later asked about the belief of the person, they must reorient their attention away from their own knowledge about reality and toward the person's false belief. An important issue for this theory now comes with the control condition used in the analyzed false belief studies. In the false photo control condition, participants are asked what is shown on a photograph of a previous situation. One can similarly argue that, in order to answer the question, participants must reorient attention away from their knowledge of the current state of affairs and toward the past state that is shown on the photograph. Therefore, when considering brain activation differences for false belief > false photo, we do not see attentional reorienting as a straightforward explanation, since attentional reorienting seems to be needed in both conditions.

Taken together, these four observations show where existing theories fail to predict results and discuss possible reasons. This evaluation points out areas of improvement for future models.

AUTHOR CONTRIBUTIONS

MS and JP wrote this review article.

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Mind-Reading Ability and Structural Connectivity Changes in Aging

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The Mind-Reading ability through the eyes is an important component of the affective Theory of Mind (ToM), which allows people to infer the other's mental state from the eye gaze. The aim of the present study was to investigate to which extent age-associated structural brain changes impact this ability and to determine if this association is related to executive functions in elderly subjects. For this purpose, Magnetic Resonance Imaging was used to determine both gray matter and white matter (WM) areas associated with aging. The resulting areas have been included in a subsequent correlation analysis to detect the brain regions whose structure was associated with the Mind-Reading ability through the eyes, assessed with the Italian version of the "Reading the Mind in the Eyes" (RME) test, in a sample of 36 healthy subjects ranging from 24 to 79 years of age. The analysis resulted in three important findings: (1) the performance to the RME test is relatively stable across the decades 20–70 (despite a slight decrease of this ability with aging) and independent from executive functions; (2) structural brain imaging demonstrated the involvement of a great number of cortical ToM areas for the execution of the RME test: the bilateral precentral gyrus, the bilateral posterior insula, the left superior temporal gyrus and the left inferior frontal gyrus, which also showed a significant volume decrease with age; (3) an age and task-related decline in WM connectivity on left fronto-temporal portion of the brain. Our results confirm the age-related structural modifications of the brain and show that these changes have an influence on the Mind-Reading ability through the eyes.

Keywords: magnetic resonance imaging (MRI), diffusion magnetic resonance imaging, aging neuroscience, growth and development, theory of mind (ToM), voxel-based morphometry (VBM), tract-based spatial statistics, mind-reading

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INTRODUCTION

Theory of mind (ToM) is the ability to attribute mental states to oneself and others and to understand that others have intentions, desires, and beliefs that are different from one's own (Premack and Woodruff, 1978). This ability is considered to be essential for social interactions, since it enables individuals to understand and predict the behavior of others, even in the presence of minimal cues, such as a facial expression or the eye gaze (Baron-Cohen et al., 1997a).

The ability to "Mind-Read through the eyes" (Baron-Cohen et al., 1997b) is a widely investigated competence that can be behaviorally assessed using the "Reading the Mind in the Eyes" test (RME test, Baron-Cohen et al., 2001). The RME test requires the attribution of mental states to others via

observation of pictures representing only the eye region of the face. It is one of the most used tasks to investigate *affective* ToM, i.e., the ability to understand affective states, emotions and feelings of other people, which is distinguished from *cognitive* ToM, defined as the ability to understand the beliefs, goals, and intentions of others (Shamay-Tsoory et al., 2010; Duval et al., 2011).

The importance of eye gaze in social interaction is noteworthy and the presence of simple abilities such as gaze following (Farroni et al., 2004) and face recognition (McKone et al., 2012; Streri et al., 2013) in newborns shows that humans are hardwired to it. Moreover, there is strong evidence that underlines how the precursors of the Mind-Reading ability through the eyes are present even in the earliest phases of development. In fact, within the first 2 years of life a succession of precursors, i.e., early cognitive structures linked to the understanding of the mind through the eyes, paves the way to the mentalistic competence: the understanding of visual perception (Flavell, 1981, 1988; Wimmer et al., 1988; Gopnik et al., 1994), social referencing (Klinnert, 1984; Sorce et al., 1985), joint attention and pointing (Butterworth, 1991, 1994; Baron-Cohen and Ring, 1994) that combined together into triadic interactions led to declarative pointing (Camaioni, 1993). Specifically, declarative pointing is a key precursor not only of referential language, but also of mentalizing in the preverbal phase of development. Specifically, it demonstrates an early understanding of others having their own mind which can be influenced with non-verbal ways of communication. Taken altogether, these precursors show the importance of the ability to extract information through eye contact for the subsequent development of more and more complex Mind-Reading abilities. In this context, examples include the ability of engaging in recursive thinking, such as first order false belief reasoning around four years of age and second order false belief reasoning around 8–10 years (Baron-Cohen et al., 2001). Even if ToM undergoes the most significant changes during childhood, it would be misleading to consider it as an immutable ability. Rather, changes continue during adolescence and early adulthood (Blakemore et al., 2007; Moor et al., 2012) and in the later years of life (see Sandoz et al., 2014 for a review).

More specifically, the decreased performance in ToM ability in the elderly seems to happen regardless of the type of task employed (eyes, videos, stories, false belief task), of the modality (verbal/visual static, visual dynamic) and of the affective/cognitive content of the task (Henry et al., 2013). The study of the developmental changes of ToM necessarily implies the analyses of the contribution of cognitive processes to the ToM performance. The main cognitive processes considered in relation to ToM changes in the elderly are executive functions, vocabulary, logical reasoning, episodic memory, and speed of processing (Sandoz et al., 2014). The importance of the cognitive decline for ToM abilities is still an open matter of debate. For example, the review by Sandoz et al. (2014) reports a pattern of significant correlations between ToM abilities and cognitive processes depending of the specific type of ToM task employed. However, the connections of ToM performances with executive functioning appear to be the most relevant. This relevance has been also demonstrated at the neural level: Mahy et al. (2014) discuss the "executive function approach" among the main theoretical views on ToM development. There are two main positions concerning the contribution of executive function to ToM reasoning: the first one considers executive function necessary to ToM functioning, while the second one necessary but not sufficient. Furthermore, the two forementioned stances make different predictions about the neural activations during ToM tasks. The review by Moran (2013) shows on the one side a strong interconnections between ToM abilities and cognitive processes in the standard ToM tasks, and on the other side, a relative independence of ToM skills from cognitive processes when the former are assessed through continuous, rather than standard categorical, tasks.

In recent years, neuroimaging techniques have become one of the most powerful tools for studying *in vivo* brain structure and functioning, also in life-span perspective. Many studies have demonstrated that aging is associated with a significant, non-linear decline in gray matter (GM) density (Sowell et al., 2003) and changes in white matter (WM) architecture that can be driven by myelin degeneration (for a review, see Raz et al., 1998). Age-related WM decline impairs cognitive performance (Raz, 2005; Davis et al., 2009). Zuo et al. (2010) demonstrated that functional connectivity decreases with age in homologs areas involved with higher order processing. Moreover, neuroimaging studies have investigated how specific behaviors and abilities, such as ToM, depend on brain structure and physiology. In this view, with the aid of magnetic resonance imaging (MRI), it was possible to investigate brain pathways associated with ToM through the life span. A recent meta-analysis of studies performed with functional MRI (fMRI; Schurz et al., 2014), showed a core cortical network composed of the middle prefrontal cortex and the bilateral temporo-parietal junction (TPJ) active when reasoning about mental states, irrespective of the task- and stimulus-formats. When considering the RME test, the core network involved is predominantly left-sided and includes: inferior frontal gyrus [Brodmann area (BA) 45], medial prefrontal cortex, precentral and middle frontal gyri (BA 6), insula and posterior temporal cortixes (TPJ; Schurz et al., 2014). Beyond these core areas, surrounding regions appear to be involved in specific ToM tasks, such as the precuneus, temporal regions and inferior frontal cortices (see Schurz et al., 2014). This complex circuitry seems to vary in its degree of activity with age, probably due to age-related compensatory mechanisms needed to maintain adequate levels of performance (Castelli et al., 2010). More precisely, in the study by Castelli et al. (2010) both younger and older adults reported comparably good behavioral performances in the RME, showing the maintenance of adequate mindreading abilities with advancing age. However, on the neural level, a relevant change in the activations emerged, with older participants showing a stronger involvement of the linguistic components of the mirror neuron system (MNS) as well as a more bilateral activation of frontal areas compared to the younger group. Regarding brain structure, only one pioneering study (Charlton et al., 2009) directly investigated the correlation between structural brain features and ToM competences using a life span perspective in subjects aged 50–90 years. A correlation was found between WM microstructure (at the whole-brain level)

and cognitive ToM abilities shading some light on age-related changes. However, this study focused only on the older age without considering the progressive changes occurring in the earlier phases of the adult age (20–50 years of age).

The main aim of the present study was to investigate how age-related structural brain changes impact affective ToM ability as measured with the RME task. To achieve this goal we used structural MRI techniques aimed at exploring structural connectivity in both GM and WM in a cohort of healthy subjects between 24 and 79 years of age. We expected to find age-related cortical and subcortical modifications. Within these areas, we wanted to assess the presence of task-related structural features that might be associated with age-related modifications in the RME performance. Secondly, we aimed at exploring the possible connections between the performances to the RME task and executive functioning, i.e., the specific cognitive dimension most constantly linked to ToM performances.

MATERIALS AND METHODS

Subjects and Psychological Assessment

Thirty-six healthy individuals (13 males, mean age 49.6 ± 17.8, age range 24–79, **Figure 1**) were included in the study. All subjects underwent clinical interview and Mini Mental State Examination test (MMSE; Folstein et al., 1975) to exclude major neurological and/or psychiatric disorders.

All subjects were asked to complete the RME test in its Italian version and the Gender test as a control condition (Serafin and Surian, 2004). The RME test consists of 36 pictures of the eye region from various human faces. Participants have to perform two tasks: the RME proper that consists in choosing what the depicted character is feeling or thinking among four mental states written underneath each picture (cut-off = 13/36, see Baron-Cohen et al., 2001); and the Gender test, in which the same 36 items are presented and the participants are required to indicate the gender. The Gender test is used as a control condition to test basic visual faces discrimination capacities.

In order to test frontal lobe executive functioning, a Letter Fluency Task (LFT; Carlesimo et al., 1996) was performed in a subgroup of elderly subjects ($n = 13$, 3M, mean age 70 ± 7.2, age range: 56–79 years). All the scores obtained from LFT test were corrected for age and the level of education (conversion formulae are reported in Carlesimo et al., 1996).

All subjects also performed a single MRI examination.

Ethics Statement

The study was approved by the Ethics Committee of Don Gnocchi Foundation, and informed written consent was obtained from all the included subjects before study initiation. The study was conducted within Don Carlo Gnocchi Foundation, IRCCS, Milan (Italy).

MRI Acquisition

The MRI examination was performed on a 1.5T Siemens scanner. The following sequences were collected: (1) a conventional dual-echo turbo spin echo and fluid-attenuated inversion recovery (FLAIR) sequence (TR/TE = 2920/22 ms, FoV = 240 mm × 180 mm, in-plane resolution = 0.75 mm × 0.75 mm, slice thickness = 4 mm, number of axial slices = 25) and FLAIR sequence (TR/TE = 9000/121 ms, FoV = 240 mm × 168 mm, in-plane resolution = 0.94 mm × 0.94 mm, slice thickness = 5 mm, number of coronal slices = 24), to exclude brain abnormalities; (2) diffusion weighted (DW) single shot spin-echo (TR/TE = 7100/94 ms, 50 axial slices, 128 × 96 matrix, FOV = 320 mm × 240 mm, slice thickness = 2.5 mm), with diffusion gradients (b-value = 900 s/mm^2) applied in 12 non-collinear directions; (3) 3D T1-weighted magnetization prepared rapid gradient echo (TR = 1,900 ms; TE = 3.37 ms; TI = 1,100 ms; flip angle = 15°; 176 contiguous, 1 mm thick axial slices; matrix size = 192 × 256; FOV = 192 mm × 256 mm).

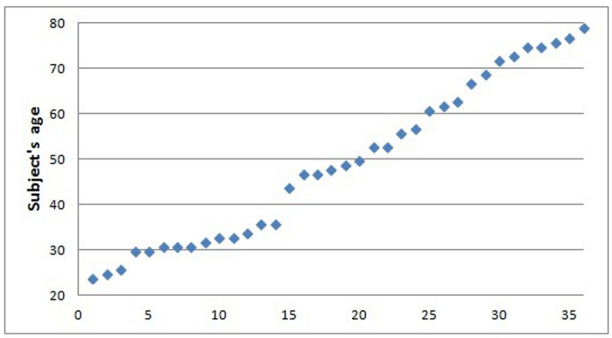

FIGURE 1 | Scatterplot representing age distribution.

MRI Data Processing

Gray Matter Analyses – Voxel Based Morphometry (VBM)

Structural GM data were analyzed with FSL-VBM (Douaud et al., 2007), an optimized voxel based morphometry (VBM) protocol (Good et al., 2001) carried out with FSL tools (Smith et al., 2004). First, structural images were bias corrected, brain-extracted and GM-segmented before being registered to the MNI 152 standard space using non-linear registration (Andersson et al., 2007a,b). The resulting images were averaged and flipped along the x-axis to create a left–right symmetric, study-specific GM template. Second, all native GM images were non-linearly registered to this study-specific template and "modulated" to correct for local expansion (or contraction) due to the non-linear component of the spatial transformation. The modulated GM images were then smoothed with an isotropic Gaussian kernel with a sigma of 3 mm. Brain tissue volume, normalized for subject head size, was estimated with SIENAX (Smith, 2002), part of FSL (Smith et al., 2004). Finally, a voxelwise general linear model (GLM) was applied using permutation-based non-parametric testing, correcting for multiple comparisons across space.

A regression analysis was also conducted at the group level on GM maps to investigate the relationship between brain structure and age. Gender and brain tissue volume were included as covariates of no interest. Results of the statistical analysis,

performed using threshold-free cluster enhancement (TFCE) method, were considered as statistically significant if surviving $p < 0.005_{corrected}$ threshold and cluster extent of 30 contiguous voxels.

A further analysis was then performed at group level on the cortical areas correlated with age (thresholded at $p < 0.05_{corrected}$ level) to investigate possible correlation between cortical volume and RME test. The statistical analysis was performed using the TFCE method, gender and brain tissue volume were included as covariates of no interest. Results were considered statistically significant if surviving $p < 0.05_{corrected}$ threshold level and cluster extent of 30 contiguous voxels.

Considering the results of the correlation analysis, we selected all GM regions that survived the $p < 0.05_{corrected}$ threshold and we calculated the number of GM voxels falling within each resulting area in each subject using a specific function (named FSL maths) of the MRI specific software FSL (http://fsl.fmrib.ox.ac.uk/fsl/) and we termed this measure Individual cluster index (ICI). Statistical analyses were then performed, using a dedicated statistical software, to investigate the presence of correlation between ICI and the score of RME test in all subjects. In a subgroup of subject ($n = 13$, 3M, mean age 70 ± 7.2, age range: 56–79 years) the same statistical analysis was performed to test the correlation between ICI and the results of LFT. Results were considered statistically significant if surviving a $p < 0.05_{corrected}$ (corresponding to an uncorrected threshold of $p < 0.008$).

White Matter Analysis – Tract-Based Spatial Statistics (TBSS)

Voxelwise statistical analysis of the fractional anisotropy (FA) data, an index of microstructural integrity, was carried out using Tract-Based Spatial Statistics (TBSS; Smith et al., 2006), part of FSL (Smith et al., 2004). First, images were corrected for eddy current distortion, then FA images were created by fitting a tensor model to the raw diffusion data, and then brain-extracted using the Brain Extraction Tool (BET; Smith, 2002). All subjects' FA data were then aligned into a common space by creating a study-specific template using non-linear registration (Andersson et al., 2007a,b), which uses a b-spline representation of the registration warp field (Rueckert et al., 1999). Next, the mean FA image was created and thinned to create a mean FA skeleton which represents the centers of all tracts common to the group. Each subject's aligned FA data were then projected onto this skeleton and the resulting data fed into voxelwise cross-subject statistics.

A regression analysis was conducted on the skeletonized WM to investigate the relationship between FA values and age. Gender was included as covariate of no interest. Results of the statistical analyses, performed using TFCE method, have been considered as statistically significant if surviving $p < 0.005_{corrected}$ threshold.

A further regression analysis has then be performed on the cortical areas correlating with age (thresholded at $p < 0.05_{corrected}$ level) to investigate possible correlation with the RME test. The statistical analysis was performed using the TFCE method. Results have been considered statistically significant if surviving $p < 0.05_{corrected}$ threshold level.

RESULTS

Psychological Assessment

All subjects presented with MMSE score within normal range (MMSE > 28/30) as well as RME test (mean 26 ± 3.89, cut-off 13/36) and RME "gender" test (mean 34.33 ± 1.82, cut-off 19/36).

Results of the LFT in the elderly subgroup were: 34.7 ± 10.7 (mean corrected score).

Statistical analyses showed an inverse correlation between RME score and age ($r = -0.355$, $p = 0.034$), whereas the score at the Gender test did not survive statistical threshold ($r = -0.326$, ns).

Correlation between RME and LFT in the elderly subgroup was not significant ($r = -0{,}001$, $p = 0{,}997$).

Gray Matter Analyses – VBM

Voxel-wise analysis on GM data (VBM) revealed a left-sided inverse correlation between GM cortical volume and age in the precentral gyrus (BA 6), the inferior frontal gyrus (BA 9) and the superior temporal gyrus/insula. An inverse correlation was also found in a small area over the right central sulcus, involving pre- and post-central gyri (**Table 1**). No direct correlation was found between cortical volume and age.

The correlation analysis between GM areas (masked with results of correlation with age) and results in the RME test showed a direct correlation in bilateral precentral gyri, the bilateral posterior insula, the left inferior frontal and left superior temporal gyri (**Figure 2**; **Table 2**). No areas were found to be inversely correlated with RME test.

As expected, the statistical correlation between ICI and RME test showed a direct correlation in each of the considered clusters, whereas the correlation between ICI and RME gender test was statistically significant only in the left superior temporal gyrus ($p < 0.003$, rho 0,478; **Figure 1**; **Table 3**).

TABLE 1 | Voxel-based morphometry (VBM) clusters of inverse correlation between gray matter volume and age ($p < 0.005_{corrected}$ threshold).

Cluster size	P_{max}	Peak cluster MNI coordinates (*x, y, z*)			Center of gravity MNI coordinates (*x, y, z*)			Brain area
308	< 0.0001	−52	−12	32	−55.4	−7.58	35.6	Left precentral gyrus
175	0.0001	−46	6	32	−47.6	11.3	32.7	Left inferior frontal gyrus
131	0.0001	−40	−8	−14	−42.5	−7.56	−12	Left superior temporal gyrus
46	0.0001	58	−12	32	56.2	−11.5	36	Right pre/ post central gyrus

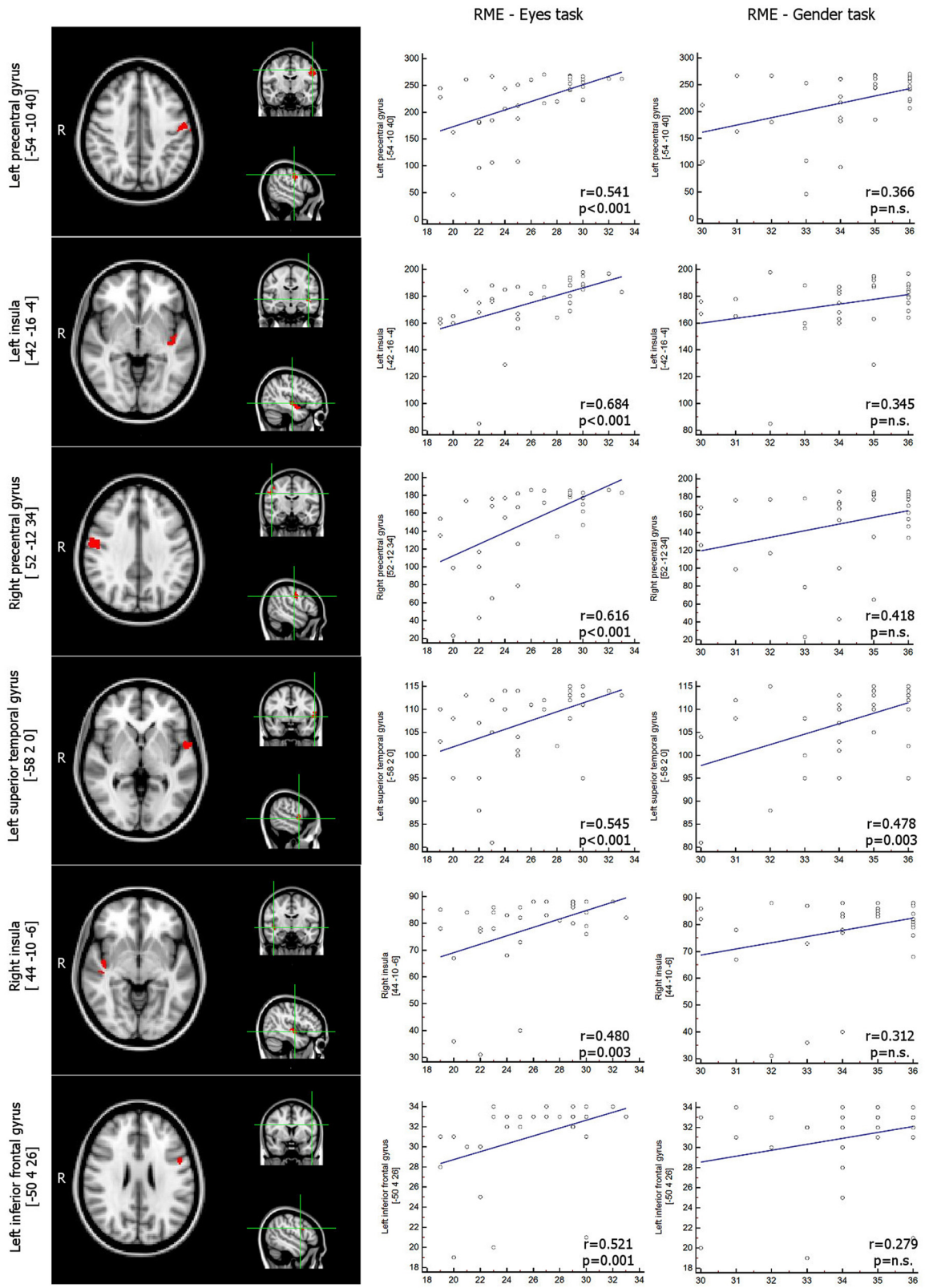

FIGURE 2 | VBM results. GM areas inversely related with RME test, $p < 0.05_{corrected}$ (among those areas that were inversely related with age, thresholded at $p < 0.05_{corrected}$) – Scatterplot representing the correlation between number of voxels within each significant GM cluster and scores in RME-Eyes task and in RME-Gender task. Coordinates are in MNI space. VBM, Voxel-based Morphometry; GM, Gray Matter; RME, Reading the Mind in the Eyes test.

TABLE 2 | Voxel-based morphometry clusters of direct correlation between gray matter volume and RME test ($p < 0.05_{corrected}$ threshold), among the cortical areas whose volume decreases with age.

Cluster size	P_{max}	Peak cluster MNI coordinates (*x, y, z*)			Center of gravity MNI coordinates (*x, y, z*)			Brain area
271	0.002	−54	−10	40	−54.7	−9.06	34.4	Left precentral gyrus – BA 4
210	0.007	−42	−16	−4	−40.4	−7.37	−10.9	Left insula – planum polare
186	0.002	52	−12	34	54	−8.03	37.2	Right precentral gyrus – supramarginal gyrus
115	0.004	−58	2	0	−56.3	1.48	3.46	Left superior temporal gyrus, BA 22
90	0.009	44	−10	−6	44.1	−13.4	−3.84	Right insula – planum polare
34	0.029	−50	4	26	−51.4	9.05	23.2	Left inferior frontal gyrus BA 44/BA 6

TABLE 3 | Correlation analyses between ICI data computed on GM areas whose volume correlated with RME test score (among those GM areas whose volume negatively correlated with age) and RME test, RME gender test and LFT.

	RME test		GENDER test		LFT	
	Correlation coefficient	*p*-value	Correlation coefficient	*p*-value	Correlation coefficient	*p*-value
Left precentral gyrus [ICI]	0.541	0.0007	0.366	n.s.	0.113	n.s.
Left insula [ICI]	0.684	<0.0001	0.345	n.s.	−0.106	n.s.
Right precentral gyrus [ICI]	0.616	0.0001	0.418	n.s.	−0.259	n.s.
Left superior temporal gyrus [ICI]	0.545	0.0006	0.478	0.003	0.116	n.s.
Right insula [ICI]	0.480	0.003	0.312	n.s.	−0.166	n.s.
Left inferior frontal gyrus [ICI]	0.521	0.001	0.279	n.s.	−0.246	n.s.

RME, Reading the Mind in the Eyes test; ICI, Individual Cluster Index; LFT, Letter Fluency Task; GM, Gray Matter.

The correlation between LFT test and ICI in the subgroup of elderly subjects was not significant in any of the considered clusters.

White Matter Analysis – TBSS

Tract-based spatial statistics analyses showed an inverse correlation between age and FA-values, involving most of the brain WM areas. In contrast, we did not find areas of WM whose FA-values were directly correlated with the same variable.

Regression analysis between WM microstructure (FA-value) and RME test score (within WM areas that correlated with age) revealed a direct correlation between FA and RME test in bilateral frontal areas anatomically compatible with the right superior longitudinal fasciculus and, only in right hemisphere, with the fronto-temporal parts of superior longitudinal fasciculus. We found a direct correlation with FA-values also in bilateral uncinate fasciculus, right inferior fronto-occipital fasciculus, right inferior longitudinal fasciculus, and with the genu of the corpus callosum (JHU White-matter tractography Atlas, FSL; **Figure 3**). We did not find any WM area whose FA-value was inversely correlated with RME score.

DISCUSSION

The eye gaze offers important information for decoding the mental and affective states of a person. In this MRI study we examined how brain structural changes that correlate with aging affect the Mind-Reading ability through the eyes within a sample of subjects from 24 to 79 years of age.

Behavioral results showed that all participants performed within the normal range on the RME test, suggesting that the Mind-Reading ability is preserved with age, as also demonstrated by previous research (Phillips et al., 2002; Castelli et al., 2010). However, investigating the relationship between age and RME score, we found a significant inverse correlation. This finding is consistent with other evidences reporting that elderly people perform worse than young people on the RME test (Slessor et al., 2007) although this decline is not as important as the one observed in cognitive ToM tasks (McKinnon and Moscovitch, 2007; Slessor et al., 2007; Pardini and Nichelli, 2009; Castelli et al., 2010). This is probably due to the minimal involvement of general cognitive abilities and executive functions in the RME test (Sandoz et al., 2014). Finally, executive functions performance did not correlate with brain areas changing with age and with the RME test performance, thus suggesting that the Mind-Reading performance is independent from general cognitive functioning.

The novelty of our study resides in the investigation of the relationship between areas of GM/WM that change with age and the performance at the RME test. In keeping with literature data, we found age-related cortical and subcortical modifications mainly involving fronto-temporal regions (Raz et al., 1998; Resnick et al., 2000, 2003; Sullivan and Pfefferbaum, 2006). Within these regions we found a direct correlation with RME performance in the bilateral precentral gyri, the bilateral posterior insula, the left inferior frontal and left superior temporal gyri. Moreover, WM results showed a direct correlation between FA and the RME test in clusters localized in frontal and temporal lobes that can be considered as part of the superior longitudinal fasciculus, the inferior fronto-occipital

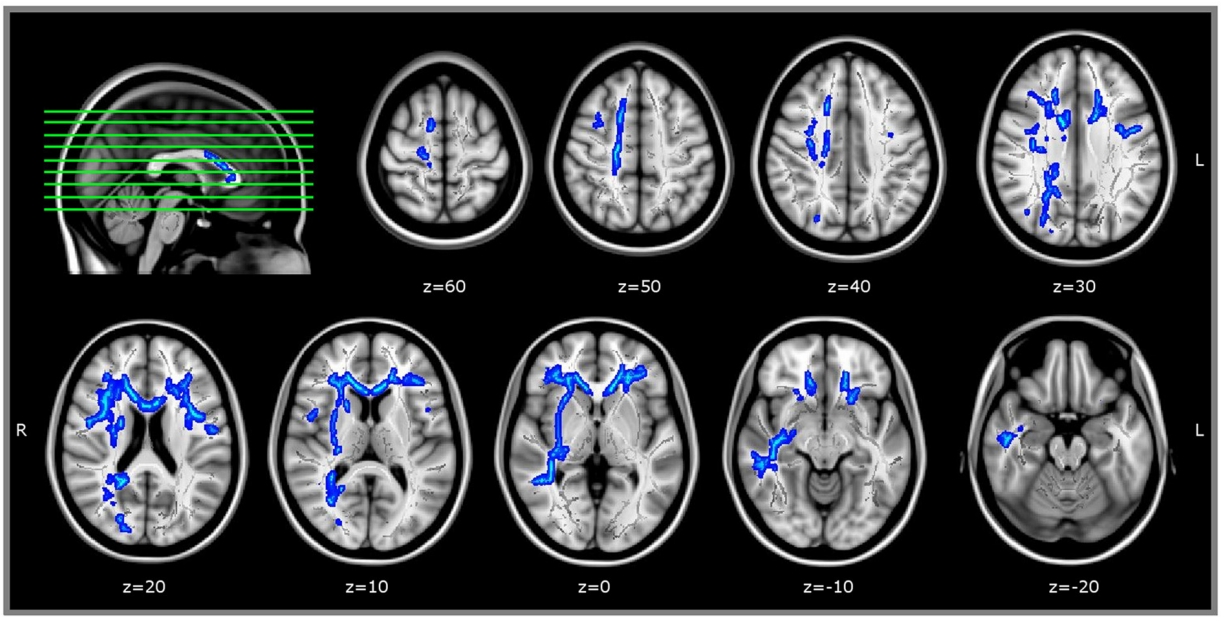

FIGURE 3 | TBSS results. WM areas whose FA-value was directy correlated with RME test, $p < 0.05_{corrected}$ (within areas inversely related with age, thresholded at $p < 0.05_{corrected}$). Coordinates are in MNI space. TBSS, Tract-Based Spatial Statistics; FA, Fractional anisotropy; RME, Reading the Mind in the Eyes test.

fasciculus and the inferior longitudinal fasciculus, all of them being considered as WM bundles connecting the frontal lobe with temporal and occipital lobes (Mori et al., 2005). Finally, we also found a WM cluster within the anterior corpus callosum, important for the connectivity of the frontal lobes (Mori et al., 2005).

Given the anatomical relationship between the WM and the GM above-mentioned clusters, it is possible that the reduction in RME test performance (although remaining within the range of normality) is driven by a more general loss of connectivity between inferior frontal regions and insular cortices reasonably mediated by the loss in microstructural integrity (as assessed by TBSS) in the fronto-temporal portions of the superior longitudinal fasciculus. These results can be related to the "anterior connectivity cluster" of the TPJ, which connects the inferior frontal gyrus, the anterior insula and the supplementary motor area with TPJ within a network that has been demonstrated to be fundamental for social abilities and to be related to the perceptual and pre-reflective aspects of Mind-Reading (Mars et al., 2012; Herbet et al., 2014, 2015).

Going into more detail about the GM results, our findings showed that the cortical volume of bilateral insula is correlated with both age (inversely) and performance on the RME test (directly). This finding is in line with evidences that associate this area with emotion recognition (Damasio et al., 2000; Phan et al., 2002; Britton et al., 2006; Kurth et al., 2010; Dal Monte et al., 2013), RME test performance (Boucher et al., 2015) and with the difficulty observed in aged subjects in decoding facial expression of emotions (MacPherson et al., 2006; Chaby and Narme, 2009).

Noteworthy, our results also show an involvement of the precentral gyrus, particularly the premotor cortex among those areas that change with age and are directly correlated with RME test. This area is involved in action planning and is considered a core region of the MNS (Rizzolatti et al., 2001). The importance of the MNS within ToM ability was stated by the interactive dual-process theory (Coricelli, 2005; Keysers and Gazzola, 2007; Uddin et al., 2007), that postulates that mentalizing abilities emerge from the interaction between two distinct neural networks: the MNS, involved in the low-level embodied representation and pre-reflexive perceptual processes (i.e., emotional empathy, basic emotion recognition, and motor intention decoding) and the mentalizing network, which is related to an higher level representation involved in the attribution of mental states to other people. A great number of studies found evidences that the MNS informs and supports the Mind-Reading ability (Decety and Chaminade, 2003; Blakemore et al., 2004; Agnew et al., 2007; Keysers and Gazzola, 2007; Castelli et al., 2010) and this interaction is hypothesized to be driven by the premotor cortex, which identifies goals and intentions of others (Rizzolatti et al., 2002). The connectivity between MNS and mentalizing network is mediated by perisylvian components of the superior longitudinal fasciculus: the arcuate fasciculus and the lateral-superficial part of superior longitudinal fasciculus (Catani and Jones, 2005; Makris et al., 2005; Rilling et al., 2008; Martino et al., 2013) whose FA we found to correlate with age and performance in RME test. Both the arcuate and the lateral superior longitudinal fasciculi are important for social cognition (Barbey et al., 2012). Finally, a recent lesion study found that the behavioral performance

at the RME test is inversely correlated with the degree of disconnection of the right perisylvian network (Herbet et al., 2014, 2015).

Our VBM results also show the involvement of the inferior frontal gyrus among the age-related areas whose volume change with RME test performance. This area has been recently demonstrated to be necessary for the RME performance (Dal Monte et al., 2014), for tuning into others' affective state of mind (Chakrabarti et al., 2006) and for language production (Price, 2010). Moreover, we found that cortical volume of the superior temporal gyrus together with the FA values of WM bundles connecting this area with the inferior frontal gyrus were associated with both age and RME performance. These results can be explained by the verbal components of the RME test that requires explicit labeling of the eyes expressions depicted in the pictures. Indeed, it has been demonstrated that Mind-Reading ability, although it implies largely implicit mentalizing processes, is influenced in part by other cognitive abilities, first of all language skills. Peterson and Miller (2012) showed that in a healthy adult sample with a mean intelligence quotient (IQ) score, the verbal IQ (which measures basic vocabulary knowledge as well as other expressive verbal skills) alone accounted for almost 25% of the variance in the RME test performance (Peterson and Miller, 2012).

Interestingly, despite the observation of a cortical volume reduction in language-specific areas such as inferior frontal gyrus and superior temporal gyrus and decreased FA in the underlying connecting WM bundles, the Mind-Reading ability is relatively well preserved with increasing age. This result is in keeping with previous research showing that language abilities, especially language comprehension, are among the ones best preserved in elderly people (Burke and Shafto, 2004; Tyler and Marslen-Wilson, 2008) and do not decline proportionally to the amount of atrophy in fronto-temporal regions (Park et al., 2002). This is mediated by the involvement of bilateral language-area that compensate this volume reduction (Cabeza, 2002; Reuter-Lorenz, 2002) and allow older people to complete the RME task successfully.

CONCLUSION

The aging-related decline in the Mind-Reading ability through the eyes could be a direct consequence of brain structural and functional changes, such as GM tissue loss and microstructural changes in WM areas, as discussed above.

Given this premise it is possible to speculate that, in healthy aging, volume reduction at the level of premotor cortex, inferior frontal gyrus, insula and superior temporal gyrus, associated with a decrease of the connections between frontal and temporal cortices, might result in a lower ability to understand the others mental states in a rapidly and intuitively way, as the Mind-Reading ability allows us to do. However, the recruitment of additional neural areas and circuits, such as bilateral language areas, might help preserve Mind-Reading performance. Our results are coherent with a previous fMRI study by our group (Castelli et al., 2010) showing that there were no differences in the RME test performance between young and old subjects, but that the elderly had increased activation, compared to young subjects, in the same network that we found in this work: the premotor cortex, the inferior frontal gyrus and the temporo-insular regions. To conclude, structural brain changes in GM and WM may explain the differences in the Mind-Reading ability across our sample and that adapted neural plasticity such as compensatory mechanisms might overcome the age-related cortical loss and account for the intact Mind-Reading through the eyes performance of elderly people (Cabeza, 2002; Park and Reuter-Lorenz, 2009; Castelli et al., 2010; Cramer et al., 2011).

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Theory of Mind and the Whole Brain Functional Connectivity: Behavioral and Neural Evidences with the Amsterdam Resting State Questionnaire

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A topic of common interest to psychologists and philosophers is the spontaneous flow of thoughts when the individual is awake but not involved in cognitive demands. This argument, classically referred to as the "stream of consciousness" of James, is now known in the psychological literature as "Mind-Wandering." Although of great interest, this construct has been scarcely investigated so far. Diaz et al. (2013) created the Amsterdam Resting State Questionnaire (ARSQ), composed of 27 items, distributed in seven factors: discontinuity of mind, theory of mind (ToM), self, planning, sleepiness, comfort, and somatic awareness. The present study aims at: testing psychometric properties of the ARSQ in a sample of 670 Italian subjects; exploring the neural correlates of a subsample of participants ($N = 28$) divided into two groups on the basis of the scores obtained in the ToM factor. Results show a satisfactory reliability of the original factional structure in the Italian sample. In the subjects with a high mean in the ToM factor compared to low mean subjects, functional MRI revealed: a network (48 nodes) with higher functional connectivity (FC) with a dominance of the left hemisphere; an increased within-lobe FC in frontal and insular lobes. In both neural and behavioral terms, our results support the idea that the mind, which does not rest even when explicitly asked to do so, has various and interesting mentalistic-like contents.

Keywords: resting state components, theory of mind (ToM), functional connectivity (FC), resting state fMRI (rfMRI), graph analysis

INTRODUCTION

A classical topic of interest both for psychologists and philosophers has been the spontaneous and autonomous flow of thoughts that occurs when persons are awake, but not involved in cognitive demands. This topic has been termed Mind-Wandering (MW) in the psychological domain (Smallwood and Schooler, 2006; Mason et al., 2007; Gruberger et al., 2011).

The first attempt to conceptualize such a cognitive process can be traced back to William James and his famous concept of the "stream of consciousness" (William, 1892), that indicates the continuous course of thoughts and feelings without a logical structure. A typical example is the interior monolog, used in psychological novels, such as the famous "Molly's monolog" in the novel "Ulysses" by James Joyce (1922). Over the past century, the construct of MW has been identified by different terms: "day-dreaming" (Giambra, 1979), "task-unrelated images and thoughts" (Giambra and Grodsky, 1989), "stimulus independent thought" (Teasdale et al., 1995), "task-unrelated thought" (Smallwood et al., 2003), "incidental self-processing" (Gilbert et al., 2005), "spontaneous thought" (Christoff et al., 2009) and "inner speech" (Morin, 2009). Despite the interest, as showed by the variety of terms created to identify it, the experimental study of MW has been largely neglected. As Gruberger et al. (2011) point out in their review, this may be due to the ontological features of the construct itself, i.e., the fact that MW occurs spontaneously and unintentionally, which makes it difficult to observe and measure it in the absence of external cues.

Initial observations of the activity of the resting brain occurred quite accidentally in the second half of the past century. Ingvar (1979, 1985) noted the presence of a specific and consistent pattern of neural activation during the rest-task conditions, and that the most important areas involved in this network were the frontal regions. This idea of a specific neural network underlying the resting condition remained unexplored for several years, until the massive advent of neuroimaging techniques. The growing importance of cognitive neuroscience and the increasing use of its brain imaging methods, namely Positron emission tomography (PET) and functional magnetic resonance imaging (fMRI), have allowed the observation of the brain networks underlying MW. In fact, using PET and fMRI it was revealed that resting brain activity involves many areas (Hampson et al., 2002; Beckmann et al., 2005; Seeley et al., 2007; Greicius et al., 2009). In this context, the medial prefrontal cortex (mPFC), the posterior cingulate cortex (PCC) and the inferior parietal lobule (iPL) were consistently identified. Moreover, it was postulated that the hippocampal formation (HF) played a role as well, even if its involvement remained controversial for a long time because it depended on the specific aims of the studies (Buckner et al., 2008). A crucial contribution for the advances of the study of the MW and of its the neural basis came from Raichle et al. (2001), who coined the construct of the "Default Mode Network" (DMN), now a key construct in the study of the human brain activity. The scientific literature has identified the core regions involved in the DMN (Buckner et al., 2008): ventral mPFC, the posterior cingulate/retrosplenial cortex, the iPL, the lateral temporal cortex, the dorsal medial prefrontal cortex, and the HF. Most interestingly, the DMN comprises different components with specific functions that are active and interact in complex forms of cognition (for example creativity, Beaty et al., 2014), in particular in social cognition. Recent reviews and meta-analyses (see for example Schilbach et al., 2008, 2012; Mars et al., 2012; Li et al., 2014) have confirmed that the DMN is involved in the complex activity of social understanding, that comprises more specific dimensions such as self-consciousness, the self-other distinction, the self-other exchange (Schilbach et al., 2008), and the autobiographical processes (Andrews-Hanna et al., 2014). A crucial ability for a successful self-other distinction and self-other exchange is theory of mind (ToM), or mindreading or mentalizing, i.e., the ability to represent self and other's mental states and to use such meta-representations to understand, explain, and foresee human behavior (Doherty, 2008). Over the past decades, the psychological and neuropsychological literature has consistently demonstrated that ToM typically develops during the preschool and school-age period, and that it undergoes continuous changes across the life-span. In particular, this ability, which is extremely important for social aspects of life, undergoes significant changes both on the behavioral and on the neural level in successful and unsuccessful neurocognitive aging (see for example Castelli et al., 2010, 2011; Baglio et al., 2012; Cabinio et al., 2015). As regards the most recent evidences concerning the neural basis of MW, a meta-analytic review by Fox et al. (2015) highlighted that focusing on the activation of the DMN alone may be overly reductive for an exhaustive description of the neural basis of spontaneous thought. In fact, they identified various regions, among which those that classically belong to the DMN (such as the medial prefrontal cortex/anterior cingulate cortex) and a series of regions outside the DMN (such as the secondary somatosensory cortex and the insula). Therefore, in the present study we decided to investigate the neural basis of MW following a whole-brain approach, i.e., looking also at areas beyond just the DMN.

Behavioral methods to study MW have been developed only recently (Gruberger et al., 2011) and they have been employed in association with brain imaging techniques. Three types of methods are deeply related to the brain imaging techniques: parametric modulation of self-relatedness, parametric modulation of cognitive load, and paradigm-free analysis of neuronal dynamics. In the first approach, neural activations during self-related tasks are compared to neural activations at rest, when MW is supposed to occur most frequently (see for example Gusnard et al., 2001). In the second one, the contrast between the task-condition and the resting-condition is the procedure of "the contrast of rest minus task." The idea at the basis of such a method was to demonstrate that to a low cognitive load in a certain task condition corresponds a high activation in the DMN areas during the task (see for example Christoff et al., 2004; McKiernan et al., 2006; Mason et al., 2007). Finally, in the paradigm-free analysis of neuronal dynamics, no behavioral paradigm is devised, because the participants simply lie resting during the examination (see for example Horovitz et al., 2008, 2009).

Two types of methods, instead, place more attention on the behavioral evaluation of MW: real-time sampling, and retrospective evaluation. In the former, participants have to indicate whether or not they were experiencing a spontaneous thought (i.e., not-linked to task performance) when they heard an auditory stimulus during an fMRI scan session (see for examples McKiernan et al., 2006; Mason et al., 2007; Christoff et al., 2009). In the latter, a questionnaire is proposed after a resting session, without interrupting the MW experience,

and asking the participants to recall the contents of the MW activity. Even if the use of self-report methods is largely employed in the psychological research, there is a paucity of studies regarding MW with such a method. The first and few attempts in the past years (Giambra, 1979; Klinger and Cox, 1987; Matthews et al., 1999) were not validated and thus did not find proper consideration in the neuroscientific literature. In recent years, three attempts to develop self-report measures of the resting activity deserve consideration. D'Argembeau et al. (2005) asked participants to rate the amount of thoughts experienced, regardless of their content, in a questionnaire immediately after the fMRI session. Delamillieure et al. (2010) devised the Resting State Questionnaire, which consists of 62 items that cluster five main types of mental activity: visual mental imagery, inner language, somatosensory awareness, inner musical experience, and mental manipulation of numbers. Participants retrospectively rate the proportion of time spent in each mental activity during the resting-state fMRI (rfMRI) acquisition using a 0–100% scale. Recently, Diaz et al. (2013) created the Amsterdam Resting State Questionnaire (ARSQ), a 27 items instrument, and administered it after a 5-min resting session in a non-fMRI session, in order to investigate the MW in a pure behavioral manner. This procedure has the advantage to limit the possible distortion due to the experimental peculiarities of fMRI acquisition. Through exploratory and confirmatory factor analyses (EFA and ECA), they identified seven factors: discontinuity of mind, theory of mind, self, planning, sleepiness, comfort, and somatic awareness. Stoffers et al. (2015) identified 11 positive associations between brain- functional network connectivity and ARSQ dimensions. Specifically, "Sleepiness", "Visual Thought", and "Discontinuity of Mind" appeared to be significantly associated with functional connectivity within the Visual, Sensorimotor and Default Mode networks.

The present study aims at evaluating for the first time the seven-factor structure of the ARSQ in an Italian sample, and at exploring the neural correlates of a subsample of participants divided in two groups on the basis of the scores obtained in the ToM factor. In particular, for the rfMRI analysis we used an approach well described in the literature (Achard et al., 2006; van den Heuvel et al., 2008; Bullmore and Sporns, 2009; Tyszka et al., 2014) to examine all the areas of the whole-brain network. Furthermore, since the literature has shown a partial overlap between areas associated with MW areas and those with the ToM network, particularly the mPFC/anterior cingulate cortex, we decided to focus on the possible correlation between the neural areas activated during the resting session and the respective ToM degree that has engaged the mind during the session itself.

MATERIALS AND METHODS

Subjects

Data were obtained from 670 participants that completed the ARSQ. Most of our sample ($n = 400$) was obtained from students enrolled at the Catholic University of Milan and Piacenza. Moreover, students of other Universities in Italy were contacted using social network and mailing lists provided by student organizations ($n = 193$). Finally, we handed out the questionnaire to a sample of people ($n = 70$) already involved in another study at Don Gnocchi Foundation in Milan. According to the recommendations of the Declaration of Helsinki about ethical principles for medical research involving human subjects, both local ethics committee approval of the Don Gnocchi ONLUS Foundation and written informed consent from all subjects to participate in the study were obtained before study initiation.

Amsterdam Resting State Questionnaire

On the basis of research by Diaz et al. (2013), we administered the ARSQ to test its structure and reliability in an Italian sample. Although an updated version of the questionnaire was recently published by the same research group (Diaz et al., 2014), it was not available when we started our study. The measurement of resting state through ARSQ is done in two steps: in the first, the participant is required to experience a resting state session, i.e., to remain alone for 5 min in a quiet and silent room, in a comfortable position with the eyes closed. Participants are also recommended to free the mind from all thoughts, and to set an alarm that will alert when the 5 min of the resting session have passed. In the second step, participants are required to fill out the questionnaire about sensations and thoughts experienced during the resting session.

The 27 items of the ARSQ and the five control items were translated into Italian with the back-translation procedure. The control items aim to evaluate whether the participants performed the questionnaire properly. Participants are asked to express their agreement with each item using a five point Likert scale: 1 = "Completely Disagree," 2 = "Disagree," 3 = "Neither Agree or Disagree," 4 = "Agree," and 5 = "Completely Agree." Diaz et al. (2013) identified and confirmed a structure of seven factors: discontinuity of mind, theory of mind, self, planning, sleepiness, comfort, and somatic awareness (see **Table 1**).

After dataset constructions we filtered the sample on the basis of the control items in order to ensure the inclusion of participants who had completed the resting state session before filling in the questionnaire. More specifically, the subjects who responded less than "agree" at least to one of the questions "I felt motivated to participate," "I had my eyes closed" and "I was able to rate the statements" or less than disagree at least to one of the questions "I have difficulty remembering my thoughts" and "I have difficulty remembering my feelings" were excluded from the sample. We also removed those subjects who did not complete the entire questionnaire. The final sample consisted of 304 subjects ($M_{age} = 29.26$ years, $SD_{age} = 11.04$).

MRI Acquisition Protocol

A sub-group of the whole dataset, which included 28 healthy right-handed subjects (mean age $\pm$ $SD = 54.32 \pm 18.79$ years; range: 21–79 years; nine males), was acquired at Don Gnocchi Foundation, IRCCS Santa Maria Nascente (Milan, Italy), using a 1.5 T Siemens Magnetom Avanto (Erlangen, Germany) magnetic

TABLE 1 | Control items and seven-factor structure of the ARSQ.

Control items	• I felt motivated to participate • I have difficulty remembering my thoughts • I have difficulty remembering my feelings • I had my eyes closed • I was able to rate the statements
Discontinuity of mind	• I felt restless • I had busy thoughts • I had my thoughts under control • I had rapidly switching thoughts • I had difficulty holding on to my thoughts
Theory of mind	• I thought about others • I thought about people I like • I place myself in other peoples' shoes
Self	• I thought about my feelings • I thought about my behavior • I thought about myself
Planning	• I thought about my work/study • I thought about solving problems • I thought about the past • I thought about the future • I had deep thoughts • I thought about things I need to do
Sleepiness	• I felt tired • I felt sleepy • I had difficulty staying awake
Comfort	• I felt comfortable • I felt relaxed • I felt happy
Somatic awareness	• I thought about my health • I was conscious of my body • I thought about my heartbeat • I thought about my breathing

resonance imaging (MRI) scanner with an 8-channel head coil. All the subjects had no history of neurological, cardiovascular, or metabolic disorders and voluntarily participated in the study.

Resting state fMRI (rfMRI), BOLD EPI images were collected at rest for approximately 6.6 min (TR/TE = 2500/30 ms; resolution = 3.1 mm × 3.1 mm × 2.5 mm; matrix size = 64 × 64; number of axial slices = 39; number of volumes = 160). Subjects were instructed to keep their eyes closed, not to think about anything in particular, and not to fall asleep. High resolution T1-weighted 3D scans were also collected (TR/TE = 1900/3.37 ms; resolution = 1 mm × 1 mm × 1 mm; matrix size = 192 × 256; number of axial slices = 176) to be used as anatomical references for rfMRI analysis. After the rfMRI session, the ARSQ was administered, as in Diaz et al. (2013).

rfMRI Data Analysis

Pre-processing of rfMRI data was carried out using FSL (Smith et al., 2004; Jenkinson et al., 2012). Standard pre-processing involved the following steps: motion correction with Motion Correction Linear Image Registration Tool (MCFLIRT – Jenkinson et al., 2002); non-brain tissues removal with Brain Extraction (BET; Smith, 2002); spatial smoothing with a 5 mm full-width at half-maximum (FWHM) Gaussian kernel; high-pass temporal filtering with a cut-off frequency of 0.01 Hz. Single-subject spatial independent component analysis (ICA) with automatic dimensionality estimation was performed using MELODIC (multivariate exploratory linear optimized decomposition into independent component) 3.0 (Beckmann and Smith, 2004). Subsequently, each subject's dataset was cleaned from artifacts using the FMRIB's ICA-based Xnoiseifier (FIX) toolbox (Griffanti et al., 2014; Salimi-Khorshidi et al., 2014), as it has been shown that FIX is a good approach for data denoising (Pruim et al., 2015) and is more effective than other approaches in detecting functional alterations in a small-sample population and using a clinical scanner (Griffanti et al., 2015). The 24 motion parameters (i.e., the six rigid-body time series, their backward-looking temporal derivatives and the squares of the twelve resulting regressors) estimated by MCFLIRT were also regressed out.

After the pre-processing, each single-subject 4D dataset was aligned to the subject's high-resolution T1-weighted image using linear registration (FLIRT, Jenkinson and Smith, 2001; Jenkinson et al., 2002) with the brain-boundary registration cost function (BBR, Greve and Fischl, 2009), registered to MNI152 standard space using Non-linear Image Registration Tool (FNIRT, Andersson et al., 2007a,b), and subsequently resampled to 2 mm × 2 mm × 2 mm resolution.

Regions of Interest

Resting state fMRI signal was extracted from the regions of interest (ROIs) defined by anatomical parceling the cortical areas using the Harvard-Oxford atlas (Frazier et al., 2005; Desikan et al., 2006; Makris et al., 2006; Goldstein et al., 2007), as seen in previous studies (Davis et al., 2013; Tyszka et al., 2014). The maximum overlap discrete wavelet transform (Percival and Walden, 2000) was then used to decompose the time series into wavelet coefficients at four scales (scale 1: 0.0066–0.0075; scale 2: 0.0075–0.016 Hz; scale 3: 0.016–0.0364 Hz; scale 4: 0.0364–0.1 Hz) and estimate the wavelet-correlation matrices at each scale (Achard et al., 2006). We focused on scale 4 (0.0364–0.1 Hz), in which the spontaneous low-frequency oscillations of the BOLD signal are mostly located (Fransson, 2005).

The wavelet-correlation matrices were used for estimating possible functional connectivity (FC) dependencies with the ToM factor. Subjects were divided in two groups, i.e., high-ToM and low-ToM, each composed by 14 subjects, depending on the mean score (respectively higher or equal/lower than 3, which is the arithmetic mean across the possible ToM scores in the range: 1–5) that the subject obtained in the answers to the three items of the factor of theory of mind ("I thought about others," "I thought about people I like," and "I placed myself in other people's shoes").

Significant differences between the high-ToM and low-ToM groups were assessed with a two-sample unpaired *t*-test using the Network Based Statistic toolbox (NBS, Zalesky et al., 2010).

RESULTS

Preliminary Confirmation of the Original 7-Factor ARSQ Structure

Descriptive analyses on the items were conducted. All the items showed a normal distribution (skewness and kurtosis < 1.5). In order to test the original structure that emerged from the ARSQ data analysis we performed a confirmatory factor analysis (CFA) with MPlus software 6.11 (Muthén and Muthén, 1998–2011) on the dataset with 27 items extracting in seven factors. The results confirmed that the original model adapts to the Italian data, showing acceptable indices of fit and parameters substantially in line with those of the original study (Diaz et al., 2013; see **Tables 2** and **3**). Composite reliability (Bagozzi, 1994) proved well-above 0.80 for all the factors except for "ToM" where the value was 0.66. All the items significantly saturated the respective latent factors. However, ten items did not saturate at more than 0.40, of which only one item of the factor "Somatic" showed a value lower than 0.2 (range: 0.17–0.88).

Resting State fMRI

All the subjects completed the MRI session; no structural alterations were found. Age and sex matching between the two groups were respectively verified by means of two-sample unpaired *t*-test and Chi-squared test (*low-ToM*: mean age $= 49.36 \pm 18.22$, three males, mean ToM factor $= 1.86 \pm 0.68$; *high-ToM*: mean age $= 59.28 \pm 18.65$ years, six males, mean ToM factor $= 3.31 \pm 0.36$).

Wavelet-correlation Matrices

We evaluated the FC differences between the two groups with a two-sample unpaired *t*-test and identified a sub-network with higher values of FC in high-ToM compared to low-ToM. **Figure 1A** shows FC of the 48 sub-network nodes (see **Table 4** for details), expressed as the mean z-score across the subjects belonging to the low-ToM (top) and high-ToM (middle) groups. Six main regions were identified and highlighted with different colors along the diagonal: the frontal lobe (16 nodes, red box), the parietal lobe (eight nodes, green box), the insular lobe (three nodes, yellow box), the limbic lobe (five nodes, light-blue box), the temporal lobe (nine nodes, purple box), and the occipital lobe (seven nodes, orange box). The 48 nodes reported in detail in **Table 4**. To note, among those nodes it is possible to detect some core areas belonging to the DMN (medial frontal gyrus, iPLs, parahippocampal gyrus and precuneus) and to the salience network (insula and cingulate gyrus). The last row of **Figure 1A** reports the statistical results of the two-sample unpaired *t*-test (high-ToM > low-ToM, $p < 0.05$, NBS-corrected for multiple comparisons). **Figure 1B** shows a graph with the 48 nodes of the sub-network and the edges relative to a significant difference of FC between the two groups. This graph indicates a marked functional asymmetry between the left and the right hemispheres, as it shows more significantly different FC in the left hemisphere than in the right one. Globally, **Figure 1** highlights a greater FC variation in the frontal and insular lobes compared to the others.

DISCUSSION AND CONCLUSION

The present study aimed at confirming the factorial structure of the ARSQ and at exploring the neural correlates of the factor of theory of mind of the ARSQ thorough brain imaging techniques.

The results of the CFA have showed satisfactory fit indexes, supporting the seven factors structure originally found by Diaz et al. (2013). The confirmation of the seven factors structure contributes to measure the human mind activity, that appears to be restless even when persons are required to think about nothing. The results have also highlighted the presence of a statistically significant difference in the levels of the FC of 48 nodes between the subjects with a low mean in the factor of Theory of Mind (low-ToM) and the subjects with a high mean in the factor of theory of mind (high-ToM), i.e., subjects who report having thought a lot about other persons. In particular, our functional whole-brain network

TABLE 2 | Fit indices for the models in Diaz et al. (2013) and current study samples.

Models	X^2 (*p*)	Df, *N*	RMSEA (90% C.I.)	SRMR	CFI
Diaz et al., 2013, #11685	2455.63 (<0.001)	303, 813	0.093	-	0.88
Present study	577.28 (<0.001)	303, 304	0.055 (0.048–0.061)	0.068	0.84

TABLE 3 | Correlations among factors.

	DoM	ToM	Self	Plan	Sleep	Comfort	SomA
DoM	–						
ToM	0.58** (0.36)	–					
Self	0.51** (0.58)	0.13 (0.59)	–				
Plan	0.59** (0.58)	0.33** (0.70)	0.60** (0.21)	–			
Sleep	0.12 (0.32)	0.11 (0.11)	−0.04 (0.24)	0.22* (0.21)	–		
Comfort	−0.47** (−0.72)	−0.03 (0.04)	−0.07 (−0.27)	−0.24** (0.20)	−0.06 (−0.25)	–	
SomA	−0.15* (0.35)	−0.12 (0.27)	0.18* (−0.71)	−0.02 (0.48)	−0.00 (0.31)	0.09 (−0.30)	–

*$p < 0.01$, **$p < 0.001$.

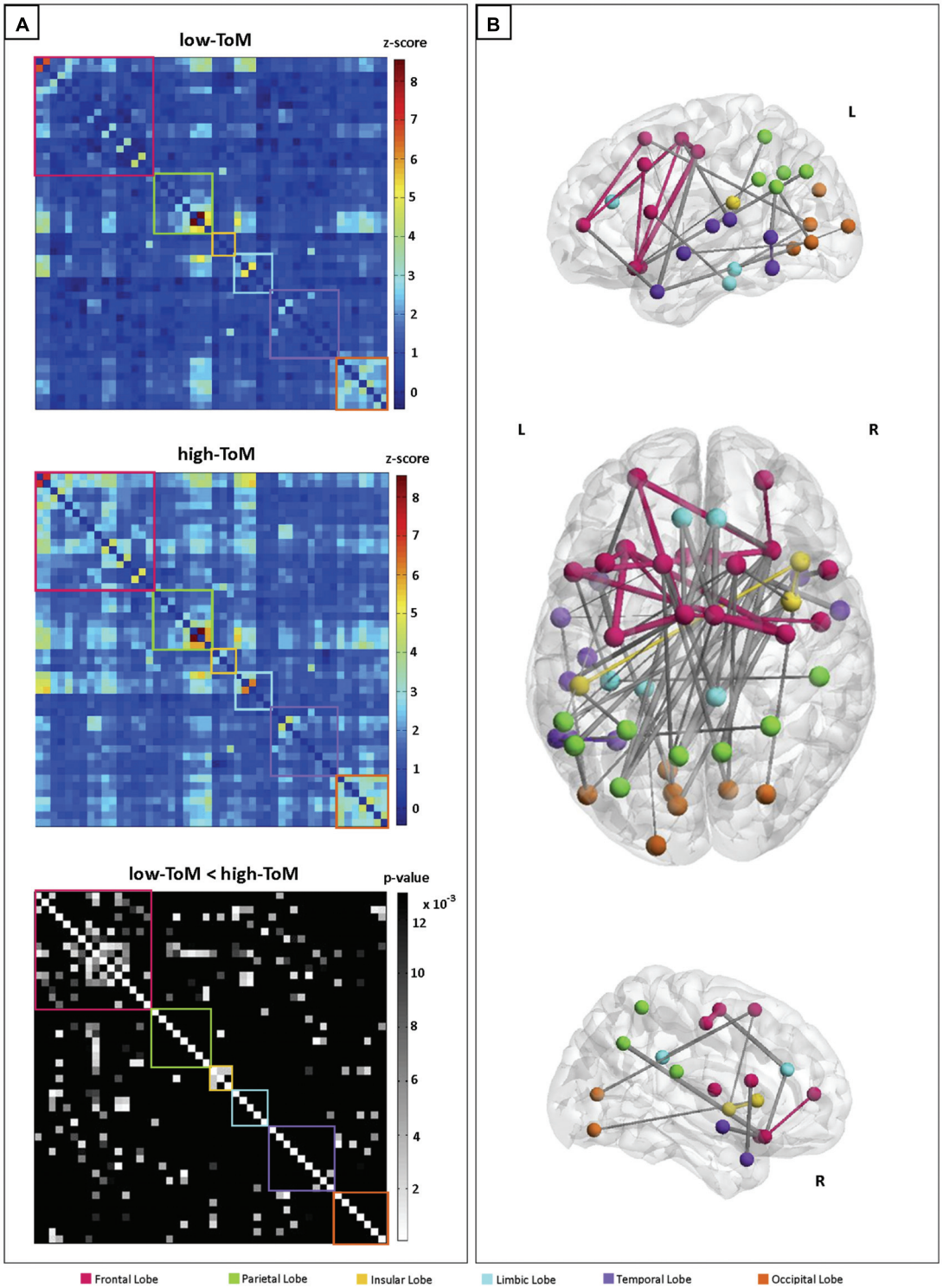

FIGURE 1 | (A) Sub-network functional connectivity (FC) matrices among the 48 nodes (frequency range: 0.0364–0.1 Hz), averaged across the subjects belonging to the two groups: low-ToM (top) and high-ToM (middle); on the bottom, the statistical results for the contrast high-ToM > low-ToM ($p_{NBS-corr} \leq 0.013$). Within-region FC is arrayed on diagonal blocks; between-region FC appears in off diagonal blocks. Colored boxes denote lobe membership: red = Frontal Lobe; green = Parietal Lobe; yellow = Insular Lobe; light-blue = Limbic Lobe; purple = Temporal Lobe; orange = Occipital Lobe. The color bars indicate the FC range (z-score: −1÷9) for the low-ToM and high-ToM connectivities matrices and the statistically significant p-values in grayscale ($p_{NBS-corr} > 0.013$ are black colored). **(B)** Graph representation of FC differences between the two groups. The edge size is proportional to the extent of FC difference between high-ToM and low-ToM. Within-region edges are represented with the color of their own region; between-region edges are colored in gray.

TABLE 4 | Characterization of the 48 cortical areas extracted from the Harvard-Oxford atlas with higher values of functional connectivity in high-ToM compared to low-ToM.

#	Coordinates (x, y, z)	Hemisphere	Lobe	Area
1	−25, 53, 8	L	Frontal	Middle frontal gyrus (BA10)
2	26, 52, 9	R	Frontal	Middle frontal gyrus (BA 10)
3	−15, 18, 57	L	Frontal	Superior frontal gyrus
4	15, 18, 58	R	Frontal	Superior frontal gyrus
5	−38, 18, 42	L	Frontal	Middle frontal gyrus
6	−51, 15, 15	L	Frontal	Inferior frontal gyrus (BA 44)
7	52, 15, 16	R	Frontal	Inferior frontal gyrus (BA 44)
8	−27, 24, −16	L	Frontal	Inferior frontal gyrus (BA 47)
9	29, 23, −16	R	Frontal	Inferior frontal gyrus (BA 47)
10	−34, −12, 49	L	Frontal	Middle frontal gyrus
11	35, −11, 50	R	Frontal	Middle frontal gyrus (BA 6)
12	−6, −3, 56	L	Frontal	Medial frontal gyrus
13	6, −3, 58	R	Frontal	Medial frontal gyrus (BA 6)
14	−6, 21, −16	L	Frontal	Subcallosal gyrus
15	6, 20, −16	R	Frontal	Subcallosal gyrus
16	49, −6, 11	R	Frontal	Precentral gyrus
17	49, −28, 22	R	Parietal	Inferior parietal lobule
18	−29, −49, 58	L	Parietal	Inferior parietal lobule
19	29, −48, 59	R	Parietal	Inferior parietal lobule
20	−55, −46, 34	L	Parietal	Inferior parietal lobule
21	−50, −56, 29	L	Parietal	Supramarginal gyrus
22	−8, −60, 37	L	Parietal	Precuneus
23	9, −58, 38	R	Parietal	Precuneus
24	−32, −73, 38	L	Parietal	Precuneus
25	41, 19, 5	R	Insular	Insula
26	38, 3, 0	R	Insular	Insula
27	−48, −32, 20	L	Insular	Insula (BA 13)
28	7, −36, 30	R	Limbic	Cingulate gyrus (BA 23)
29	−7, 37, 21	L	Limbic	Anterior cingulate (BA 32)
30	7, 36, 23	R	Limbic	Anterior cingulate (BA 32)
31	−22, −32, −17	L	Limbic	Parahippocampal gyrus (BA 36)
32	−36, −29, −25	L	Limbic	Parahippocampal gyrus (BA 36)
33	−45, −20, 7	L	Temporal	Superior temporal gyrus (BA 13)
34	−40, 11, −30	L	Temporal	Superior temporal gyrus
35	41, 13, −29	R	Temporal	Superior temporal gyrus
36	−56, −4, −8	L	Temporal	Middle temporal gyrus
37	57, −1, −10	R	Temporal	Middle temporal gyrus (BA 21)
38	−53, −30, 11	L	Temporal	Superior temporal gyrus (BA 41)
39	−57, −53, 1	L	Temporal	Middle temporal gyrus
40	−52, −53, −17	L	Temporal	Inferior temporal gyrus (BA 20)
41	−33, −54, −16	L	Temporal	–
42	−13, −66, −5	L	Occipital	Lingual gyrus (BA 18)
43	27, −75, −12	R	Occipital	Lingual gyrus
44	−9, −80, 28	L	Occipital	Cuneus (BA 19)
45	−17, −96, 7	L	Occipital	Cuneus
46	−45, −76, −2	L	Occipital	Middle occipital gyrus
47	−10, −75, 8	L	Occipital	Cuneus (BA 23)
48	12, −74, 8	R	Occipital	Cuneus (BA 23)

#, Identification number; BA, Brodmann area; L, left; R, right.

analysis showed that high-ToM subjects show more FC in the frontal lobe and in the insula, with a dominance of the left hemisphere.

The mPFC, a core region of the DMN, has been consistently identified as part of a circumscribed neural circuit underlying mentalizing (Amodio and Frith, 2006; Frith and Frith, 2006;

Schurz et al., 2014). Moreover, our findings suggest that connectivity within the frontal lobes facilitates mentalizing ability. The evidence of frontal lobe involvement in ToM is in line with previous MRI results provided over the past years (see for example Stone et al., 1998), also by lesion studies: subjects with frontal lobes lesions show deficits in the solution of ToM tasks (see for example Rowe et al., 2001; Bird et al., 2004).

Without any intention to establish a causal relation between neural activation and psychological activity during resting state, it is possible to argue that the higher FC in the areas involved in the voluntary control of behavior, consciousness and executive function may depend on two reasons. In the first case higher FC may express the attempt to "control" the mental activity in order to comply with the experimental instruction "to free the mind from every kind of thoughts." In the second case, the unrested mind involves itself in thinking about others by using the frontal lobe connectivity to decouple its own perspective from that of other's.

Interestingly, our findings show that the FC changes are not limited to the areas belonging to the DMN, but are extended to include other networks. In fact, the insula is part of the "salience network," which is impaired by damages to the frontal lobes. In terms of functionality, the insula mediates feelings linked with specific emotional states (Damasio et al., 2000; Critchley et al., 2004, 2005), revealing its role in binding cognition and emotion (Kurth et al., 2010). The insula is also involved in social emotion processing (Lamm and Singer, 2010), i.e., the affective states that we experience in the interaction with other people and that are related to the social context. It may be important to remember that the items of the factor of theory of mind were "I thought about others," "I thought about people I like," and "I placed myself in other people's shoes" and that the insula has been found to be active in various type of ToM tasks, especially in the Eyes Test that evaluates the mindreading ability through eye gaze (Schurz et al., 2014). The insular cortex may also be considered the main cortical locus of an interoceptive system that regulates affective feeling states from the skin (Olausson et al., 2002; Loken et al., 2009). In the light of these evidences, the higher insular FC in High-ToM subjects may express the first-person experience with others in terms of affective and emotional feelings and in terms of proximal and proprioceptive involvement with them.

It is interesting to notice that the ability of mentalizing, as measured by the ToM factor in terms of "thinking about others," implies on the neural level the involvement of brain areas linked both to the cognitive and the affective components, namely the frontal lobes and the insula, respectively. The functional asymmetry between the hemispheres with significantly higher FC in the left side can presumably be connected with the construct of narrative thought (Bruner, 1990). According to Bruner, ToM would be better understood if reworded in terms of autobiographical construction of the self. The latter is grounded on language that neuroscientific evidences posit as a prevalent left hemisphere activity.

This study has also some limitations. Although the CFA showed satisfactory parameters, the moderate reliability of the items of the ToM factor should suggest a cautious generalization of the results about the correlation between fMRI evidences and the ToM latent factor.

Future research will have to increase the number of items of the ToM factor. A greater number of behavioral details of the resting-mind contents may support a more comprehensive interpretation of the neural variability. Finally, the cross-cultural invariance should be investigated comparing Dutch and Italian results.

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Mentalization, attachment, and subjective identity

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In a life-span perspective, Baglio and Marchetti make the hypothesis of "the existence of multiple kinds of Theory of Mind" and urge the transition from a discrete to a dimensional approach in the study of mentalization ("ToM may vary along a quantitative and a qualitative continuum"). We resist such a plea and argue that we can stick to a discrete approach which posits just a single early-developing mindreading system, and then works out a "third-person first" perspective on mentalization, according to which the understanding of other minds both ontogenetically precedes and grounds the understanding of our own minds. In this third-person first framework, Baglio and Marchetti's claim that mentalization is "a multifaceted set of competences liable to influence—and be influenced by—a manifold of psychosocial aspects" is reformulated as follows: first-person mentalization evolves in an interplay of third-person mentalization, autobiographical memory and socio-communicative skills attuned by cultural variables. Let us examine these points one by one.

In the first place, we take a *nativist-modularist* perspective on third-person mentalization (henceforth "mindreading"). After Onishi and Baillargeon's (2005) groundbreaking paper, enough evidence has accumulated to endorse the hypothesis that a form of primary mindreading is not a developmental achievement, but an innate social-cognitive evolutionary adaptation (Baillargeon et al., 2013, 2014). Such adaptation is implemented by a mechanism computing a body of knowledge specific to the domain of naïve psychology, which comes online during the first year of age (Carruthers, 2013). Such early-developing domain-specific mindreading mechanism underpins *basic* mentalistic abilities (including the metarepresentational capacity to pass spontaneous-response false belief tests) which are to be distinguished from the full range of mature activities that may employ such skills. During the development these basic mindreading abilities "may eventually be recruited by higher cognitive processes for more complex tasks," thus *higher-order mentalistic activities* may emerge, which "may well interact (in a non-modular way) with other cognitive processes, and may not be uniform across individuals or cultures" (Scholl and Leslie, 1999, p. 140). The focus on the neurocognitive bases of mentalizing abilities, therefore, does not rule out the influence of socio-cultural variables.

In the second place, we take a *cognitive-constructivist* stance on the debate on first-person mentalization (henceforth "introspection"). The argument for this claim builds on Carruthers' (2011) Interpretive Sensory-Access (ISA) account of the nature and sources of self-knowledge, which is a strong case for the claim that mindreading has a *functional* and *evolutionary* priority over introspection. According to the ISA account, although we can have non-interpretive access to our own sensory and affective states, the self-attribution of propositional attitude states is always a process of self-interpretation that exploits the same sensory channels that we utilize when working out other people's mental states.

Carruthers's theory of introspective self-knowledge, however, does not predict that mindreading is also *developmentally* prior to introspection (Carruthers, 2009b, p. 167). By contrast, we make just such a claim.

In an attempt to explain why we have the (false) intuition that there is introspection for our thoughts, Carruthers takes very seriously Wilson's (2002) hypothesis that the self-transparency assumption "may make it easier for subjects to engage in various kinds of adaptive self-deception, helping them build and maintain a positive self-image" (Carruthers, 2009a, p. 138, n. 5). Moreover, in looking at the possibility that the emergence of introspection is a by-product of the evolution of mindreading, Carruthers considers such possibility as compatible with the hypothesis that introspection "might have come under secondary selection thereafter, perhaps by virtue of helping to build and maintain a positive self-image, as Wilson [. . .] suggests" (Carruthers, 2009a, p. 128).

Thus, here Carruthers is opening the door to the topic of defense mechanisms. Moreover, the ISA theory heavily draws on the confabulation data from the huge cognitive dissonance and causal attribution literatures (2011, chap. 11), and such data—we believe—can hardly be separated from the topic of the construction and maintenance of "a positive self-image." There is a problem, though. Carruthers' (2011) focus is on introspection construed as knowledge of one's own current mental states; and this knowledge "is arguably more fundamental than knowledge of oneself as *a self with an ongoing mental life*" (Carruthers et al., 2012, p. 14; italics added). Now, insofar as Carruthers takes introspection merely as a competence to self-attribute one's own current mental states, Wilson's hypothesis of the self-defensive nature of introspection cannot be built into the ISA theory. For the topic of defenses makes sense only in the context of the construction and protection of the psychological self-consciousness or subjective identity ("a self with an ongoing mental life"). But once introspection is seen in this context it becomes possible to make the hypothesis that it *develops* through the act of turning on oneself the competence to mind-read others; and that this occurs through that socio-communicative interaction with caregivers (and successively other social partners) investigated in attachment theory research [this seems to be what is at stake in Fernyhough's (2009) and Hernik et al.'s (2009) commentaries on Carruthers (2009a)].

As regards attachment theory, it is to be noticed that it builds within a contextualist and systemic framework, where (individual) biology and (social) relationality go hand in hand. Individuals are pre-wired to the interpersonal relationship from the birth, and mindreading is integral to such pre-organization. It makes perfect sense, therefore, that the early-developing core mindreading system is an innate social-cognitive adaptation that is independent of the attachment system (Gergely and Unoka, 2008). This leads us to reject the hypothesis, variously put forward by a number of attachment theorists and infant researchers, that there is an inherent causal and functional link between the quality of early infant attachment on the one hand, and the development of mindreading on the other.

When we take into consideration introspection, in contrast, the child's socio-communicative interaction with caregivers is *constitutively* involved in the construction of the virtual inner space of the mind—an introspective (as opposed to bodily) form of self-consciousness that then evolves as narrative identity. The development of introspection is therefore an outward-in process through which a subject constructs itself as *psychologically* self-conscious (and not only as *physically* self-conscious) in an interplay of metarepresentational abilities, autobiographical memory, and socio-communicative capacities modulated by socio-cultural variables. The young child who turned her mindreading abilities upon herself under the thrust of caregivers' mind-minded talk, by the end of the preschool years begins to grasp her introspective self-description as rationalized in terms of autobiography (Fivush, 2011).

This process of narrative self-construction is inseparably cognitive and affective in nature. Attachment theory and infant research have shown that affective growth and construction of identity cannot be separated. The description of the self that from 2 to 3 years of age the child keenly pursues is an "accepting description," i.e., a description that is indissolubly cognitive (as *definition* of self) and emotional-affectional (as *acceptance* of self). Briefly, the child needs a clear and consistent capacity to describe itself, fully legitimized by the caregiver and socially valid. Accordingly, one cannot ascribe concreteness and solidity to one's own self-consciousness if the latter does not possess, at its core, a description of identity that must be clear and, indissolubly, "good" as worthy of being loved.

The incessant construction and reconstruction of an acceptable and adaptively functioning identity is therefore the process through which our intra- and inter-personal balances are produced, and hence a foundation of psychological well-being and mental health. This finds illustration in the developmental psychopathology of attachment, according to which the abusive or seriously neglective behaviors of the attachment figures may give rise to disturbances in identity.

"Identity" is a central diagnostic criterion for personality disorders in DSM-5. Here we will look briefly at Borderline Personality Disorder (BPD), this being a clinical condition that—as Hernik et al. (2009) suggest—"may become an important source of new data that could illuminate relationships between mindreading and self-awareness and their developmental antecedents" (p. 148).

In the first place, the majority of the studies that investigated the ability of BPD patients to mind-read other people found an equal or superior mindreading ability in BPD. In Franzen et al.'s (2011) economic exchange game experiment, for example, patients with BPD had to recognize fair or unfair attitudes and deception through emotional cues from facial expressions of others, attributing mental states in the interaction with social partners. They turned out to perform better than healthy controls. This makes perfect sense when mindreading is analyzed in the context of the attachment history of the patients with BPD. In Franzen et al.'s (2011) virtual trust game participants must recognize others' intentions in a situation in which the other person could not be cooperative and/or could potentially hurt. BPD patients have been highly trained to mind-read, being their relationship with caregivers characterized by the need to protect themselves by means of an anticipation of neglectful or abusive behaviors, learning to read signals of threat or rejection (Linehan, 1995).

Second, BPD patients' impairments in mentalization cannot be conceptualized independently from their difficulties with

autobiographical memory. Let us consider Preißler et al.'s (2010) study, where patients with BPD were asked to perform two higher-order mentalization tasks—Baron-Cohen et al.'s (2001) "Reading the Mind in the Eyes" (RME) task; and the "Movie for the Assessment of Social Cognition" (MASC: Dziobek et al., 2006), a more ecologically valid task in which participants are required to attribute mental states to movie characters in an everyday life-relevant context. BPD patients' performance on the RME did not show any impairments in mentalization compared to non-clinical controls. In the MASC, in contrast, PTSD intrusive symptomatology in the BPD group played an important role in the emergence of disturbed recognition of the feelings, thoughts, and intentions of the movie characters.

This is well in line with Dziobek et al.'s (2011) study, which used an fMRI adaptation of the Multifaceted Empathy Test. A region comprising the left superior temporal sulcus and gyrus (STS/STG) seems to play a role in higher-order mentalizing tasks such as those mentioned above (see, e.g., Saxe and Kanwisher, 2003). Now, Dziobek et al. found a reduced activation of the STS/STG region in BPD patients who reported high levels of recurring traumatic memories.

This leads us to a third point. The caregiver's neglect of a child's emotional responses is assumed to play a central role in the etiology of BPD (Lyons-Ruth et al., 2005). On the one hand, the absence of empathic affect-regulative-mirroring interactions may prevent the child from creating "the necessary mappings between the emerging causal representations of emotional states in others and emerging distinct emotional self-states," which in turn may give rise to "compromised second-order representations of self-states" (Hernik et al., 2009, p. 148). On the other hand, BPD individuals' need to implement strategies to cope with the deficit in affect self-regulation may contribute to the disruption of autobiographical memory (see, e.g., Van den Broeck et al., 2012, 2015). In BPD patients, then, an interplay of impairments in first-person mentalization and autobiographical memory occurs, which disrupts the development of "autobiographical reasoning." This is the ability to create relations between different parts of one's past, present, and future life and one's personality and development; by so doing, it embeds personal memories in a culturally, temporally, causally, and thematically coherent life story, thus offering ways of establishing and re-establishing the diachronic continuity of the self (Habermas, 2011). The impairment of autobiographical reasoning, therefore, leads to identity disturbance—a "markedly and persistently unstable self-image or sense of self" (APA, 2013, p. 664)—which has long been considered one of the defining features of BPD (see, e.g., Adler et al., 2012; Jørgensen et al., 2012).

In summary, we maintained that first-person mentalization/introspection is not simply a matter of self-attributing one's own current mental states; it is rather a higher-order mentalistic activity that gives shape to a psychological (as opposed to bodily) form of self-consciousness. Furthermore, introspection cannot be singled out from the context of that construction and defense of subjective identity that is the key to the developmental psychopathology of attachment. This was illustrated by the inextricable interweaving of mentalization, autobiographical reasoning, and identity disturbance in BPD patients.

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Maternal Talk in Cognitive Development: Relations between Psychological Lexicon, Semantic Development, Empathy, and Temperament

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In this study, we investigated the relationship between mothers' psychological lexicon and children's cognitive and socio-emotive development as assessed through conceptual and semantic understanding tasks, in addition to the traditional tasks of theory of mind. Currently, there is considerable evidence to suggest that the frequency of mothers' mental state words used in mother-child picture-book reading is linked with children's theory of mind skills. Furthermore, mothers' use of cognitive terms is more strongly related to children's theory of mind performances than the mothers' references to other mental states, such as desires or emotions (Rollo and Buttiglieri, 2009). Current literature has established that early maternal input is related to later child mental state understanding; however it has not yet clarified which maternal terms are most useful for the socio-emotional and cognitive development of the child, and which aspect of the cognitive development benefits from the mother-child interaction. The present study addresses this issue and focuses on the relationship between mothers' mental state talk and children's behavior in conceptual and semantic tasks, and in a theory of mind task. In this study fifty pairs consisting of mothers and their 3 to 6-year-old children participated in two sessions: (1) The mothers read a picture book to their children. To assess the maternal psychological lexicon, their narrative was codified according to the categories of mental state references used in literature: perceptual, emotional, volitional, cognitive, moral, and communicative. (2) After a few days, the conceptual and semantic skills of the children (tasks of contextualization and classification, memory, and definition of words) and their psychological lexicon were assessed. The results suggest close links between the frequency and variety of mothers' mental state words and some semantic and conceptual skills of children.

Keywords: psychological lexicon, shared reading, semantic development, children's temperament, mother's empathy

INTRODUCTION

Mother-Child Talk about Inner States and the Development of Theory of Mind

There is an abundance of studies showing that language, and in particular, the use of it in social interactions, is at the core of the processes involved in mind understanding. "Primitive access to the social-cultural world is available through participation in its routines, but access to the ways in which the world semiotically structures concepts, ideas, frames, and theories is available only through language. Thus the cultural system reflected in adult ideas about others' mental states becomes more visible to children as they participate as language users in culturally constituted activities (games, routines, work, commerce, storytelling)" (Nelson, 1996, p. 312). Language constitutes systems of symbols conventionally used in constructions that convey meaning between people (Aitchison, 2012). People use, and children learn to use, varying systems for talking together in different settings.

Children can learn to think about their experience and to interpret it from the conversations with their mothers, and certainly, narratives about the past and the future in the children's experience incorporate talk about mental states. Parents tend to treat the children as social partners and conversationalists almost from birth, and children respond with attentive looks, gurgles, smiles. This practice is important to the children's entering into meaningful communicative exchanges (Astington and Jenkins, 1999; Nelson, 2005). A current cognitive development area of great current interest is children's theory of mind while the semantic domain corresponding to the purported theory is that of internal state terms. In studying the linguistic correlates of the theory of mind, particular attention has been devoted to psychological lexicon or mental-state language, a type of talk that several studies (e.g., Bretherton and Beeghly, 1982; Bartsch and Wellman, 1995; Camaioni et al., 1998) have classified in the following categories: physiological (e.g., to be hungry, to be thirsty, to be sleepy), perceptual (e.g., to hear, to see, to look, to observe, to recognize, to be cold, to be hot, to feel ill), emotional (e.g., to love, to enjoy, to be afraid, to be sorry), volitional (e.g., to want), cognitive (e.g., to know, to understand, to remember, to think), communicative (e.g., to say, to tell, to call), and moral (e.g., duty = to be obliged to do, power = to have the permission to be good to to be bad).

Children's language is important in assessing the development of their mental states (Rollo, 2007). The development of mental state words has been investigated by a number of researchers (Bretherton and Beeghly, 1982; Wellman and Bartsch, 1988; Wellman, 1991; Bartsch and Wellman, 1995) for clues to children's understanding of the mind, with the assumption that the use of such words (especially *know* and *think*) refers to internal states reflecting an organized theory of those states (Nelson and Kessler Shaw, 2002; Meins et al., 2006; Lecce et al., 2010).

Plenty of research conducted on children's development of social cognition has examined the relations between mother's mental state language produced during parent-child book reading, and children's psychological lexicon (Dunn et al., 1987; Dunn, 2002; Ruffman et al., 2002; Pons et al., 2003; Adrian et al., 2005; de Rosnay et al., 2004; de Rosnay and Hughes, 2006; Taumoepeau and Ruffman, 2006, 2008; Slaughter et al., 2007; Hughes, 2011; Ziv et al., 2013). Also examined was the connection between the children's mental state language and their performance on tests of theory of mind understanding (e.g., false-belief tasks, Wimmer and Perner, 1983). These studies have shown that mother-child conversations on inner states improves the children's understanding of the mind and their use of psychological lexicon.

Specifically, there is a growing body of evidence supporting a social interactionist framework in which parents input facilitates the development of children's social understanding (Ruffman et al., 2002; Taumoepeau and Ruffman, 2006, 2008; Rollo and Farris, 2012). Ruffman et al. (2002) explained the correlation between mothers' mental state utterances and children's theory of mind and "this relationship held even when many potentially mediating variables were accounted for, including the children's language ability, their initial social understanding (as manifested in their initial theory of mind and mental state language), their age and the mothers' educational background" (Rollo and Farris, 2012, p. 275).

Also, other studies found that it is a composite series of utterances that correlates with later children's theory of mind performance (psychological terms like *think*, *know*, *want*, *hope*). Whereas other aspects of a mothers' talk, like descriptive or causal words and links to a child's experience, seem to have a less influence on child's performances (Beeghly et al., 1986; Harris et al., 1989; Wellman and Woolley, 1990; Booth et al., 1997).

Ruffman et al. (2002), and Taumoepeau and Ruffman in two longitudinal studies (2006, 2008) showed that mothers refer most frequently to desire terms when the children are younger, whereas with older children they increase the use of belief and knowledge references. In particular, Taumoepeau and Ruffman (2006, 2008) found that maternal talk to 15-month-old children about the child's desires predicted children's mental state language and emotion task performance at 24 months. At 24 months of age mothers' reference to others' thoughts and knowledge was the most consistent predictor of children's later mental state language at 33 months.

Mothers' references to *think* and *know* increased with children's age. Thus, before 2 years of age, mother input about desire may be a mechanism by which children's emerging implicit understanding about mental life is made explicit. This mechanism can be conceptualized within the zone of proximal development (Vygotskij, 1934) such that mothers' use of specific types of mental state talk supports the child's social understanding (Rollo and Farris, 2012).

There is evidence that maternal input is linked to child mental state understanding, it has not yet been determined which maternal term is most useful for socio-emotional and cognitive development of the child, and which aspect of the cognitive development benefits the mother-child interaction.

The present study addresses this issue and focuses on the relation between mothers' mental state talk and children's performances in conceptual and semantic tasks and in a theory of mind task.

Therefore, the aim of the present research was to look more closely at how beliefs, desire and emotion usage in maternal language contributes to the prediction of children's theory of mind. In this light, the language (and the mothers' narrative in particular) is considered the driving force not only for the development of the socio-cognitive understanding, but also for the semantic development (conceptual, lexical, and metacognitive level in semantic relationships; Ebert, 2015).

Factors Related to Mother-Child Narrative

Picture book reading poses an important context for promoting socio-cognitive understanding. For Fletcher and Reese (2005, p. 67) "within the picture book reading interaction, there are three components: an adult, a child and a book. Each component interacts with the other components to establish the social interaction." What parent characteristics influence the quality of picture book reading interaction? Studies have examined distal factors such as socioeconomic level (SES) and culture, but also more proximal factors such as maternal sensitivity, parenting styles and parental beliefs. The effects of SES and culture have been studied through a myriad of research works (Fletcher and Reese, 2005; Vernon-Feagans et al., 2008), however, no large-scale studies have examined the effect of maternal psychological characteristics on maternal talk. Specifically, we were interested in examining whether maternal empathy could play a role in the frequency and quality of mothers' mental state utterances during a task that involved a picture book.

Empathy as "a core component of social cognition, and involves operations aimed at detecting other's mental states and predicting their future behavior" (Preti et al., 2011, p. 51) is a psychological characteristic that may influence mother's psychological lexicon. Indeed the literature suggests that among the critical aspects of maternal sensitivity may be empathy-related behaviors, e.g., to treat the child as an independent person with his thoughts, emotions and feelings (de Rosnay and Hughes, 2006). We have not found previous studies that established whether mothers' empathy predicts maternal psychological language. However, we expect that the empathic concern, involving both emotional and cognitive processes, would prompt mothers to use a larger proportion of internal state words.

Similarly, children's temperament "defined as average emotional state across a representative sample of life situations" (Mehrabian, 1996, p. 261), influences theory-of-mind development (Wellman et al., 2011) and could play an important role in a performances of theory of mind, as the psychological lexicon.

While the relation between temperament and linguistic development has already been investigated (e.g., Usai et al., 2009; Garello et al., 2012), few studies have examined the direct link between child temperament and child psychological language. Although various other factors influence children's theory of mind, the temperament as constitutionally base of the individual differences in emotional, motor, and attentional reactivity, could contribute to children's acquisition of theory of mind insights (Wellman et al., 2011).

In summary, the literature on maternal variables involved in the development of children's theory of mind, does not take into account: (a) the variables related to individual characteristics that may influence the psychological lexicon of both mothers and children; (b) general aspects about the influence of mothers' language on children's conceptual development. Specifically, further investigations are needed to estimate the effect of both mothers' empathy and children's temperament.

Therefore, there were two aims of this study. First, we examined mother's mental state lexicon, in order to describe its main characteristics in relation with the child's gender and age, and to test the relation between the mothers' frequency of mental state utterances and children's semantic and conceptual performance. Second, we examined aspects of the mother (empathy) and of the child's development (temperament) involved in psychological states understanding in relation to the child's age and gender. Specifically, (a) we expected to replicate the results of the previous study (Rollo and Longobardi, 2005) by identifying the maternal category of psychological lexicon and their variation connected with children's age and gender. Furthermore, (b) we expected to find not only an association between the mothers' frequency of mental state utterances and the frequency of the same categories of mental lexicon used by children, but also (c) an additional association between the psychological lexicon in maternal narrative and children's performance in definitional tasks. Lastly, (d) we sought to identify the relation between the mother's empathy quotient and psychological lexicon, and (e) between children's temperament and psychological lexicon.

METHOD

Participants

Fifty mother-child dyads were recruited from three preschools classes in a northern Italian city ($N = 50$) in accordance with local ethics committee approval.

The children (28 girls, 22 boys) ranged from 3 to 6 years of age (mean age = 4 years and 8 months; $SD = 9$ months) and the mothers' mean age was 35.7 ($SD = 1.6$). To assess changes caused by age, the full sample of children was split into two age groups: 3–4 years ($N = 26$) and 5–6 years ($N = 24$).

According to the parents' reports, all the children speak Italian as their main language, with 90% of the mothers reporting that Italian is spoken exclusively. The remaining families reported both parents and their child speak two languages.

Only 22% of the mothers had a foreign origin but spoke fluent Italian. The mothers indicated their completed education: 60% had completed 3–5 years of university; 30% had completed lower secondary school (*Scuola secondaria di primo grado*), which corresponds to Middle School, and only 10% had not pursued any studies after completing upper secondary school (*Scuola secondaria di secondo grado*), which corresponds to the high-school level. All mothers were of middle-class socioeconomic status (SES).

Procedure

The criteria used for the sample selection were as follows: (a) the age of the children ranged between 3 and 6 years;

(b) both mothers and children did not report any mental or physical problems or disorders and, (c) both mothers and children spoke Italian. A group of trained psychologists contacted a school and presented the research rationale and objective. Mothers who agreed to be recruited for the study filled out an informed consent form. The form was composed by two parts: the research description and quotation of the relevant law (Legislative Decree no. 196/2003, "Codice in materia di protezione dei dati personali"- Code Privacy), which was retained by the mothers; the signature sheet expressing the consent for their participation into the project together with agreement on data disclosure, which was retained by the researcher. All mothers and children met in a quiet room in the school for the following two sessions: (1) The mothers read a picture book to their children. Their shared reading was recorded and coded by two trained independent raters who listened to the audio recording and scored them on the basis of the psychological lexicon manual (described later) using a paper-pencil system. (2) After a few days, the definitional skills of children were assessed with the VCS-Assessment Test of Conceptual and Semantic Development for preschoolers (Valutazione dello sviluppo Concettuale e Semantico in età prescolare, Bellacchi et al., 2010).

In addition, the mothers were given two additional reports to be completed independently and at their home. These included a self-report measure for the assessment of their empathy status- the Empathy Quotient (EQ, Baron-Cohen and Wheelwright, 2004)—and a report-form questionnaire to evaluate their child's temperament-the Italian Questionnaires on Temperament (Questionari Italiani del Temperamento-QUIT, Axia, 2002).

MATERIALS

Psychological Lexicon Measures

The mothers read a picture book consisting of 21 images arranged in chronological order ("Frog, where are you?," Mayer, 1969) to their children. The maternal and children narratives were recorded, transcribed and coded by two trained independent raters. For each narrative, the proportion of mental words/total used words was calculated. Reliabilities were calculated for each code able utterance, over both child and mother utterances together. Interrater reliabilities (Cohen's k) ranged between 0.80 and 0.92.

The internal state words produced during the mother-child picture-book narratives were coded according to the categories of mental state references used in literature. The following 11 category code scheme was applied to the internal state words (Camaioni et al., 1998 and Ruffman et al., 2002 modified; Rollo and Longobardi, 2005) used by the mothers and children: (1) positive emotional words (e.g., to love, to enjoy, to be friends); (2) negative emotional words (e.g., to be afraid, to become angry); (3) cognitive words (e.g., to know, to understand, to remember, to think); (4) perceptual words (e.g., to hear, to see, to look, to observe, to recognize, to be cold, to be hot, to feel ill); (5) moral words (e.g., to forgive, to obey, to apologize, to repent, to be good, to be bad); (6) words referring to obligation (e.g., duty = to be obliged to do, power = to have the permission to do); (7) volitional words (e.g., to want, to look for, to wish); (8) ability state words (e.g., to be able, to attempt); (9) physiological words (e.g., to be hungry, to be thirsty, to be sleepy); (10) words referring to emotional displays (e.g., crying, smiling, laughing), although these utterances had strong links to emotions, they were coded separately because they described external manifestations; and, (11) communicative words (e.g., to say, to tell, to call, to ask).

During the mother-child narratives there were several categories of mental state utterances referring to the protagonist of the story as simple descriptions of a picture's contents (e.g., "The child is looking at the frog"). Therefore, we coded both the 11 categories and who they were related to: mother, child, mother-child pair or protagonists of the story.

Semantic Development Measures

VCS-Assessment of Conceptual and Semantic Development for preschoolers (Valutazione dello sviluppo Concettuale e Semantico in età prescolare, Bellacchi et al., 2010) was used in order to assess the definitional skills of the children.

The test consists of the following four sub-tests that assign different measures for the changes concerning semantic representations in preschool children:

1) contextualization task: assessed knowledge concerning objects or persons typical of certain places or situations;
2) classification task: evaluated the use of taxonomic relationships to categorize objects, providing two different scores, a score of classification (conceptual component = Classification) and a score of explanation of the criteria used to classify objects (metacognitive component = Explanation);
3) words memory task: assessed the use of different types of associative or semantic relationships between terms in supporting learning and retrieval from memory of links object-word (Associative, Taxonomic, or Arbitrary relationship);
4) definitional task: assessed the use of taxonomic and linguistic relations in defining words.

Specific material—stimulus and appropriate sheet of notation were available for each task. For the contextualization task, 36 figures showing various contexts/situations were given (e.g., Bathroom, Street, Playground, Farm, Sea, Circus, etc.). For this task, children had to match each object to the context it belonged to. The classification sub-test consisted of five series of images representing five categories of objects: Animals, Fruits, Furniture, Clothes, and Vehicles. Children had to indicate which object did not fit with the others. The word memory task consisted of 36 images-cue/target-words. All words were concrete nouns and the frequency of use was medium-high in the child lexicon. The child was required to remember a word associated in the presentation to a specific image. The definitional task presented, (in random order), 12 concrete words with high frequency of use: four names (cat, hat, chair, tree), four verbs (fall, eat, play, run), and four adjectives (bad, good, great, red). The child had to explain the meaning of each word, as if they had to explain it to a foreign person. After coded responses for each of the sub-tests were obtained the scores in: Contextualization task, Classification task, Explanation task, Words memory task, Associative relationship,

Taxonomic relationship, Arbitrary relationship, and Definitional task (Orsolini et al., 2010).

Mother Empathy Quotient

The Empathy Quotient (EQ, Baron-Cohen and Wheelwright, 2004-Italian version edited by Liliana Ruta) was a self-report questionnaire that was developed to measure the cognitive, affective, and behavioral aspects of empathy (Preti et al., 2011).

The questionnaire contains 40 empathy questions. For each question, the responses were submitted using a four-point Likert scale: "strongly agree," "slightly agree," "slightly disagree," and "strongly disagree." Each of the questions receives a score of one point if the respondent records an empathic behavior of "slightly" and 2 points if the respondent records an empathetic behavior of "strongly," so the scores can range from 0 to 80. Scores that ranged from 33 to 52 corresponded to a person close to the mean, 53 to 63 corresponded to a person with a empathy quotient over the mean, while higher scores (over 64) referred to a person who is very empathic. A cut off score of fewer than 32 was the most useful to differentiate adults with autism spectrum conditions from controls (Baron-Cohen, 2012).

"The original version of the EQ shows acceptable internal consistency, concurrent, and convergent validity, and good test retest reliability (Baron-Cohen and Wheelwright, 2004)" (Preti et al., 2011, p. 53). For this study, the questionnaire showed good internal consistency (Cronbach's alpha = 0.74).

Child Temperament

The Italian Questionnaires on Temperament (QUIT, Axia, 2002) were validated for an Italian sample to measure child temperament from the first month after birth to 11 years of age, with four different age groups: 1–12 months, 13–36 month, 3–6 years, and 7–11 years. The 3–6 years version of the QUIT used in this study, consisted of 60 six-point likert-type questions of children's day-to-day behaviors. For each question, mothers' answers are rated on a Likert scale from 1 ("never") to 6 ("always"). The QUIT investigates six temperamental dimensions: social orientation (pleasure in social situations and interactions with others), inhibition to novelty (emotional reaction to novelty experience), the level of motor activity (gross motor activity, speed reaction to environment experience), positive emotionality (intensity of positive emotional reactivity and expression), negative emotionality (intensity of negative emotional reactivity and expression) and attentional capacity (ability to focus attention and to shift attention from one focus to another; Garello et al., 2012). For this study, the questionnaire for the 3–6 years age group showed good internal consistency (Cronbach's alphas ranged from 0.55 to 0.77).

RESULTS

Psychological Lexicon Categories and their Relationship to Children's Age and Gender

The first aim of this study was to describe the main characteristics inherent in the theory of mind of maternal language (psychological lexicon) developed during a picture-reading task, and to verify how the maternal psychological state references changed with children's age and gender.

We found some significant differences in mothers' psychological lexicon (see **Tables 1**, **2**) with respect to children's gender and age. As expected, the analyses showed that mothers used a higher proportion of Cognitive and Volitional words with older children and a higher proportion of terms referred to Obligation state with boys.

The remaining mean scores under the two age groups were similar, although younger children scored marginally higher on Perceptual terms than older children.

The mean scores under the two gender groups were similar, although girls scored marginally higher on Positive and Negative Emotional and Perceptual terms than boys.

In addition, Analysis of Variance (ANOVA) showed a significant difference between the mothers of older children and the mothers of younger children and who they referred to while reading the story. The mothers of older children were more likely to refer to themselves, the children, or both [e.g., "have you got what's happened?"; "do you like this little dog?"; $M = 0.03$ vs. 0.01; $F_{(1,\ 48)} = 8.18$; $p = 0.006$]; the mothers of younger children were used to referring more frequently to the story itself [e.g., "the little dog is happy"; "the child learned that the frog had ran away"; $M = 0.75$ vs. 0.68; $F_{(1,\ 48)} = 4.02$; $p = 0.05$].With respect to the characteristics of the children's language produced during the picture-reading task, although children have had little psychological lexicon, the analyses showed that the older children used, on average, a proportion higher of terms that referred to Obligation state [$M = 0.07$ vs. 0.01; $F_{(1,\ 48)} = 6.186$; $p = 0.016$] and that boys produced more terms that referred both to Negative emotional states [$M = 0.06$ vs. 0.01; $F_{(1,\ 48)} = 4.80$; $p = 0.033$] and Cognitive states [$M = 0.20$ vs. 0.06; $F_{(1,\ 480)} = 6.77$; $p = 0.012$]. Finally, boys had more numerous references to themselves [$M = 0.14$ vs. 0.03; $F_{(1,\ 48)} = 5.67$; $p = 0.021$].

Correlations between Categories of Mental Lexicon (Mothers/Children)

We also expected to find an association between the mothers' frequency of mental state utterances and the frequency of the same categories of mental lexicon produced by children. There were no significant correlations between the terms used by mothers and those produced by the children during the shared reading, however the children had a poor psychological lexicon. This is probably because the reading task was interpreted by the mothers as a task, where they had to talk, and the child had a passive role. Therefore children did not talk much. For this reason we could not investigate any relationship between mothers' words and children's words.

Semantic Development Measures

In considering the scores obtained by the children in the test VCS, in all the analyses conducted, the child's gender showed no significant effect on the semantic-conceptual measures.

Regarding the child's age, a series of ANOVAs that were carried out on the scores obtained from the test VCS-Assessment

TABLE 1 | Means (SDs), *F*- and *P*-values of mothers' categories of psychological lexicon and children's age.

Mothers' mental state words	Age in years		Fisher *F*-Test (1, 48)	$p < 0.050$
	3-4 ($N = 26$)	5-6 ($N = 24$)		
(1) Positive Emotional	0.10 (0.06)	0.12 (0.07)	0.46	n.s.
(2) Negative Emotional	0.08 (0.05)	0.08 (0.06)	0.10	n.s.
(3) Cognitive	0.08 (0.04)	0.14 (0.11)	4.88	0.032
(4) Perceptual	0.32 (0.14)	0.26 (0.15)	2.56	n.s.
(5) Moral	0.01 (0.01)	0.01 (0.01)	0.37	n.s.
(6) Obligation	0.05 (0.05)	0.04 (0.04)	0.48	n.s.
(7) Volitional	0.07 (0.07)	0.12 (0.10)	4.27	0.044
(8) Ability	0.04 (0.04)	0.04 (0.04)	0.29	n.s.
(9) Physiological	0.06 (03)	0.13 (0.04)	0.78	n.s.
(10) Emotional Displays	0.01 (0.01)	0.03 (0.05)	2.75	n.s.
(11) Communicative	0.14 (0.07)	0.14 (0.08)	0.00	n.s.

TABLE 2 | Means (SDs), *F*-and *P*-values of mothers' categories of psychological lexicon and children's gender.

Mothers' mental state words	Gender		Fisher *F*-Test (1, 48)	$p < 0.050$
	Girls ($N = 28$)	Boys ($N = 22$)		
(1) Positive Emotional	0.12 (0.07)	0.10 (0.06)	0.410	n.s.
(2) Negative Emotional	0.08 (0.05)	0.07 (06)	0.571	n.s.
(3) Cognitive	0.10 (0.09)	0.12 (0.07)	0.422	n.s.
(4) Perceptual	0.31 (0.14)	0.27 (0.14)	0.888	n.s.
(5) Moral	0.01 (0.01)	0.01 (0.01)	0.016	n.s.
(6) Obligation	0.02 (0.03)	0.06 (0.06)	7.371	0.009
(7) Volitional	0.07 (0.07)	0.11 (0.10)	1.695	n.s.
(8) Ability	0.04 (0.04)	0.04 (0.03)	0.363	n.s.
(9) Physiological	0.06 (04)	0.14 (0.08)	1.240	n.s.
(10) Emotional Displays	0.02 (0.03)	0.02 (0.03)	0.006	n.s.
(11) Communicative	0.14 (0.09)	0.15 (07)	0.258	n.s.

of Conceptual and Semantic Development in preschool age (*Valutazione dello sviluppo Concettuale e Semantico in età prescolare*, Bellacchi et al., 2010) showed a significant difference in the scores obtained by children aged 3–4 and 5–6 years in some sub-tests (see **Table 3**). Older children received on average higher scores than the younger children in the Contextualization task ($p = 0.006$), and in the Definitional task ($p = 0.001$). However, there were no significant differences in the other tasks (in Classification task $p = 0.074$).

Psychological Lexicon and Semantic Development

Table 4 reports the correlations between the categories of children's psychological lexicon and their semantic development. In particular, correlations between Cognitive utterances and Explanation and Associative tasks were statistically significant. In addition, both Contextualization, Words memory and Definitional Tasks correlated with Obligation state terms. These results confirm the association between different aspects of child

TABLE 3 | Means (SDs), *F*-and *P*-values of semantic development and children's age.

Semantic-Conceptual Tasks	Age in years		Fisher *F*-Test (1, 48)	$p < 0.050$
	3-4 ($N = 26$)	5-6 ($N = 24$)		
Contextualization	29 (4.62)	32 (2.39)	8.434	0.006
Classification	8.2 (2.49)	9.3 (1.74)	3.342	n.s.
Explanation	12 (9.09)	15 (6.47)	2.095	n.s.
Words Memory	20 (5.16)	21 (4.71)	1.486	n.s.
Associative	49 (35.38)	61 (34.82)	1.580	n.s.
Taxonomic	44 (24.02)	48 (24.11)	.265	n.s.
Arbitrary	39 (19.20)	39 (20.63)	0.004	n.s.
Definitional	16 (8.28)	24 (7.51)	12.931	0.001

semantic competence which are reflected both in language and in conceptualization.

By using a multiple regression we examined the relationship between mothers' mental state utterances (as Positive Emotional words, Negative Emotional words, Cognitive, Perceptual, etc.) and children's semantic and conceptual skills (as Contextualization, Classification, etc.), while controlling for both children's age in months and gender. A multiple regression was calculated to predict Contextualization score based on age, gender, and mothers' mental state utterances. A significant regression equation was found [$F_{(13,\ 36)} = 2.782$; $p < 0.01$] with an R^2 of 0.50. Children's age was the most relevant variable in determining a change in Contextualization task ($\beta = 0.58$; $t = 3.902$; $p < 0.001$; 95% CI: 0.107–0.338); as children's age increases by one month, Contextualization score increases by 0.22.

Mothers' mental state utterances—while controlling both children's age and gender—did not significantly predict other conceptual and semantic task.

A multiple regression was calculated to predict Definitional score based on age, gender, and mothers' mental state utterances. A significant regression equation was found [$F_{(13,\ 36)} = 2.532$; $p < 0.05$] with an R^2 of 0.49. Children's age was the most relevant variable in determining a change in Definitional task ($\beta = 0.65$; $t = 4.227$; $p < 0.001$; 95% CI: 0.281–0.799); as children's age increases by 1 month, Definitional score increases by a half point ($B = 0.54$).

By using a multiple regression we examined the relationship between mothers' mental state utterances and children's semantic and conceptual skills, while controlling for children's age in months, children's gender, mothers' empathy, and children's temperament. The model did not significantly predict children's conceptual and semantic skills, except that Contextualization. In Contextualization case, a significant regression equation was found [$F_{(20,\ 29)} = 2.262$; $p < 0.5$] with an R^2 of 0.61. Children's age was the most relevant variable in determining a change in Contextualization performance ($\beta = 0.56$; $t = 3.367$; $p < 0.01$; 95% CI: 0.084–0.346); as children's age increases by 1 month, Contextualization increases by 0.215.

Given that we found children's performance in Contextualization and Definitional tasks to be influenced by their age, we wanted to see how maternal lexicon (dependent

TABLE 4 | Correlations between children's frequency of mental state utterances and their conceptual performances.

Children's mental state words	Children's' Semantic-Conceptual Performances							
	Contex	Class	Expl	Words	Assoc	Tax	Arb	Def
(1) Positive Emotional	−0.03	−0.15	−0.17	−0.07	−0.17	−0.11	0.06	−0.16
(2) Negative Emotional	0.21	0.09	0.10	0.34*	0.06	0.20	0.23	0.28
(3) Cognitive	0.09	0.23	0.28*	0.28*	−0.04	0.09	0.26	−0.01
(4) Perceptual	−0.21	0.11	−0.04	−0.09	0.13	−0.06	0.03	−0.18
(5) Moral	0.08	0.17	0.17	−0.01	0.12	−0.08	−0.22	0.29*
(6) Obligation	0.30*	0.17	0.20	0.31*	0.18	0.12	−0.02	0.44**
(7) Volitional	0.03	0.17	0.22	0.03	0.08	−0.02	−0.20	0.32*
(8) Ability	−0.01	0.08	−0.02	0.19	0.11	−0.29*	0.20	−0.05
(9) Physiological	−0.01	0.08	−0.02	0.19	0.11	−0.29*	0.20	−0.05
(10) Emotional Displays	−0.25	0.10	−0.12	−0.21	0.00	−0.14	−0.09	−0.08
(11) Communicative	−0.13	0.12	0.15	0.14	0.12	0.05	−0.03	0.11

*$p < 0.05$; **$p < 0.01$, $N = 50$.
Legend: Contex, Contextualization task; Class, Classification task; Expl, Explanation task; Words, Words memory task; Assoc, Associative relationship; Tax, Taxonomic relationship; Arb, Arbitrary relationship; Def, Definitional task.

variable) changes depending on both children's contextualization and definitional scores at different ages. In each age group, we split both Contextualization and Definitional scores in "high scores" (≥50° percentile) and "low scores" (≥50° percentile), based on the comparison between the scores in this sample and normative scores (Bellacchi et al., 2010). As the two groups were not balanced, we ran the Mann-Whitney *U*-Test and the analysis revealed that, as regard the *Contextualization tasks*, there were no statistically significant differences in maternal lexicon when younger children (3-4 years old) had high scores ($N = 18$) or low scores ($N = 8$). Nevertheless, it seems that the mothers addressed lexical categories preferentially to their child, when they were in the "low scores" category ($p = 0.045$), or preferentially to the main character of the story, when children were in the "high scores" category ($p = 0.045$). As regard older children (5-6 years old), the ANOVA revealed a statistically significant difference between the two groups in Ability (e.g., to be able or to attempt): the mothers whose children had had high scores ($N = 12$) were used to using ability state words more [$F_{(1, 22)} = 6881$; $p = 0.016$] than the mothers whose children had had low scores ($N = 12$).

As regard the younger children's (3-4 years old) *Definitional tasks*, the Mann-Whitney *U*-Test showed statistically significant differences in maternal lexicon between children with high scores ($N = 17$), and children with low scores ($N = 9$). The mothers whose children had had high scores were more likely to use Ability state words ($p = 0.020$); the mothers whose children had had low scores were more likely to use Cognitive words ($p = 0.007$). There were no statistically significant differences in older children (5–6 years old).

The Empathy Quotient

In this study, we also investigated some aspects of the mothers' empathy that may be involved in understanding of the mind. Mothers were divided into two groups depending on the scores reported: Low ($N = 28$), mothers close to the mean with scores ranging from 33 to 52, and High ($N = 22$), mothers with an empathy quotient over the mean with scores ranging from 53 to 80 (see **Table 5**).

There was a significant statistical difference between the two groups: more emphatic mothers encouraged their children more by using words that were referred to Ability states ("you're capable, you can do it"). This result was also confirmed by the significant correlation between the score of empathy (Empathy Quotient considered as a continuous measurement) and the category relating to Ability terms ($R = 0.39$; $p = 0.005$). Although the differences were not significant, mothers with high empathy quotient more frequently used Emotional words (both Positive and Negative), and also Cognitive and Physiological words.

Children Temperament

In a final step (in response to objective "e"), we expected to identify a relationship between the children's temperament and psychological lexicon. There was only one significant correlation ($R = -0.34$; $p < 0.05$) between mothers' utterances referred to Obligation states and the children temperament dimension of Social orientation - with increasing child social orientation, the obligation state in maternal language decreases and vice versa. The results also showed some significant correlations between the psychological lexicon used by children and their temperament dimensions: Attention and Positive Emotional terms ($R = -0.29$; $p = 0.041$); Positive emotionality and Perceptual terms ($R = 0.38$; $p = 0.006$); Negative emotionality and Perceptual terms ($R = 0.39$; $p = 0.006$). Therefore, children who used more emotional words had lower scores in attention, and children who used more perceptive terms had higher scores in both (positive and negative) emotional dimension of temperament.

DISCUSSION

The present study was supported by Vygotskij's thesis that culture and society (e.g., family) play an important role in facilitating the acquisition of higher order mental functioning. In particular, the

TABLE 5 | Means (SDs), *F*-and *P*-values of mothers' categories of psychological lexicon and mothers' empathy quotient.

Mothers' mental state words	Empathy Quotient		Fisher *F*-Test (1, 48)	$p < 0.050$
	Low ($N = 28$)	High ($N = 22$)		
(1) Positive Emotional	0.10 (0.06)	0.12 (0.07)	1.80	n.s.
(2) Negative Emotional	0.07 (0.04)	0.09 (0.06)	1.23	n.s.
(3) Cognitive	0.10 (0.07)	0.12 (0.10)	0.31	n.s.
(4) Perceptual	0.30 (0.13)	0.28 (0.16)	0.18	n.s.
(5) Moral	0.01 (0.02)	0.00 (0.00)	2.94	n.s.
(6) Obligation	0.04 (0.06)	0.03 (0.03)	0.42	n.s.
(7) Volitional	0.09 (0.08)	0.09 (0.09)	0.01	n.s.
(8) Ability	0.03 (0.03)	0.05 (0.04)	4.35	0.042
(9) Physiological	0.06 (0.04)	0.14 (0.04)	0.91	n.s.
(10) Emotional Displays	0.02 (0.03)	0.02 (0.03)	0.02	n.s.
(11) Communicative	0.14 (0.08)	0.15 (0.08)	0.13	n.s.

cooperative task of shared reading enables the child to internalize ways of thinking through exposure to conversations about "thinking" with adult partners (Taumoepeau and Ruffman, 2008).

The main research question of this study was whether there was an important relation between a mother's narratives, with particular reference to the frequency and variety of psychological state terms, and the conceptual and semantic skills of children in tasks of contextualization and classification, memory and definition of words.

In studying the linguistic correlates of ToM, particular attention has been devoted to psychological lexicon or mental-state language. Taumoepeau and Ruffman (2006) have examined the relation between mother's mental state references and a later child's desire and emotion understanding. With regard to this issue, the most important result was that mothers who talk about psychological states promote their children's mental-state understanding. The effect of maternal language is not restricted to false belief understanding. It also applies to the later understanding of belief-based emotions. Why mothers' emotional utterances relate to the development of child socio-emotional understanding? Part of the explanation can be accounted for by general word learning, such that children learn about mental state terms in the same way that they learn about ordinary language (Huttenlocher et al., 1991; Peterson and Slaughter, 2003; Taumoepeau and Ruffman, 2006).

According to Ruffman et al. (2002), Harris et al. (2005), mothers' mental descriptions predicted children's correct emotion attributions even when the sample was restricted to children who had mastered the simpler false-belief task.

Other studies have suggested that the mother's explanations of emotional states in conversation predicts children's understanding of emotion (Dunn, 2002; Meins et al., 2002).

However, it has not yet been clarified which aspect of cognitive development takes advantage of mother-child interaction during picture-book reading. The current study examined the link between mothers' mental state talk and children's semantic and conceptual skills. So, we asked: whether the theory of mind of the mothers expressed in their mental-state language is useful for the semantic-conceptual development of the children; whether there is a link between maternal words, attributed to the theory of mind in explicit form, semantic and conceptual development of children.

We found results that confirmed literature data on the changes in the maternal psychological lexicon which depend on the age and gender of children, but there were also some interesting associations between maternal language and semantic development. Compared to the literature, we first identified relations between the categories of children's psychological lexicon and their semantic development. In particular, correlations between Cognitive utterances and Explanation and Associative tasks were statistically significant. In addition to these two, both Contextualization, Words memory and Definitional Tasks correlate with Obligation states terms. These results confirmed the association between different aspects of child semantic competence which are reflected both in language and in conceptualization. By using a multiple regression we examined the relationship between mothers' mental state utterances and children's semantic and conceptual skills, but the model showed no significant results and children's age was the most relevant variable in determining a change.

The analysis confirmed that children's age and gender are more influential than maternal lexicon on semantic and conceptual development. Maternal lexicon by itself cannot explain conceptual differences. When maternal lexicon finds expression in an interactive context, our personal development seems to be more relevant than interaction in semantic and conceptual development. Mothers modify their lexicon based on children's characteristics: they refers more to their child whether they perceive them as less expert, or to the main character of the story, when their child is expert. Moreover, mothers talk more about their child ability when they are more capable in contextualization as well as in definitional tasks, while they spur on their child's memories, thoughts, and considerations, when they perceive them to be more capable.

As we have been emphasizing throughout this paper, the theory of mind understanding is not an individual construction. It is a collaborative construction that continues over many years, indeed through life. The parents with their talk in narratives or in conversational settings, control children's exposure to psychological lexicon (Taumoepeau and Ruffman, 2008).

Although the main findings were the links between the maternal lexicon and semantic and conceptual skills of their children, this study aimed also to examine specific characteristics of the shared reading between mother and child, taking into account the possible influence of mothers' empathy and children's temperaments. We believed, indeed, that other less investigated variables, such as personality, were worth to be evaluated. In particular, we thought that the mothers who used Emotional and Cognitive words would have been more empathetic; moreover, their children would have had better semantic and conceptual skills. Mothers who are more empathetic toward their children's feelings, should have a rich psychological lexicon, elicitate and reinforce the use of nouns and meanings. Indeed, we found that more empathetic mothers had used more Ability terms.

Though, there was only a significant difference between the mothers with higher empathy quotient and those with lower empathy quotient, we believed that this dimension of mother's personality must be explored. The role of children's temperament was less clear instead: while it is demonstrated the role that temperament has in language development (e.g., ...), its effect on psychological lexicon has not been clarified yet. Although significances were weak, ur results suggest that the effects of maternal vocabulary cannot be separated from important dimensions of personality, such as temperament and empathy.

LIMITATIONS

This study has limitations. First, we did not control for factors of interaction, e. g. the language development of children or the perception of the task by mothers. As we presented in the results, this may mean that the mothers interpreted the task as a task were they had to talk, and the children had a passive role. For this reason children did not talk much and we could not investigate any relationship between mothers' words and children's words. Furthermore, we used two self-report forms to assess the mothers' empathy and the children's temperament.

CONCLUSIONS AND FUTURE DIRECTIONS

Shared reading is an important occasion for the children to engage in the pleasure of listening, to follow along by looking at aesthetically pleasing illustrations, and to develop both socio-emotional understanding and knowledge about things and people of the world.

Grazzani and colleagues, in training studies, have suggested that the usefulness of language-based intervention in educational contexts (e.g., kindergartens), actively involves children in conversation about inner states, and consequently increases their theory of mind abilities (Ornaghi and Grazzani, 2013; Grazzani and Ornaghi, 2014). These studies consisted of three phases: pre-test, training and post-test. During training, the children listened to the stories of an illustrated story book enriched with psychological terms. The children in the training group showed gains in their understanding of mental state words and in their performance on theory of mind and emotion understanding tasks.

We intend to further our research to arrange training for the mothers, increasing their use of some categories of psychological lexicon so as to better control the effect on child development. The understanding of own and others' psychological states is influenced by educational interactions, like shared reading.

This study contained elements of novelty. The most important were: (a) the consideration of individual characteristics (mothers' empathy and children's temperament), and (b) the analysis of children's conceptual and semantic development. Future research should therefore concentrate on the role of both individual and educational variables. Among the neurobiological aspects, it would be interesting to assess the child's temperament and the empathetic provisions of the caregiver.

AUTHOR CONTRIBUTIONS

All authors listed, have made substantial, direct and intellectual contribution to the work, and approved it for publication.

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Are maternal reflective functioning and attachment security associated with preadolescent mentalization?

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This study investigated the impact of maternal reflective functioning (RF) and attachment security on children's mentalization. The Adult Attachment Interview (AAI) was administered to mothers in a sample of 41 mother–preadolescent dyads. AAI transcripts were rated in terms of the Berkeley AAI System (Main and Goldwyn, 1998) and the Reflective Functioning Scale (RFS; Fonagy et al., 1998). Preadolescent mentalization was assessed using a semi-structured interview adapted from O'Connor and Hirsch (1999) and also by analyzing mental-state talk produced during an autobiographical interview. Relationships between maternal RF and children's mentalization were analyzed, with consideration given to the different RFS markers and references to positive, negative, and mixed-ambivalent mental states. Children's mentalization was positively correlated with the mother's RF, particularly the mother's ability to mentalize negative or mixed-ambivalent mental states. No significant differences in mentalization were observed between children of secure and insecure mothers.

Keywords: reflective functioning, mentalization, mental-state talk, attachment, adolescence

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Introduction

The present study focuses on the relationship of the mother's reflective functioning (RF) and her attachment security with her preadolescent children's ability to mentalize.

Mentalizing refers to the capacity to perceive and understand oneself and others in terms of mental states (feelings, beliefs, intentions, and desires) as well as the ability to reason about one's own and others' behavior in terms of mental states (Fonagy et al., 1998).

Fonagy et al. (1998) introduced the concept of mentalization, operationalized as RF in the wake of studies conducted on the "theory of mind" (ToM) within the domain of cognitive psychology (e.g., Leslie, 1987; Perner, 1991). His research and theoretical assumptions focused mainly on the development of mentalization and individual differences, expanding the concept beyond false beliefs, autism, and childhood (e.g., Baron-Cohen et al., 1985; Perner et al., 1989).

According to Fonagy et al. (1998), mentalization is necessary for good social adjustment because it allows one to represent causal mental states, discriminate internal, and external realities, infer other's mental states from behavioral and contextual clues and regulate behavior and emotional experience.

In this perspective, mentalization is a protective factor for the individual and one's social development. Consistent with this standpoint, many studies have found deficits in mentalization ability in psychopathological conditions (Bateman and Fonagy, 2004; Fonagy and Bateman, 2008; Rothschild-Yakar et al., 2010; Fonagy et al., 2011; Sharp et al., 2011). Similarly, satisfactory

mentalization ability was found to be protective against the development of psychopathology (Sharp et al., 2006; Ostler et al., 2010).

The development of mentalization critically depends upon interpersonal experiences and specifically upon interactions with more mature minds, assuming these interactions are benign, reflective, and sufficiently attuned (Fonagy, 2006). Actually, mentalization deficits have been found in individuals who experienced abuse. For instance, abused children showed developmental delay in emotion-understanding processes (Frodi and Smetana, 1984; Smith and Walden, 1999) and in the performance of ToM tasks (Cicchetti et al., 2003; Pears and Fischler, 2005), independent of their intellectual level and socioeconomic condition. Likewise, traumatized children found it difficult to learn an emotional lexicon (Beeghly and Cicchetti, 1994) just as adults who were abused as children exhibited deficits in the ability to recognize facial expressions (Fonagy et al., 2003).

Currently, it is thought that maternal mentalization allows children to develop their mentalization capacity through the mother's ability to regulate the child's affective state, especially in moments of increased arousal. Mothers who respond to their children's affective displays with contingent marked affective displays of their own allow their babies to modulate their own affective states; this process is thought to be especially important in the modulation of negative emotions (Fonagy et al., 2002) because it permits the child to not activate an attachment system that would deactivate the mentalization system (Fonagy, 2006; Fonagy and Target, 2008). Recent neuroimaging studies have supported this hypothesis (Bartels and Zeki, 2000, 2004), demonstrating that the activation of attachment system-related brain areas deactivates mentalization-related brain areas.

Mothers who are able to mentalize the affective states of their children help them to develop their own abilities to regulate emotions, which in turn permit them to process emotional stimuli without defensively avoiding them or feeling overwhelmed. Maternal mentalization allows the child to adapt to affective states without being destabilized and to experience and recognize the affect that he/she feels. This experience permits the development of the child's ability to know the subjective meaning of his/her feelings beyond a mere intellectual understanding. It also promotes the ability to acquire "mentalized affectivity," which would allow the child to feel thoughts and think about feelings (Jurist, 2005).

Although many studies have investigated the relationship between the mother's mentalizing ability and the child's attachment security, very few empirical studies have addressed maternal influences on the child's actual mentalizing ability. The latter focused on: (1) the relationship between the mother's attachment security and the child's mentalization, and (2) the relationship between the mother's mentalization and the child's ability to understand emotions and solve ToM tasks.

The mother's security with respect to her own childhood experiences has been shown to be predictive of her child's ability to recognize painful feelings and face difficult situations (Steele et al., 2002), understand emotions, especially negative ones (Laible and Thompson, 1998; Steele et al., 1999, 2003, 2008), and solve false-belief tasks (Fonagy et al., 1997).

However, only a few empirical studies, generally limited to preschool-aged children, have investigated the relationship between the mother's and child's mentalization abilities. Meins et al. (2002, 2003), for example, observed a positive correlation between a mother's "mind-mindedness," defined as the mother's ability to interpret the child's internal states accurately, and her 4-year-old child's performance on a battery of ToM tasks. Other studies have shown positive correlations between a child's performance on Harris (1989) belief-desire ToM tasks, a maternal proclivity to describe children in mentalistic terms (Meins et al., 1998), and maternal RF (Steele and Steele, 2008).

Some studies have focused on the maternal tendency to face painful emotional states. Consistent with Fonagy et al.'s (2002) hypothesis, the maternal ability to talk about negative emotions has been shown to be predictive of the ability to understand emotions (Dunn and Brown, 2001) and of the early acquisition of ToM (Hughes and Dunn, 2002). A child's tendency to avoid recognizing and facing negative emotions has been negatively correlated with the maternal ability to understand the child's mind (Sharp et al., 2006), and more frequent maternal mental-state talk about positive feelings was found to be associated with less maternal RF and sensitivity to child needs (Borelli et al., 2012). Another study demonstrated that family dialog involving negative emotions was predictive of better performance on tests of understanding emotions (Dunn and Brown, 2001). Regarding maternal attachment patterns, an association between dismissive attachment and deficits in processing negative emotions was observed. Specifically, recent neuroimaging studies demonstrated that dismissive mothers are not able to process sadness (Strathearn et al., 2009) and inhibit negative affective responses (Leckman et al., 2004; Strathearn, 2006; Crittenden, 2008). Therefore, these mothers cannot mirror these same emotions in their children.

Up to now the relationship between maternal and childhood mentalization during early adolescence is understudied in that most research has focused on pre-school children. To the best of our knowledge, only one study (Benbassat and Priel, 2012) has investigated the role of parental RF on adolescent adjustment; it found that parental RF correlated with adolescent RF and social competence in a sample of adolescents aged 14–18 years. The impact of maternal attachment security on child mentalizing ability has also been investigated only in childhood.

During early adolescence, mentalizing abilities increase (Choudhury et al., 2006; Dumontheil et al., 2010; Goldstein and Winner, 2012; Valle et al., 2015) concurrently with other cognitive changes, such as understanding the concepts of possibility and logical necessity (Piéraut-Le Bonniec, 1980). Bosco et al. (2014) noted that the development of ToM is particularly consistent between ages 11 and 13 years. Furthermore, preadolescence is an important turning point in the development of narrative thinking (Bruner, 1986). Between the ages of 10 and 12, there is a clear shift in plot structure and in the interpretative understanding of human actions (Genereux and McKeough, 2007).

Investigations into the relationships among maternal mentalization, attachment security and mentalization in preadolescent children could aid in the design of preventive and therapeutic actions focused on the parent–child relationship

during this under-considered developmental period. The importance of parental sensitivity during preadolescence is also frequently underestimated even though the early adolescent really needs to be understood as a feeling and thinking individual in the face of multifaceted developmental challenges, and impaired mentalization in both the parent and the child may be a serious risk factor for the emergence of family conflict, behavior disorders in childhood, and psychopathology.

Recent studies found that during adolescence mentalization is a protective factor against the emergence of proactive aggression (Taubner et al., 2013) and eating disordered behavior (Rothschild-Yakar et al., 2010, 2013). Other studies have shown that mentalization deficits in adolescence have an impact on BPD symptoms through the mediating role of emotion dysregulation (Sharp et al., 2011; Ha et al., 2013).

The goal of this study was to investigate the relationship between maternal reflecting functioning, maternal attachment security and the mentalization abilities of their preadolescent children.

A previous study on the same dyads (Scopesi et al., 2015) analyzed the relationship between the mental state talk of mothers and their preadolescent children, finding a significant role of maternal RF in children's mental state talk. In this study, this relationship was further analyzed by taking into account not only the overall mothers' RF but also their specific markers of mentalizing as well as the emotional context in which they mentalized. In particular, four markers of RF were considered, namely, "Awareness of the nature of mental states" (marker A), "Explicit effort to tease out mental states' underlying behavior" (marker B), "Recognizing developmental aspects of mental states" (marker C) and "Mental states in relation to the interviewer" (marker D), (Fonagy et al., 1998). In addition, as the examined literature revealed a crucial role of the maternal ability to mentalize negative emotions, we differentiated maternal mentalization of positive, negative and mixed-ambivalent mental states, hypothesizing that mothers who can mentalize negative and mixed-ambivalent mental states have children who are more competent mentalizers themselves.

Concerning maternal attachment patterns, this study took into account both a categorical classification and a dimensional approach, considering both the Adult Attachment Interview (AAI; Main and Goldwyn, 1998) overall classification and the scores reported by the mothers on AAI's state-of-mind subscales. It was expected that mother's RF would significantly correlate with the mentalization ability in their children whereas the association between maternal attachment security and childhood mentalization would be less significant; however, it was hypothesized that a maternal idealizing or derogatory state of mind regarding attachment would be associated with less mentalizing in children.

Materials and Methods

Participants

A total of 41 mother–child dyads agreed to participate in this study. The children included 15 females and 26 males, aged 12.3–12.11 years, who were attending the state school. Subjects were from the working and middle socioeconomic classes. Most subjects were from intact families (75.6%), and most children were firstborns (65.9%). No subject suffered from a learning disorder or any other psychological condition as reported by the mothers and teachers. Only 59% of parents gave consent for their children to be administered the Wechsler Intelligence Scale for Children (WISC)-III. All of the children's IQ results were within normal standards (range = 99–140; $M = 115.88$; SD = 11.22).

All participants were born in Italy from Italian parents, and Italian was the first or sole language for all of them. The mothers ranged in age from 37 to 53 years ($M = 43.39$; SD = 4.66). Their education level was between 8 and 23 years ($M = 13.51$, SD = 3.5), with 34.1% reporting 16 or more years of education, 46.4% reporting 13–15 years of education, and 19.5% reporting fewer than 12 years of education. They each had between 1 and 5 children ($M = 1.98$; SD = 0.82). Among the 41 mothers, 39 women (95.1%) reported working full-time outside the home.

Measures

Maternal Attachment Pattern

The AAI (Main and Goldwyn, 1998) was administered to mothers to assess their attachment pattern. This well-established and widely validated semi-structured interview takes about an hour and includes 18 questions concerning childhood experiences of attachment. The coding system allows the classification of the attachment state of mind into five categories: secure (F), dismissive (Ds), preoccupied (E), unresolved with respect to past loss or trauma (U), Cannot Classify (CC).

Because of the sample size in this study, analyses based on attachment pattern classifications were conducted using the standard secure-versus-insecure (Dismissive, Preoccupied, Unresolved, and Cannot Classify) categorization. Moreover, as suggested by Bakermans-Kranenburg and van IJzendoorn (2009), a dimensional approach to AAI data was used in addition to the categorical system. To explore the relationships between specific dimensions of maternal attachment representations and the mentalizing abilities of their children, this study took into account the following continuous rating scales of the AAI transcripts: "Idealization regarding mother," "Idealization regarding father," "Derogation regarding mother," "Derogation regarding father," "Overall derogation of attachment," "Insistence on lack of recall," "Involving anger," "Passivity of thought processes," and "Coherence of the transcript."

All of the AAIs were coded in terms of the Berkeley AAI System (Main and Goldwyn, 1998) by the first author. Ten randomly selected AAIs were then re-coded by an independent coder. The resulting inter-rater reliability was excellent (Cohen's $k = 0.84$).

Maternal Reflective Functioning

The Reflective Functioning Scale (RFS) developed by Fonagy et al. (1998) was applied to the AAI transcripts to evaluate the mothers' RF. The RFS was designed to use the AAI narratives to evaluate the capacity for mentalization, namely, "the capacity to perceive and understand oneself and others in terms of mental states" and

"the capacity to reason about one's own and others' behavior in terms of mental states" (Fonagy et al., 1998, p.7).

In the AAI protocol, some questions require a RF (e.g., "Why do you think your parents behaved as they did during your childhood?"), while others merely permit it (e.g., "Could you describe your first separation from your parents?").

According to the RFS scoring guidelines, there are four markers of reflecting functioning: "Awareness of the nature of mental states" (marker A), "Explicit effort to tease out mental states' underlying behavior" (marker B), "Recognizing developmental aspects of mental states" (marker C), and "Mental states in relation to the interviewer" (marker D). The following statements are illustrations of RF. For instance, awareness of the nature of mental states (marker A) could be evident in the following sentence: "My mother often seemed happy, but I think that probably she sometimes would not show to us her concerns," in which the subject shows that he is aware of the opaqueness of the mental states and that mental states are susceptible to disguise. In addition, the explicit effort to tease out the mental states underlying behavior (marker B) is exemplified in this statement: "I screamed because I felt awfully helpless, I was not able to think what to do, I felt really vulnerable!" An example of marker C is "When I was young I felt my brother was a nasty boy, now I think he was a very sad child" ("Recognizing developmental aspects of mental states") while "I think that it can be painful for you to have to hear this sad story!" illustrates marker D ("Mental states in relation to the interviewer").

After rating each identified passage of the AAI, an overall classification is assigned to the interview considered as a whole, ranging from –1 (negative RF) to 9 (exceptional RF).

In this study, the following variables were taken into account: the RFS overall score, the frequency of each of the four markers of RF, and the frequency of the references to positive, negative and mixed-ambivalent mental states in the context of RF.

The following is an example of mentalizing about mixed-ambivalent mental states: "When I grew up I became rather confused about the way I felt about my mother: When I was a child I felt she was my father's victim; once I became a teenager I noted that their relationship was much more complicated than I thought earlier. Sometimes I thought she provoked his anger; for instance, when she went out without telling him when she should come back; sometimes she came back the day after, so I realized that she had a love affair and I did not know if she was right or wrong. Sometimes I was sympathetic with her; sometimes I felt really cross."

Validation studies of the RFS (Fonagy et al., 1998) have documented discriminant and predictive validity, good inter-rater reliability, low correlations with education level, and no correlations with either SES or age. In this study, no correlation emerged between mothers' RF and their education level (Spearman's $\rho = 0.063$, $p = 0.695$).

This study's first author coded all of the transcripts. A group of 10 randomly selected transcripts was re-coded by an independent rater. The inter-rater reliability was excellent (Cohen's $k = 0.87$). Both coders were blinded to children's scores on the measures of mentalization and mental-state talk.

Children's Mentalization

Two measures were used to assess the mentalization ability of the children: (1) a mentalization test adapted from the measure designed by O'Connor and Hirsch (1999) and (2) the mental-state talk produced within an autobiographical narrative, the Child Attachment Interview (CAI). Two different measures were used to evaluate mentalization in an autobiographical narrative focused on attachment to parents as well as in an impersonal context because, according to Fonagy et al. (1998), reflective capacity in the attachment context should not be expected to generalize to other domains.

O'Connor and Hirsch's (1999) measure of mentalization

A semi-structured interview was adapted from the measure developed by O'Connor and Hirsch (1999). This brief interview utilizes a photograph of a typical school setting in which a schoolteacher chooses a student from among different pupils who have their hands raised to answer her question. After explaining to the child that the scene takes place during a lesson, the child's attention is drawn to one of the pupils who had not been chosen by the teacher. The child is then asked why, in his/her opinion, the pupil was not chosen; what the teacher may think and feel; what the pupil may think and feel; and what will happen afterward.

According to the guidelines suggested by O'Connor and Hirsch (1999), the narratives produced by the children were evaluated on three increasing levels of mentalization ability.

At level 1, references to mental states are lacking or refer to general attributions or stable character traits (e.g., "The teacher didn't choose that pupil because she didn't see him" or "The teacher didn't choose that pupil because she shows favoritism to some other pupils"). Level 1 narratives lack references to specific events or situations. As indicated by O'Connor and Hirsch (1999, p. 261), "the behavior is not considered as influenced by the context, and there is no attempt to understand the circumstances that determine that behavior."

Level 2 narratives include, at a moderate level of mentalization, specific references to thoughts and feelings that clearly indicate an ability to understand the relationships among behavior, thoughts, and internal states. A level 2 narrative shows awareness that specific internal experiences are linked to a specific external context (e.g., "The teacher didn't choose that pupil because she knows that he knows the right answer and wants to give other pupils the opportunity to talk").

Level 3 narratives are characterized by a more advanced level of mentalization and indicate second-order mentalizing abilities. At this level, the presence of recursive thinking or of a more advanced ability to reflect on mental states can be observed (e.g., "The teacher didn't choose that pupil and chose the girl because she realizes that the girl is very sad and always remains aside, and the teacher wants to show her some consideration").

No previous study has shown any significant correlation between O'Connor and Hirsch's (1999) measure and age, gender, verbal IQ, or verbal fluency. Significant positive correlations have been found with measures of adjustment and friendship quality while inverse correlations emerged with a measure of depressive symptoms (O'Connor and Hirsch, 1999).

The second author, blinded to the coding of the psychological lexicon and of maternal RF and attachment patterns, coded the mentalization measure adapted from O'Connor and Hirsch (1999). An independent coder coded half of the tests. The inter-rater reliability was excellent (Cohen's $k = 0.82$).

Child Attachment Interview (CAI)

The CAI (Shmueli-Goetz et al., 2000) is a semi-structured interview designed to assess the child's state of mind regarding the attachment to each parent in middle childhood and adolescence. The CAI protocol consists of 17 questions regarding the family composition and how the child describes him/herself and his/her relationship with each parent. The child is asked to talk about specific relational episodes with each parent, specifically regarding when he/she is ill, upset, or angry, feels neglected or rejected, or needs help. Like the AAI, the CAI investigates emotional responses to loss and separation experiences.

For the purposes of this study, CAIs were not used to classify attachment patterns for that had been examined in another study. In the current study, CAIs were used to evaluate the frequency and quality of the mental-state talk in the context of an autobiographical narrative. A mastery of words referring to inner states, such as beliefs, emotions, and desires, implies that the child understands that human beings may have different psychological states. It also shows that the child is capable of representing these mental states and using them to understand the behavior of others (for reviews, see Carpendale and Lewis, 2004; Symons, 2004).

For this reason, the frequency of mental state terms has been considered a good index of psychological understanding and an important marker of children's mental state awareness in real-life contexts (Bartsch and Wellman, 1995). Furthermore, as Peterson and Slaughter (2006) noted, the analysis of mental state words in narratives allows the exploration of individual differences in the use of ToM capacities, especially when the False–Belief test is no longer informative.

Mental-state talk in the CAI transcripts was coded into the following categories:

- Emotional terms: every term that refers to one's or others' emotional state (e.g., "Every time we met, we **had a quarrel**"; "I **like** company of friends");
- Cognitive terms: every term that refers to a cognitive process (e.g., "It is hard to **understand**"; "I can't **remember** what I did that time");
- Volitional terms: every term that refers to need, desire or preference (e.g., "I never **want** to be on the wrong side"; "I **needed** some help");
- Terms related to skills: every term that refers to one's or others' skill (e.g., "She was very **good at** persuading people"; "When I don't **succeed** in doing maths, he always helps me").

Uncertainty markers included uncertain mental verbs (e.g., believe, suppose), modal adverbs (e.g., perhaps), modal verbs (e.g., should), and modal adjectives (e.g., probable, possible, and likely), (e.g., "Maybe now it's different"; "It's just because she is not sure, just for this reason I suppose"). References to terms that indicate uncertainty can signal one's awareness of the opacity of mental states and can be regarded as an indicator of mentalization ability (Howard et al., 2008).

The following data were extracted from the CAI transcripts: total number of words produced (verbal productivity), numbers of emotional, cognitive, and volitional lexicon terms, number of ability-related terms, number of uncertainty markers, and the sum of terms referring to mental states (overall psychological lexicon).

Two independent coders, who had been appropriately trained, evaluated all of the CAIs with respect to the frequency of use and quality of the mental-state talk. They were blinded to maternal RF and attachment patterns. The inter-rater reliability was excellent (Cohen's $k = 0.86$).

To analyze the richness of the psychological lexicon, the root types/token ratio (types/$\sqrt{}$tokens) was calculated for the total number of terms referring to mental states and for the specific categories of the emotional, cognitive, and volitional lexicons as well as of words related to skills. The square root has a mitigating effect on the impact of the number of tokens; this transformation is necessary because the number of types increases much more slowly than does the number of tokens in sampling texts (Rizzi, 1995).

Children's Verbal Intelligence

The WISC-III verbal scale was administered to evaluate children's verbal IQ.

Procedure

The headmaster of the school sent an information letter about the research project to 360 families of children attending the second year of the middle school. Of the 360 families contacted, 46 mothers (13%) agreed to be contacted further, and 41 ultimately agreed to participate in the study. Both children and parents were informed about the aim of the study, after which both parents gave their written consent to participate. Consent to administer the WISC-III verbal scale was obtained only for 24 children. All evaluations took place at the school. Senior psychology students who had previously been trained in the administration of the instruments administered the measures. The AAIs were audiotaped, the CAIs were videotaped, and then both were transcribed verbatim.

This study followed the APA ethical guidelines (American Psychological Association, 2010).

Results

Maternal Reflective Functioning and Maternal Attachment Pattern

Table 1 reports the descriptive statistics of the mothers' scores on the RFS and the AAI subscales related to the state of mind. Correlation analyses revealed no significant associations between RF variables and maternal education (r's between –0.12 and 0.23).

The distribution of mothers' attachment classifications in our sample was as follows: 25 Secure (61%), 6 Dismissive (14.6%), 6 Preoccupied (14.6%), 2 Cannot Classify (4.8%), and 2 Unresolved (4.8%). Because of the small number of mothers classified as

Dismissive, Preoccupied, Cannot Classify, and Unresolved, these groups were combined into a single insecure group. Therefore, the final distribution of attachment classifications was as follows: 25 secure (61%) and 16 (39%) insecure. Analysis of variance revealed no significant differences in maternal education as a function of attachment security ($F = 0.976$). Correlation analyses revealed no significant associations between scores on the state-of-mind subscales and education (*r*'s between –0.13 and 0.24).

TABLE 1 | Descriptive statistics of mothers' scores on Reflective Functioning (RF) and Adult Attachment Interview (AAI) subscales.

	Minimum	Maximum	*M*	SD
RF				
RF global	−1	7	3.71	1.6
Marker A	0	4	0.83	1.07
Marker B	0	16	5.41	4.27
Marker C	0	10	1.73	2.32
Marker D	0	1	0.02	0.16
Ref. pos. MS	0	6	1.34	1.6
Ref. neg. MS	0	10	4.05	2.79
Ref. mix. MS	0	9	1.15	2.24
AAI scales				
Idealization regarding mother	1	7	2.63	1.63
Idealization regarding father	1	6	2.38	1.54
Derogation regarding mother	1	8	1.79	1.78
Derogation regarding father	1	9	1.46	1.52
Overall derogation of attachment	1	9	2.07	1.93
Insistence on lack of recall	1	5	1.61	0.95
Involving anger regarding mother	1	9	2.12	2.28
Involving anger regarding father	1	8	1.61	1.64
Passivity of thought processes	1	8	2.94	1.90
Coherence of the transcript	3	8.5	5.73	1.56
Coherence of mind	3	8.5	5.73	1.56

Marker A, Awareness of the nature of mental states; Marker B, Explicit effort to tease out the mental states underlying behavior; Marker C, Recognizing developmental aspects of mental states; Marker D, Mental states in relation to the interviewer; Ref. pos. MS, references to positive mental states; Ref. neg. MS, Reference to negative mental states; Ref. mix MS, Reference to mixed-ambivalent mental states.

Mann–Whitney *U* comparisons revealed significant differences in RF variables between secure and insecure mothers (**Table 2**). Specifically, securely attached mothers reported higher overall RF scores in addition to higher scores on all of the other markers of RF except for marker D ("Mental states in relation to interviewer"). They also reported more frequent references both to positive and negative mental states. No significant difference emerged in the frequencies of references to mixed-ambivalent mental states as a function of attachment security.

Correlations analyses revealed significant associations between RF variables and scores on AAI state-of-mind subscales (**Table 3**). In particular, the Coherence subscale of the transcript (CT) correlated positively with most RF variables except for the marker *D* score and references to mixed-ambivalent mental states. With regard to the other AAI subscales, Overall derogation of attachment (OD) and Insistence on lack of recall (ILR) showed a more consistent pattern of significant association with different RF variables than did the other scales. The marker *D* score and references to mixed-ambivalent mental states did not correlate with any AAI subscales.

Children's Mentalization and Mental-State Talk

Based on the test adapted from O'Connor and Hirsch (1999) 11 children (26.8%) showed a low level of mentalization while 24 children (58.5%) showed ordinary and six children (14.6%) showed high levels of mentalization. Analyses of variance revealed no significant differences in mothers' education ($df = 2$; $F = 0.641$) and children's verbal IQ. ($df = 2$; $F = 1.502$) as a function of children mentalization. Chi-square analysis revealed no significant differences between boys and girls in levels of mentalization ($\chi^2 = 0.35$; $df = 1$; $p = 0.55$).

Regarding the children's mental-state talk in the CAI narratives, correlation analyses revealed no significant associations with either maternal education (*r*'s between –0.064 and 0.25) or children's verbal IQ. (*r*'s ranged from –0.027 to 0.16). A higher frequency in the use of markers of uncertainty was found in girls ($F = 8.304$; $p = 0.006$). No other significant gender differences emerged regarding the use of mental-state talk.

TABLE 2 | Comparisons between insecure and secure mothers on RF scores.

	Insecure mothers *N* = 16		Secure mothers *N* = 25			
	M	SD	*M*	SD	*Z*	*p*
RF global	2.56	1.21	4.44	1.39	−3.741	<0.0001
Marker A	0.38	0.72	1.12	1.17	−2.228	0.026
Marker B	2.94	3.42	7.00	4.04	−3.382	0.001
Marker C	0.75	1.00	2.36	2.71	−2.120	0.034
Marker D	0	0	0.04	0.20	−.800	n.s.
Ref. pos. MS	0.31	0.48	2	1.73	−3.556	<0.0001
Ref. neg. MS	2.69	2.44	4.92	2.69	−2.542	0.011
Ref. mix. MS	0.69	1.70	1.44	2.52	−1.345	n.s.

Marker A, Awareness of the nature of mental states; Marker B, Explicit effort to tease out the mental states underlying behavior; Marker C, Recognizing developmental aspects of mental states; Marker D, Mental states in relation to the interviewer; Ref. pos. MS, references to positive mental states; Ref. neg. MS, Reference to negative mental states; Ref. mix MS, Reference to mixed-ambivalent mental states.

TABLE 3 | Spearman correlation coefficients between maternal scores on the RF and AAI subscales.

	IDM	IDF	DM	DF	OD	ILR	IAM	IAF	PTP	CT
RF global	−0.27	−0.33*	−0.33*	−0.19	−0.39*	−0.52***	−0.20	−0.08	−0.31*	0.76***
Marker A	−0.07	−0.01	−0.24	−0.18	−0.44*	−0.29	−0.33*	−0.27	−0.09	0.46**
Marker B	−0.33*	−0.24	−0.28	−0.22	−0.45**	−0.51***	−0.17	−0.14	−0.15	0.61***
Marker C	−0.06	−0.14	−0.21	−0.12	−0.20	−0.18	−0.28	−0.01	−0.40**	0.49**
Marker D	−0.17	−0.17	−0.08	−0.06	−0.11	−0.12	−0.09	−0.07	−0.20	0.20
Ref. pos. MS	−0.10	−0.09	−0.40**	−0.27	−0.47**	−0.30	−0.34*	−0.34*	−0.24	0.53**
Ref. neg. MS	−0.35*	−0.37*	−0.17	−0.09	−0.26	0.46**	−0.15	−0.07	−0.12	0.52**
Ref. mix. MS	−0.15	−0.16	−0.18	−0.12	−0.25	−0.24	−0.18	−0.02	−0.16	0.30

*Marker A, Awareness of the nature of mental states; Marker B, Explicit effort to tease out the mental states underlying behavior; Marker C, Recognizing developmental aspects of mental states; Marker D, Mental states in relation to the interviewer; Ref. pos. MS, references to positive mental states; Ref. neg. MS, Reference to negative mental states; Ref. mix MS, Reference to mixed-ambivalent mental states; IDM, Idealizing mother; IDF, Idealizing father; DM, Derogation mother; DF, Derogation father; OD, Overall Derogation; ILR, Insistence on lack of recall; IAM, Involving anger mother; IAF, Involving Anger Father; PTP, Passivity of thought processes; CT, Coherence of the transcript; *p < 0.05, **p < 0.01, ***p < 0.001.*

We also calculated Spearman's correlations between the mentalization measure adapted from O'Connor and Hirsch (1999) and the different categories of the mental-state lexicon (**Table 4**). Analyses showed that children's level of mentalization correlated positively with the emotional, cognitive, and volitional lexicons, as well as with the overall psychological lexicon. Markers of uncertainty were positively, though not significantly, associated with level of mentalization.

TABLE 4 | Spearman correlation coefficients between the mentalization measure (adapted from O'Connor and Hirsch, 1999) and children's mental-state talk.

	Mentalization
Emotional lexicon	0.38*
Cognitive lexicon	0.41**
Volitional lexicon	0.38*
Lexicon referred to abilities	0.29
Uncertainty markers	0.29
Overall psychological lexicon	0.51***

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Maternal Reflective Functioning and Children's Mental-State Talk and Level of Mentalization

Spearman's correlations between maternal RF scores and children's mental-state talk are reported in **Table 5**. The overall maternal RF score correlated positively with the cognitive, volitional and overall psychological lexicons and with uncertainty markers in children's narratives.

When considering the specific RF markers, neither marker C nor marker D correlated with any mental state talk category in children's narratives whereas marker A (Awareness of the nature of mental states) and marker B (Explicit effort to tease out mental states underlying behavior) were significantly associated with different categories of children's mental state talk.

Maternal references to negative mental states correlated with the cognitive lexicon, the overall psychological lexicon and uncertainty markers. Similarly, maternal references to mixed-ambivalent mental states significantly correlated with the emotional lexicon, the overall psychological lexicon and uncertainty markers. No significant correlation was found between maternal references to positive mental states and children's mental-state talk.

The children's mentalization level correlated positively with the mothers' overall RF score ($\rho = 0.32$; $p < 0.05$) and references to mixed-ambivalent mental states ($\rho = 0.42$; $p < 0.01$). No significant correlations were found with any of the four markers of reflecting functioning and with references to positive or negative mental-states.

Maternal Attachment and Children's Mental-State Talk and Level of Mentalization

With regard to the relationship between maternal attachment pattern and mental state talk, analyses of variance revealed no significant differences between the children of secure and insecure mothers in terms of the frequency of use of mental-state terms (*F*s between 0.006 and 0.822). To explore whether a dimensional perspective of attachment security yielded a significant relationship, a Pearson's correlation analysis was performed between the different categories of children's mental-state talk and the mother's scores on the AAI subscales. An inverse correlation emerged between the frequency of use of markers of uncertainty in the children narratives and two scales of the AAI transcript, namely, maternal idealization regarding the mother ($r = -0.435$; $p = 0.005$) and maternal insistence on lack of recall ($r = -0.337$; $p = 0.031$).

No significant associations emerged between maternal attachment security and children's level of mentalization ($\chi^2 = 4.49$; $p = 0.105$). Nevertheless, all six children with a level of mentalization of three were children of secure mothers whereas about half of the children who obtained a score of one or two on the O'Connor and Hirsch (1999) measure had mothers with an insecure attachment (45.5% for children who obtained a score of 1 and 45.8% for children who obtained a score of 2). When collapsing categories one and two together, a significant relationship between maternal attachment security and children's level of mentalization was found ($\chi^2 = 4.49$; $p = 0.034$). A Spearman's correlation analysis between children's mentalization level and mothers' scores on the AAI subscales was also carried out. No significant correlations emerged (*r*'s between –0.18 and 0.16).

TABLE 5 | Spearman correlation coefficients between maternal scores on the RF scale, scores from the children's mentalization measure (adapted from O'Connor and Hirsch, 1999) and children's mental-state talk.

	Emotional lexicon	Cognitive lexicon	Volitional lexicon	Lexicon referred to abilities	Uncertainty markers	Overall psychological lexicon
RF global	0.23	0.38*	0.45**	0.21	0.51***	0.42**
Marker A	0.32*	0.35*	0.21	−0.02	0.25	0.38*
Marker B	0.12	0.37*	0.43**	0.16	0.54***	0.36*
Marker C	0.12	0.29	0.23	0.18	0.30	0.26
Marker D	0.01	−0.25	−0.15	−0.09	−0.16	−0.17
Ref. pos. MS	0.04	0.20	0.22	0.02	0.23	0.25
Ref. neg. MS	0.09	0.38*	0.27	0.07	0.38*	0.31*
Ref. mix. MS	0.35*	0.29	0.30	0.26	0.44**	0.37*

*Marker A, Awareness of the nature of mental states; Marker B, Explicit effort to tease out the mental states underlying behavior; Marker C, Recognizing developmental aspects of mental states; Marker D, Mental states in relation to the interviewer; Ref. pos. MS, references to positive mental states; Ref. neg. MS, Reference to negative mental states; Ref. mix MS, Reference to mixed-ambivalent mental states. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.*

To evaluate the extent to which maternal variables could predict children's use of mental terms, we conducted a stepwise regression analysis using maternal RF global score and the classification of secure/insecure from the AAI as predictors of both children's overall psychological lexicon and markers of uncertainty. The final models are reported in **Table 6**. The models explain approximately 11% of the variance in children's psychological lexicon and markers of uncertainty. Specifically, only maternal RF predicted children's use of mental terms ($t = 2.19$, $p = 0.034$ for the overall psychological lexicon; $t = 2.16$, $p = 0.037$ for markers of uncertainty).

Discussion

Maternal Reflective Functioning and Children's Mentalization

Analyses of maternal RF yielded significant correlations with children's mentalization and all subtypes of mental-state talk with the exception of the emotional lexicon. The category of mental-state talk that was most significantly connected to maternal mentalization was the uncertainty markers, followed in order by the volitional lexicon, overall psychological lexicon and cognitive lexicon. Therefore, it appears that the predisposition to use the language of emotional states *tout court* is less distinctive of mentalization ability than the tendency to use a mentalistic lexicon that refers to oneself and others in terms of psychological agents having their own beliefs, wishes and thoughts.

Our results are consistent with the hypothesis that the cognitive lexicon is an indicator of mentalization ability, especially when it expresses a degree of uncertainty. Developmental psychologists have long observed that a child's ability to distinguish between different degrees of uncertainty is a sophisticated competence that is reached later in development. Some researchers consider these cognitive terms to be the only genuine category within the psychological lexicon (Moore et al., 1989). The degree of uncertainty expressed in linguistic production appears to be strictly connected to the RF indicator described by Fonagy et al. (1998) as the awareness that mental states are opaque and susceptible to being masked. To express such awareness, an individual must use uncertainty markers, including uncertain mental verbs, adjectives, adverbs, and modal verbs.

Our results are also consistent with previous studies showing that a mother's mentalization ability predicts the same ability in her children (Meins et al., 1998, 2002, 2003; Steele et al., 2008). However, such comparisons between studies should be considered with caution, given their differences in measurement tools and in the ages of the children sampled between this report and previous studies.

The current study also aimed to identify which specific aspects of maternal RF are most strongly related to children's mentalization ability and mental-state talk, with the purpose of understanding which maternal competencies should represent the main focus of therapeutic actions. Marker A (awareness of the nature of mental states) and, especially, marker B (explicit effort to highlight the mental states that lay behind behavior) were the most significant maternal competencies.

Children's mentalization abilities and their mental-state talk were more correlated with maternal competence in the mentalization of negative or mixed-ambivalent mental states than it was with maternal competence in the mentalization of positive mental states, which is consistent with results from previous

TABLE 6 | Relationships between maternal variables and children's production of mental-state terms.

	Children's overall psychological lexicon $F(1,39) = 4.828$; $R^2 = 0.11$; $p = 0.034$					Children's markers of uncertainty $F(1,39) = 4.674$; $R^2 = 0.11$; $p = 0.037$				
	B	SE	β	*t*	*p*	*B*	SE	β	*t*	*p*
Maternal RF global	0.134	0.061	0.332	2.19	0.034	0.061	0.028	0.327	2.16	0.037

studies (Dunn and Brown, 2001; Hughes and Dunn, 2002; Sharp et al., 2006; Steele et al., 2008).

Maternal Attachment and Children's Mentalization

Although no significant differences were observed between the mentalization abilities of children of secure vs. insecure mothers, all children with a high level of mentalization were the children of secure mothers. Using a dimensional perspective of attachment, it was found that a maternal dismissive strategy, based on idealization and insistence on a lack of recall, was significantly and negatively correlated with a marker of children's mentalization ability (i.e., frequency of uncertainty markers in linguistic production). Future studies should focus on the specific impact of this maternal strategy on children's mentalization abilities. Specific difficulties in recognizing mixed and negative emotions have been detected in the children of dismissive mothers (Steele et al., 2008).

The results of this study could have been influenced by the distribution of insecure attachment patterns among the mothers included in our sample. In particular, Steele et al. (1999, 2008) observed that dismissive mothers represented 70% of insecure mothers, whereas only 38% of insecure mothers in our sample were dismissive. Another possible interpretation of the absence of an association between the security of maternal attachment and children's mentalization is the older age of the children in our sample compared to that of previous studies (i.e., preadolescent vs. primarily preschool-aged children). This result was consistent with the findings of a longitudinal study by Steele et al. (2008), who observed a reduction in the effect of the mothers' attachment on the understanding of emotions in their 11-year-old children compared to their 6-year-old children.

Influence of the Constructs and Instruments on Findings in this Study

The differences between this study and previous reports, related to the operationalization of the constructs and the measures, permit only a tentative comparison. Some studies have examined younger children with ToM tests and have mainly operationalized maternal mentalization as maternal mind-mindedness (Meins et al., 1998, 2002, 2003). We preferred not to use ToM tests in this study to evaluate mentalization in children because many studies (e.g., Bloom and German, 2000) have observed that verbal false–belief tests require linguistic and cognitive abilities that do not specifically grasp all the dimensions of "mentalization" (i.e., relational and affective regulation aspects). Interestingly, this study did not find significant correlations between maternal RF and education, nor between children's mentalization and mental-state talk, that in turn did not also correlate with children's verbal IQ.

Previous studies that also evaluated children's mentalization using the psychological lexicon produced in an autobiographical interview have noted that the frequency of a psychological lexicon in a real-life context is a good indicator of one's awareness of mental states. Moreover, these studies have indicated that such an approach additionally allows the exploration of individual differences in mentalization (Peterson and Slaughter, 2006) and of the influences of maternal mentalization on children's mentalization (Ruffman et al., 2002; Taumoepeau and Ruffman, 2006, 2008; Mcquaid et al., 2008).

Sharp and Fonagy (2008) highlighted the confusion between the many concepts of maternal RF derived from different theoretical backgrounds and between the different instruments or measurement tools used to study these concepts. Maternal RF has only been used in studies by Fonagy, with the aim of studying the impact of RF on the performance of 5- to 11-year-old children on ToM tests (Fonagy et al., 1997) and on tests of understanding emotions (Steele et al., 1999, 2002, 2003). However, RFS has shown predictive validity (Fonagy et al., 1998), supporting its use in this application in the present study. However, our study would have been more complete had we also used the parental RF-PDI (Parent Developmental Interview; Slade et al., 2004), which measures the maternal ability to treat a specific child as a psychological agent. In fact, it has been observed that parents manifested different degrees of mentalization abilities relative to different children (Sharp and Fonagy, 2008). Moreover, AAI and RFS are not independent measures. On one hand, this may present a limitation of the present study, but on the other hand, it was interesting to explore how different insecure patterns may impact RF. Following a dimensional approach to AAI, the current study found that involving anger, a marker of the preoccupied state of the mind regarding attachment, was inversely correlated with RF in the specific domain of positive mental state, while the two different dismissing strategies – i.e., derogation and idealization – correlated with specific impairment of RF. Idealizing mothers resulted not able to mentalize negative mental states, while derogating mothers showed a specific deficit in mentalizing positive mental states.

Concerning the evaluation of mentalization in preadolescents, we chose to use one assessment measure within the autobiographical personal context and one within a non-personal context. Interestingly, the two measures were significantly correlated and neither showed a significant effect with gender, IQ, or maternal education.

Study Limitations

In addition to some of the limitations mentioned above, another limitation of the current study was that the frequency of the psychological lexicon, unlike RFS and the test adapted by O'Connor and Hirsch (1999), did not consider the possible distorted quality of mentalization. Recent studies revealed this aspect to be crucial in the evaluation of mentalization ability (Sharp et al., 2007).

Furthermore, less than 15% of the mothers originally contacted agreed to participate in the research. Thus, it is not possible to know the extent to which our sample can be generalizable and what implications this limited participation might have had on the present study. Compared to other previous non-clinical samples (Bakermans-Kranenburg and van IJzendoorn, 2009), the dismissive classification in this study appeared to be underrepresented in the AAI. In addition, the study could have been methodologically improved if an on-line measure of the mother-child interaction had been used and if verbal IQ had been obtained for all of the children.

Conclusion

Children's mentalization was positively correlated with maternal RF, particularly the ability to mentalize negative or mixed-ambivalent mental states. These results are in line with studies indicating a *trans*-generational continuity of mentalizing abilities between mothers and their children. Significant differences in mentalization abilities between children of secure and insecure mothers were not observed, although all children with a high level of mentalization had secure mothers. Future studies should investigate the long-term impact of maternal RF on children's mentalization abilities, especially during adolescence, when a mother's ability to understand her child's mental states could be an important protective factor against the development of psychopathological conditions or health-risk behaviors. The findings of the present study support the need to implement mentalization-based treatments for parents of pre-adolescents and to investigate their outcomes.

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Enhancing "theory of mind" through behavioral synchrony

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Theory of mind refers to the abilities underlying the capacity to reason about one's own and others' mental states. This ability is critical for predicting and making sense of the actions of others, is essential for efficient communication, fosters social learning, and provides the foundation for empathic concern. Clearly, there is incredible value in fostering theory of mind. Unfortunately, despite being the focus of a wealth of research over the last 40 years relatively little is known about specific strategies for fostering social perspective taking abilities. We provide a discussion of the rationale for applying one specific strategy for fostering efficient theory of mind—that of engaging in "behavioral synchrony" (i.e., the act of keeping together in time with others). Culturally evolved collective rituals involving synchronous actions have long been held to act as social glue. Specifically, here we present how behavioral synchrony tunes our minds for reasoning about *other* minds in the process of fostering social coordination and cooperation, and propose that we can apply behavioral synchrony as a tool for enhancing theory of mind.

Keywords: theory of mind, social perspective taking, behavioral synchrony, ritual, interventions

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Introduction

Philosophers have long debated the means by which we can, with any certainty, know of the mental worlds of others. This problem of *other* minds—that is *how* it is we think we know what other people know, feel and think—is not one that we can easily solve with logic alone (Dennett, 1981). However, throughout our evolution, humans have been endowed with the sufficient cognitive architecture that allows for us to, at the very least reason about the minds of others—our "theory of mind" (Premack and Woodruff, 1978; Wimmer and Perner, 1983; Baron-Cohen, 1999). This capacity for understanding others' behaviors in terms of underlying mental states allows us to be empathic (Schnell et al., 2011), makes us adept cultural learners (Herrmann et al., 2007; Chudek and Henrich, 2011), and is involved in our moral reasoning (Moran et al., 2011; Young et al., 2011), our ability to coordinate and cooperate (Sally and Hill, 2006), as well as our ability to compete with, or manipulate, other individuals (Ybarra et al., 2007, 2010; Sher et al., 2014). Although this list is far from exhaustive, it should be clear that being an efficient mindreader facilitates successful navigation of the many challenges humans face in their socio-cultural environments. Indeed, those who are sometimes described as "mindblind"—individuals diagnosed along the autism spectrum—often experience tremendous hardships in everyday social interactions (Baron-Cohen et al., 1985).

Notably, being *able* to reason about other minds does not necessarily equate to being *accurate* at mindreading. Specifically, our reasoning about other minds is often inaccurate in one of two ways. For instance, when thinking about others' minds could be most informative, such as when taking directions, we often fail to do so all together (Keysar et al., 2003; Samson and Apperly, 2010). Further, it is (extremely) common for individuals to think about and ascribe minds to entities when there is little to no evidence of a mind (at least not in the typical sense). For example, people frequently think about their computers as intentional beings with "minds of their own," and

people the world over ascribe mental states such as knowledge and intentions to bodiless spirits, ghosts, and gods (Waytz et al., 2010b). This set of inaccuracies represents systematic errors in mind perception and attribution—both true-misses and false positives. Moreover, our reasoning about the *content* of others' minds is often inaccurate and systematically biased by our own perspectives and knowledge (Birch, 2005; Bernstein et al., 2011). This egocentrism prevents accurate attribution of, and subsequent reasoning about, the contents of other minds.

The mismatch between the human propensity for reasoning about other minds and our noted deficits in accurately doing so emerges from the imperfections of our evolved capacities, and the lengthy process of their development across the lifespan (Gehlbach, 2004; Brüne and Brüne-Cohrs, 2006). This gives rise to substantial individual variability in some domains of theory of mind such as emotion recognition and empathic tendencies (Baron-Cohen et al., 2001; Baron-Cohen and Wheelwright, 2004), while strikingly less so in others, such as reasoning about false beliefs (Liu et al., 2008). As such, what we refer to more generally as "theory of mind" is but a placeholder for a suite of related systems that function at different levels of cognitive processing. Implicit, automatic and inflexible systems for agency detection, face recognition, gaze following, emotion processing, joint attention, and our naïve theories of causality motivate a reflexive understanding of others' behavior as resulting from underlying mental states (Apperly and Butterfill, 2009). This reflexive reasoning is elaborated with explicit, verbal and flexible thought (Epley and Caruso, 2008), only when we have the cognitive resources and motivation to do so (Rhodes, 2014).

As such, any account of how to foster theory of mind must take into consideration the various interconnected systems at play when people reason about the minds of others (Harwood and Farrar, 2010; Schaafsma et al., 2015). By understanding the parts of the process, we can begin to examine how to grease those gears and enhance our theory of mind capabilities. With such a framework in mind, we present behavioral synchrony, the act of keeping together in time with others, as a novel tool for honing and enhancing theory of mind. Specifically, we present evidence of the processes by which behavioral synchrony can correct for common inaccuracies in mental state reasoning by motivating directed reflexive mental state reasoning, and decreasing the egocentrism that would otherwise inhibit more explicit reasoning about others' mental worlds.

Music and Behavioral Synchrony

A recent study suggests that merely coordinating your actions with a complete stranger through participation in a musical game is sufficient to induce an empathic pain response of the same magnitude of that among very close friends (Martin et al., 2015). We argue that this choice of task, joint music making, is of special interest as it incorporates elements of synchronous action that are particularly capable of fostering theory of mind. The success of this intervention is particularly noteworthy considering the reported difficulties in enhancing theory of mind through explicit instruction. Specifically, studies that examine practicing and learning how to infer and engage with the minds of others in both typically developing and clinical samples (Ozonoff and Miller, 1995; Goldstein and Winner, 2012) remain inconclusive. Indeed, the difficulty in "teaching" theory of mind follows from the lack of a clearly defined relationship between experiential input (e.g., learning about mental states through parent–child discourse; Sabbagh and Callanan, 1998; Farrant et al., 2011) and cognitive scaffolding (e.g., executive function; Benson et al., 2013) in the ontogeny of a theory of mind. In contrast to explicit instruction, behavioral synchrony may offer unique opportunities to foster accurate mental state reasoning.

The production of music through coordinated rhythmic movement is a complex multimodal integration problem that humans are particularly capable of solving; we have got a knack for synchronizing our behavior with others and with signals in our environments (Overy and Molnar-Szakacs, 2009; Konvalinka et al., 2010). Establishing this synchrony, through spatiotemporal coordination to an external stimuli, is in and of itself a complicated dynamic task (Phillips-Silver et al., 2010). Yet, children within their first few years of life develop the ability to synchronize with others (Feldman, 2007; Kirschner and Tomasello, 2009). Early experiences of socially contingent, imitative, and synchronous behaviors help define the boundaries between self and other, while simultaneously allowing for effective navigation of those boundaries in fostering efficient interpersonal coordination (Nadel et al., 2005).

Across the lifespan, the ease with which we synchronize with others helps solve even the most mundane of joint coordination problems. Consider the complexity of the seemingly simple task of two separate minds and bodies figuring out how to lift and transport a heavy object. This requires those individual minds and bodies to perceive and react to each other, their respective movements and the constraints of the external world (Allport, 1924). Thus, sensory-motor coordination deficits can be particularly problematic in everyday life. Interestingly, movement abnormalities and deficits in spatiotemporal coordination are some of the earliest known precursors to diagnoses along the autism spectrum (Williams et al., 2001; Grossberg and Seidman, 2006) and are correlated to later deficits in empathic ability (Piek and Dyck, 2004). This connection between synchronous action and shared mental experiences—from keeping together in time, to keeping together in mind—is one that we are only recently beginning to understand.

Music and dance are the quintessential forms of coordinated human synchronous behavior. Ehrenreich (2006) and McNeill (1995) highlight the ubiquity of music, dance and drill in various forms of collective ritual throughout the anthropological and historical records while stressing the peculiar power behavioral synchrony has in both the management and rallying of large groups of physical bodies and, most strikingly, their mental states. In their now foundational studies, Wiltermuth and Heath (2009) empirically tested the core hypothesis laid out by Ehrenreich (2006) and McNeill (1995) that behavioral synchrony promotes cooperation. In a standard public goods game, groups that moved and/or sang synchronously, out-cooperated groups who did so asynchronously or did nothing at all by consistently contributing higher amounts to a shared account, from which all participants take an equal share. Synchrony fostered increased commitment

to the group, and promoted greater feelings of liking, similarity and trust. Importantly, this heightened sense of group identity did not emerge when participants completed the very same task in an asynchronous manner—pointing to the effectiveness and specificity of behavioral synchrony in cultivating social cohesion above and beyond the effects of simply being part of a group. Indeed, such findings point to synchrony detection as one of the possible mechanisms responsible for establishing intergroup boundaries and for creating intergroup bias, speaking to its broad influence on social cognitive processing.

Attesting to the robustness of the effect of synchrony on cooperative behaviors, this result has since been replicated in more naturalistic settings (Cohen et al., 2010), and amongst diverse cultural groups (Cohen et al., 2013; Fischer et al., 2013). Further, the reported sensitivity to synchrony amongst conspecifics in promoting prosocial behaviors develops early (Kirschner and Tomasello, 2010) and emerges in infants as young as 14 months (Cirelli et al., 2014a). These converging lines of research provide strikingly clear evidence of how culturally evolved collective ritual practices around the world have galvanized this reliably developing cognitive connection between synchronous action and sociality.

However, there remains little consensus in this rapidly growing literature about the precise mechanisms by which these effects occur. Here, we put forth the hypotheses that in the process of fostering social cohesion and cooperation, behavioral synchrony enhances our capacities for theory of mind through two interrelated processes: (1) readying our minds for reflexive reasoning about mental states and (2) decreasing the egocentric biases that impede our accuracy in doing so. Of particular interest here, is not that synchrony fosters cooperation—but *how* it does so. Building from the literature on synchrony, cooperation and social cohesion, we lay the groundwork for understanding behavioral synchrony as a means to enhance theory of mind.

Behavioral Synchrony and Reflexive Mental State Reasoning

Hove and Rise (2009) demonstrated that simply synchronizing with a visual target on a computer was not sufficient to induce increased affiliation with physically present others; it is really all about *interpersonal* synchrony. This connection between synchronizing with others and figuring out with whom to cooperate and affiliate seems to fall out of early developing inferences about our social worlds. In 14-month-old infants, for example, synchronous action functions as both motivator and cue for directing later, non-generalized, prosocial behaviors (Cirelli et al., 2014b). Kirschner and Tomasello (2010) have argued that in keeping in time with others, synchrony leads pre-school aged children to hold a representation of others in mind with a specific focus on the collective intention and shared attention that emerges from synchronous action. This capacity for sharing attention and intention emerges early in life and is a critical feature of the developing child's theory of mind (Tomasello et al., 2005; Baillargeon et al., 2010).

In adults, synchronizing with others directs one's attention toward those they have synched up with and in the process increases the likelihood with which they attribute them with personhood and mind (Macrae et al., 2008). Notably, synchrony induces greater memory for details of those with whom we synchronize with, but not greater generalized memory capacity (Miles et al., 2010). Thus, in the process of turning our attention toward those we synchronize with while increasing both the likelihood with which we attribute personhood to those individuals *and* hold this representation of the other in mind, behavioral synchrony engages the cognitive systems that ready our minds for thinking about the mental states of others.

Furthermore, synching up with others makes us better able to infer and predict other's future behaviors, increasing not only cooperative tendencies, but also the *ability* to successfully cooperate. In one study (Valdesolo et al., 2010), participant dyads were instructed to either rock in or out of synchrony with each other in chairs, and then worked together in navigating a steel ball through a wooden labyrinth. Success on this task was determined by the ease with which participants could infer and predict their partners' subtle movements, while dynamically adjusting their own, without the use of verbal communication, in order to quickly get the ball through the maze. Synchronous pairs, compared to asynchronous pairs, were significantly quicker at navigating the ball through the labyrinth. Further, success on this task was mediated by a synchrony-induced increase in the ability to detect subtle differences in temporal movement on an unrelated task. That is, participants were better able to accurately report whether a ball on a screen moved at the same or a different pace (which varied across trials) after passing behind an opaque rectangle; raising the interesting possibility that moving in synchrony with others promotes a domain-general increase in ability for tracking agency—another early developing feature of our core cognitive capacity for theory of mind (Gergely et al., 1995; Baron-Cohen, 1999; Johnson, 2000).

Collectively, these lines of research provide convergent evidence for the various ways in which behavioral synchrony prepares us for engaging with the mental world of others'. By fostering shared and other-directed attention, individuals in synchrony become acutely aware of what others' perceive, making the jump from what others see to what others think cognitively easier to compute (Sebanz et al., 2006). Further, the act of synchronizing, keeping to the beat, in and of itself dictates not only what others should do, but will do. Thus freeing up cognitive resources otherwise spent on predicting others' behaviors, allowing for, as will be described below, more explicit reasoning about others' mental worlds.

Behavioral Synchrony, Egocentrism, and Psychological Distance

In creating a sense of "we" amongst previously unrelated individuals, behavioral synchrony has been consistently demonstrated to foster increased liking, feelings of similarity, and affiliation (Haidt et al., 2008; Hove and Rise, 2009; Wiltermuth and Heath, 2009; Lakens and Stel, 2011; Valdesolo and DeSteno, 2011). Synchrony actually makes us less able to distinguish our own faces from those of whom we have synched up with (Paladino et al., 2010)—blurring the boundaries between self and

other. In this act of getting over one's self, behavioral synchrony may engage and foster explicit mental state reasoning through a reduction of our egocentric biases that otherwise hinder our ability to reason about another's perspective.

Further, psychological distance can inhibit the social cognitive processes involved in mental state reasoning. The larger the psychological distance between two individuals or entities (e.g., the greater the dissimilarity), the less likely they would believe they shared any meaningful connections, attitudes, traits, and of particular interest here, the less likely they would be to attribute minds to each other (Waytz et al., 2010a). When asked to think about others who are perceived as psychologically distant (e.g., the homeless), individuals dehumanize others and fail to even recruit the brain networks used in everyday social cognitive processes (Harris and Fiske, 2006). Further, simply tagging others as not being in-group members has been demonstrated to be sufficient for upping the threshold of mind perception—requiring more humanness (on a doll and human face-morphing task) before we willingly attribute them with mental states (Hackel et al., 2014). Interestingly, naturally occurring synchrony in dyadic interactions occurs significantly less when interacting with psychologically distant others (Miles et al., 2009). Synchrony then, when experimentally induced in the lab or experienced through collective ritual, might aid in decreasing psychological distance (Vacharkulksemsuk and Fredrickson, 2012), and increase the likelihood with which we explicitly engage with and reason about others' mental worlds.

General Discussion and Future Directions

The act of keeping together in time with others, participation in synchronous collective ritual, binds individuals into cohesive groups (McNeill, 1995; Ehrenreich, 2006). This is but one culturally evolved solution to the problem of sustaining large-scale cooperation in groups (Henrich and Henrich, 2007). Here, we argue that synchrony fosters cooperation by exploiting our everyday social cognitive reasoning about other minds. That is, by directing attention to others and their mental states, while decreasing the perceived psychological distance between individuals, behavioral synchrony makes us better able to reason about other minds and thus coordinate and cooperate. Behavioral synchrony then, like the human propensity for imitation, is part of a larger suite of processes that allow for effective interpersonal coordination between physical bodies *and* minds (Chartrand and Lakin, 2013). The human capacity for interpersonal coordination and cooperation is remarkable, and known to reliably recruit neurological systems involved in mental state reasoning (McCabe et al., 2001; Balslev et al., 2006; Lissek et al., 2008). In turn, the ease with which one reasons about others' mental states has been linked to the ability to successfully coordinate in joint-action paradigms (Humphreys and Bedford, 2011; Curry and Chesters, 2012).

The connection between behavioral synchrony and the cognitive systems we use to engage with others' mental worlds underscores the interconnectedness of our behavior- and mind-reading abilities. Theory of mind is not telepathy—it is a complex inferential and predictive process that attempts to make sense of real cues that exist out there in our environments—behaviors (Whiten, 1996). Following a simulationist perspective on the mechanisms underlying theory of mind processes (Gallese, 1998; Frith and Frith, 2006), when we move together in time with others, understanding their behavior becomes a much simpler task as the behavior of others is matched in our own, making it cognitively less demanding and less difficult to reason about their mental states (Keller et al., 2014).

Research explicitly exploring how behavioral synchrony can foster theory of mind is sparse. However, there is an emerging literature examining the benefits of musical group interaction and dance-movement therapy in enhancing various components of theory of mind in typically developing and clinical samples of young children. Both of these applications heavily involve synchronous interactions with others and are found to increase social cognitive processes that promote reflexive mental state reasoning (e.g., joint attention, imitation, gaze following; Landa et al., 2011), as well as explicit tendencies for empathy and perspective taking (McGarry, 2011; Behrends et al., 2012; Rabinowitch et al., 2013).

Thus, the question remains as to how broadly the current hypotheses can be put into practice. We are currently building an in-depth research program exploring how behavioral synchrony can differentially enhance different components of theory of mind—directly testing the hypotheses that synchrony fosters both explicit and implicit mind perception, empathy and perspective taking using a battery of measures built specifically to capture correlates of theory of mind. With promising results, the question of what this synchrony-induced mental state reasoning accomplishes in terms of other processes we know to be related to theory of mind—such as in the domains of moral reasoning and cultural learning—remains open for future research. Our hope is that we have made a case here for the viability of this research program and inspire future research toward the goal of better understanding the mechanisms underlying mental state reasoning in order to foster better social perspective taking.

What emerges from an understanding of the connection between behavioral synchrony and theory of mind is a cohesive framework from which to understand the already well-established effects of synchrony on coordination, cooperation and cohesion—understanding the process by which joint physical action leads to joint mental connection. This framework provides answers to (or at the very least testable hypotheses regarding) the question of why behavioral synchrony is so ubiquitous in collective rituals around the world. From army drills to church choirs, culturally evolved collective rituals involving synchrony tune our minds for reasoning about other's mental states. In doing so, individuals become better able to learn from, coordinate, cooperate, and empathize with others—shaping human sociality. Presently, we argue that we can exploit this culturally galvanized connection between synchrony and mental state reasoning—and apply synchrony as a tool for fostering theory of mind.

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The Resilience Program: preliminary evaluation of a mentalization-based education program

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In order to manage with the burden of mental health problems in the world we need to develop cost-effective and safe preventive interventions. Education about resilience to support the ability to cope with life challenges in general, may be a useful strategy. We consider the concepts of Theory of Mind and Mentalization to be relevant in this context. In this paper we describe a simple modular intervention program based on these concepts which can be tailored to specific needs and situations in individual therapy as well as group levels. The program has shown promising results in pilot studies and is now tested in controlled trials in settings such as schools and educational institutions, adults diagnosed with ADHD, and children in care.

Keywords: mental health education, mentalization, theory of mind, resilience, conflict prevention

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Introduction

There is an increasing awareness that the burden of mental health problems in the world cannot be addressed by therapeutic interventions alone (Kazdin and Blase, 2011). Alongside improving treatments, we need to develop cost-effective and safe preventive interventions (Fonagy et al., 2005; Rhule, 2005; Roth and Fonagy, 2006; O'Connell et al., 2009; Kazdin and Blase, 2011).

One promising approach is structured mental health education. A number of meta-analyses suggests that mental health education has positive effects on perceived health and behavior in a wide range of settings (Montgomery et al., 2006; Knouse et al., 2008; Donker et al., 2009; Baskin et al., 2010; Xia et al., 2011), such as parent management training (Montgomery et al., 2006), anxiety (Hedman et al., 2011), eating disorders (Perkins et al., 2009), and in pediatric health care (Cushing and Steele, 2010). The apparent most important behavioral components in these programs are specific goal setting, self-monitoring, feedback, and contingency management (Cushing and Steele, 2010), but it is not always clear whether these programs also build a capacity for increased resilience to withstand future challenges.

Resilience and Mentalization

Resilience is defined as successful adaptation to adversity, including successful recovery from adverse life events and sustainability in relation to life challenges, individually and on group- and community-levels (Zautra et al., 2010).

The term Mentalization refers to the skills involved in understanding mental states, not only in others but also one's own mental states as well as their connections with behavior. This is central in mutual understanding of relationships, self-control, motivation, and flexible understanding of

what is going on in the world around. Theory of Mind is thus an integrated part of mentalization (Fonagy et al., 2002; Fonagy and Bateman, 2011; Liotti and Gilbert, 2011).

A compromised ability to mentalize is considered as a core neuropsychological deficit in autism spectrum disorders (Castelli et al., 2002; Philip et al., 2012) and borderline personality disorder (Allen and Fonagy, 2006). Individuals with psychiatric disorders such as schizophrenia, obsessive-compulsive personality disorder, psychosomatic disorders, eating disorders, panic disorders, and depression may also be in a non-mentalizing state of mind. (Hains and Arnsten, 2008; Fonagy and Bateman, 2011; Sharp and Venta, 2012). The same holds for completely normal individuals in severe distress.

The psychological research about mentalization is supported by neuro-imaging studies demonstrating frontal and temporal functional changes (Fonagy et al., 2005; Bisson, 2007; Blakemore, 2008; Hains and Arnsten, 2008; Lombardo et al., 2009; Fonagy and Bateman, 2011; Gweon et al., 2012; Zaki and Ochsner, 2012; Nolte et al., 2013; Happé and Frith, 2014). Mentalization based treatment programs have proved valuable in the treatment of adults with borderline personality disorder (Bateman and Fonagy, 2013), as well as in work with adolescents who self-harm (Rossouw and Fonagy, 2012). These results have stimulated interest in extending mentalization knowledge and tools from adult psychiatry in to child and adolescent psychiatry and in to mental health promotion in coping with stressful challenges (Midgley and Vrouva, 2012). For example, trials have indicated that a mentalization-based approach can be effective in reducing bullying in schools, when applied at a whole-system level (Fonagy et al., 2009).

Based on these findings we have developed a modular mentalization-based intervention program that we call 'the Resilience Program' in which a social field education model is combined with a self-directed web-based approach. The aim of this article is to describe the Resilience Program briefly and present preliminary results and ongoing studies.

The Resilience Program

The Resilience Program is a flexible web-based modular mental health education program that can be used in general mental health promotion as well as in supporting people with mental health problems independent of character and complexity. The program can be used in any organizational context (e.g., youth work, education, social care) and can be integrated with any daily routines and in combination with other interventions, with low or high intensity. Hitherto our pilot experiences clearly indicate that following a brief period of training the program can be used by any professional and by lay persons, including parents, and students.

The Resilience Program website[1] contains all information and a number of presentations about the Program, which consists of knowledge about resilience, mentalization and self-control, social learning theory, cognitive training, and neuroscience. This knowledge is transformed into a coherent yet simple, easy to understand set of presentations combining daily language texts, pictures, and short films.

It is possible to use the Resilience Program as a completely self-directed program. However, the program is most often introduced to target groups in short lectures and courses followed by discussions, group work, and follow-up supervision. Whenever possible we use a social field model of delivery, for instance a whole school intervention approach including both teachers and parents. Afterward teachers and parents use whichever program modules they find relevant to their setting, in talks and education with their children (down to the age of 6–7 years) and adolescents. The program is thus organized as free-standing modules that can be combined for individual purposes. It is clear from the material what is applicable for children and adolescents and what is useful for the adults around them.

For illustrative purposes, we present two examples from the Resilience Program (copied directly from the program website) describing in daily language and metaphors what is going on in the brain and our minds in mentalizing and non-mentalizing states.

The Story of the House of Thoughts is a metaphor for the core idea about mentalizing and non-mentalizing states. It is read aloud by parent, teacher, or instructor. Children can then eventually write or draw their own personal version of the story – their own house.

The Story of the House of Thoughts

In some way, we may say that our thoughts live inside our heads. Imagine that your thoughts live in a house with many rooms where you can wander around and discover them. When you discover thoughts, you are using the world's finest tool – your attention, which is a kind of spotlight. When you throw light on a thought, you spot it and discover it. Thereafter you can shift your attention and discover another thought.

The House of Thoughts has plenty of rooms – a number of exciting thoughts may live in one room, perhaps some sad or angry thoughts live in another room and various happy thoughts live in a third room.

From The House of Thoughts, your thoughts can call you if they want to be discovered. This may be really exciting and good, but could be irritating too – especially if the thoughts are annoying and keep knocking all the time, trying to take charge over your attention. In the case where you have sad, anxious, or angry thoughts that take charge and force you into their room all the time, you might end up believing there are no exciting or happy thoughts to be found anywhere and that is not much fun.

... Yet this is not the case at all. All the happy and exciting thoughts are just waiting in other rooms in the House of Thoughts, waiting for you to discover them with your attention. Maybe there are even tools to be found in one room that could be used to fix some other thoughts in another room in the house. There may also be thoughts in a room that need to be left in peace, so they will not disturb you too much. If you often go to explore The House of Thoughts with your attention, then it becomes easier to be in charge of your thoughts.

[1] http://myresilience.org

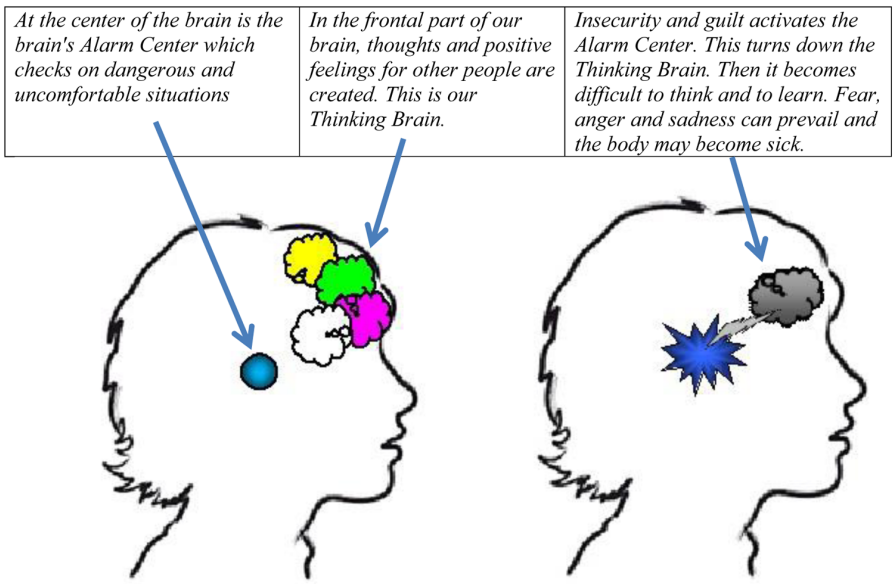

FIGURE 1 | Picture from the Resilience Program describing "the Thinking Brain" and the "Alarm Center".

The section about the Thinking Brain and the Alarm Center explains the neurobiology behind mentalizing in simple terms (see **Figure 1** and the italic text below the figure):

The Thinking Brain and the Alarm Center

Here, you can read about how your brain works when all is well and when things go wrong.

Unpleasant and dangerous situations can cause the alarm center to be over-sensitive. This means that the next time you are in a situation that resembles the 'danger' situation, the center may overreact with the result that you become afraid, angry, or sad – perhaps without any reason at all. It becomes difficult to think rationally – instead you react instinctively to 'survive' mentally and socially.

It is obviously good that the alarm center takes over when we are facing real danger. If your life is at risk there is no time to consider the pros or cons of taking action – you have to react promptly with fight or flight. However, it is not so desirable if the thinking brain turns off when there is no serious danger to you. An example is when you go blank in an exam situation, or when you panic about something that in fact is not dangerous at all. If your alarm center has been over-sensitive, it can be provoked just by thinking about an unpleasant situation.

The only thing you learn when you are alarmed is to be on guard in similar situations. You do not become more resilient, but you are at risk of becoming more vulnerable. Thoughts about your psychological and social survival will dominate your thinking. Vulnerability can be seen as anger, fear, and sadness.

If you on the other hand, become overprotected and do not face any challenges, your alarm center will believe that everything is 'dangerous,' which makes you vulnerable as well.

Very unpleasant and dangerous situations (traumas, accidents, and assaults) of course increase the risk of over-sensitizing the alarm center. Unfortunate micro-events can, by chance, also create permanent over-sensitivity in the alarm system (e.g., a horror movie). The most frequent cause of imbalance in the alarm center is insecurity in everyday life for example within family, in school or at work, and stress at a level that overloads the working memory and causes loss of overview.

Other people's thoughts are invisible. That is why we sometimes misunderstand another person and believes that he or she does not want any good for us. Such thoughts can trigger the alarm center. If the other person is in an alarm state as well, we have two alarmed brains fighting each other and/or fleeing from each other.

Fortunately, the brain can be trained to become resilient instead of becoming vulnerable. When the thinking brain and the alarm center face appropriate challenges, neither to big nor too small, the thinking brain is able to control the alarm center, so it is not triggered without reason. The brain's working memory is trainable too, thus making it easier to cope with life.

Evaluation of the Resilience Program

The Resilience Program has been developed in 2005–2007 inspired by mentalization research, cognitive, and neuroscience and social learning theory. The program was pilot tested in the Municipality of Aarhus in Denmark in 2008–2010 (Lundgaard Bak, 2012). The primary result was that the program had a very high feasibility.

In 2013 we began to investigate the efficacy and efficiency of the program, using the intervention methods described above, in four controlled studies: a school study involving 60 schools and a youth education study involving 16 educational institutions; a study with 9,000 looked after children; and a study with 8,000 young people with ADHD. Data collection will start in late 2015 and be repeated in the following years. Results will be presented

in 2016–2018. Trial protocols can be seen at the program website[2] on the sub-site 'about us.'

The Resilience Program is currently implemented locally in five European countries and is also being tested in studies with various other methodologies by independent researchers.

Materials and Methods

In order to illustrate the potential use of the Resilience Program, we here present 3 years follow up results from an exploratory pilot study in spring 2011 using the first version of the Resilience Program in a low-income city area in Denmark.

Pilot Study Background Information

Ninety percentage of the population in the target area of the study is immigrants from Middle East countries. In the area, there are several social clubs for adolescents. In 2009–2011, one of the clubs was challenged by increasingly severe disruptive behavior among the adolescents, for reasons which the managers of the clubs were not able to clearly identify. For that reason the managers asked for this intervention. At the time of intervention in spring 2011, 130 adolescents were registered members of the club.

The staff in the Municipality of Aarhus are regularly offered post-graduate education. In the period 2009–2011, the staff in the trial club in the area had two other post-graduate courses, one about coaching, and one about body relaxation.

Because of encouraging findings from the pilot trial described here, the managers implemented the same program and training in a neighbor club in the area in the late 2012. The neighbor club did not receive the other mentioned post-graduate courses. Data before and after intervention from this neighbor club is included in the study.

Intervention Method

All staff members received a 3-days Resilience Program course with follow-up supervision for 3 months. The staff introduced the adolescents to the program. A sub-group among the adolescents received a more intensive education (45 min × 6).

Data Collection

The results in the social club study are based on the following data:

- The frequency of incidents where staff members use physical force in high-risk conflicts in order to protect persons from physically damaging themselves or other persons. We have incident data from the trial club and the neighbor club in the period 2009–2014.
- Staff sick leave. This is standard administrative data in the organization. We have data from all clubs in the municipality from 2008 to 2014.
- Questionnaire data. In spring 2014 the staff in the trial club and the neighbor club filled out a questionnaire asking them to evaluate how meaningful (on a 10 point scale) they *presently* consider their post-graduate courses from 2011: the coach course, the body relax course and the Resilience Program course. They were also asked if they specifically use Resilience Program modules in direct talks and education with adolescent in their present daily work in the club.

[2]http://myresilience.org

Results

Force Incidents

The yearly force incidence rate in the trial club was nearly halved after the intervention (58%, 95% CI 41–81%), while this rate remained low and stable in a neighboring club. Compared with the neighboring club, the rate in the trial club was four times higher before the trial and reduced to two times higher after trial (rate ratio 4.36, 95% CI 2.41–8.56 and rate ratio 2.28, 95% CI 1.37–3.92, respectively). See also **Figure 2** and **Table 1**.

In the neighboring club, the intervention was introduced in March 2012, giving no changes in yearly force incidence rate after intervention (rate ratio 1.02, 95% CI 0.48–2.13).

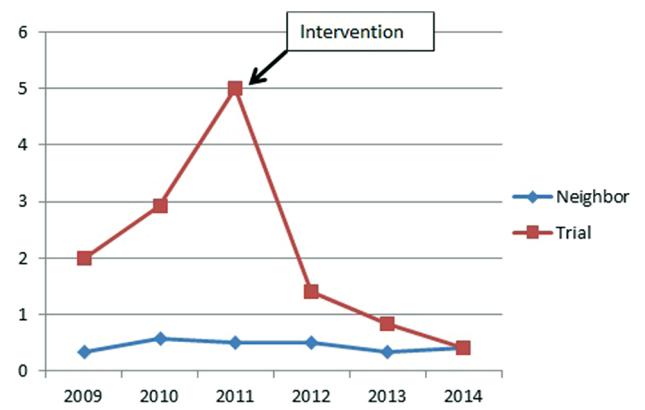

FIGURE 2 | Yearly force incident rates per 100 club member in 2008–2014, before and after the intervention in spring 2011.

TABLE 1 | Yearly force incident rates per 100 club member in 2008–2014, before and after the intervention in spring 2011.

	Before	After	Rate ratio*	(95% CI)*	
Trial club	27.8	16.0	0.58	0.41	0.81
Neighbor club	6.4	7.0	1.11	0.53	2.40

**Poisson regression.*

TABLE 2 | Average yearly sick leave (days) per employee 2008–2014, before and after the intervention in spring 2011.

	Before	After	Difference	(95% CI)	
Trial	23.3	11.3	−12.0	−13.5	−10.6
Neighbor	26.4	18.1	−8.3	−10.6	−6.0
All other*	20.3	14.7	−5.5	−5.8	−5.2

**Including all other clubs in the municipality.*

TABLE 3 | Staff evaluation of the meaningfulness of three educations, and their specific use of the RP program with adolescents in the club.

	2014 evaluation of Meaningfulness of post-graduate education (10 point scale) average. (xx) = response rate in %			RP use with adolescents
	Coaching 2010–2011	Body relaxation 2009	RP Spring 2011: Trial Late 2012: Neighbor	
Trial club ($N = 12$)	7, 6 (92)	5, 2 (75)	8, 1 (100)	80% (83)
Neighbor club ($N = 12$)	8, 6 (92)	4, 3 (58)	8, 9 (83)	100% (66)

All members of the staff in the two clubs, except one person who had changed job, filled out the questionnaire.

Staff Sick Leave

The average yearly sick leave days was significant reduced in all clubs in the municipality in 2008–2014, but the reduction in the trial club was larger than that of all other clubs (12.0 vs. 5.5 days) and that of a neighbor club (12.0 vs. 8.3 days). See **Table 2**. Compared to all other clubs, the trial club had more sick leave days before the trial and had fewer sick leave days after the trial, with a statistical significant difference of 3.0 days (95% CI 1.8 to 4.2) before trial and of −3.4 days (95% CI −4.3 to −2.6) after trial.

Three-Year Follow up Questionnaire

As can be seen from **Table 3**, the response rate to the questions is generally high although varying. In both clubs the coach education and the Resilience Program course is rated higher than the body relaxation course. The Resilience Program is still used by a large majority of the staff in both clubs in communication with the adolescents.

Because the scores are not normal distributed, we used Kruskal–Wallis test to check the differences in the distributions of scores between different programs or clubs.

Among trial club, both RP and coaching had a higher score than body relaxation ($p < 0.05$ and $p < 0.01$, respectively), while there was no difference between RP and coaching ($p = 0.66$). The same is true for neighbor club (the corresponding p-values: $p < 0.01$, $p < 0.01$, and $p = 0.57$, respectively).

If we compare the same program between trial club and neighbor club, there is no difference for any program (all $p > 0.10$).

Discussion

Clearly the most interesting result of this study is the fact that the vast majority of the staff is still using the Resilience Program in their daily work 3 years later. The staff themselves rated the Resilience Program as well as the coaching education as very valuable. This impression is confirmed by interviews with the club managers. They consider the simple dissemination of knowledge about mentalization and the neurobiology of mentalization as the key factor in the intervention and this is what is still used by the staff.

Immediately after the intervention and in the following years, the frequency of force incidents and the sick leave decreased in the trial club. There may be two reasons for this development: natural fluctuations in conflict causal factors (regression toward the mean) and/or a positive effect of the intervention. Because this is not a controlled trial, we cannot determine which of the hypotheses is most likely to be true.

Despite the positive evaluation and use of the Resilience Program in the neighbor social club 1 year later in spring 2012, this has not affected the force incident rate in that club. This may indicate that the RP program in the form it was delivered was not effective in relation to this outcome in that club. Another hypothesis may be that the force incident frequency in that club is as low as can be, considering the challenges children and young people and families in this low income area face in their lives. Maybe a further decrease cannot be expected. However, it is also important to notice that the development in the frequency of high risk conflicts leading to incidents of using force in 2009–2010 was very different in the trial club and the neighbor club so one should be cautious in the interpretation of the data since the two clubs in this respect cannot be considered comparable.

Conclusion

The exploratory pilot study results suggest that the Resilience Program may be promising and that randomzied testing of the program is justified. The program is easy to understand, even for disadvantaged children and adolescents. The results indicate that the program may contribute to building a safe mental environment for disadvantaged adolescents and the staff around them in social youth clubs.

The ongoing randomized trials will show if the Resilience Program is efficient as a completely self-directed online program as well as a group-based education and training program used within organizational contexts such as schools and educational institutions.

May be this type of low cost brief intervention programs focused on education can contribute to the solution of societal mental health problem challenges.

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Training for generalization in Theory of Mind: a study with older adults

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Theory of Mind (ToM) refers to the ability to attribute independent mental states to self and others in order to explain and predict social behavior. Recent research in this area has shown a decline in ToM abilities associated with normal aging that is of a moderate magnitude or greater. Very few studies have investigated whether it is possible to improve older adults' ToM abilities. The present study was designed to address this gap in the literature by evaluating the impact of a ToM training on practiced and transfer tasks. We provided older adults with a variety of activities designed to facilitate the generalization of benefits to other ToM-demanding tasks. Participants were 63 healthy older adults, native Italian speakers (M_{age} = 71.44, SD = 5.24, age range: 63–81 years). Participants were randomly assigned to one of two groups: the ToM training (age range: 63–81 years) and the physical-conversation training (age range: 64–81 years). Training effects were measured using the strange stories (practiced task) and the animation task (transfer task). Results revealed the efficacy of the training in producing improvements on practiced but also on transfer tasks.

Keywords: Theory of mind, training, older adults, generalization effect, mentalizing ability

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Introduction

Theory of Mind (ToM) refers to the ability to attribute independent mental states to self and others in order to explain and predict social behavior (Carruthers and Smith, 1996; Baron-Cohen et al., 2000). It is a fundamental skill used throughout the life span, with important implications for social communication abilities and social relationships (Henry et al., 2013). Recent research in this area has shown a decline in ToM abilities associated with normal aging that is of a moderate magnitude or greater and that can only be partially attributed to a more general decline in cognitive skills associated with making inferences (for a review, see Henry et al., 2013).

Despite the fact that many studies have shown an age-related decline in mental state understanding and have highlighted the importance of ToM for social relationships (Shamay-Tsoory and Aharon-Peretz, 2007; Krach et al., 2010), to date only one study has tested the possibility to train older adults on ToM. It is a study by Lecce et al. (2015) on a non-clinical sample. Older adults (age range: 58–85 years) were assigned to one of three training conditions: ToM-conversation, physical-conversation and social-contact. In the ToM-conversation condition, older adults took part in guided conversations about mental states. In the physical-conversation training, subjects took part in conversations that focused on physical rather than mental inferences. The ToM- and the physical-conversation trainings were closely matched in length and structure, and both used short narratives as prompts. Finally, in the social-contact group, participants took part in general conversations about aging, without a specific focus on mental states inferences. Results showed that

the ToM training group increased its ToM skills significantly more than the other two control groups, supporting the view that advanced ToM skills may be enhanced in healthy aging through mental states conversations.

Although interesting, Lecce et al. (2015) study is limited in that the training focused on a single group of tasks and adopted a verbal modality only. Is also paid little attention to the application of ToM to real life contexts in which people receive information from a combination of sources and modalities. For example, a recent model proposed by Achim et al. (2013) called the eight sources of information framework (8-SIF), posits that mentalizing in real life requires to take into account eight different sources of information as they emerge from the cross of the following main sources: (1) immediate, (2) memory, (3) agent, and (4) context. Some of these information are readily available through our senses, whereas others are less explicit and are stored in memory. Notably, the discrepancies between mentalizing activated in Lecce's study and used in real life context are relevant for two main reasons. First, ToM is a multicomponential ability involving several processes at a number of levels, from perceptual to conceptual (Castelli et al., 2000; Stone and Gerrans, 2006). Second, the use of a single type of task limits the generalization of the program's effects. Given that the most desirable outcome of a cognitive intervention is the possibility to transfer the benefit to material that is not practiced during the training, research should be focused on designing training programs able to produce generalization to several components of ToM. This issue represents the focus of the present study. Generally speaking, the transfer effect is related to the existence of brain plasticity. The maintenance of a certain grade of plasticity in aging (e.g., Greenwood, 2007) is demonstrated by the effectiveness of cognitive interventions aimed to preserve an adequate cognitive functioning, limiting the normal decline of several functions, such as memory (e.g., Cavallini et al., 2010; Bottiroli et al., 2013) and reasoning (e.g., Anand et al., 2011). Given the possibilities to change cognitive performance in aging, many approaches to trainings have been attempted to promote transfer (e.g., Cavallini et al., 2003a,b; Jennings et al., 2005; Lustig and Flegal, 2008).

Existing studies on this issue have highlighted the importance of three features of the training (e.g., Zelinski, 2009; Cavallini et al., 2010; McDaniel and Bugg, 2012; Bottiroli et al., 2013): repetition, variability of tasks, and a learner-oriented approach. Zelinski (2009), in the field of cognitive interventions, proposed that extended practice training involving extensive repetition of tasks produces transfer in multiple domains in aging studies. It is a bottom up approach that leads to improvement of basic cognitive skills. Since extended practice approach tends to limit the use of domain-specific strategies, it has greater potential than programs based on strategy learning in producing transfer to untrained tasks. This is because extended practice approach stimulates the underlying cognitive skills of the target ability. This approach is found to be successful with respect to executive functions (Bherer et al., 2005; Tang and Posner, 2009). For instance, interventions based on practicing attention and inhibition have been found to be successful in increasing working memory skills (Borella et al., 2013). Regarding the second feature of the training (i.e., variability of tasks), McDaniel and Bugg (2012) have suggested that increasing the variation that is experienced during the course of training, at the level of stimuli and tasks, is crucial to improve transfer. Indeed, the diversity of tasks increases the chance that training exercises will produce desired gains. In the best case scenario, the tasks could contribute to performance improvement in an additive fashion, and thus yield large transfer effects. As far as the third feature is concerned (i.e., a learner oriented approach), Cavallini et al. (2010) and Bottiroli et al. (2013) have highlighted the importance of adopting a learner-oriented approach based on strategy adaptation in order to better encourage transfer effects. They recommend treating older adults as active partners in attempting to achieve generalization in untrained tasks (learner-oriented approach). The core method of this approach is to involve older adults not only in practice on different tasks, but also in analyzing the features of tasks and in discussing how strategies could be applied to new materials (strategy adaptation). This approach is predicated on the premise that spontaneous generalization rarely occurs. Indeed, older adults may not realize that abilities/strategies trained within one task context can be modified or adapted to slightly different material and contexts (Hertzog and Dunlosky, 2012). An active involvement of older adults in the training would permit them to overcome this limitation.

The ToM Training

The studies cited above (Cavallini et al., 2010; McDaniel and Bugg, 2012; Bottiroli et al., 2013) provide important insights into the principles of effective ToM training. Therefore, in designing our intervention, we treated participants as active partners in the transfer process, making them aware that the various ToM tasks have different characteristics, rely on different modalities (i.e., verbal visual, static, and dynamic), and are based on a specific combination of agent- and context-related information. Crucially, in our training, we provided participants with practice on a variety of ToM tasks and made them reflect that using ToM in an appropriate way requires the attribution of mental states to a character/person given a specific context. We designed a set of activities using an array of materials and modalities to stimulate advanced ToM reasoning. All these activities required the interpretation of others' mental states. More precisely, we used stories, oral stimuli, and static images. These activities were followed by guided group conversations in which the experimenter kept to a series of pre-developed questions as prompts and made sure that all people took part in the conversation, discussing their points of view. This is because there is strong agreement in the literature that mental states conversations predict later ToM skills (Appleton and Reddy, 1996; Peterson and Slaughter, 2003; Ensor and Hughes, 2008; Ornaghi et al., 2011; Lecce et al., 2014b). Notably, in these conversations we paid special attention to adopt a dynamic approach in order to make people reflect that mental states are transitory and can change over time. Thus, in our training program we presented people with a variety of complex social situations (e.g., misunderstanding, faux-pas) and asked them to solve the social problems of each social scenario. To this end, after having presented the social scenario, we asked our participants the following question: *What could you do or say in order to resolve*

the problem? We adopted this strategy because trying to find a solution is a useful methodology to actively involve participants in the training (Bottiroli et al., 2013). Older adults were also asked to imagine a personal situation similar to that reported in the story presented by the experimenter and describe how he/she would have resolved it. Requiring participants to think of individual experience makes the task more meaningful. It also represents a method to help participants to realize that the skills that they have been working on during the training can be transferred to everyday life.

Notably, in designing our training we followed the SAFE norms that are known to maximize the training effects (Durlak et al., 2011). According to this, a training program should be sequenced, active, focused, and explicit. In our intervention we connected and coordinated sets of activities respecting increasing levels of difficulty (i.e., Sequenced). We gave participants the opportunity to act on the material, since it is well documented that practice is a necessary condition for skill acquisition (Zelinski, 2009; McDaniel and Bugg, 2012; i.e., Active). We dedicated enough time and attention to every ToM task for learning to occur (i.e., Focus). Finally, we explicitly stated the learning aims in order to make older adults aware of what they were expected to learn in terms of mentalizing abilities and that skills learnt during the training can be used with other materials and in everyday life (i.e., Explicit).

The Current Study

The aim of the present study was to test the efficacy of a new ToM training designed to promote mental states understanding and to investigate the generalization to a far ToM transfer task. Participants were randomly assigned to one of two groups: the ToM training and the physical-conversation training. As previously stated, in the ToM training participants were involved in several tasks and conversations on mental states. In the physical-conversation training, older adults practiced and discussed materials about physical occurrences with a trainer. Participants were involved in inferential discussion without using mental state expressions. To evaluate transfer effects, we selected a non-verbal ToM task, the animation task (Abell et al., 2000; Castelli et al., 2000) that selectively evokes mental state attribution by its motion properties. The use of a task that differs in structure (involving humans vs. geometric shapes) and modality (verbal static vs. visual dynamic) from those used in the training is crucial as it allows researchers to test if the training simply fostered the set of skills necessary to solve the practiced task or produced a genuine change in ToM understanding. The animation task (Abell et al., 2000; Castelli et al., 2000) can be considered as a far transfer task as cues for mental state attributions are restricted to pure movements and interactions without any vocal or facial expression prompts. This task has been successfully used in clinical (Abell et al., 2000; Salter et al., 2008; White et al., 2011), neurological (Castelli et al., 2000, 2002; Bird et al., 2004), and developmental studies (Campbell et al., 2006; Moriguchi et al., 2007). Overall, these studies have shown that these animations successfully detect mentalizing difficulties in individuals with autism (Abell et al., 2000), schizophrenia (Russell et al., 2006), and activate brain regions implicated in mental state understanding (Castelli et al., 2000). The rationale for expecting an improvement in this far transfer task is that our dynamic approach will foster the accuracy of mental state attributions and the ability to understand the mental states involved in a social situation (Bianco et al., submitted).

Materials and Methods

Participants

Participants were a total of 63 healthy older adults, native Italian speakers (M_{age} = 71.44, SD = 5.24, age range: 63–81 years). They were recruited through the University of Third Age and aggregation centers located in the North of Italy. The inclusion criteria were: no psychiatric or neurological diseases and no cognitive impairment. No tangible incentives (e.g., money or gifts) were given to participate. Participants were randomly assigned to one of two groups: the ToM training (age range: 63–81 years) and the physical-conversation training (age range: 64–81 years). Preliminary separate one-way analyses of variance were performed on background variables to establish the equivalence of the two groups before the training. Groups did not differ significantly in age [$F(2,62) = 0.00$, MSE = 27.86, $p = 0.98$, $\eta^2 = 0.00$], years of education [$F(2,62) = 0.13$, MSE = 9.22, $p = 0.72$, $\eta^2 = 0.00$], or vocabulary [drawn from the Primary Mental Abilities test; Thurstone and Thurstone, 1963; $F(2,62) = 2.80$, MSE = 22.69, $p = 0.10$, $\eta^2 = 0.04$]. Descriptive statistics for age, percentage of males and females, years of education, and vocabulary are shown in **Table 1**. All participants completed and accepted an informed consent form prior to beginning of the study.

Measures

Primary Mental Abilities Test

At pre-test, verbal skills were assessed through the Vocabulary subtest of the PMA test (Thurstone and Thurstone, 1963). The Vocabulary test was used to gain an objective measure of the participants' actual level of education and an estimate of their crystallized intelligence. Since it evaluates knowledge of words meaning, subjects were asked to identify the correct synonym of 50 target words by selecting one of four alternatives. Time limit was 8 min. One point was given for each correct answer (range 0–50).

TABLE 1 | Participants characteristics of ToM training and physical-conversation training.

Participant characteristics	ToM training ($n = 37$)	Physical-conversation training ($n = 26$)
Age	71.43 (5.05)	71.46 (5.59)
% Female	86.5	85.5
Years of education	9.43 (2.96)	9.15 (3.15)
Vocabulary	42.81 (4.21)	40.78 (5.46)

Age ranged from 63 to 81 years. Maximum vocabulary score = 50. Scores in parenthesis refers to Standard Deviation.

Strange Stories Task

The strange stories task (White et al., 2009) was used to assess the efficacy of our training. We administered 10 ToM stories and four Physical stories of the strange stories task at both pre- and post-test. ToM stories assessed the ability to understand people's mental states in five scenarios involving misunderstanding, double bluff, persuasion, sarcasm, and white lie. The Physical stories assessed the ability to make inferences on physical (rather than mental) events and required the integration of information between sentences and inference from implicit information. The two types of stories were similar in length and complexity. After having read the stories, subjects were asked to answer the test question. Participants were allowed to consult the text until a response was given in order to avoid memory loads. Responses were rated using a three-point scale: 0 for incorrect answers, one for partially correct answers, and two for full and explicit answers (range 0–20 for ToM stories and 0–8 for Physical stories). Two raters independently coded 25% of the responses at pre- and post-test and inter rater agreement was established using Cohen's Kappa. This agreement was good for both the mental (at pre-test, $\kappa = 0.91$; at post-test, $\kappa = 0.79$) and the Physical stories (at pre-test, $\kappa = 0.71$; at post-test, $\kappa = 0.83$).

Animation Task

The animation task (Abell et al., 2000; Castelli et al., 2000) was used to measure transfer effects of our training. It evaluates individual's ability to attribute mental states to animated geometric shapes. We administered four ToM and four Goal-directed animations at both pre- and post-test. All the animations featured two characters, a big red triangle and a small blue triangle, moving about on a framed white background. Each sequence lasted between 34 and 45 s. In the ToM condition, interaction between the two triangles was scripted to imply complex mental states. In one animation, one triangle tried to persuade the other to let it go free; another sequence showed the little triangle surprising the big triangle; the third animation represented the small triangle mocking the big one, and the last one showed the big triangle coaxing the little one out of an enclosure. In the control "Goal-directed" condition, the characters interacted on a simple, behavioral basis. The interactions represented in this condition were reciprocal but did not involve mental states. One sequence showed the smaller triangle following the bigger one, and the remaining three represented the triangles fighting, chasing one another, and dancing together. Animations were presented in a pseudo-random order, counterbalanced within each group. Before starting the task, the experimenter informed the participants that they would be shown eight animations on a computer, with two triangles interacting between themselves. At the end of each animation, participants were asked to describe what happened in the animation. No feedback was given. Answers were coded for the level of intentionality. This score reflects the degree of attribution of mental states to the shapes, ranging from 0 (non-deliberate action), to 5 (deliberate action aimed at affecting another's mental state; possible score range 0–40). Two raters independently coded 25% of the responses at pre- and post-test and inter rater agreement was established using Cohen's Kappa. The inter rater agreement was good (at pre-test, $\kappa = 0.87$; at post-test, $\kappa = 0.80$).

Each response was also assigned to one of three types of descriptions: action, interaction, mentalizing. Any response comprising a simple action statement (no mention of interaction between the triangles, or mental states) was rated as action (e.g., "the triangles are bouncing"). Any response that explicitly mentioned interaction between the triangles (no mention of mental states) was classified as interaction (e.g., "the little triangle touches the big one"). Descriptions that included mental state terms were classified as mentalizing (e.g., "the triangles are happy").

Design and Training Procedure

Participants were pre-tested on ToM tasks and on verbal ability. Information about level of education was also gathered during the pre-test. After the pre-test, subjects took part in a training program that consisted of four lessons. At the end of the training program, they were post-tested on ToM tasks to evaluate the effects of the training.

The training program in both conditions was conducted by female trainers. The activities in both groups increased in the level of complexity lesson after lesson and made use of a range of modalities and materials (visual stimuli, audio stimuli, and written stimuli). The activities of the control condition strictly matched those of the experimental condition, but focused on physical rather than mental states inferences. Below, more details for each condition are provided.

A full description of the training materials in each condition is provided in **Table 2**.

ToM Training

The ToM training program of the present study was based on that of Lecce et al. (2015) and, thus, made extensive use of the mental states narratives that were presented in each of the four lessons. In addition to this material, the present training program proposed a set of activities of increasing difficulty, that required the understanding that people can have different perspectives of the same reality. In the first lesson, people were explicitly told the main aim of the training program and were familiarized with the cognitive activities and processes involved in the intervention. The second lesson focused on visual perspective-taking, the third lesson focused on conceptual perspective-taking, and the fourth lesson on real-life perspective taking. The visual-perspective-taking tasks made participants reflect on the fact that the same stimulus (e.g., a number) may be perceived differently by asking them to view it from the other's perspective. The conceptual perspective- taking activities were designed to help participants to recognize that two people might have different desires, beliefs, or access to knowledge. These activities were presented using three modalities: visual, written, and audio. Finally, the real-life perspective-taking activities were designed to be more complex tasks as they require people to consider more sources of information at the same time (Achim et al., 2013). These information regarded both the agents and context and could be found in the immediate scenario and in memory. These real-life perspective-taking activities, thus, assessed the ramifications

TABLE 2 | Description of training lessons by group.

Lesson	Component	Material	ToM training	Physical-conversation training
1	Introduction to the main content of the training	Exemplifying stimuli	The trainer presented the aims of the ToM training and were introduced to the nature of inferences on mental states and on its relevance in real life. Subjects practiced with examples of scenarios requiring mental-state inferences and reasoning. Material adapted from Lecce et al. (2014b, 2015).	The trainer presented the aims of the physical-conversation training and were introduced to the nature of inferences on physical states and on its relevance in real life. Subjects practiced with examples of scenarios requiring physical inferences and reasoning. Material adapted from Lecce et al. (2014b, 2015).
2	Visual perspective-taking	Visual stimuli	The trainer presented eight visual stimuli depicting a room where an avatar stood behind a table. Unambiguous (e.g., 8) or ambiguous (e.g., 6) numbers were shown either on the wall or on the table. When the ambiguous numbers were shown on the table the subjects and the avatar perceived the stimulus differently. Participants were required to make a judgment about how the numeral appeared to themselves and how the number appeared to the avatar in the scene. Material adapted from Surtees et al. (2012).	The trainer presented eight visual stimuli depicting a 4×4 grid. Subjects were told the grid was a bookcase. Some slots contained objects and participants were instructed to imagine they had to push certain objects, in order to drop them on the floor. Some slots in the grid were occluded behind so that the object could not be dropped. Critical instructions required the participants to ignore objects in the occluded slots and to push other objects, in order to accomplish the request. Material adapted from Dumontheil et al. (2010).
3	Conceptual perspective-taking	Visual stimuli	The trainer showed a full picture and subsequently a small portion of the same picture. Participants were asked to imagine what two individuals, exposed only to the small portion of the picture, would think the image was. Seven pictures were shown. Material adapted from Lalonde and Chandler (2002).	The trainer showed a complete picture and subsequently a small portion of the same picture. Participants were asked to recollect which part of the big image the small portion depicted. Seven pictures were shown. Material adapted from Lalonde and Chandler (2002).
	Conceptual perspective-taking	Audio stimuli	The trainer presented participants with three very short oral stories, where a misunderstanding between characters occurred. These oral texts were read by the trainer and were based on Italian idiomatic expressions containing ambiguous words with double meaning. The contextual information of these stories was kept to the minimum. Participants answered a series of questions about: - character's beliefs and points of view; - what the main character could do or say in order to resolve the problem.	The trainer presented participants with three very short oral stories about physical phenomena. Participants answered a series of questions about: - specific facts of the story or details; - the physical event not explicitly mentioned in the text (inference). Material adapted from Lecce et al. (2014b, 2015).
	Conceptual perspective-taking	Written stimuli	The trainer presented seven mental state stories similar to those of the revised strange stories task (White et al., 2009). The stories referred to complex social situations. Participants answered a series of questions about: - the main character's mental state; - one character's belief about the other characters' mental state; - mental state underlying social behavior; - what the main character could do/say in order to resolve the problem. Older adults were asked to imagine a personal situation similar to that reported in the story and describe how he/she would have resolved it.	The trainer presented seven stories about physical phenomena similar to those of the revised strange stories task (White et al., 2009). Participants answered a series of questions about: - specific facts of the story or details presented in the text; - the physical event not explicitly mentioned in the text (inference).
4	Real-life perspective-taking	Audio stimuli	The trainer presented, through audio stimuli, three pieces of real-life conversations, each involving two human characters. Conversations were rich in mental states terms and referred to ambiguous and complex social situations (e.g., misunderstanding, sarcasm). After having listened to each conversation, participants answered a series of questions about: - character's beliefs and points of view; - mental states involved; - what the main character could do or say in order to resolve the problem. Older adults were asked to imagine a personal situation similar to that reported in the conversation and describe how he/she would have resolved it.	The trainer presented, through audio stimuli, one oral description about non-mental phenomena. After having listened to the stimulus, participants answered a series of questions about what they had just heard.
	Real-life perspective-taking	Written stimuli	The trainer presented a short portion of a novel (Coelho, 1998, p. 88) to participants. Participants answered a series of questions about: - character's mental states and points of view; - mental-states lexicon involved. Older adults were asked to imagine a personal situation similar to that reported in the portion of the novel and describe how he/she would have resolved it.	The trainer presented two written riddles to participants. Riddles were ecological so that they were similar to the ones in newspapers. In order to correctly answer, details of the text needed to be linked and an inference beyond explicit information was required.

of such perspective taking in complex, contextualized social scenarios. Participants were presented with real-life scenarios and asked to infer the beliefs and desires of human characters to explain their behaviors. These activities were presented using the oral and written formats.

After each single item of each group of tasks, participants were asked to individually answer a series of questions in order to elicit a complete and explicit understanding of the mental states and behavior of characters. In order to promote the *dynamic nature* of mental states, participants were asked how they could resolve social ToM situations. Older adults were also asked to imagine a personal situation similar to that reported in the task and describe how they would have resolved it. In each lesson, individual practice was followed by group discussions led by the trainer. Crucially, the trainer used mental state expressions, and made frequent use of positive and corrective feedback.

Physical-Conversation Training

The physical-conversation training was designed to be closely matched to those of the experimental condition. It had the same structure and the same length of the ToM training. The main difference was that the stimuli and the content of the stories that were discussed in the training were about physical, not mental occurrences. Participants practiced on a range of materials but without a focus on mental states. During the training, participants were asked to make inferences on physical, rather than mental, features of the stimuli. In each lesson, individual practice was followed by group discussions led by the trainer. The trainer encouraged participants to take part in the group conversations, provided feedback but, crucially, made no use of mental state expressions.

Results

Preliminary Analysis

Before examining the training effects, we compared individuals' performance at the pre-test on the various tasks by running a series of *t*-tests on the percentage of correct responses. The comparison between the two ToM tasks showed that performance on the ToM stories ($M = 61.17$, SD = 14.22) was significantly higher than that on the ToM animations [$M = 54.17$, SD = 15.46; $t(59) = 2.83$, $p = 0.01$], revealing the different level of complexity of these two tasks. For the animation task, results showed a higher level of intentionality scores in the ToM ($M = 53.93$, SD = 15.22) than in the goal-directed animations [$M = 43.01$, SD = 12.36; $t(62) = 5.95$, $p < 0.001$].

In addition, to establish the equivalence of the two training groups at the pre-test, preliminary separate one-way analyses of variance were performed on ToM tasks. Results showed that groups did not differ in their pre-test scores on ToM stories [$F(2,58) = 1.26$, $p = 0.27$, $\eta^2 = 0.02$], physical stories [$F(2,60) = 0.00$, $p = 0.95$, $\eta^2 = 0.00$], ToM animations [$F(2,61) = 2.51$, $p = 0.18$, $\eta^2 = 0.04$], and goal-directed animations [$F(2,61) = 0.14$, $p = 0.71$, $\eta^2 = 0.00$; **Table 3**]. Similar results were obtained when we considered the frequency of participants' answers on each type of description of the ToM animations: action, interaction, and mentalizing. Indeed, at the pre-test, groups did not differ either in the interaction [$F(2,61) = 0.14$, $p = 0.71$, $\eta^2 = 0.00$] or in mentalizing [$F(2,61) = 1.76$, $p = 0.19$, $\eta^2 = 0.03$]. The only significant difference was found on pre-test scores in the action description [$F(2,61) = 5.04$, $p = 0.03$, $\eta^2 = 0.08$], where the physical-conversation training group reported a higher score than the ToM training group.

TABLE 3 | Means value and standard deviations for ToM task performance as a function of Group condition (ToM and physical-conversation groups) and Time (pre- and post-test).

	ToM training		Physical-conversation training	
	Pre	Post	Pre	Post
Strange stories	59.42 (14.89)	79.62 (12.70)	63.60 (13.11)	75.56 (17.03)
Physical stories	65.62 (16.48)	68.05 (19.24)	65.86 (13.94)	67.79 (20.36)
ToM animation				
Intentionality	56.49 (12.68)	64.00 (12.17)	50.38 (17.88)	54.00 (14.36)
Action descriptions	0.24 (0.49)	0.17 (0.57)	0.73 (1.18)	0.36 (0.86)
Interaction descriptions	2.67 (0.91)	2.28 (1.07)	2.46 (1.03)	2.68 (0.90)
Mentalizing descriptions	1.08 (1.01)	1.54 (1.07)	0.77 (0.76)	0.96 (0.67)
Goal-directed animation				
Intentionality	43.51 (10.46)	45.75 (10.38)	42.31 (14.85)	44.20 (12.72)

Scores in parenthesis refers to Standard Deviation.

ToM Training Effects

In order to analyze the effect of the training, a mixed-design ANOVA was conducted on each task, with time (pre- and post-test) as the within-subjects factor and training group (ToM and physical-conversation) as the between-subjects factor. Since on pre-test score of ToM animations the two groups tended to differ, although not significantly, we adopted a rigorous approach and ran ANCOVA on gain scores controlling for performance at pre-test. Gain scores were computed by subtracting pre-test scores from the corresponding score on the post-test score. Finally, we were also interested in examining on which type of description (action, interaction, and mentalizing) the ToM- vs. physical-conversation training had an effect. In order to answer this question we ran a mixed-design 2 (time) × 2 (training group) × 3 (type of description) ANOVA.

ToM Practiced Task

For ToM stories, results showed a significant main effect of time, $F(1,57) = 55.21$, MSE = 126.78, $p < 0.001$, $\eta^2 = 0.49$ and a significant time by group interaction, $F(1,57) = 5.79$, MSE = 126.78, $p = 0.02$, $\eta^2 = 0.09$. An inspection of the scores at pre- and post-test showed that the ToM group improved more than the physical-conversation group.

For Physical stories, neither the main effect of time, $F(1,59) = 0.52$, MSE = 236.17, $p = 0.47$, $\eta^2 = 0.01$, nor the

time by group interaction, $F(1,59) = 0.00$, MSE = 236.17, $p = 0.97$, $\eta^2 = 0.00$, were significant.

ToM Transfer Task

For ToM animations, results revealed a significant main effect of time, $F(1,58) = 6.25$, MSE = 118.09, $p = 0.01$, $\eta^2 = 0.10$. The time by group interaction was not significant, $F(1,58) = 0.83$, MSE = 118.09, $p = 0.37$, $\eta^2 = 0.01$. Since on pre-test score of ToM animations the two groups tended to differ, although not significantly, we ran an ANCOVA with gains as the dependent variable and pre-test performance as covariate. Although the effect of the covariate variable was significant $F(1,57) = 37.65$, MSE = 5.79, $p < 0.001$, $\eta^2 = 0.40$, results revealed that the ToM training group improved more than the physical-conversation training group, $F(1,57) = 5.74$, MSE = 5.79, $p = 0.02$, $\eta^2 = 0.09$.

Results from the mixed-design 2 (time) × 2 (training group) × 3 (type of description) ANOVA showed that the time by group by type of description interaction approached significance, $F(2,116) = 2.80$, MSE = 0.84, $p = 0.06$, $\eta^2 = 0.05$. In order to better describe this interaction, we conducted three separate ANOVAs for the action, interaction, and mentalizing gain scores, respectively. Since groups differed on the action and (marginally) on mentalizing at pre-test, we covaried controlling for these variables.

For gains in action descriptions, there were no significant differences between groups, $F(1,58) = 0.05$, MSE = 0.45, $p = 0.82$, $\eta^2 = 0.001$; note that the pre-test action score was a significant covariate, $F(1,58) = 50.13$, MSE = 22.41, $p < 0.001$, $\eta^2 = 0.47$. For gains in interaction descriptions, our analysis revealed that the ToM training group decreased the frequency of use of interaction descriptions in response to ToM animations, whereas the physical-conversation group increased it, $F(1,58) = 4.88$, MSE = 1.22, $p = 0.03$, $\eta^2 = 0.08$. For mentalizing descriptions, although pre-test score was significant as covariate, $F(1,58) = 2.34$, MSE = 0.79, $p < 0.001$, $\eta^2 = 0.34$, the ToM training group showed higher gains in the frequency of use of mentalizing descriptions in response to ToM animations than the physical-conversation group, $F(1,58) = 4.41$, MSE = 0.79, $p = 0.04$, $\eta^2 = 0.07$. These data are crucial as they have revealed that the ToM training program influences the frequency of use of mentalizing descriptions to describe the animations.

For Goal-directed animations, the effect of time, $F(1,58) = 1.24$, MSE = 87.79, $p = 0.27$, $\eta^2 = 0.02$, and of the time by group interaction were not significant, $F(1,58) = 0.09$, MSE = 87.79, $p = 0.76$, $\eta^2 = 0.00$.

Discussion

This study evaluated the effects of a ToM training program based on conversations about mental states and on a dynamic approach in healthy older adults. Results of the present study are promising as they indicate that our ToM training is effective in promoting ToM performances and transfer. Indeed, the ToM training advantage was evident in both the practiced and the transfer ToM tasks. The results from the strange stories (practiced ToM task) confirmed findings of our previous study (Lecce et al., 2015). The positive results in the animation task (transfer ToM tasks) are particularly relevant given that this ToM task strongly differs from those used during the training. This task makes use of non-verbal stimuli with geometric shapes as protagonists, instead of human beings. Here, it should also be noted that the animation task does not present any relevant contextual information that can help individuals in making inferences, as participants are deprived of any external and social cues. These characteristics make the animation task a challenging measure of ToM and ensure that our transfer effect produces a promising result. Interestingly, we coded participants answers to consider the type of description they used to illustrate the content of ToM animations. This, we believe, was crucial for at least two reasons. Firstly, it allowed us to see whether the animations evoked differential responses from people in the two training conditions. Secondly, it allowed us to examine in detail the nature of the change produced by our training program. Notably, our results revealed that at the post-test participants in the ToM training decreased the use of interaction descriptions and improved that of mentalizing description. These results revealed that our training program helps participants to make a transition from interaction to mentalizing description. Thus, our training was effective in promoting older adults' ability to attribute mental states to non-verbal and online stimuli in ToM situations. Here, it should also be noted that participants in the control group increased their interaction descriptions after the training. This result was expected and can be explained if we consider that the activities of the control group were focused on physical inferences and were directed to make people reflect on the physical features of a given situation.

An interesting issue, here, regards the mechanisms that underlie the positive effects of our training. Transfer can arise from a variety of reasons and the design of our study did not allow us to fully examine this issue and to answer the question of what did participants learn from our ToM training and how they transfer this acquisition to a new task. However, some speculative explanations can be proposed. We believe that our training program helped older adults to become more sensitive to and aware of mental states that guide social behaviors. In addition, our training is likely to have strengthened older people's ability in making appropriate context-sensitive inferences to detect relevant information in social situations, and to construct appropriate models of complex social interactions. This last seems to be a mechanism that is particularly crucial in driving ToM advanced development beyond early childhood (Bianco et al., submitted).

We also argue that the benefits of this intervention, in terms of transfer effect, derive, at least in part, from the dynamic approach we used. Indeed, during our training participants were asked not only to analyze and reflect on the different mental features of complex social situations (such as misunderstandings and double bluffs), but also on how they could resolve these situations. Making older adults reflect on the fact that mental states are not static but can change over time is, we think, a prerequisite for obtaining a change in ToM. In addition to the dynamic nature of the activities and to the learner oriented approach, the ToM training was unique in that it made extensive use of conversations on mental states, that is likely to have played a role in improving the efficacy of the training. Theoretical (Nelson, 2005) and empirical findings support the view that conversations on mental

states help individuals to improve their awareness that others have different points of view on the same situation and make them able to use their training experience to reflect on the mind of self and others (Lecce et al., 2015). This is important for older adults who show a reduction in social network size (Antonucci, 2001), with a consequent decrease in experience of daily social interactions (Wang and Su, 2013). Crucially, the ToM training group reported a better ToM performance than the matched active control group that made use of conversations on physical, rather than mental, states. This indicates that what matters in terms of ToM development are not the general features of social conversations, but their mental nature. The same conclusion can be drawn for preschoolers (Lecce et al., 2014a) and school aged children (Lecce et al., 2014b). This result is, we believe, interesting as it suggests that the mechanisms involved in the development/improvement of the ToM abilities can be similar throughout the life span.

Our results are certainly important from both a theoretical and a practical point of view. Theoretically, they provide evidence that not only cognitive abilities (such as memory) can be improved in aging, but also that socio-cognitive skills are sensitive to interventions, confirming the plasticity of older people (Greenwood, 2007). In relation to this issue, Rosi et al. (2015) have recently conducted a study comparing old (range: 60–69 years) to old–old (range: 70–85 years) people's performance on ToM tasks after a ToM training. Interestingly, they found that not only the old, but also the old–old participants increased ToM performance after the training, suggesting a similar level of plasticity in the two age groups. In addition, we believe that our data are theoretically interesting as they fit with the idea that ToM skills cannot be totally explained by general cognitive skills, such as executive function. Indeed, our training poses few emphasis on inhibition, shifting, and working memory. So, the positive effects that we found speak to the idea that executive function, although important, are only one of the possible mechanisms underlying ToM.

From a more practical point of view, our results can be interesting for the treatment of those clinical age-related conditions associated with a ToM deficit, such as Parkinson or Alzheimer diseases (for a review, see Kemp et al., 2012). Hence, they open a new door for ToM intervention research and encourage new training efforts to hone ToM approaches for training. The next step, we believe, will be to verify whether our ToM training, or adapted versions of it, is also effective in improving ToM performance of older adults affected by neurodegenerative diseases.

Some limitations of the current study should also be mentioned. The first concerns the participants of our study. In the training we involved older adults belonging to the University of Third Age and aggregation centers. This may have maximized benefits of our training as these participants were motivated in taking part in the lessons and had several opportunities to use ToM skills. Future studies should therefore be conducted with other older adults selected from the general population who are less involved in social relationships. The second limitation regards the design of our study. We focused mainly on the change in performance from pre-test to post-test, and we did not consider what variables could be responsible for the ToM improvement. In the future, cognitive (such as executive functions and problem solving) and social variables (such as quantity and quality of close social relationships) should be measured and considered as possible predictors of the success of a training.

Future research should also examine the social consequences of improvements in ToM. This is a very interesting issue as for older adults social relationships are crucial and old age is characterized by a change in social relationships (Carstensen et al., 2003). We also hope that our work will stimulate research into the specific processes that underpin older adults' progress in reasoning about mental states.

In conclusion, the current findings extend the existing literature on ToM interventions for older adults by showing that our ToM training program was effective in stimulating gains in ToM tasks that were not practiced during the training and that differed in several ways from those used in the training. Our results illustrate the importance of mental states conversation and the relevance of a dynamic approach to training and of the variability of the tasks used.

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Approaches to assessment in time-limited Mentalization-Based Therapy for Children (MBT-C)

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In this article we describe our clinical approach to assessment, formulation and the identification of a therapeutic focus in the context of time-limited Mentalization-Based Treatment for Children (MBT-C) aged between 6 and 12. Rather than seeing the capacity to mentalize as a global construct, we set out an approach to assessing the developmental 'building blocks' of the capacity to mentalize the self and others, including the capacity for attention regulation, emotion regulation, and explicit mentalization. Assessing the child's strengths and vulnerabilities in each of these domains provides a more nuanced picture of the child's mentalizing capacities and difficulties, and can provide a useful approach to case formulation. The article sets out an approach to assessment that includes a consideration of mentalizing strengths and difficulties in both the child and the parents, and shows how this can be used to help develop a mutually agreed treatment focus. A clinical vignette illustrates the approach taken to assessment and connects it to routine clinical practice.

Keywords: Mentalization, MBT, time-limited therapy, middle childhood, assessment, case formulation, therapeutic focus

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Introduction

John, 8 years old, has lived with his foster family for 1 year. His carers have contacted our Service because he is aggressive at home and at school. John is socially isolated because he has great difficulty in connecting with other children. The social worker explains that he was placed in foster care at the age of two, and has lived with three different foster families since then. His mother was a teenager when he was born, without a husband and with severe psychiatric problems at that time, which made it difficult for her to be emotionally available for John. During the first individual assessment session, the therapist and John were sitting together, choosing from a table full of various different shells, to explore how he felt within the foster family and also how he felt toward his biological mother, whom he visited regularly. John was strikingly able to place the seashells according to how he saw the relationships in his family. He put the two families, which are both important to him, on their own chairs. He put a shell representing himself balanced between the arm-rests of the two chairs, and told the therapist that he sometimes didn't know what family he really belonged to. The therapist commented that she could imagine it would be difficult to know where you belong if you have lived in four different families, when you are only 8 years old. John chose the largest shell for his foster father Carey, "because Carey is a very big man." The therapist linked this to John's earlier statement that Carey seemed to be very important to John. John agreed enthusiastically.

In this interaction, John is 'mentalizing' about himself: He is able to explain how he feels attached to both families but is often unsure where he belongs, using shells to help find a way to express how he thinks about himself in relation to important others. The therapist is being curious about what John is communicating in the way he positions the shells. She really wants to get to know John and is trying to be open-minded about what is inside him and what is happening between them.

John was one of the first children in the time-limited Mentalization-Based Treatment for Children (MBT-C) program, which was set up at the De Jutters Child and Adolescent Mental Health Service (CAMHS), in the Netherlands, from the beginning of 2012. Developing a time limited program started under the pressure of insurance companies no longer wanting to pay for long-lasting therapies. But it was also a response to a growing awareness that, with high levels of mental health needs among children and limited resources available worldwide, there is a pressing need for relatively short-term interventions that are outcome-oriented, and based on a sound understanding of child development and a plausible theory of therapeutic change. However, there are real challenges to developing time-limited ways of working with extremely vulnerable children, such as John. In order to be effective, time-limited work requires a clear approach to assessment, not only to identify those children who are most likely to benefit from this approach, but also as a way of developing a clear formulation that can lead to an agreed focus for the intervention.

In this article we want to describe our clinical approach to assessment, formulation and the identification of a therapeutic focus in the context of time-limited MBT-C. We start by giving a brief introduction to MBT-C, before going on to describe the approach to assessment that has been developed at the De Jutters CAMHS, with a specific focus on the way in which the assessment of the capacity to mentalize, and the way this is linked to the child's presenting difficulties, can help to create an agreed focus for a piece of time-limited therapy. A number of clinical vignettes will be used to illustrate the approach that has been developed.

Background

What is Mentalization-Based Treatment for Children (MBT-C)?

Mentalization-Based Treatment for Children is an adaptation of a therapeutic approach that was developed in the context of adult psychotherapy, in particular for the treatment of adults with Borderline Personality Disorder (BPD, Bateman and Fonagy, 2009). MBT emerged out of a recognition that the key elements of BPD – such as emotional lability, and the instability in personal interaction – could be understood as a consequence of deficits in the capacity to mentalize, i.e., the capacity to be able to understand the behavior of others and one's self in terms of intentional mental states. Where this capacity is limited or inhibited, interactions with others – as well as one's own behavior – can often be experienced as confusing and overwhelming, leading to breakdowns in affect regulation and the sense of a coherent self (Fonagy et al., 2002).

Empirical research in the field of developmental psychology and neuroscience has established that the capacity to mentalize is innate to human beings, with its own 'developmental line' across the lifespan, linked to specific elements of brain maturation; but that the full development of this capacity is associated with the quality of early attachments and parenting, and that the capacity for mentalizing can be significantly impaired by early maltreatment, abuse and relational trauma (Gergely and Unoka, 2008; Allen et al., 2014; Ensink et al., 2014). It followed from this that a therapeutic approach which focuses on enhancing the capacity to mentalize – at least for adults with BPD – could have significant therapeutic benefits. This hypothesis has now been supported by evidence from clinical trials, and MBT is increasingly recognized as an important new development within the field of adult psychotherapy. In recent years, MBT has been used as an approach to a broader range of psychopathologies, including depression, eating disorders and psychosis (Brent et al., 2014; Luyten et al., 2012; Skarderud and Fonagy, 2012). In recent work, Fonagy and Allison (2014) have suggested that MBT not only addresses the deficits in mentalization that may underlie (or maintain) a range of psychopathologies, but that it also helps to build 'epistemic trust,' i.e., trust in the authenticity and personal relevance of interpersonally transmitted knowledge – a crucial capacity which they suggest may be at the heart of all successful forms of psychotherapy.

Although MBT was first developed in the context of adult therapy, from the beginning it was also inspired by the work of child psychotherapists, in particular the tradition of 'developmental therapy' that had been established by Anna Freud and her colleagues at the Hampstead Clinic (now the Anna Freud Centre) in London (see Fonagy and Target, 1996; Hurry, 1998). Verheugt-Pleiter et al. (2008) were the first to articulate a model of mentalizing in child therapy, identifying ways in which MBT could be integrated into traditional models of long-term psychoanalytic therapy with children. In recent years there has been a steady growth in the development of mentalization-based interventions for children (see Midgley and Vrouva, 2012), including MBT for families (Keaveny et al., 2012), MBT for Adolescents (Rossouw and Fonagy, 2012), as well as a range of interventions focused on the early parent–infant relationship (e.g., Minding the Baby, Slade, 2006. Although not developed as a distinct model, a number of clinicians have described their own approaches to using aspects of MBT with children (e.g., Ramires et al., 2012; Zevalkink et al., 2012; Lindqvist, 2013; Perepletchikova and Goodman, 2014). The development of a time-limited model of MBT-C at De Jutters in the Netherlands should be understood in the context of this broader set of developments, and emerged out of discussions with a wide range of colleagues (see Lindqvist, 2013), including several from the Anna Freud Centre in London, interested in developments in this field.

The aim of long-term mentalization-informed child psychoanalytic psychotherapy, as described by Verheugt-Pleiter et al. (2008) and Zevalkink et al., (2012), is to enhance mentalization and to strengthen the sense of being able to self-regulate. Separate goals are to enhance a coherent sense of self, to enlarge the possibilities to regulate emotions and to

strengthen the sense of self agency. The question is if these goals are also applicable to time-limited work with children. Our initial hypothesis is that working in a limited time-frame means you can help to develop the process in which these goals are set in motion; but for children with more severe levels of disturbance, we would not expect to reach all of these goals by the end of a time-limited intervention. We do not deal with all the problems but we try to promote mentalizing and coping in such a way that a developmental process is back on track, and the family and child feel in a position where they are better equipped to tackle the problems that first brought them to therapy. As Winnicott (1962) put it, the question that one is asking may not be 'how much can one do?' but rather 'what is the least that needs to be done?' In the case of MBT-C, the aim is to foster sufficient enhanced capacity to be thoughtful about the intentions of the other, and the impact of others on our own mental states, even in the face of stress.

For children seen in the service, the child comes to his MBT-C therapy once a week for 12 weeks, and at the same time the parents are offered MBT-parents therapy. In some cases we work with family therapists as well, who can also visit the family once a week at home as part of our outreach service. After eight sessions we review with the child and his or her parents and decide if we will offer another 12 treatment sessions or if we will stop after 12 sessions. We can prolong up to three series of 12 sessions. The decision to stop or go on with the therapy depends on how quickly the problems diminish and goals are met, and whether the child and family feel that continuing with therapy would help to achieve this. Negotiating this decision is itself part of the work to promote mentalizing, as we aim to explore the situation from multiple perspectives, before making a final decision.

Which Children might Benefit from Time Limited MBT-C?

The service at De Jutters is for children, age 6–12 years old. Children are usually referred by family doctors, special services for foster and adoption children and therapist colleagues working with adults in psychiatric services, and present with a wide range of difficulties, including internalizing disorders like anxiety problems, post-traumatic stress, and mood disorders but also externalizing difficulties like ADHD, or a combination of both which you often see with reactive attachment disorder. At this stage we are still establishing which children can benefit most from a time-limited MBT intervention. Based on our clinical experience, a time-limited MBT-C approach can be used very effectively with children with mild anxiety problems or mood disorders; however, there are a number of relatively short-term, evidence-based interventions, based on Cognitive Behavioural Therapy (CBT), which have already demonstrated their capacity to support these children (see Fonagy et al., 2014, for a full review), so our focus in developing the MBT-C approach has been elsewhere. Because MBT has a relational focus and is rooted in attachment theory, we think MBT-C is likely to be especially appropriate when attachment relations are at risk; when the duration of the problems is longer and the problems are more complex because of trauma or severe family pathology; or when there is a mix of internalizing and externalizing problems (which may be an indication of emerging personality disorder in adolescence).

It can be challenging to relate these criteria to DSM-5 (American Psychiatric Association [APA], 2013) classifications only. The children who are offered MBT-C in our service are often adopted or in foster care, with histories of chronic trauma, and may have a diagnosis of reactive attachment disorder. Another group of children is from multi-problem families with a parent with a psychiatric disorder. For some children there is a combination of internalizing problems (like anxiety and/or depressive disorder) and externalizing problems, like ADHD and/or behavioral problems, complicated by grief or loss of an attachment figure.

In thinking about which children can benefit most from time-limited MBT-C, we have found it helpful to draw on the distinction made by Fonagy et al. (1993), between children with 'mental process' and 'mental representation' disorders. In the latter, historically thought of as 'neurotic' disorders, the child's difficulties may be the result of conflicts between different sets of mental representations (e.g., a wish to damage and a fear that to do so would risk the child being rejected by the care-giver). In the former, there may be a more significant deficit in the development of mental functioning itself – possibly for genetic reasons, but in many cases as a result of early trauma and/or abuse. Fonagy (2002) described his way of thinking about children with a severe mental process disorder, who often are severely traumatized, adopted, or foster care children and/or children of parents with psychiatric histories. They seem to have problems such as: an imperfect mental representation of self and others, low frustration tolerance, low self-esteem, no coherent inner world, impaired self-object representation, impaired affect regulation, inflexible defense systems, problems with social capacities, difficulty in noticing the intentions of others, impaired sense of reality, weak attention regulation, or memory function, limited language understanding, especially when this is linked to an emotional context. As empirical studies are beginning to demonstrate (e.g., Schimmenti et al., 2014; Schimmenti and Bifulco, 2015), these children are far more likely to have an insecure or disorganized attachment style. They are the children who are usually referred to our service, and the challenge we set ourselves was to see whether it was possible to develop effective time-limited interventions for this group of children, to whom we might have traditionally offered more open-ended or long-term therapy. In changing our usual practice, we quickly came to appreciate that a careful process of assessment, and a clear development of a therapeutic focus, would be essential if this work was to have any chance of success.

Discussion

The Process of Assessment for Time-Limited MBT-C

At De Jutters service, we generally start the assessment phase with a family session, followed by three individual sessions with the child, whilst a separate therapist meets with the parents

or carers. The assessment ends with a joint family session, in which the formulation is shared with the child and family, and recommendations are made regarding treatment. The overall aim of the assessment is to develop some kind of 'mentalizing profile' of the child, parents, and family, and to explore what links this might have with the difficulties that brought the child to treatment. If the child is offered time-limited MBT-C, we also use the assessment process to help reach an agreed focus for the work. At the same time, we hope that the assessment process is therapeutic in itself, and also allows us to assess the child and family's capacity to make use of this particular way of working.

Meeting the Child and Family for the First Time

The first family meeting – which both therapists usually attend – is somewhat structured, and draws on ideas developed in the context of family-based MBT (Keaveny et al., 2012). The aim of the initial family meeting is to try and build an initial alliance with the family, and introduce them to some of the key components of a mentalizing approach – but also to help us understand something about the quality of attachment relationships in the family, and to identify strengths and weaknesses in the family's capacity to mentalize together, including any specific areas (e.g., when issues of aggression or sexuality are raised) where the family's capacity to mentalize appears to be vulnerable.

There are three elements to this initial family meeting: first, each member of the family is invited to introduce one of the others, and is asked to say a little bit about them as a person (e.g., what they like, or the kind of person they are). After this verbal introduction of each other we ask the family members to select an animal for each other, and invite some discussion about these choices, looking for more implicit information about how different members of the family see each other or see themselves. There can often be a playful quality to these introductions, as family members surprise themselves (and each other) with the way they are introduced, or the images that others have of them. We then ask all the members why they think they are here, and listen to their own problem formulation, which is important information to keep in mind when looking for a focus of the therapy. After this we finish the session by doing a family game, which gives the therapist the opportunity to see how the family members interact with each other. Often we choose a structured task, when some structure is needed; because we want it to be a good experience for everyone and not to let things get out of hand. However, when the family has already shown some capacity to take turns, listen and work together collaboratively, we like to choose a freer task like drawing or creating something out of clay together. This might involve us inviting them to make their dream family house, or a family zoo. One reason for doing some type of family activity is to see how the family relate to each other in a play-based situation – the process of doing this is as important (if not more so), than what is actually created.

During our first family session John was there with both his foster parents. When he had to choose an animal for each person, John chose a chimpanzee for himself. John's foster mother guessed this was because he could sometimes be quite cheeky. When the therapist checked this with John, he nodded, but added that chimpanzees also have sharp teeth. The therapist wondered aloud why that mattered to John, and John's foster father said that chimpanzees sometimes had to protect themselves when things didn't feel safe. John smiled, and then chose a gorilla for his foster father and he pointed out that they are both monkeys, but from different families. "They belong to the family of the apes, they belong to each other but they also have their own family," John said with a lot of feeling. Foster father responded to him in a warm and genuine way, putting his arm on his shoulder in a gentle way, and adding, "Just like us."

Assessment Meetings with the Parents

The three sessions with the parents usually take place while the child is being seen by a separate therapist, and in these three sessions the therapist tries to use the core features of the 'mentalizing stance,' including empathy, curiosity, and an interest in different perspectives, to try to get an appraisal about the problems and also about the mentalizing capacities and difficulties of the parents themselves (see also Muller and ten Kate, 2008; Muller and Bakker, 2009). By that, we mean the parent's capacity to think of the child as a separate person, with a mind of his or her own, and to see the child's behavior (and their own, as parents) in terms of intentional mental states (Slade, 2006). Although we do not explicitly make use of Slade's Parent Development Interview (PDI, Slade et al., 2004), we find some of the questions that are used in this attachment-focused interview helpful clinically, such as 'I'd like you to choose three adjectives that you feel reflect the relationship between you and (your child). Does an incident or memory come to mind with respect to each of these adjectives?,' or 'Tell me about a time in the last week or two when you felt really angry as a parent. What kinds of situations make you feel this way? How do you handle your angry feelings? (see also Muller et al., 2012). This helps to open the conversation to feelings parents might feel ashamed of. Where appropriate, we might also ask a question that is part of the Adult Attachment Interview (George et al., 1996): 'How do you think your own experiences of being parented affect your experience of being a parent now?' This question helps us to identify possible 'ghosts in the nursery' (Fraiberg et al., 1975), i.e., issues or experiences from the parents' own histories which may be influencing the way they relate to their child.

Slade et al. (2004) have also developed a coding of the PDI interview for 'Parental Reflective Functioning' (i.e., the specific capacity to mentalize in relation to one's child), and although we do not use this coding system in any formal way, we have found this helpful to alert us to key features of parental mentalizing (or failures of mentalizing). For example, we look to see whether the parents show a curiosity about exploring the meaning of their child's behaviors in terms of intentional mental states (e.g., whether his difficulty with separation might be related to his worries about his mother's health difficulties); and whether they are able to acknowledge the 'opacity' of their child's mind, i.e., that they can guess what their child may be thinking or feeling, but that none of us can ever be absolutely certain what is happening in the mind of the other. Features like this are helpful indicators of the parent's capacity to sustain a stance of 'mind-mindedness'

(Meins et al., 2002), even in the face of their child's difficult behavior.

In the assessment of the foster parents they underlined the importance of healthy food. After John had visited his mother he told stories about all the candy and the snacks he had eaten. Back in the foster family he had trouble eating the normal food, which irritated the foster parents a lot because he spoke extensively about everything he ate when he was with his mother. They explained to him that the food of his mother was not really healthy and the food in their family was, and they instructed him not to eat too much candy while visiting his mother, because of his weight problems. But after this they explained that John stopped telling them about what he ate when he visited his mum, although they guessed he was probably still eating a lot of candy. John's foster mother spoke of her frustration about this, and said she couldn't understand why John didn't listen to their advice. After further exploration, it became clear that foster mother had problems with being overweight herself when she was a child, and was very worried that John would be bullied in the way she had been. Her voice became softer as she remembered her own experiences, and the therapist then invited them to think whether John's reasons for eating the junk food might be similar or different to foster mother's, when she was a child. The foster carers began to think about how, for John, what he ate might feel like a question of which 'parents' he was loyal too. Feeling sympathy with his situation, they thought about whether they should stop talking to Jack about the unhealthy food and instead react positively to his enthusiastic way of telling, and to respond to his happiness about the contact with his mother. They decided to try and change their way of speaking to John, wanting to emphasize instead that there are differences in the way things go in the two families, but that it was okay to enjoy these differences. Foster mother in particular recognized that this wouldn't be easy for her, but that this was more her problem than John's.

In this assessment meeting with John's foster carers, it was apparent that they were able to use the space provided by the therapist to explore John's experiences, and to separate their own needs and wishes from his. In doing so, they were able to think how they could best provide him with a sense of security and safely. This is not always the case with the families who are referred to our service. As part of the assessment meetings with parents, we always try to assess if the parents, or the home-situation is (to use Winnicott's term) "good enough." This topic is a source for team discussion, because many of these children come from multi-problem families. But when there is no safe haven an intervention to take the child out of the threatening situation might be necessary before starting therapy.

Assessment Meetings with the Child

Alongside our meetings with the parents, we do an assessment of the child, usually in three sessions, and try to make a profile about the global functioning of the child, in which a link is made between the child's capacity for mentalizing and his or her presenting problems and difficulties. We also try to look for the vital spark in the child (Winnicott, 1971); something that seems a strength or a little burning flame that might help in the therapy. It can be things he likes to do or is good at or what he is curious about. We also contact the school to hear their thoughts, problems and observations about the child. Although we do not routinely use validated, structured measures as part of the assessment, these can be incorporated. For example, some referrals might require a cognitive assessment, such as the Wechsler Intelligence Scale for Children (WISC, Wechsler, 2004), or the use of a screening tool for autistic disorders, such as the Autism Spectrum Screening Questionnaire (ASSQ, Ehlers et al., 1999). These can be incorporated, according to clinical need, as long as they are conducted in a manner consistent with the overall therapeutic stance (see below).

Each assessment session usually lasts for approximately 45 min, and the sessions are relatively unstructured, although the therapist will provide a set of objects that the child can use. In these sessions about 30 min are free play for the child and 15 min are structured by the therapist. We always make time to create a genogram using shells or animals, which sometimes may last a bit longer than 15 min. The child is asked to pick a shell for each family member, and place them to describe the family. The choosing and placing of shells can be very revealing of the child's view of the family and a good starting point for talking about representations of self and others, now and retrospectively. We always try to do a little bit of projective research in asking the children to tell a story using several pictures, such as those used in the Thematic Apperception Test (TAT; Murray, 1943). And we include some drawings which are to be finished by the child, trying to see what they know about how emotions look. In line with the MBT approach, during these sessions the therapist should feel free to be active and responsive and engaging in play if that is regarded as helpful. Because many children with attachment disorder are chaotic and fragmented we often choose not to work in the playroom, because of the overload of toys and the size of the room, but to work in a more contained little office with limited play materials.

The 'stance' taken by the therapist in MBT-C work is absolutely essential, especially when we are working with chronically traumatized children where the theme of limits is all the time an explicit and implicit theme in the therapeutic relationship and the therapy. These children often cannot find words to express their dissociated or denied experiences but often evoke these feelings in others, in enactments. Therefore it is essential for the child psychotherapist, just like the sensitive and supportive parent, to continually pay attention to his or her own subjective experiences, what is felt in the relationship with the child, the non-verbal language of emotion and in the own body (Wallin, 2007). This is what calls affect attunement Stern (1985, 2004, in Wallin, 2007, p. 60), which means being present, participating, moving along, sharing the subjective experience of someone else, without trying to change them. In this way you can give meaning as a child therapist to the expressions of a child, without knowing, without wanting to change, but by absorbing, tolerating, bearing the feelings of the child trying to understand, to attune and to be curious.

By mentalizing about the therapeutic relation and searching for what cannot be articulated, from 'mismatch and repair' (instead of a perfect understanding), we search for hypotheses about the inner world of the child. The focus is mainly in the here and now of the therapeutic relationship. The therapist tries

to convey to the child that she is someone who wants to help, and that she is interested in the experiences of the child. Confirming the child's gestures, thoughts, and feelings, as well as exploring the child's intentions, the therapist aims at strengthening the child's self-agency. The therapist is following the child in the content of the play but is active in managing and creating the process.

In the assessment phase we try to find out, based on our clinical experience and understanding of child development, if a child is functioning according to his or her developmental age and explore the child's interests, longings and friendships. But we are also paying particular attention to the child's capacity to mentalize. In thinking about the assessment of the capacity to mentalize in middle childhood, we do not currently use any formal research assessment, but we have found it helpful to draw upon the work of **?**, who have developed a Child Reflective Functioning Scale (CRFS), which has been used to rate children's responses to the Child Attachment Interview (CAI, Shmueli-Goetz et al., 2008). This is an adaptation of the Adult Attachment Interview (George et al., 1996), the most widely used measure of adult reflective functioning. As with the PDI for parents, a number of questions in the CAI can be helpfully drawn on as part of a clinical assessment (e.g., 'Can you tell me three words to describe your relationship to your father?,' 'Can you tell me about a time with your dad that links to each of those words?'); but we have used the CRFS primarily to help alert us to some of the features of mentalizing in middle childhood that indicate areas of strength and vulnerability in the child. For example, the CRSF highlights certain features of the capacity to mentalize the other in middle childhood, such as the ability to understand that different people may perceive a given behavior differently, based on their knowledge or beliefs; but it also gives helpful indications of what we might look for when this capacity is impaired, such as bizarre responses, or descriptions of behavior without any reference to mental states ('mum did this and then she did that and then I did this'). Watching out for some of these 'mentalizing markers' in the course of the assessment can be very helpful, when trying to make a formulation.

Rather than seeing the capacity to mentalize as a global construct, we have found it very helpful to think about the developmental 'building blocks' of explicit mentalizing, as set out by Verheugt-Pleiter et al. (2008). In this work, they distinguish between attention regulation, emotion regulation and mentalization (Verheugt-Pleiter et al., 2008). Assessing where the child is in relation to each of these elements provides a more nuanced picture of the child's mentalizing capacities and difficulties.

In exploring the attention regulation capacities of a child, we ask ourselves a number of questions as the assessment progresses. Can the child regulate his impulses, focus his attention, listen to others, behave according to his developmental age? Does the child have a sense of a skin in which he lives? When there has been some containment in the early phase of life a child learns he has a skin, which is a natural limit of his body and at the same time is the beginning of a sense of an internal and external world. It is the basis of a normal sensori-motor regulation capacity and the integration of bodily, posture and movement experiences. Therefore we always try to look for striking reactions to sound, light, touch, temperature, movement in space, gross motor skills, and fine motor skills. Is a child open to everything around him, overly aroused, or hypersensitive?

During his assessment meetings, John reacted very sensitively, particularly to sound. He heard others talking in the adjoining room, or the slamming of doors and was immediately distracted. About his fine motor skills the therapist noticed that he used the tweezers grip and was reasonably well able to work in a fine motor way, which he demonstrated in the coloring of some drawings. He was not yet able to write the letter J of John, his own name; he wrote the little hook at the bottom of the letter J in the wrong direction. If he took pleasure in an activity he was well able to keep his attention span. If he found an activity difficult (like trying to compose a small story) he made it very clear that he didn't like it. He was then much less able to maintain his attention span. John was sufficiently well able to regulate his attention, and he could also enter into moments of joint attention. During emotionally charged moments, like during the making of the genogram with the shells, it was immediately clear how little he had learned about focussing and maintaining attention about what he felt inside. With the help of the therapist he could begin to find some words to express himself a little bit. But he then got very distracted and active and stepped out of the contact with the therapist, doing something on his own.

When a child has a difficult start in life or lives in difficult circumstances he can often only poorly mentalize about painful or vulnerable matters and will often act them out through his body. Such children are often easily aroused and hyper-vigilant, which makes it harder to regulate their attention and emotions. Being able to manage impulses from the inside is an essential requirement that precedes learning to mentalize, because a mental representation has to get more priority than the physical reality (Verheugt-Pleiter et al., 2008). In other words, you have to be able to endure a feeling without immediately action to be able to mentalize.

In order to get some indication about the emotion regulation capacity of the child we want to know which emotions the child knows? Which emotions are a problem? What are the antecedents of a problematic behavior or feeling? We might read a book with the child in which all kinds of feelings are drawn using several fish drawings and ask the child if he can recognize how the fish feels. We then ask the child to draw a fish himself. We also show some pictures and ask the child to make up a little story and try to link this little story to his own life. Is a child able to play or fantasize or not? Does the child accept limits? What enactments does the therapist see or sense in the room? What are the therapist's own feelings and thoughts about this child?

In the second session John and his therapist were working with clay and his work got stuck to the table. Therefore he had to start again because it was not possible to remove the clay work from the table without damaging it. Despite the frustration, he showed he was very well able to accept limits. Limits in time, limits in material. He indicated that he took pleasure in playing with water during clay sculpting, but he refrained from doing this right away and by seeking eye contact with the therapist he asked for approval first. When he was emotionally touched by a

topic, like when placing the shells, he had difficulty saying why it was touching him or what happened inside him. He demonstrated that it emotionally touched him by wanting to do something else, standing up, or starting to talk about something else. When the therapist underlined his behavior by saying it might be painful for him not knowing where he belongs he didn't show a reaction. When he saw a seashell in a corner of another table he briefly mentioned that this must be a naughty shell that needed to lie in the corner. When the therapist asked him if he himself sometimes had to stand in a corner because he was naughty he nodded sadly.

To monitor the explicit mentalizing capacities we want to know if a child has any representation of him- or herself? Of others? Any attunement toward others? Any curiosity toward others or himself? Any fantasy? Drawing on a question from the CAI, we ask for three words to describe himself, and then we ask for an example of each adjective (e.g., can you tell me about a time when you were 'angry?'). We try to look at whether the child has a capacity for explicit mentalizing (i.e., to be curious about his own or other's thoughts and feelings, and how they might relate to the way he or others behave), and if he does, we try to explore in what contexts the child is able to make use of this, and in what contexts such a capacity breaks down. This is important because mentalizing is not a fixed capacity, but comes and goes, according to the context and our levels of emotional regulation.

During the second session John wanted to play with the clay. He started making a bowl for his mother, in the shape of a heart, because he said he loves her very much. He then wanted to make a Donald Duck bowl for his younger brother (who lived with their mother), but while working on this he started thinking that the heart bowl could very well be for everyone. He made a second bowl for his foster father because he says he loves him too very much and that bowl becomes a cat's bowl. Then there was some clay left, and John spontaneously came up with the idea that he would like to make a bowl for himself. He wanted to make the Donald Duck bowl for himself and not for his brother. The therapist thought to herself that it was difficult for John as his brother lived with their mother and he probably had jealous feelings about it, at least according to his foster mother. John told her that the bowl he was making for himself must be very strong. He reinforced the edges of the tray well. "It must be able to hold water, that is very important," he told her. The therapist wondered aloud if he wanted to become strong himself, not being angry all the time, being able to keep his feelings inside him. John nodded, and said that he worried his foster parents wouldn't want to keep him when he got angry all the time.

Gathering Our Thoughts into a Formulation – And Creating a Story

The fifth and final session in the assessment phase is again with parents and the child together, where we present our assessment in a way that we hope can be understood by both parents and the child. In this meeting we try to formulate something about how we have mentalized about the child, the family and how these link to the problems that brought them to treatment.

In the case of John, our assessment indicated that John's foster carers have a good capacity to see John as a boy with thoughts and feelings, which can help them to make sense of his behaviors. Although there were areas where their capacity was limited, possibly due to issues deriving from their own histories (e.g., foster mother's response to John not being careful about his diet and putting on weight), they were able to make use of the therapeutic space provided in the assessment to reflect on their own mental states, and thereby separate out what belonged to John and what belonged to them. In doing so, they were able to think about John's loyalty conflict in a different way, and modify how they responded to his behaviors accordingly.

Likewise, John demonstrated a capacity, under the right circumstances, to regulate both his attention and affects, and even to make use of explicit mentalizing to make sense of his own behavior and the reactions of others (i.e., when he spoke about his worry that his foster carers would reject him if he behaved badly). However, it was also apparent that these capacities could easily be lost or compromised when John felt anxious or afraid; and that John's vulnerability to such disruptions were probably heightened by his early history, during which he may not have received the kind of 'maternal mind-mindedness' (Meins et al., 2002) or 'contingent mirroring' (Fonagy et al., 1993) that helps to develop the child's own capacity to mentalize. John's reported aggression and social isolation could be understood as a consequence of this vulnerability, and it was felt that a short-term MBT-C intervention, with work with his foster-carers alongside it, could help to begin him to strengthen these capacities, in the context of a therapeutic relationship in which he was able to gradually regain a sense of 'epistemic trust' (Fonagy and Allison, 2014).

Sharing such a formulation with children and their parents is not always easy, and it is important to avoid using overly technical language. We have recently experimented with offering the family a small story, which offers them some of our own thoughts about what we have learnt from the assessment, using a metaphorical language which invites the family to engage with the work at a symbolic level.

In their final session, the therapist thanked John and his foster carers for coming, and explored how they had found the process so far. She then told them that she'd been thinking a lot about all they had shown and told her, and that she had made a small story, which she would like to share with them. John looked very pleased about this, and he leant in against his foster mother's body, as if waiting to hear a story at bed time. The therapist then began: There was once a little chimpanzee. He lived for a while with his mother in a group but had to leave her when he was really little, because she couldn't take care of him anymore. That was sad, because the chimpanzee hadn't learned all the words and rituals that are used in a chimpanzee family. After traveling around, and staying in different places, the little chimpanzee came to a family of gorillas. This looked a bit like home, but sometimes he felt out of place and worried if the gorilla family would let him stay. He often lacked the words to describe what he thought or felt. He sometimes felt very alone because he missed his mother and because he had lived so long with others where he had felt an outsider. When he felt sad he sometimes became angry, because that helped him feel a bit bigger. At the gorilla's it did feel like home often, but sometimes it didn't. He was a chimpanzee after all. So he decided he wanted to find his own words and rituals to become stronger and not so angry anymore and he decided he wanted to live with the gorillas and

visit the chimpanzee family once in a while. The gorillas loved the little chimpanzee and they were willing to learn more about how a chimpanzee is.

On 'Focus'

Inspired by Developmentally Directed Time Limited Psychotherapy for Children (Haugvik and Johns, 2008) core features of arranging the therapy constellation of a time limited MBT-C program are choosing a focus or metaphor for the therapy, which should emerge out of carefully observing and listening to everything the child conveys during the assessment sessions, both verbally and non-verbally. This focus can be helpfully summed up with a motto, or short phrase, which can be shared with the child and parents at the start of treatment. Together we try to look for a motto which gives meaning for the therapy and in which the child feels confirmed and recognized. Often the motto will draw upon something the child has said or drawn, so that it is a joint creation, between the therapist and the family. Sometimes the child doesn't come up with anything to contribute to the motto. The metaphor can still be formulated because it helps the therapist to focus and mark the playing field for the therapy and it usually helps the parents. Sometimes the therapist spontaneously looks for a motto together with the child in the last assessment session. But more often the therapists think of a motto or little story and share this with the child and parents in the final assessment session.

The mutual treatment focus or metaphor represents a time perspective and can be related to Stern's concept of "key metaphor," representing relational and emotional central themes (Haugvik and Johns, 2008). The focus becomes a joint point of departure as well as a direction for the therapy, and is an important part in forming the therapeutic alliance. In the focus, the therapist helps the child to know what is going to happen in the therapy. Many children are sent to therapy by parents or other adults, and do not know why they have to come. When time is limited the task of stimulating agency and participation in the child is extra important. The focus functions as an invitation to the child to engage in the therapy process.

It is important that the focus bears meaning to the child, creating an experience that "this is about me." The therapist conveys by the focus that he or she is someone who wants to help the child and who knows about the child's difficulties. The starting point in focus-formulation is the reason for the family seeking help. However, the focus must not be a problem description. Rather it is supposed to be a support to the therapeutic direction by pointing to the child's resources and skills, and what can be developed in therapy. It also stimulates parental reflective functioning by directing the parent's attention to the child's inner world. Furthermore it helps the child's mentalization by conveying that he or she is held in mind, and stimulates the child to be interested in their own feelings and thoughts. This way the focus becomes a model for both parents and child for how one can "hold someone's mind in mind." The focus also helps the therapist, directing him to a mentalizing approach toward both parents and child.

John was touched by the story about the chimpanzee and the gorilla family; he became quiet and looked seriously at the therapist. He then spontaneously said 'I want to become a proud and happy chimpanzee living in peace with other apes.' The therapist asked John if this might be a focus for the therapy? John thought that would be a good idea. 'We have work to do,' the therapist said to John, with a smile. She then checked with the foster parents, who agreed on the focus, pointing out they had work to do as well, because they wanted to find ways to help the chimpanzee to feel more in control of his emotions and more connected to them and the other family members. When everyone agreed on the focus the child therapist and John went to their own play therapy room and John made a little monkey out of clay with a big smile on his face. The therapist made such this was put in the room on the same spot, every time John came in for his therapy, to help them keep the therapy focus in mind.

By using material from the initial sessions the therapist can formulate a focus that resonates for both child and parents. Counter-transference feelings can capture relevant themes as well as feelings that the parents might have toward the child. Using these feelings in the focus can be helpful in bringing curiosity of both parents and child, but can also alert the therapist to places where their own mentalizing capacity may have become temporarily inhibited. For example, when reviewing her feedback session in supervision, John's therapist noticed that the focus that she had proposed spontaneously during the meeting ('I want to become a proud and happy chimpanzee living in peace with other apes') focused more on desired changes in his behavior (and feelings), which perhaps reflected a pressure to try and sort out John's difficult behavior. Perhaps something more exploratory, such as 'Getting to know the chimpanzees and the gorillas better,' or 'Finding out what chimpanzees need to be proud and happy,' would have encouraged more of a sense of curiosity and interest in mental states and their link to how we feel and behave?

The child's own use of metaphors related to its experiences in play can be helpful in formulating the focus in a way that the child can relate to. The focus should be short, easy to understand for both child and parents, and demonstrate recognition as well as curiosity and hope. Themes of the focus are often related to control, autonomy, dependency or self-esteem. The focus formulation is exploratory and/or affect regulatory. Furthermore it needs to raise recognition and give meaning to the parents (Lindqvist, 2013).

Concluding Remarks

The capacity to mentalize is a spontaneous, intuitive and unconscious process, which most of us use all the time without noticing, in order to help us make sense of the way others behave, and the way we respond to the people in our lives. But just as all of us are prone to context-specific losses of this capacity, especially in stressful circumstances, so too more entrenched mentalizing difficulties can often underlie – or at least help to maintain – a range of mental health difficulties that may bring a child to the attention of services. A time-limited MBT-C intervention could be one approach to helping these children and their families. Although the approach still requires systematic empirical validation, the model is consistent with empirical research

on the role of mentalizing in psychopathology, and addresses problems that are well recognized among clinicians who deal with traumatized children. Based on our clinical experience so far, we are very optimistic about how well this time-limited MBT-C protocol can work for a range of children – although we don't yet know who actually benefits most from this approach, and research systematically evaluating the effectiveness of this approach, as well as identifying 'what works for whom' – will be essential.

In this article we have described the assessment process that we have developed in a service offering time-limited MBT-C. It is always important to do a sound assessment of the child and the parents to be able to choose a focus within a time limited frame. An assessment that focuses specifically on both evaluating and promoting the capacity to mentalize has a number of advantages. When the parents' capacity to mentalize increases it helps enormously to stimulate the mentalizing capacity of the child. Working at the same time with the parents and child enhances the therapeutic process. Supervision meetings with other child therapists and the family therapist together can help to unravel enactments and help ensure that the therapist notices her own breaks in mentalizing. An open curiosity about such breaks in mentalizing – whether in oneself or others – is at the heart of a mentalizing approach to therapy.

At the end of two phases of MBT-C (i.e., 24 sessions in total), John learned to be able to recognize, name and express more about all he felt about his life in the here-and-now: his loyalty toward his mother, his jealousy toward his biological brother and his two foster sisters. He learned to express his anxiety about having to leave his foster home again, his difficulty of really trusting and believing he could stay with his foster parents and was loved for who he was. He also put into words his anger about having to leave his biological family and two other foster families. Most of the time he could tolerate difficult feelings inside him instead of acting them out. He felt he was stronger and had more self-agency. This led to changes in the way he interacted with others in the foster family, with his biological mother and at school with peers. For the first time he was invited to a birthday party of a classmate at school. He had the feeling he was becoming who he really was, without the persistent aggressive outbursts and mis-trust toward others. Although his interactions with his foster carers was not always easy, by the end of the time-limited MBT-C John and his foster carers knew much more about the chimpanzees and gorillas – what made them frightened or happy, in what ways they were similar, and in what ways they were different.

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Exploring the Role of Theory of Mind in Moral Judgment: The Case of Children with Autism Spectrum Disorder

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This paper adds to the growing research on moral judgment (MJ) by considering whether theory of mind (ToM) might foster children's autonomous MJ achievement. A group of 30 children with autism spectrum disorder (ASD) was compared in MJ and ToM with 30 typically developing (TD) children. Participants were tested for MJ with a classical Piaget's task and for ToM with a second order False Belief task. In the moral task, children were told two versions of a story: in one version the protagonist acted according to a moral intention but the action resulted in a harmful consequence; in the other version the protagonist acted according to an immoral intention, but the action resulted in a harmless consequence. Children were asked which of the two protagonists was the "naughtier." In line with previous studies, the results indicated that, while the majority of TD participants succeeded in the second order False Belief task, only few individuals with ASD showed intact perspective taking abilities. The analysis of the MJ in relation to ToM showed that children with ASD lacking ToM abilities judged guilty the protagonists of the two versions of the story in the moral task because both of them violated a moral rule or because they considered the consequences of the actions, ignoring any psychological information. These results indicate a heteronomous morality in individuals with ASD, based on the respect of learned moral rules and outcomes rather than others' subjective states.

Keywords: school children, moral judgment, theory of mind, autism spectrum disorder, moral education

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INTRODUCTION

The psychological roots of morality have been one of the major focuses of attention of philosophy for centuries. More recently, experimental psychologists empirically investigated moral reasoning in children and adults in the attempt to appreciate the impact of this process on individuals' social lives.

Piaget (1932) studied the psychological origins of moral judgment in children by using moral dilemmas, in which answers varied along one cognitive dimension (intention) and one contextual dimension (consequence). Piaget (1932) demonstrated that children up to the age of six use consequences rather than intentions to judge culpability in such dilemmas, so they consider the obedience to the moral rule more important than intentions. Piaget called this phase the

"heteronomous stage," in which children consider moral rules as unchangeable and requiring strict obedience. Later in their development, at the end of the school years, children view rules as flexible and related to social principles that vary according to people's intentions. Piaget named this stage the "autonomous stage," in which moral transgressions are judged considering the intentions behind the actions (Piaget, 1932).

Subsequent research on children confirmed the role of perspective taking in moral reasoning. The majority of children tend to consider intentional behaviors "wrong" compared to the accidental ones (Nunez and Harris, 1998). The relationship can also run from moral judgment to theory of mind (ToM), so that preschool children judge the intentionality underlying an action depending on the moral valence of the action itself (Leslie et al., 2006a; Pellizzoni et al., 2010). Adults usually rely on mentalistic motivations to define moral judgements about agents' behaviors. While unintentional behaviors are usually explained merely in terms of mechanical causal factors, intentional actions are interpreted by considering agents' knowledge that a behavior might cause negative effects on others (Knobe, 2005).

A number of research on TD adults and children indicated the role of perspective taking in moral reasoning. However, as long as perspective taking precedes the development of moral judgment (MJ) in childhood, it is difficult to identify the actual weight of ToM on morality.

Recently, studies of morality in individuals with autism spectrum disorder (ASD) provided important insights into the role of ToM abilities in MJ. Given the mentalizing impairments that characterize individuals with ASD (Baron-Cohen et al., 1985; Baron-Cohen, 1989; Hill and Frith, 2003), it might be predicted that MJ would be impaired in these individuals. Surprisingly, the majority of previous studies showed that individuals with ASD are sensitive to moral transgressions, despite a lack of ToM abilities.

Blair (1996) investigated the ability of children with ASD to distinguish between moral and conventional transgressions. While moral transgressions determine a consequence for the rights and welfare of others, conventional transgressions determine a consequence for the social order. Thus, it is the responsivity to the distress of a victim that is crucial to distinguish moral from conventional transgressions (Smetana et al., 2008). Blair (1996) investigated the responses to the moral/conventional distinction of two groups of children with ASD: one group lacking the ability to mentalize and the other group showing the capacity to mentalize. Typically developing children and moderate learning difficulty children were evaluated as control groups. The results indicate that all the groups made the moral/conventional distinction. Thus, ToM abilities were not crucial for basic MJ.

Leslie et al. (2006b) investigated whether children with ASD make basic MJ in comparison to TD controls in two experiments. In the first experiment, children were tested for very basic MJ about prosocial ("good") and antisocial ("bad") acts (Killen, 1991). Participants with ASD were also tested on two standard false belief tasks (Baron-Cohen et al., 1985; Perner et al., 1989). The first experiment indicated that the ASD group, despite a lower ToM performance compared to controls, made simple bi-valued MJs as TD children. The second experiment replicated and extended Blair's study by introducing a new control task: the "cry baby" story. In this story, the action of the protagonist determined neither a moral nor a conventional transgression. However, the action caused a distress of a baby. Thus, if the participants would simply react to the distress of another person, then they will judge the "cry baby" story as a moral transgression. The same participants with ASD tested in the first experiment were considered (with and without ToM). The results of the second experiment supported the findings of Blair (1996): children with ASD who failed standard false belief tasks distinguished between moral and conventional transgressions. Moreover, both TD and ASD children distinguished between the distress of a "cry baby" and the distress of a victim in a moral transgression. Taken together the results of the two experiments suggest that children with ASD who fail standard false belief tasks may present a basic moral sense.

Lecciso et al. (2008) analyzed the value of the intention behind moral actions and its link with mentalising abilities in high-functioning children with ASD and in normally developing children. The results indicated that, although children with ASD showed difficulties in both first-order and second-order false belief tasks, their ability to make moral judgements was not impaired.

Recently, Kretschmer et al. (2014) investigate relations between moral reasoning, executive functioning and ToM in children with ASD compared to TD children. A dilemma was presented to participants and they had to judge if the protagonist's behavior was correct or not. In addition, participants completed two ToM tasks, a working memory and an inhibition test. The results indicated that children with ASD did not differ from TD children in cognitive and affective aspects of moral reasoning, ToM and executive functioning. However, there was a correlation between moral reasoning and inhibitory control and between ToM abilities and inhibition. Thus, these results showed that ToM is not a prerequisite for MJ but that inhibitory control might play a mediating role between ToM and MJ in children with ASD.

These studies on MJ in ASD has focused on the ability to distinguish between intentional moral and conventional harms (Blair, 1996). They also focused on the MJ of intentional negative acts as good or bad (Leslie et al., 2006b; Lecciso et al., 2008; Kretschmer et al., 2014). Both kinds of studies found that ASD and TD individuals possess the same basic understanding of moral right and wrong: they can distinguish morally acceptable from morally unacceptable acts.

Other studies applied more complex moral reasoning paradigms, which varied the intentionality of immoral acts requiring participants to involve ToM abilities to make MJ.

Grant et al. (2005) investigated whether children with ASD are able to weight up both the motive and outcome of behavior for judgments of culpability, compared with a group of children with moderate learning difficulties and a group of TD children in MJ. Participants were presented with pairs of stories in which motive and outcomes were combined into three conditions: (A) different motives (ill/good), same outcome; (B) same motives (good), different outcomes (damage to a person/damage to a property);

(C) different motives (ill/good) and different outcomes (damage to a person/damage to a property). Participants were asked to judge which protagonist was the naughtier and to justify verbally this judgement. Justifications were analyzed to assess whether correct culpability judgements derived from appropriate, adult-like reasoning, or whether correct judgements did not involve an appreciation of intentions. Results showed that children with ASD were as likely as controls to judge ill intentions more culpability than good ones regardless the outcomes. They judge injury to persons as more culpable than damage to property. Thus, participants with ASD were able to evaluate intentions and outcomes in making MJ. However, no measures of ToM abilities were considered in this study. Moreover, differently from controls, the majority of the justifications given by the children with ASD were reiterations of the story rather than explanations of their judgements.

Moran et al. (2011) tested whether ASD adults would consider both the intentions and the outcomes of a person's actions when expressing MJ, in comparison to TD controls. Participants read vignettes in which protagonists produced either a negative or a neutral outcome based on the belief that they were causing the negative outcome (negative belief) or the neutral outcome (neutral belief). The MJs required both processing beliefs and intentions and processing outcomes. Participants in both groups were also tested for ToM abilities. The results indicated that there were no differences between participants with ASD and TD controls in ToM abilities. However, adults with ASD showed an over-reliance on the action's negative outcome and an under-reliance on information about a person's innocent intention compared to controls. These findings indicate that individuals with ASD don't integrate mental state information into MJs.

Zalla et al. (2011) investigated the ability of adults with ASD to distinguish moral, conventional and disgust transgressions using a set of six transgression scenarios. Each transgression was followed by questions about permissibility, seriousness, authority contingency, and justification. The results showed that individuals with ASD were able to distinguish between moral and conventional norms. However, they failed to distinguish moral and disgust transgressions and were unable to provide appropriate moral justifications. Moreover, they judged conventional transgressions and disgust transgressions to be more serious compared to TD controls. The seriousness rating correlated with their ToM impairment. The authors concluded that individuals with ASD might be responsive to rule violations, even though they fail to use relevant information about the agent's intentions in moral reasoning.

Shulman et al. (2012) compared moral and social reasoning in individuals with and without ASD. Familiar schoolyard transgressions were shown to participants and a yes/no question examining the acceptability of the portrayed behaviors was asked to them. They also had to judge the appropriateness of the behavior and explain their judgments concerning acceptability. The judgments were categorized into different categories, corresponding to the Kohlberg's developmental model of morality. For example, concern over the damage resulting from the specific transgression corresponded to the first stage of pre-conventional level and justifications based on an awareness of general principles prohibiting the depicted behaviors corresponded to the second stage of pre-conventional morality. The results indicated both groups made the moral/social distinction. Participants with TD were more flexible than participants with ASD, providing more examples of behaviors that might be considered as transgressions in one context but not in another one. Moreover, participants with ASD considered more often than TD participants the expected damage which would result from the transgressions and they cited more often a specific simple rule prohibiting such behavior (e.g., "that's bad," "you can't do that"). These results seem to indicate that participants with ASD are at a pre-conventional level of moral development, in which intentions are not yet included in their moral reasoning. However, the authors did not consider differences in ToM abilities between ASD and TD participants. Differences in MJ between groups were explained considering that individuals with ASD focus on the details. Thus, it becomes difficult for them to discern the relevant features (e.g., the intentions) as different and as more important than irrelevant ones (Happé and Frith, 2006).

In summary, previous studies showed that individuals with ASD are able to perform at the same level as TD individuals in basic moral reasoning despite a lack of ToM (Blair, 1996; Leslie et al., 2006b; Lecciso et al., 2008; Kretschmer et al., 2014). Basic moral reasoning tests, which presented participants with a yes/no question to examine the acceptability of an action, have in common that they do not require individuals to explain moral decisions, but only to distinguish whether an action is 'good' or 'bad.' This might explain the similar performance of individuals with and without ASD.

Other studies revealed differences in moral reasoning between individuals with TD and individuals with ASD when more complex moral reasoning paradigms were applied that put higher demands on reasoning (Grant et al., 2005; Moran et al., 2011; Zalla et al., 2011; Shulman et al., 2012). Specifically, while TD individuals integrate intentions into their justification of moral reasoning, individuals with ASD seems to employ a compensatory strategy, in which the rigid application of a learned moral rule might supply for ToM deficits in this population.

The results of the empirical studies described so far are consistent with the recent philosophical conceptualization of morality in individuals with ASD. Kennet (2002) described individuals with ASD as lacking the ability to self-develop moral rules or to apply them into new situations. According to Kennet's view, since individuals with ASD have ToM deficits, they fail to represent other people's thoughts in a particular situation, which is crucial to elaborate a moral judgement. However, individuals with ASD develop moral judgements by other means, like for example by reasoning on explicit rules taught by others and/or by inferring the social norms from past experiences (Kennet, 2002). Krahn and Fenton (2009) recently supported such a view of morality in ASD: individuals with ASD are viewed as not morally autonomous because they lack a sense of intersubjectivity – the ability to understand moral behavior from the viewpoint of an agent involved in an action.

Thus, nowadays philosophers converge in the hypothesis that individuals with ASD should not be considered fully mature moral agents (autonomous) because of their significant social impairment. On the contrary, these individuals express heteronomous MJ based on overlearned abstract knowledge about normative rules (Kennet, 2002; Krahn and Fenton, 2009; Damm, 2010). For the best of our knowledge, this hypothesis of a heteronomous morality in individuals with ASD has never been empirically tested using a developmental model of morality. This model might be helpful to conceptualize MJ in ASD as developmentally immature, rather than merely atypical, whit important implication for interventions.

The only study so far, for the best of our knowledge, that tried to explain morality in individuals with ASD according to a developmental model of morality is Shulman et al. (2012), which indicated that children with ASD tend to express judgments at a pre-conventional stage of Kohlberg's moral development model. However, this study explained these results in terms of attention to details rather than in terms of ToM abilities, which were not evaluated in the participants. This study left open the question of whether ToM abilities might play a crucial role in the development of a mature level of morality in ASD.

The present study tested the hypothesis of an heteronomous morality in individuals with ASD, in the light of the Piagetian model of moral development in children. Even though Piagetian framework of moral development has been challenged in the last decades, Piaget's dilemmas might offer an ideal context to verify the hypothesis of a heteronomous MJ in children with ASD, because the answers could vary along intention, transgressions of a moral rule and consequences. To achieve this aim, we investigated ToM and MJ in children with ASD and in typically developing children. We predicted that, if individuals with ASD are heteronomous agents, they will consider more the consequences of the actions or the violations of the moral rule when solving Piaget's dilemmas rather than the others' intentions.

MATERIALS AND METHODS

Participants

Two groups participated in the study. The first group included 30 TD school children (all males; average chronological age = 10 years and 6 months; $SD = 1.687$). The TD participants were recruited at school and they were interviewed during the school hours. The second group included 30 participants with ASD (all males; average chronological age = 11 years and 8 months; $SD = 3.808$; average $IQ = 87.57$; $SD = 17.344$). The participants with ASD were diagnosed by expert clinicians using the DSM-IV criteria and Autism Diagnostic Observation Scale (ADOS) scores (Lord et al., 1999). The participants in both groups were all males, considering the higher prevalence of ASD in this gender. Only the IQ scores of the clinical groups were known, but since the TD group consisted of a random group of typically developing children, who were average performing students in mainstream education, the mean IQ of the control group can be considered to be in the normal range. Official authorizations to carry out the research were provided by the school director and the teachers of the classes involved. Informed written consent was obtained from the parents of each participant. The research was conducted in the absence of any commercial or financial relationship that could be construed as a potential conflict of interest. The study was approved by the local ethics committee and carried out in accordance with the Society for Research in Child Development's (SRCD) Ethical Standards for Research with Children, the Italian Psychological Association's Ethical Standards for Research with Humans, and the World Medical Association's Helsinki Declaration, as revised in October 2008.

Materials

The participants were tested for mentalizing abilities with a second-order FB task (Perner and Wimmer, 1985) and for moral judgment with a classic Piagetian dilemma. The two tasks were presented in a written form. The FB task included also colored pictures, representing the most salient parts of the story.

Procedure

Participants were tested individually in a quiet room of the school during a school day. For the FB and the moral judgment tasks, the participants were instructed to read the stories carefully and to imagine each hypothetical situation. The experimenter was available for explanation and support. The order of task presentation was counterbalanced between subjects.

Second-Order False-Belief Attribution Task

In the second-order FB attribution task (Perner and Wimmer, 1985), the children were told a story in which two characters, A and B, saw an ice-cream van in the park. Later, each was independently told that the ice-cream van had moved from the park to the church, but they did not know that the other one had also been informed. The participants were asked where A thought B would go to buy ice cream. To respond correctly, the children must employ recursive thinking about mental states, by predicting one person's thoughts about another's thoughts. Specifically, the participants should take into account A's ignorance of B's knowledge of the true location of the ice-cream van. The second-order FB question was administered only if the child passed a memory question and a reality question. The belief question was scored in a pass or fail manner (Baron-Cohen, 1989). Specifically, the answer was considered correct if the child considers the false belief in order to predict the behavior of the protagonist. On the other side, the answer was considered incorrect if the child considers the real facts to predicts the behavior of the protagonist.

Moral Judgment Task

Moral judgment was assessed by telling children the following stories, in which two protagonists used the scissors without the supervision of an adult (transgression):

(a) Margherita wants to play with the scissors when her mum is gone. As soon as she plays with the scissors she cut a little hole in her dress.
(b) Lucia wants to please her mother with a little present. She decides to cut some flowers from a colored paper sheet and

give them to her mum. While she's doing her job, she cut a big hole in her dress.

In the first version of the story, the character intentionally acted unfairly but she caused an insubstantial material damage. In the other version, the character acted fairly but she caused a considerable material damage. The participants were asked to decide which of the two protagonists was naughtier and why. An experimenter, which was blind to the group from which the responses were drawn, judged the participants' answers. The responses were coded as follows: intention – the child refers to the intention of the protagonist (e.g., "Margherita was the naughtier because she used the scissors just for fun); transgression of a moral rule (moral rules)- the child considers both protagonist as equally nasty (e.g., "Both children were naughty because they used the scissors without the supervision of an adult); consequence – the child refers to the consequence of the action (e.g., "Lucia was the naughtier because she made a bigger hole in her dress compared to Margherita"). While the answers using the intentions indicate the autonomous stage, the other two categories indicate an heteronomous stage.

Design and Analysis

A series of non-parametric analysis were applied to compared ASD children and TD children in MJ and ToM. Chi-square was used to compare group differences in ToM and MJ in the general sample. Moreover, chi-square was used to compare group differences in MJ in two subgroups of participants, with and without ToM abilities. Finally, Fisher's exact test was applied to compared the frequency of participants that expressed heteronomous vs. autonomous MJ in the participants with and without ToM abilities.

RESULTS

The results indicated that, while half of the TD participants succeeded in the second-order FB task (50%), only a few children with ASD (5%) showed intact perspective-taking abilities ($\chi^2 = 7.5$; df = 1; $p = 0.006$).

As shown in **Figure 1**, children with ASD judged the culpability on an action mainly in terms of consequences (23%) and transgression of a moral rule (17%). Only a few of the children with ASD referred to the intentions (10%). On the opposite, TD children mainly referred to the intentions (30%) and only a few of them considered the consequences (10%) and the transgression of a moral rule in their judgment (10%). The differences between group were statistically significant ($\chi^2 = 10.200$; df = 2; $p = 0.006$).

Then, we considered the MJ in children with TD and ASD divided into two subgroups of participants, with and without ToM abilities. In the subgroup of participants that failed the False-Belief Task (**Figure 2**), the results indicated that, even though the differences between groups are not statistically significant ($\chi^2 = 4.627$; df = 2; $p = 0.099$), there is a tendency in TD children to consider the intentions of the participants (18%). On the opposite, children with ASD tend to consider mainly the consequences (28%) or the transgression of the moral rules (25%).

In order to identify the heteronomous participants, we collapsed in a unique group the participants that considered the consequences and the transgression of the moral rules in the MJ and we compared them to the autonomous participants, who considered the intentions (**Table 1**). The results indicated that there is a tendency in children with ASD lacking ToM to be mainly heteronomous agents, while TD children tend to be mainly autonomous agents (Fisher's exact test $p = 0.06$).

When we considered the participants that passed the ToM task (**Figure 3**), TD children mainly considered the intentions (55%). Only few children with ASD passed this task and they were distributed between those that considered the intentions (10%) and those that considered the consequences (15%). The differences between groups are statistically significant ($\chi^2 = 6.97$; df = 2; $p = 0.031$).

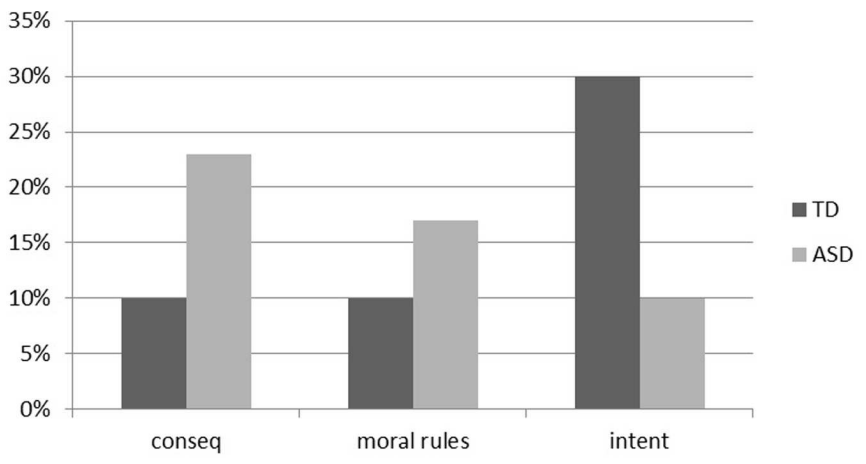

FIGURE 1 | Percentage of participants with autism spectrum disorder (ASD) and with typical development (TD) who expressed a judgment of consequence (conseq), transgression of a moral rule (moral rules) and intention (intent) in the Piaget's moral judgment (MJ) task.

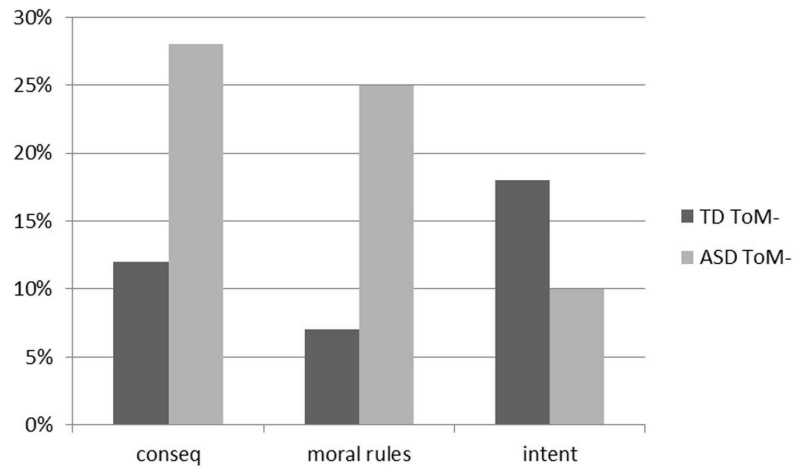

FIGURE 2 | Percentages of participants with typical development that failed the theory of mind task (TD ToM−) and percentages of participants with autism spectrum disorder that failed the theory of mind task (ASD ToM−) which expressed a MJ according to the intention (intent), the transgression of the moral rule (moral rules) and the consequences (conseq) of the protagonists.

As shown in **Table 2**, the results indicated that, even though the differences between groups are not statistically significant (Fisher's exact test $p = 0.2898$), there is a tendency in TD children to be mainly autonomous agents.

DISCUSSION AND CONCLUSION

In line with previous studies, our results indicated that children with ASD develop a MJ, despite their deficit in ToM. However, children with ASD who lacked ToM abilities showed more negative MJ concerning actions that broke the rules of morally appropriate behavior or regarding damaging outcomes. Reduced ToM abilities in children with ASD seem to enhance their likelihood to conform rigidly to a social norm or to consider the outcomes of an action, which is typical of a heteronomous stage of moral development in the Piagetian model. Thus, the results of our study confirm our hypothesis of a heteronomous morality in individuals with ASD. Our results are also consistent with a recent philosophical conceptualization of morality in individuals with ASD. As described in the introduction, philosophers nowadays agree that individuals with ASD should not be considered fully mature moral agents due to their social deficits (Kennet, 2002; Krahn and Fenton, 2009; Damm, 2010). These results indicate, as Kohlberg (1971) already said in his studies, that philosophy and psychology can significantly enrich each other in achieving new knowledge in the field of morality.

A possible explanation for these results might be that individuals with ASD reach the heteronomous stage of moral development thanks to their experiences, which promotes the learning of moral rules developed by other people, but fail to advance to the autonomous stage due to their ToM deficits. Similar to the morally heteronomous TD children, children with ASD seem to have an immature sense of morality, so they view moral rules as unchangeable and requiring strict obedience. According to the Piaget's model of moral development, the developmental transition from a heteronomous morality to an autonomous one might be promoted by the metarepresentational ability to consider others' viewpoints (Piaget, 1932). Thus, the results of the present study emphasize the importance of evaluating ToM in children with ASD, indicating that interventions aimed at improving children's MJ need to take theory-of-mind abilities into consideration as a possible pivotal ability. It might be of interest to investigate the possible effect of ToM training on moral reasoning in children with ASD in a future intervention study.

A possible alternative explanation for our results might be that executive functions (EFs) also play a key role in moral judgement, considering the atypical inflexibility in morality expressed by individuals with ASD. Indeed, EFs have been shown to be impaired in young individuals with ASD and ToM deficits but not in the TD control group in whom the two abilities were found to be independent (Ozonoff et al., 1991). Moreover, a recent study found a correlation between moral reasoning and inhibitory control in school children with ASD (Kretschmer et al., 2014). Thus, in future studies, it might be of interest to investigate whether possible prefrontal impairments in ASD, which are capable of causing dysfunctions in a wide variety of neuropsychological domains, such as ToM and EF, might also account for rigid moral judgements in ASD.

TABLE 1 | Frequencies of participants with autism spectrum disorder that failed the theory of mind task (ASD ToM−) and typical development that failed the theory of mind task (TD ToM−) that showed heteronomous or autonomous MJ.

	Heteronomous	Autonomous
TD ToM − ($n = 15$)	8	7
ASD ToM − ($n = 25$)	21	4

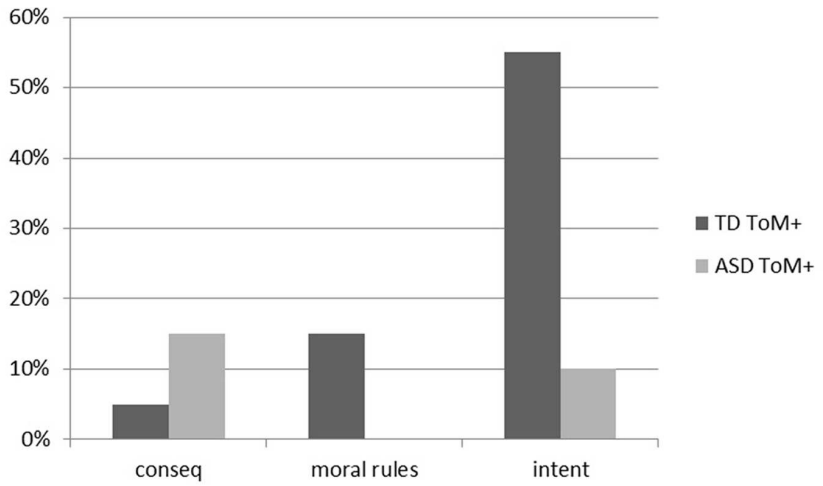

FIGURE 3 | Percentages of participants with typical development that succeeded in the theory of mind task (TD ToM+) and percentages of participants with autism spectrum disorder that succeeded in the theory of mind task (ASD ToM+) which expressed a MJ according to the intention (intent), the transgression of the moral rule (moral rules) and the consequences (conseq) of the protagonists.

TABLE 2 | Frequencies of participants with autism spectrum disorder that succeeded in the theory of mind task (ASD ToM+) and with typical development that succeeded in the theory of mind task (TD ToM+) that showed heteronomous or autonomous MJ.

	Heteronomous	Autonomous
TD ToM + ($n = 15$)	4	11
ASD ToM + ($n = 5$)	3	2

This study has some limitations that need to be acknowledged. First, participants were asked to read the second order false belief vignette, which is a rather complex story, so that participants may fail this task just by a lack of motivation or basic understanding. However, as we explained in the procedure, the second-order FB question was administered only if the child passed a memory question and a reality question. These questions allowed to control for possible intervening effects of a lack of motivation or basic understanding in the participants performance (Perner and Wimmer, 1985). Moreover, we decided to test ToM abilities with the "ice-cream van story" rather than a different version of the test, the so-called 'birthday puppy story' (Sullivan et al., 1994), for several reasons. The "birthday puppy story" has been shown to elicit better performance in TD children, thanks to a simplified procedure (Hayashi, 2007) and an additional question about the content of the belief (Miller, 2012). However, its wording is more complex than "the ice-cream van" story, and it includes deception, whose beneficial effects on second-order false belief understanding are still controversial (Miller, 2012). Given that individuals with ASD are known to have difficulties with deception (Russell et al., 1991) and with the understanding of language (Volkmar et al., 2005), we decided to administer the Perner and Wimmer's task to reduce the possible effect of language and deception. Moreover, considering that individuals with ASD respond most favorably to information that is presented visually (see for example Ganz, 2007), we presented the FB task with colored vignettes representing the most salient parts of the story, to aid participants' understanding and motivation.

A second limitation of our study might be that we used only one task to assess perspective taking. Since the use of only one task has been identified as a methodological limit in previous studies on ToM (see for example, Valle et al., 2015), it might be of interest to use in a future study more different tasks to assess perspective taking, to better define participants mentalistic abilities. Moreover, we used laboratory tasks, which seem to enhance the abilities of children with ASD to reason about social contents (see for example, Sally and Hill, 2006). Thus, it would be interesting in the future to further investigate ToM and MJ in more ecological settings, such as daily life situations.

CONCLUSION

The results from the present study lead to the need of important intervention strategies which might help individuals with ASD understand and reason about social interactions in an effective way. Rather than simply teach the "immorality" of an action, new programs should teach the mentalistic principles upon which moral rules are based, and stress the psychological motives of the behavior. It might be of interest, in a future study, to investigate the effect of a training in ToM abilities on autonomous MJ in individuals with Autism Spectrum Disorder.

AUTHOR CONTRIBUTIONS

RF contributed to the conception and design of this work. She collected, analyzed and interpreted the data. She wrote

the manuscript. MP made the conception and design of this work. She contributed to the analysis and interpretation of the results. LF, GS, MF, and AS contributed to data collection, to the analysis and interpretation of the results. GD contributed to the conception and design of this work and to the interpretation of the data. All the authors reviewed the final version of the manuscript and approved it for publication.

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Emotion Understanding in Clinically Anxious Children: A Preliminary Investigation

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Children's understanding of the nature, origins and consequences of emotions has been intensively investigated over the last 30–40 years. However, few empirical studies have looked at the relation between emotion understanding and anxiety in children and their results are mixed. The aim of the present study was to perform a preliminary investigation of the relationships between emotion understanding, anxiety, emotion dysregulation, and attachment security in clinically anxious children. A sample of 16 clinically anxious children (age 8–12, eight girls/boys) was assessed for emotion understanding (Test of Emotion Comprehension), anxiety (Screening for Child Anxiety Related Emotional Disorders-Revised and Anxiety Disorder Interview Schedule), emotion dysregulation (Difficulties in Emotion Regulation Scale) and attachment security (Security Scale). Children who reported more overall anxiety also reported greater difficulties in regulating their emotions, and were less securely attached to their parents. The results also showed that more specific symptoms of anxiety (i.e., OCD and PTSD) correlated not only with emotion dysregulation and attachment insecurity but also with emotion understanding. Finally, there were interrelations among emotion understanding, attachment security, and emotion dysregulation. The present results provide the first comprehensive evidence for a socio-emotional framework and its relevance to childhood anxiety.

Keywords: emotion understanding, anxiety, emotion regulation, attachment, children, clinical sample

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INTRODUCTION

Emotion understanding can be considered as the affective side of Theory-of-Mind (Wellman, 2014) and can be defined as the understanding of the nature, origins, consequences and regulation of emotion in the self and others (Harris et al., in press). Emotion understanding has been intensively investigated, especially in typically developing children, during the last 30–40 years. At least six conclusions have emerged from this large corpus of empirical investigations. First, in accordance with Piaget's hypothesis about the development of consciousness "from the periphery to the center" (Piaget, 1974a,b), children's understanding of emotions develops from a peripheral and superficial understanding of rather visible and non-reflective aspects of emotions (e.g., recognition of basic emotions, understanding of the impact of external causes and desires on emotions) to a more central and deeper understanding of the more invisible and reflective aspects of emotions (e.g., understanding of mixed and moral emotions, understanding of the possibility of regulating emotions by using cognitive strategies) via an intermediate "stage" where children understand the

distinction between expressed and felt emotions, the impact of beliefs and memories on emotions and the impact of emotions on cognitions. Second, although some variation in rate of development has been observed across cultures (often related to socio-economic factors) this movement from the periphery to the center seems to be universal. Third, stable individual differences in children's understanding of emotions have been observed from early childhood to late adolescence. Fourth, many interrelated social, cognitive and emotional factors such as children's language, intelligence, executive functions, and maternal attachment relationships (including maternal sensitivity, as well as emotional responsiveness and communication) contribute to these developmental changes and individual differences. Fifth, children's emotion understanding is related, not only to the quality of their psychological well-being (self-esteem, anger, behavioral problems, etc.) and their social relationships with peers and adults (friendship, popularity, cooperation, etc.) but also to their ability to resolve cognitive problems alone or in a group. Sixth, it is possible to help typical and challenged children to improve their emotion understanding via, for example, cognitive-behavioral programs, language-based interventions or philosophically based programs both in an experimental setting and at school (e.g., Marchetti et al., 2006; Gavazzi and Ornaghi, 2011; Nunez, 2011; Daniel and Gimenez-Dasi, 2012; Albanese and Molina, 2013; Andrés-Roqueta et al., 2013; Baron-Cohen et al., 2013; Molina et al., 2014; Harris et al., in press; Viana et al., submitted, for reviews and illustrations).

This corpus of investigations represents a substantial advance in our comprehension of children's understanding of emotions. However, although several studies have looked at emotion understanding in challenged children (e.g., autistic, deaf, with specific language impairment), few have looked at the relation between emotion understanding and anxiety in children. Anxiety is an emotional disorder involving the experience of fear and danger that is either irrational and/or disproportionate to the perceived threat and has a negative impact on one or more areas of children's normal functioning and/or psychosocial development (e.g., Fonseca and Perrin, 2011). Studies that have investigated the relation between children's understanding of emotions and anxiety show mixed results. For example, studies have shown that children suffering from social anxiety have difficulties interpreting others' facial (Simonian et al., 2001) and vocal (McClure and Nowicki, 2001) emotional cues. It has also been demonstrated that socially anxious children experience difficulties in understanding the relations between emotions, intentions, and beliefs in social situations (Banerjee and Henderson, 2001), and that a decreased ability to differentiate between emotions relates to social anxiety in children and adolescents (Rieffe et al., 2008). Sprung and Harris (2010) found that, in hurricane Katrina-exposed children, there was a positive correlation between their knowledge about thinking (including emotions) and their capacity to report on their negative intrusive thoughts. Southam-Gerow and Kendall (2000) found that anxious children have a less developed understanding of the possibility of hiding and changing emotions. A recent meta-analysis found a small-to-medium, negative correlation between general internalizing problems, such as anxiety and depression, and children's ability to understand emotional cues (Trentacosta and Fine, 2010).

The relation between children's understanding of emotions and their ability to regulate those emotions also deserves attention. The regulation of emotions is a complex and dynamic process involving the ability to assess the context surrounding an emotional experience, identifying and evaluating the emotional experience, as well as modifying the expression of emotion in accordance with personal goals and social demands (e.g., Jacob et al., 2011). It has been suggested that children must possess an understanding of emotions in order to be able to effectively regulate their emotions (Suveg et al., 2009; Izard et al., 2011). Indeed, in an intervention study, Izard et al. (2008) employed an emotion-based prevention program developed for young children, and showed that gains in emotion regulation were mediated by gains in emotion understanding. Other research has found that a better emotional understanding relates to improved emotion regulation abilities in children (Cunningham et al., 2009).

In a different line of research, the links between children's emotion understanding and parent–child attachment relationships have been investigated. An attachment relationship may be understood as the bond between child and caregiver, which constitutes an emotional and behavioral system aimed at establishing and maintaining caregiver proximity in threatening situations (e.g., Manassis, 2011). According to Bowlby (1973, 1982), caregivers who respond sensitively and consistently to their children's attachment-related needs and behaviors lay the foundation for the development of a secure attachment relationship. Securely attached children come to think of themselves as being able to elicit proximity and care from their attachment figures in times of distress, which allows them to explore their environment confident that they will be able to elicit help should they need it. Research investigating this association has shown that well-functioning attachment relations within families play an important role in the development of children's emotional understanding (see e.g., de Rosnay and Harris, 2002; Ontai and Thompson, 2002; de Rosnay et al., 2008). For example, Steele et al. (1999) found that infant-mother attachment at 1 year predicted children understanding of mixed emotions 5 years later.

In line with the research concerning children's emotion understanding, research focusing on childhood anxiety has also directed its attention toward the relation between anxiety disorders and insecure attachment relationships with parents (e.g., Muris et al., 2000, 2001; Shamir-Essakow et al., 2005), as well as difficulties in regulating emotions (e.g., Suveg and Zeman, 2004; Carthy et al., 2010; Neumann et al., 2010). Although several authors have argued that emotion regulation abilities in children may be related to attachment security (e.g., Cassidy, 1994; Sroufe, 1996), the vast majority of studies has investigated either the association between anxiety and attachment security, or the association between anxiety and emotion regulation abilities (e.g., Esbjørn et al., 2012, for a review). Very few studies have investigated the relation between emotion regulation, attachment security, and anxiety within the same individuals (however, see Bosquet and Egeland, 2006; Brumariu et al., 2012; Bender et al.,

2015, for exceptions). Furthermore, many of these studies have been conducted using community samples. Thus, an examination of the associations among anxiety, emotion regulation, and attachment security within clinical populations is called for in order to see whether the interrelations found in community samples correspond to those found in clinical populations (Esbjørn et al., 2012).

In summary, to the best of our knowledge, no research has simultaneously examined the relationships between emotion understanding, anxiety, emotion regulation and attachment security either within the same individuals or in clinically anxious children. By investigating the relation among these four variables, we should not only expand the field of research on the development of emotion understanding among atypical children (e.g., beyond autism) but also improve our understanding of the interplay among these variables. It is also important to combine these variables in the same study so as to expand our knowledge about the role of socio-emotional factors in the etiology and maintenance of anxiety disorders in childhood. Although research has demonstrated that traditional cognitive-behavioral therapy (CBT) is an effective tool in relation to childhood anxiety (e.g., Barrett et al., 2001; Hirshfeld-Becker et al., 2008), meta-analytical investigations have shown only moderate effect sizes for the efficacy of CBT with children and called for the improvement of traditional CBT treatment (Reynolds et al., 2012). In order to develop treatment protocols that target a greater range of the factors involved in the etiology and maintenance of childhood anxiety, and thus, maximize treatment outcome, a simultaneous investigation of the various factors related to childhood anxiety disorders, such as emotion understanding, emotion regulation and attachment, is called for.

The goal of the present study was to conduct a preliminary examination of the associations between children's anxiety, their understanding of emotions, their difficulties regulating emotions, and the quality of parent–child attachment relationships in a sample of children diagnosed with anxiety disorders. Because many of the previous investigations have been conducted using community samples, we asked whether we would find the same associations among anxiety, emotion understanding, emotion regulation, and attachment security, as other studies; namely that more anxious children will show more limited emotion understanding, greater difficulties regulating their emotions, and report less attachment security than less anxious children (e.g., Brumariu et al., 2012; Bender et al., 2015). Additionally, we asked whether a better emotional understanding in children would be associated with less anxiety, fewer emotion regulation difficulties, as well as more secure attachment relationships with parents, as suggested, in theory, by the literature.

MATERIALS AND METHODS

Participants

Participants were 16 children (eight girls, eight boys) ranging from 8 to 12 years ($M = 10.38$, $SD = 1.54$). Children had been referred for anxiety treatment to the Copenhagen Child Anxiety Project (CCAP) at the University of Copenhagen; they were a sub-sample of children referred for participation in a randomized trial, assessing the efficacy of two types of CBT intervention for anxiety (Esbjørn et al., 2015). For intervention purposes, all children had to have one of four anxiety disorders [generalized anxiety disorder (GAD), separation anxiety disorder (SAD), specific phobia (SP) and/or social phobia (SoP)] as their primary diagnosis. Children were diagnosed using the ADIS-IV interview assessment; only children scoring above the clinical cut-off for at least one of the anxiety disorders were included. Because studies have shown that children with cognitive developmental delays exhibit poorer social skills and problem solving abilities than typically developing children (Fenning et al., 2011; Wieland et al., 2014), only children with a full-scale IQ of 85–115 were examined in the current study (mean IQ for the sample was 105.13; $SD = 8.29$). Also, because of previously found gender differences with regard to childhood anxiety and emotion regulation difficulties (e.g., Bender et al., 2012), we balanced gender in the current study by including an equal number of boys and girls. From the eligible sample of 21 children (13 girls, 8 boys), five girls were excluded (the eight girls included in the current study were matched as closely as possible to boys with respect to IQ and age). All children were Danish and had provided valid answers to all measures of interest at pre-treatment. See **Table 1** for additional clinical and demographic information.

Procedure

All data presented here constitute pre-treatment data. Children were assessed at the University Clinic at the University of Copenhagen prior to their participation in the CBT programs. All testing was carried out on the same day by members of the CCAP staff and students associated with CCAP. Prior to inclusion in the project, parents had provided informed, written consent to participate in the study. On the day of testing, children and parents were informed that they could terminate participation in the study at any time. Parents and children were interviewed and assessed separately. For child questionnaire measures, experimenters read aloud the various items and children were asked to check the answers they felt were most appropriate.

Measures

Anxiety Disorders Interview Schedule for DSM-IV: Child and Parent Versions (ADIS-IV-C/P)

The ADIS-IV-C/P (Silverman and Albano, 1996) is a semi-structured interview assessing anxiety disorders and other types of psychopathology in children according to DSM-IV criteria (American Psychiatric Association [APA], 1994). The instrument consists of two separate interviews, one conducted with the child, and one conducted with the child's parents. Both children and parents rate the severity of symptoms experienced by the child on a scale from 0 to 8, where a rating of 4 or higher indicates clinical levels of difficulties and leads to a diagnosis of the disorder in question. Based on the separate child and parent interviews, a combined diagnostic description of the child is created, summarizing any number of diagnoses obtained via

TABLE 1 | Sample clinical and demographic information.

	n
Primary ADIS-IV diagnosis ($n = 16$)	
Generalized anxiety disorder	3
Separation anxiety disorder	7
Social phobia	1
Specific phobia	5
Number of ADIS-IV diagnoses ($n = 16$)	
One diagnosis	5
Two diagnoses	7
Three diagnoses	4
Family status ($n = 16$)	
Child lives with both parents	12
Parents are divorced	4
Number of siblings (n = 16)	
Three siblings	3
Two siblings	2
One sibling	9
No siblings	2
Educational level mother ($n = 14$)	
Short	2
Medium (vocational; business, technical)	1
Medium (academic; BA)	3
Long (Master's)	8
Educational level father ($n = 13$)	
Medium (vocational; business, technical)	3
Medium (academic; BA)	2
Long (Master's)	8
Family income ($n = 13$)	
Below average	1
Average	1
Above average	3
High	8

See http://www.dst.dk/en/Statistik/emner/indkomster/familieindkomster for the Danish average family income.

both child and parent severity ratings. In the current study, most children presented with one or two anxiety disorders with a maximum of three diagnoses recorded per child (see **Table 1**). The ADIS-IV-C/P has been shown to be a reliable instrument for deriving DSM-IV anxiety disorder diagnoses in children (Silverman et al., 2001).

Screen for Child Anxiety Related Emotional Disorders-Revised (SCARED-R)

The SCARED-R (Muris et al., 1998; Muris and Steerneman, 2001) is a self-report questionnaire, assessing DSM-IV related anxiety disorder symptoms in children. The SCARED-R consists of 66 items and nine subscales, which provide indices of the following DSM-IV anxiety disorders: (1) separation anxiety disorder (SAD), (2) panic disorder, (3) social phobia, (4) obsessive-compulsive disorder (OCD), (5) post-traumatic stress disorder (PTSD), (6) generalized anxiety disorder (GAD), and (7) specific phobias. Items are rated on a 3-point Likert scale (0 = almost never; 1 = sometimes, and 2 = often) and assess the frequency with which children experience the symptoms described by the various items. The total score of the SCARED-R is reported as a sum score ranging from 0 to 132. The SCARED-R has shown good internal consistency (Muris and Steerneman, 2001). In this study, Cronbach's α was 0.93 for the SCARED-R total score; subscale's α ranged from 0.62 to 0.90 (two items of the OCD subscale had zero variance and were removed from the Cronbach's α calculations).

Test of Emotion Comprehension (TEC)

The TEC (Pons and Harris, 2000) consists of a picture book containing cartoon scenarios, which are accompanied by various descriptions and stories designed to test children's understanding of emotions. Each scenario comes with four possible emotional story outcomes, represented as the facial expressions of the story protagonist, which are left blank in the scenario itself. After children are introduced to the individual scenario and the experimenter has read the accompanying story, children are asked to attribute an emotion to the story protagonist(s) by pointing at the most appropriate of the four possible emotional outcomes. The TEC assesses nine different components of emotion understanding: (1) recognition of facial expressions, (2) understanding of external causes of emotions, (3) understanding of desire-based emotions, (4) understanding of belief-based emotions, (5) understanding of the influence of a reminder on present emotional states, (6) understanding of the possibility to regulate emotional states, (7) understanding of the possibility of hiding emotional states, (8) understanding of mixed emotions, and (9) understanding of moral emotions. The TEC yields a total score from 0 to 9 based on children's overall level of emotion understanding. The TEC has been translated into 23 languages until now. It has shown good test–retest reliability, as well as concurrent, criterion and construct validity. It has been standardized in Italian and Portuguese (see e.g., Pons et al., 2014 for a recent review).

Difficulties in Emotion Regulation Scale (DERS)

The DERS (Gratz and Roemer, 2004) is a self-report questionnaire, which consists of 36 items and measures difficulties with regard to emotion regulation. Items are rated on a 5-point Likert scale, ranging from 1 (almost never) to 5 (almost always) and assess the frequency with which respondents experience emotion regulation difficulties. The DERS consists of six subscales: (1) non-acceptance of negative emotional responses, (2) difficulties engaging in goal-directed behavior when experiencing negative emotions, (3) difficulties controlling impulses when experiencing negative emotions, (4) lack of awareness of emotional responses, (5) limited access to emotion regulation strategies perceived as effective, and (6) lack of clarity of emotional responses. The DERS has shown good internal consistency (Neumann et al., 2010). However, it has been suggested that the subscale assessing lack of awareness of emotional responses be removed when interpreting the DERS total score (Bardeen et al., 2012). In the current study, the lack of awareness subscale was removed and the DERS index computed based on the remaining five subscales, yielding a score from 1 to 5. Cronbach's α for the DERS total without the awareness subscale (items $n = 30$) was 0.92.

Security Scale

The Security Scale (Kerns et al., 1996) is a self-report measure, which assesses children's perceptions of security in parent–child relationships. The instrument consists of 15 items, which assess: (1) the degree to which children perceive their parents as being responsive and available, (2) children's tendency to rely on their parents in times of distress, and (3) children's ease and interest in communicating with their parents. Items are rated on a 4-point scale using an opposing statements format ("Some kids... Other kids..."). For example, "Some kids find it easy to trust their mom BUT other kids are not sure if they can trust their mom." Children are asked to indicate which of the two statements is more characteristic of them, and whether this statement is "really true" or "sort of true" for them. The Security Scale yields an overall score from 1 to 4, where higher scores indicate a more secure attachment. In order to get a more comprehensive picture of children's attachment relationships, children were asked to fill out the Security Scale for both their mothers and fathers. These two scores were then added and divided by two to get an overall parental attachment security score, ranging from 1 to 4. The Security Scale has shown good internal consistency (Kerns et al., 1996; Van Ryzin and Leve, 2012). In this study, Cronbach's α was 0.81 for mother, and 0.73 for father.

Cognitive Ability/IQ Index: Wechsler Intelligence Scale for Children-III (WISC-III) Subtests

In the present study, an index of children's IQ was obtained using the WISC-III (Wechsler, 1991), which assesses children's verbal, performance, and full scale IQ. The subtests employed in the current study included the verbal subtests Information, Similarities, Vocabulary, and Arithmetic, as well as the performance subtests Picture arrangement, Picture Completion, Coding, and Block Design. Based on children's scores on these subtests, the full scale IQ was computed.

RESULTS

Data Analyses

In this study, we employed one-sample *t*-tests to test for differences between the various measure mean scores obtained here and mean scores found in other studies. One-sample *t*-tests compare a sample mean to a known or hypothesized value of the mean in the population. In this case, the hypothesized population means for the individual measures were the weighted overall means extracted from the literature (see Appendix A). To test for associations among the various measures, we used one-tailed, bivariate Pearson's correlations, which measure the strength and direction, as well as the significance of linear relationships between pairs of variables. We chose to employ one-tailed correlations due to the small sample size of this preliminary study, as well as the directional assumptions regarding the correlation (i.e., positive versus negative) among the assessed variables.

In order to see whether the current sample of clinically anxious children differed from other samples of both non-clinical, as well as clinically anxious children, we first compared the mean scores obtained in this study to mean scores obtained from the literature. Next, we examined the relations among the overall measures of anxiety, emotion understanding, emotion regulation, and attachment security, to see whether we would find the associations that have been found in various, separate lines of research in this sample of clinically anxious children. Finally, we investigated the associations between the subscales of the SCARED-R and the overall measures of emotion understanding, emotion regulation, and attachment security, in order to see which aspects of children's anxiety symptoms explained the relations among the overall measures. **Table 2** shows the sample means and correlations among the variables examined in this study.

Comparison with Clinically Anxious and Non-clinical Samples

In order to compare the mean scores obtained in this study to overall mean scores from the literature, one-sample *t*-tests were used (see Appendix A for a list of studies and values from the literature). Results showed that children in this study did not differ from community samples of children with regard to their level of anxiety ($M = 27.31$, $SD = 16.37$) and scored significantly lower than other samples of clinically anxious children from the US [$t(15) = -6.00$, $p < 0.001$]. However, results also showed that children who reported higher levels of anxiety also received a higher number of anxiety diagnoses ($r = 0.71$, $p = 0.001$). Results further showed that children in this study did not differ from community samples of children with regard to their emotion understanding ($M = 7.81$, $SD = 1.33$), their emotion regulation difficulties ($M = 2.27$, $SD = 0.46$), or their perceptions of parent–child attachment security ($M = 3.29$, $SD = 0.39$).

Relation between Anxiety, Emotion Regulation, Attachment and Emotion Understanding

One-tailed, bivariate Pearson's correlations were used to investigate the relations among the overall measures of anxiety, emotion understanding, emotion regulation, and attachment security (see **Table 2**). Results showed that children who reported higher levels of anxiety had more difficulties regulating their emotions ($r = 0.49$, $p = 0.03$) and thought of their attachment relationships as less secure ($r = -0.49$, $p = 0.03$). Although negative, the relation between children's overall level of anxiety and their level of emotion understanding was not significant. Correlation analyses also showed that children who had a more developed understanding of emotions had fewer difficulties regulating their emotions ($r = -0.46$, $p = 0.04$), and thought of their attachment relationships as more secure ($r = 0.42$, $p = 0.05$). Finally, analyses showed that children who reported perceptions of a more secure attachment relationship with their parents also reported fewer difficulties in regulating their emotions ($r = -0.42$, $p = 0.05$).

To determine which subscales of the SCARED-R accounted for the relations among the total SCARED-R scores and the other measures, one-tailed, bivariate Pearson's correlations were conducted (see **Table 2**). The analyses showed that the association between anxiety and emotion regulation was largely due to an association between the OCD subscale and the DERS

TABLE 2 | Sample means (*SD*) and correlations table.

		1	2	3	4	5	6	7	8	9	10	11
	M (*SD*)											
(1) TEC	7.81(1.33)	1										
(2) DERS	2.04(0.55)	−0.46 *	1									
(3) SecScale	3.29(0.39)	0.42 *	−0.42*	1								
(4) ADIS	1.94(0.77)	−0.01	0.32	−0.20	1							
(5) SCARED-R	27.31(16.37)	−0.22	0.49*	−0.49*	0.71**	1						
(6) SAD	0.48(0.28)	0.17	0.33	−0.24	0.71**	0.72**	1					
(7) Panic	0.29(0.28)	−0.13	0.37	−0.46*	0.35	0.78**	0.30	1				
(8) Soc. phobia	0.39(0.41)	−0.16	0.26	−0.34	0.67**	0.83**	0.59**	0.48*	1			
(9) OCD	0.31(0.26)	−0.51*	0.62**	−0.61**	0.40	0.79**	0.45*	0.62**	0.65**	1		
(10) PTSD	0.44(0.51)	−0.63 **	0.41	−0.55*	0.54*	0.67**	0.36	0.46*	0.50*	0.78**	1	
(11) GAD	0.44(0.49)	−0.17	0.34	−0.34	0.80**	0.85**	0.67**	0.45*	0.78**	0.57*	0.62**	1
(12) Spec. phobia	0.51(0.25)	−0.04	0.36	−0.24	0.36	0.76**	0.42*	0.79**	0.59**	0.46*	0.16	0.45*

*TEC, Test of Emotion Comprehension; DERS, Difficulties in Emotion Regulation Scale; SecScale, Security Scale (parents); ADIS, Anxiety Disorder Interview Schedule (number of diagnoses); SCARED-R, Screen for Child Anxiety Related Emotional Disorders-Revised. SCARED-R subscales (reported as mean values, range: 0–2): SAD, separation anxiety disorder; Panic, panic disorder; Soc. phobia, social phobia; OCD, obsessive-compulsive disorder; PTSD, post-traumatic stress disorder; GAD, generalized anxiety disorder; Spec. phobia, specific phobia. *$p \leq 0.05$; **$p < 0.01$.*

($r = 0.62$, $p = 0.005$). The relation between anxiety and perceived attachment security was due to associations between the Security Scale and the Panic disorder subscale ($r = -0.46$, $p = 0.04$), the OCD subscale ($r = -0.61$, $p = 0.007$), and the PTSD subscale ($r = -0.55$, $p = 0.01$), respectively. Although the overall measures of anxiety and emotion understanding did not correlate significantly with each other, the subscale analyses showed significant associations between the TEC and the OCD subscale ($r = -0.51$, $p = 0.02$), as well as the PTSD subscale ($r = -0.63$, $p = 0.004$).

DISCUSSION

This was the first study to investigate the relations among anxiety, emotion understanding, emotion regulation, and attachment security in the same sample of clinically anxious children. The findings of the current study are in line with previous studies showing that more anxious children have greater difficulties in regulating their emotions (e.g., Carthy et al., 2010), and experience attachment relationships with their parents as less secure (e.g., Colonnesi et al., 2011). Also in line with previous findings, this study shows that a better emotional understanding in childhood is associated with higher attachment security (e.g., de Rosnay and Harris, 2002) and fewer emotion regulation difficulties (e.g., Izard et al., 2008). Finally, this study shows that children who report a more secure attachment also report fewer difficulties regulating their emotions. Although previous research has demonstrated these associations in separate studies, using predominantly community samples, the current study combines and extends these findings to children with anxiety disorders.

When investigating the relations between the subscales of the SCARED-R and the overall measures of emotion understanding, emotion regulation difficulties, and attachment security, respectively, results showed that the OCD subscale correlated positively with emotion dysregulation and negatively with emotion understanding and attachment security. The PTSD subscale correlated negatively with emotion understanding and attachment security. And finally, the Panic disorder subscale correlated negatively with attachment security. Although none of the children in this study were specifically diagnosed with OCD, PTSD, or Panic disorder, these subscales contain items that may also be regarded as more generic indices of intrusive anxiety problems (e.g., "I have thoughts that frighten me," "I do things to get less scared of my thoughts," "When frightened, I sweat a lot," and "When frightened, my heart beats fast"). This study replicates and extends the findings of previous research on intrusive thoughts in hurricane-Katrina exposed children (Sprung and Harris, 2010); a better understanding of emotion is associated with less PTSD and OCD.

Although the present study cannot answer questions regarding the causal pathways connecting anxiety, emotion understanding, emotion dysregulation, and attachment security, the results obtained here once again underline the relevance of socio-emotional factors in relation to childhood anxiety. Based on theoretical conceptions and previous research, as well as the results obtained in this study, we can formulate testable hypotheses regarding the interactions among these factors. For example, research on the development of emotion understanding has shown that parents who establish secure attachment relationships with their children also tend to use more mental state language in conversation with their children (e.g., McQuaid et al., 2008). This is thought to not only provide a safe environment for children to experience an adequate range of their own emotions but also to teach children about emotions, their antecedents and consequences, via discussions with their parents (see Harris, 1999). Similarly, it has been argued that the defining characteristic of a secure attachment relationship is the effective parent-child co-regulation of children's emotions in times of distress (Sroufe, 1996). This is thought to help children develop adequate strategies for handling their own emotional arousal and lay the basis for later emotional self-regulatory

abilities (see Sroufe, 2005). Thus, one hypothesis is that children's attachment relationships with parents may constitute the basis on which developing emotional competencies are built.

Consistent with previous findings, this study found a relation between children's perceptions of attachment security and reported levels of anxiety. However, recent studies (e.g., Brumariu et al., 2012; Bender et al., 2015) raise questions regarding the nature of this association; that is whether attachment security relates directly to anxiety or whether the effect is mediated via other factors. Although this could not be tested in the current study, given the theoretical importance of attachment security to child emotional functioning (e.g., Cassidy, 1994), as well as the well-established link between emotional dysregulation and childhood anxiety, another hypothesis is that attachment security relates to anxiety via children's emotional capacities, including children's emotion understanding and regulation. Indeed, research suggests that the relation between attachment security and childhood anxiety may be mediated by children's emotion regulation abilities (Brumariu et al., 2012; Bender et al., 2015).

Although some studies have found an association between children's understanding of emotions and anxiety, there was no significant relation between the overall measures of these two factors in the current study (the only significant relation was between emotion understanding and the specific measures of PTSD and OCD). Children in this study were relatively old and scored high on emotion understanding. It is possible that emotion understanding is more strongly related to anxiety in younger children who have a less developed understanding of emotions. In any case, emotional understanding appears to be a part of the socio-emotional framework surrounding child anxiety via its links to attachment security and emotion dysregulation. However, whereas the association between emotion understanding and attachment security seems to be relatively clear, the relation between children's understanding of emotions and their ability to regulate their own emotions is less clear. Although it is plausible that some understanding of emotions is necessary for an effective regulation of emotional states to take place, emotional regulation often precedes an explicit knowledge of emotions (Southam-Gerow and Kendall, 2002). More research is needed to study the relation between emotion understanding and emotion regulation in children with anxiety disorders. Meantime, we hypothesize a dynamic relationship between the two factors based on the assumption that the affective experiences that children collect via their emotion regulation efforts will influence the cognitive structures and processes related to the regulated emotional states, and vice versa (Rieffe et al., 2005; Pons et al., 2010).

Taken together, the findings presented here and other findings and concepts found in the literature point to a series of testable hypotheses regarding the socio-emotional framework relevant to childhood anxiety (see **Figure 1**). The proposed framework is to be regarded as the beginnings of a conceptualization of the relevant socio-emotional factors and their relation to each other, as well as to child anxiety. Future research will need to refine and revise the hypotheses laid out here. Also, a number of other factors, such as behavioral inhibition (e.g., Shamir-Essakow et al., 2005), peer relations (e.g., Bosquet and Egeland, 2006), cognitive biases (see Hadwin et al., 2006), cognitive development (e.g., Fenning et al., 2011), and gender (e.g., Bender et al., 2012), are likely to be related to this framework, and future investigations need to examine how the various factors are associated with each other. It is our hope that the revision and development of the socio-emotional framework proposed here will lead to a better understanding of the etiology and maintenance of anxiety disorders in childhood, which in turn will help develop more effective prevention and treatment protocols for child anxiety.

An unexpected finding of the current study was that children showed lower levels of anxiety than clinically anxious children in other studies and did not differ from community samples of children with regard to their level of anxiety. However, previous research has found that Danish children tend to score lower on self-report measures assessing anxiety and worry than, for example, US children (e.g., Reinholdt-Dunne et al., 2012; Esbjørn et al., 2013), and that Danish individuals tend to overrate their own health in self-report measures (Jürges, 2007). Further, we have to keep in mind that community samples also include children who experience clinical levels of anxiety, and thus,

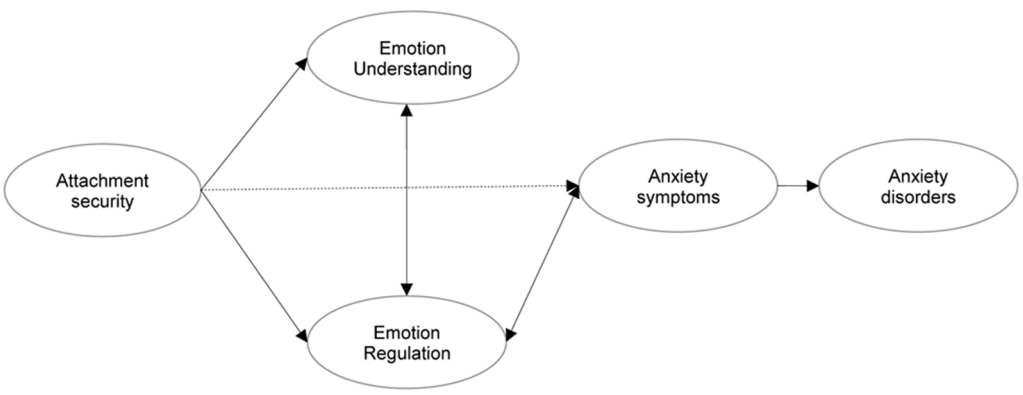

FIGURE 1 | Testable hypotheses regarding the socio-emotional framework of child anxiety.

anxiety levels found in community samples are not synonymous with the expected levels of anxiety found in positively non-anxious children. While we cannot definitely identify the reason for this finding, the high correlation (0.71) between children's anxiety symptoms as assessed by the SCARED and the number of children's ADIS-IV anxiety diagnoses indicates that we successfully assessed differentiating levels of anxiety in the current sample of Danish children diagnosed with anxiety disorders.

The present results cannot in themselves answer questions regarding causal pathways among the various factors. Furthermore, the findings presented here are preliminary and based on a small sample of clinically anxious children and should therefore be interpreted with caution. However, in an effort to control for possible confounding influences, the sample was carefully selected with respect to gender, age, as well as cognitive abilities. In sum, the results underline the links between anxiety, emotion understanding, emotion dysregulation, and attachment security, and highlight the importance of combining the various lines of research concerned with these factors. Although studies separately examining the individual associations have identified the factors of interest in relation to childhood anxiety, it is now time to develop a comprehensive picture of the interrelations among these factors, and future research should investigate these using larger samples, as well as longitudinal and experimental research designs. Based on this, as well as other studies and theoretical concepts, a socio-emotional framework was proposed, outlining hypotheses regarding the pathways connecting the various socio-emotional factors to each other, as well as anxiety in children.

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SUPPLEMENTARY MATERIAL

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Evidence for Trait Related Theory of Mind Impairment in First Episode Psychosis Patients and Its Relationship with Processing Speed: A 3 Year Follow-up Study

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This study aimed to confirm whether first-episode psychosis patients present a stable trait impairment in theory of mind (ToM) and to examine the potential relationship between ToM and clinical symptomatology and neurocognition. Patients with a first episode of psychosis ($N = 160$) and healthy controls ($N = 159$) were assessed with an extensive neuropsychological test battery, which included a mental state decoding task known as "The Reading the Mind in the Eyes" (Eyes test), at baseline and reassessed after 1 and 3 years. The clinical group performed below healthy controls on the Eyes test while not showing test-retest differences between baseline and follow-up administrations. Analyses revealed age, education and premorbid IQ as potential moderators. Poorer performance on the Eyes test was not linked to clinical symptomatology but was associated with greater neurocognitive deficit, particularly related to processing speed. The persistence of ToM deficits in patients suggests that there are trait related metalizing impairments in first episode psychosis. This study shows the influence of processing speed and moderator variables on efficient ToM.

Keywords: first episode psychosis, theory of mind, processing speed, clinical symptoms, schizophrenia

INTRODUCTION

There has been a growing interest over the last three decades in theory of mind (ToM), defined as the ability to attribute mental states to oneself and others (Baron-Cohen, 1991). ToM impairment has been confirmed in schizophrenia (Sprong et al., 2007; Bora et al., 2009), with important implications for social functioning (Bora et al., 2006). However, whether ToM deficits are state

dependent or trait characteristics, and the nature of the relationship with neurocognitive deficits and clinical symptoms remains controversial.

A review of the literature supports the hypothesis that deficits in ToM are specific rather than secondary to symptoms or general cognitive decline. Bora et al. remark in their meta-analysis (Bora et al., 2009), that the persistence of ToM deficits, even in "remitted" patients, suggests trait related metalizing impairments in schizophrenia. However, a more severe ToM impairment related to positive and negative symptoms (Bora et al., 2008), and well as disorganization and other behavioral symptoms (Brüne, 2005b), point toward specific ToM deficits in schizophrenia as state dependent (Pousa et al., 2008). In terms of neurocognitive functioning, studies are contradictory when establishing ToM deficits as an independent trait (Bozikas et al., 2011) or secondary to general neurocognitive dysfunction (Pentaraki et al., 2012), and particularly related to working memory, attention and executive functions (Bozikas et al., 2011).

Regretfully, as So et al. (2010) pointed out, most of the available studies are limited in their generalizability in that they have small samples sizes without appropriate healthy control groups, and few are longitudinal or differ in the measurement of ToM performance. Meanwhile, few studies have examined ToM in first episode psychosis (FEP) patients (Inoue et al., 2006; Thompson et al., 2012; Bora and Pantelis, 2013; Fernandez-Gonzalo et al., 2014). To the best of our knowledge, two studies with FEP presented longitudinal, 1-year follow-up, designs: Addington et al. (2006) with 50 FEP and 55 non-psychiatric controls; and Horan et al. (2012) with 55 FEP patients, but without long-term information for a control group. While studies that investigate ToM impairment in early phases are important to understanding the nature of ToM dysfunction in schizophrenia, longitudinal studies are necessary to investigate the trajectory of ToM deficits and to shed light on the controversy of whether such deficits are state-like or trait-like.

AIMS OF THE STUDY

The aims of our study were to explore whether there is a difference in ToM performance in FEP patients relative to healthy individuals and to determine the stability on performance at 1 and 3-year follow-ups. We hypothesized that FEP patients would have persistently lower performance compared to that of healthy volunteers. We also aimed to explore the ties between ToM and other neuropsychological and clinical variables. We hypothesized that ToM deficits would be related to neurocognitive decline and residual symptomatology.

METHODS

Participants

The study sample comes from a large epidemiological program on first-episode psychosis (PAFIP) at University Hospital Marques de Valdecilla (Santander, Spain). Ethical approval was obtained from the local Ethics Committee. A more detailed description of PAFIP has been previously given (Pelayo-Terán et al., 2008).

The patient group consisted of 160-medication naïve subjects (Age: 16–60, M: 32.11) included in the first-episode psychosis program of Cantabria, Spain, (PAFIP) recruited from January 2005 to December 2010. Written informed consent was obtained from all participants after complete description of the study. The patients met the following criteria: (1) 15–60 years of age; (2) living in the catchment area; (3) were experiencing their first episode of psychosis; (4) had no prior treatment with antipsychotic medication or, if previously treated, a total lifetime of adequate antipsychotic treatment of less than 6 weeks; and (5) met the DSM-IV criteria for brief psychotic disorder, schizophreniform disorder, schizophrenia or not otherwise specified (NOS) psychosis. The diagnoses were confirmed through the use of the Structured Clinical Interview for DSM-IV (SCID–I) (First et al., 1996) conducted by an experienced psychiatrist 6 months on from the baseline visit. Diagnoses of FEP patients were classified as: schizophrenia ($N = 87$), schizophreniform disorder ($N = 40$), brief psychotic disorder ($N = 22$) and psychosis NOS ($N = 11$). These patients were randomly assigned to: aripiprazol ($N = 64$), quetiapine ($N = 46$) or ziprasidone ($N = 50$).

A group of 159 healthy volunteers (Age: 15–51, M: 29.01) were initially recruited from the community through advertisements. They had no current or past history of psychiatric, neurological or general medical illnesses, including substance abuse and significant loss of consciousness as determined by using an abbreviated version of the Comprehensive Assessment of Symptoms and History (CASH) (Andreasen et al., 1992).

Sociodemographic and Clinical Variables

The patients were screened for demographic and clinical characteristics: age, education and symptoms of psychosis, assessed by mean scores on the Scale for the Assessment of Negative Symptoms (SANS) (Andreasen, 1983) and the Scale for the Assessment of Positive Symptoms (SAPS) (Andreasen, 1984). The SANS and SAPS scores were used in generating dimensions of positive (scores for hallucinations and delusions), disorganized (scores for formal thought disorder, bizarre behavior, and inappropriate affect) and negative (scores for alogia, affective fattening, apathy, and anhedonia) symptoms (Grube et al., 1998). Depressive symptoms were evaluated using the Calgary Depression Scale for Schizophrenia (CDSS) (Addington et al., 1992).

Neuropsychological Assessment

The neuropsychological evaluation was performed at any time between week-6 and week-13, as this time is considered optimal for patients' stabilization (González-Blanch et al., 2007). Trained neuropsychologists administered the tests.

The tests were grouped in the following cognitive domains consistently shown to be impaired in schizophrenia (Nuechterlein et al., 2004): 1- Verbal memory: the Rey Auditory Verbal Learning Test (RAVLT) (Rey, 1964) (list recall score); 2- Visual memory: Rey Complex Figure (RCF) (Osterrieth, 1944) (delayed recall); 3- Working memory: WAIS-III digits

Abbreviations: FEP, First Episode Psychosis; ToM, theory of mind.

forward and backward subtests (Wechler, 1997) (standard total score); 4- Executive function: Trail Making Test (TMT) (Reitan and Wolfson, 1985; Periáñez et al., 2007) (trail B-A score); 5- Processing speed: WAIS-III digit symbol subtest (Wechler, 1997) (standard total score); 6- Motor dexterity: Grooved Pegboard Test (Lezak, 1995) (time to complete with dominant hand); 7- Attention: Continuous Performance Test (CPT) (Cegalis and Bowlin, 1991) (correct responses); 8- Premorbid IQ: WAIS-III vocabulary subtest (Wechler, 1997).

Theory of Mind Task

The Reading the Mind in the Eyes (Eyes test) (Baron-Cohen et al., 2001) was applied to assess ToM abilities. The test requires participants to identify the mental state just from the eye region. Studies that have used the Eyes test have provided evidence of a different aspect of ToM ability: mental state decoding skill (Bora et al., 2006).

Statistical Analysis

The Statistical Package for Social Science, version 19.0 (SPSS Inc., Chicago, IL), was used for statistical analyses.

Parametric χ^2 and *t*-tests were first used to compare patients and healthy volunteers on demographic characteristics and ToM measure. Due to the longitudinal nature of the present study, repeated measure analysis of variance (ANOVA-r), adjusted for the covariates sex, age, education, and premorbid IQ, were then used to compare main effects of group, as well as group-by-time interactions on ToM. The relationship between ToM, and clinical and neuropsychological variables were then tested with Pearson correlations. *Post-hoc* comparisons were Bonferroni corrected. Finally, *t*-test and logistic regression analyses were conducted to overcome correlational limitations. The performance of the regression model was examined via Nagelkerke's R^2, a measure of the proportion of explained variation in the logistic regression models, and in addition, logistic regression yields odds ratios (ORs), which measures the strengths of associations.

All statistical tests were two-tailed, and significance was determined at the 0.05 level.

RESULTS

Sociodemographic and ToM Group Comparisons

A comparison of the 160 FEP patients and the 159 healthy controls regarding sociodemographic and ToM characteristics is presented in **Table 1**. Patients showed significantly reduced skills in ToM as can be seen in **Figure 1**.

Between-group effect on Eyes test for 107 patients and 111 healthy controls at baseline, 1-year and 3-years follow-up assessments revealed a significant main effect of group ($F = 31$; $df = 1$; $p < 0.001$), showing the patients significant impairment. There were no significant effects in within-group and time-by-group interaction in the Eyes test performance. Age ($F = 4.04$; $df = 1$; $p < 0.046$), education ($F = 4.16$; $df = 1$; $p < 0.042$) and particularly premorbid IQ ($F = 28.2$; $df = 1$; $p < 0.001$) were significant covariates (see **Figure 2**).

TABLE 1 | Comparison of sociodemographic characteristics and ToM measure for FEP patients and healthy controls.

	n	FEP patients	Healthy controls	Statistic	*p*
		Mean (*SD*)	Mean (*SD*)		
Sex (female%)	160/159	46.3	39	$\chi^2 = 1.72$	0.19
Age (years)	160/159	32.17 (10.78)	29.13 (7.93)	$t = 2.86$	0.004*
Education (years)	159/159	10.38 (3.55)	10.76 (2.77)	$t = -1.07$	0.284
Premorbid IQ	159/159	9.09 (2.55)	9.54 (2.03)	$t = -1.73$	0.085
Eyes test (baseline)	152/159	21.03 (4.78)	23.77 (4.31)	$t = -5.34$	<0.001*
Eyes test (1-year)	133/133	21.31 (5.18)	24.89 (3.75)	$t = -6.48$	<0.001*
Eyes test (3-year)	124/118	21.33 (5.68)	24.57 (3.74)	$t = -5.26$	<0.001*

*Premorbid IQ, WAIS III Vocabulary standard score; Eyes test, correct responses. *p < 0.05.*

Relationships of ToM with Clinical and Neurocognitive Variables

We conducted correlations analyses among clinical and neurocognitive variables presented in **Table 2**. Due to the large number of variables analyzed, Bonferroni correction was applied to the level 0.003 (0.05/15). After Bonferroni correction, the Eyes test did not correlate with any baseline or follow-up clinical variables: however, it moderately correlated with all baseline and 1 and 3-year follow-up neuropsychological measures (all $p <$ 0.003, except verbal memory).

In order to further explore the relationship between ToM and neurocognive function we subgrouped patients according the Eyes test's mean score in healthy subjects (Eyes test ≤ 24 = deficit ToM; Eyes test > 24 = normal ToM). Based on those criteria, 119 (78%) patients presented low performance vs. 33 (22%) which were classified as normal at Eyes test baseline assessment. Using the same methodology, at 1 and 3-year follow-up, 34 (26%) and 40 (33%) exhibited efficient ToM vs. 98 (74%) and 83 (67%) showing Eyes test underperformance, respectively. The deficit and non-deficit ToM subgroups showed significant differences in all seven cognitive domain scores at baseline (all $p < 0.017$), all but visual memory and executive functions at 1-year follow-up, and all but working memory and executive functions at 3-year follow-up. Z-scores comparisons of neuropsychological performance in the three assessment moments are presented in **Table 3** and the neuropsyhological profiles in each ToM subgroup and assessment time can be consulted in **Figure 3**.

Regression Model of the Relationship between Neurocognitive Performance and ToM

Logistic regression analyses were conducted to determine the independent effect of the seven cognitive domains on ToM. **Table 4** lists the results obtained. Processing speed (OR =

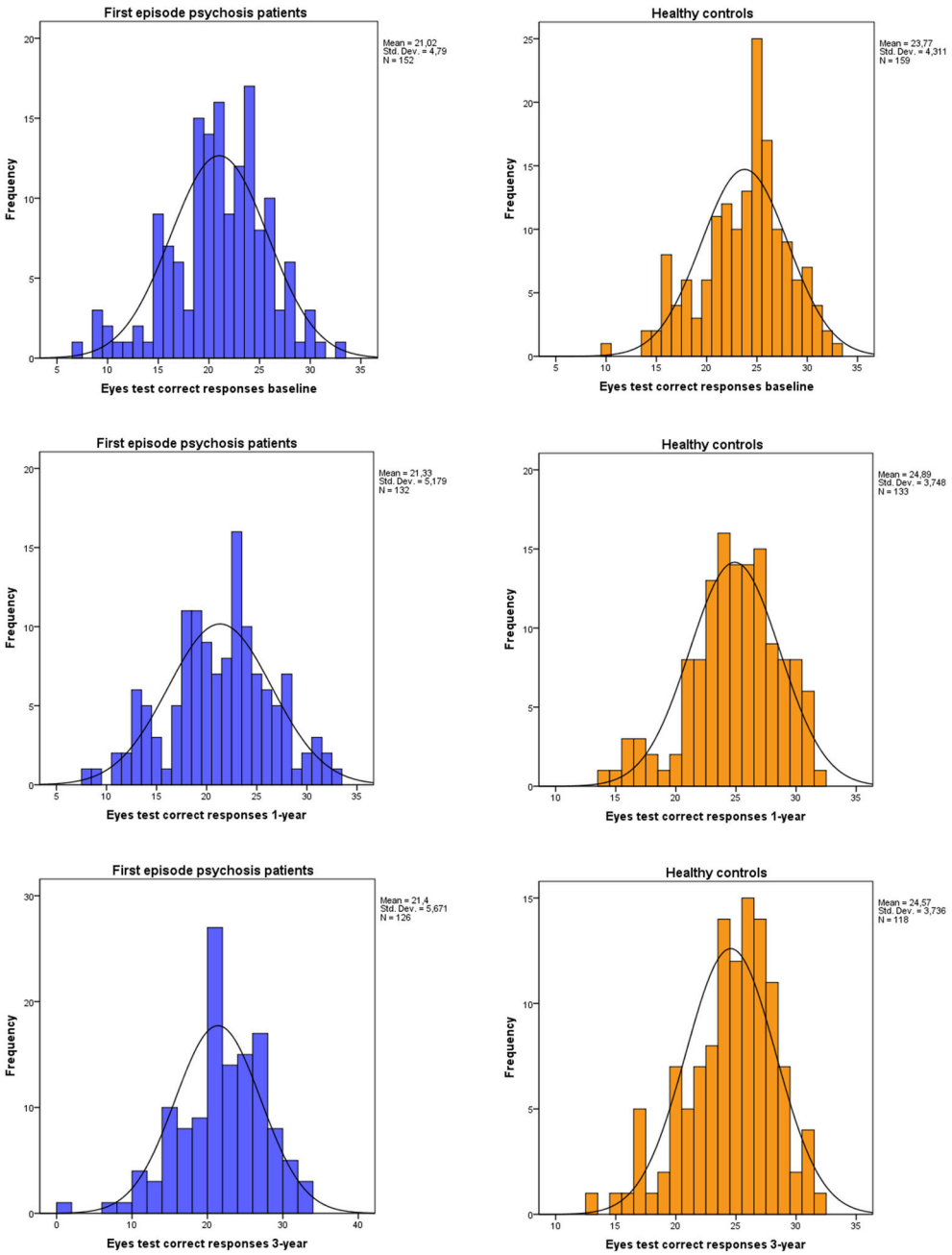

FIGURE 1 | Distributions of correct responses to the Eyes test at baseline, 1- and 3-year follow-up for both first episode psychosis patients, and healthy controls.

1.635; 95%CI 1.049–2.55; $p = 0.03$) was the unique significant contributor to efficient ToM, showing a trend toward significance in visual memory (OR = 1.431; 95%CI 0.949–2.158; $p = 0.087$). These regressions showed a well fitted model [$\chi^2_{(7)} = 24.047$, $p = 0.001$, R^2 Nagelkerke = 0.255] that predicted ToM performance with 73.9% accuracy and classified correctly 87.8% of patients with efficient ToM and 45.9% of patients with ToM impairment.

DISCUSSION

This study investigated ToM deficits in FEP patients while overcoming previous studies' limitations. We confirmed that impairment in ToM is a stable trait feature in the largest sample of FEP patients analyzed to date with a longitudinal 3-year follow-up design.

Research in this field suggests that many FEP patients experience a range of difficulties in recognizing the emotions and

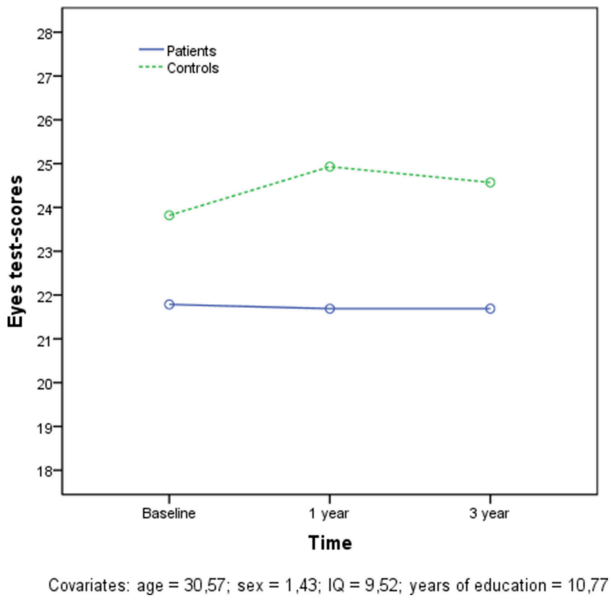

FIGURE 2 | Longitudinal results in the Eyes test for both patients and controls.

TABLE 2 | Correlations of Eyes test with baseline, 1-year and 3-year clinical and neurocognitive variables.

	n	Baseline	1-year	3-year
CLINICAL VARIABLES				
Age at onset	152	0.103		
DUP	152	−0.025		
SAPS	(152/139/132)	−0.039	−0.041	−0.069
SANS	(152/138/131)	−0.148	−0.201*	−0.117
Psychotic dimension	(152/139/132)	−0.016	−0.034	−0.06
Negative dimension	(152/138/131)	−0.101	−0.178*	−0.097
Disorganized dimension	(152/140/132)	−0.037	−0.052	−0.063
CDDS	(152/141/133)	0.06	−0.126	0.205*
NEUROCOGNITIVE VARIABLES				
Verbal memory	(152/128/118)	0.329**	0.176*	0.194*
Visual memory	(152/127/118)	0.277**	0.276**	0.284**
Working memory	(152/126/118)	0.273**	0.321**	0.345**
Executive function	(145/118/113)	0.241**	0.297**	0.262**
Processing speed	(152/128/118)	0.28**	0.351**	0.357**
Motor dexterity	(152/128/118)	0.351**	0.381**	0.419**
Attention	(150/125/117)	0.47**	0.29**	0.404**

*SAPS, Scale for the Assessment of Positive Symptoms; SANS, Scale for the Assessment of Negative Symptoms; CDSS, Calgary Depression Scale for Schizophrenia. *$p < 0.05$. **$p < 0.003$.*

intentions of others, as well as reflecting upon and questioning their own thinking. However, it was unclear the extent to which these deficits are stable over time, and their associations with core aspects of the disorder, such as symptoms and neurocognition. Our results showed that ToM deficit in FEP are present at illness onset, remains long-term stable, and are not related with clinical symptoms but neuropsychological deficits. Results support the notion that ToM dysfunction may be characteristic of psychosis, which does not change with treatment, consistent with the assertion that deficits in ToM are a trait of schizophrenia (Lysaker et al., 2011). The persistence of ToM deficits, even in remitted patients, suggests that they are trait related metalizing impairments (Bora et al., 2008). Previous studies found metacognitive deficits even in patients who were totally free of residual symptoms (Hamm et al., 2012), whereas some studies suggest ToM abilities seem to be related to both, positive and negative symptoms (Kohler et al., 2010). We did not find association between ToM and with clinical symptoms, neither in the acute nor in the stable phase.

Concerning neurocognitive results, we interpreted the ToM deficits as being related to a more general cognitive dysfunction confirmed in schizophrenia and FEP patients (Bora et al., 2006, 2008). Multiple cognitive deficits could mediate the observed impairments of ToM ability (Bora et al., 2009). In the present study, inefficient processing speed emerges as the neurocognitive domain specifically related to ToM dysfunction. Processing speed and episodic memory are the domains most frequently reported as significantly impaired in a large body of schizophrenia studies (Schaefer et al., 2013).

Two theoretical approaches have explained ToM deficits in autism spectrum disorders (Wilkinson and Ball, 2012). The "Theory-Theory" hypothesizes that the inference of others' mental states is an innate and learner orientated specific domain, suggesting a developmental trajectory for the understanding of mental state concepts. This approach, notably supported by Baron-Cohen, argues that there are selective deficits in ToM develop over time, resulting in individuals inability to integrate social information (e.g., attentional cues) and make effective mental state inferences about other individuals. On the contrary, "Simulation-Theory" proposes that inferences about others' mental states arise by imagining oneself in the position of the other person and simulating what they might believe, desire or intend. The argument is that the difficulty experienced by individuals in understanding mental states reflects a deficit in some aspect of the simulation process, feeding incorrect information into the simulation procedure (i.e., information relating mainly to their own perspective). A new position, called "hybrid consensus," considers the interactions of both theories and their interdependencies, and may represent the future for empirical evidence. The indications are that pervasive domain general deficits in, for example, executive functioning and working memory, may provide some of the key components for an explanation of the wide range of developmental difficulties seen in autism and schizophrenia spectrum disorders.

It is reasonable that poor emotion recognition, found in patients with schizophrenia spectrum disorders, may be more than just impaired in the capacity to correctly infer emotions from the eyes of other people. Patients may struggle to understand other's emotions when they also are less able to process and integrate information coming from many channels into complex ideas about the self and others (Lysaker et al.,

TABLE 3 | Paired *t*-test comparisons of Z-scores neuropsychological performance in ToM subgroups at baseline, 1 and 3-year follow up.

ToM	Baseline		*p*	1-year		*p*	3-year		*p*
	Non-deficit	Deficit		Non-deficit	Deficit		Non-deficit	Deficit	
n	33 (22%)	119 (78%)		34 (26%)	98 (74%)		40 (33%)	83 (67%)	
Verbal memory	−1.72	−2.48	0.004	−0.81	−1.34	0.027	−0.91	−1.7	0.002
Visual memory	−0.27	−0.76	0.015	−0.36	−0.68	0.107	−0.76	−1.61	0.001
Working memory	−0.08	−0.59	0.013	−0.41	−0.76	0.021	−0.35	−0.66	0.074
Processing speed	−1.01	−1.58	0.011	−1.21	−2.25	0.001	−0.76	−1.67	<0.001
Executive function	−0.89	−1.81	0.016	−1.69	−2.92	0.111	−1.07	−2.11	0.12
Motor dexterity	−0.39	−1.62	<0.001	−0.99	−2.16	0.005	−0.72	−1.86	<0.001
Attention	−0.74	−3.96	<0.001	−1.03	−2.53	0.03	−1.32	−3.71	0.003

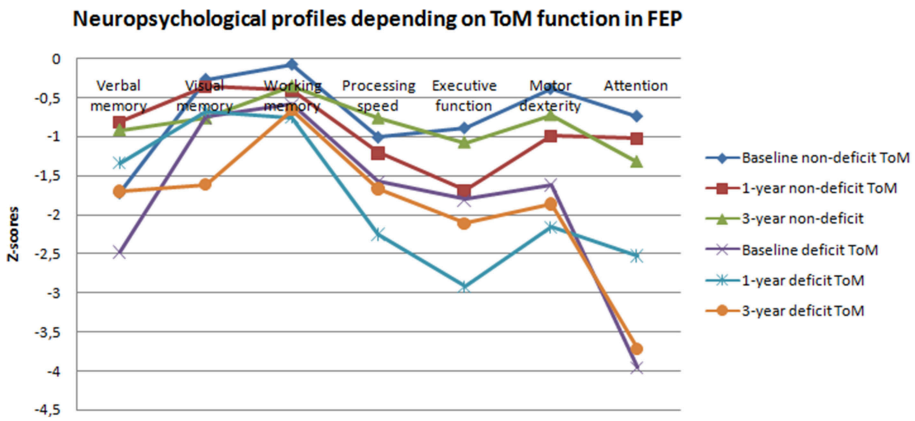

FIGURE 3 | Neuropsychological profiles according on ToM function in first episode psychosis patients.

TABLE 4 | Neurocognitive predictors of ToM in FEP at 3-year follow-up.

	B	*SE*	Wald	Significance	OR	95% CI	
PREDICTORS (*n* = 118)							
Verbal memory	0.181	0.180	1.018	0.313	1.199	0.843	1.705
Visual memory	0.358	0.210	2.921	0.087	1.431	0.949	2.158
Working memory	−0.204	0.280	0.530	0.467	0.816	0.471	1.412
Executive function	−0.041	0.085	0.231	0.631	0.960	0.813	1.134
Processing speed	0.492	0.227	4.708	0.030	1.635	1.049	2.550
Motor dexterity	0.196	0.185	1.118	0.290	1.216	0.846	1.748
Attention	0.038	0.059	0.404	0.525	1.038	0.924	1.167

Model $\chi^2_{(7)} = 24.047$, $p = 0.001$, R^2 *Nagelkerke* $= 0.255$.

2014). Our results are in accordance with McGlade et al. (2008), confirming that mental estate decoding is mediated by global cognitive function, and particularly by the influence of processing speed. Rehabilitation of sensory processing, in both its speed and its accuracy, could improve ToM ability.

Although previous studies have not found significant effect of age on performance in ToM tasks (Green et al., 2012), our results confirm age as a moderator on the Eyes test. The older we are, the more accurate our recognition of facial emotion. The potential moderating influences of IQ deficits on ToM performance in remitted patients, as well as the potential interactions involving education have been previously suggested (Kettle et al., 2008; Bora et al., 2009). Regretfully, the problem of how IQ interferes with ToM performance remains unresolved, in part because the IQ and ToM test used in the available studies vary considerably (Brüne, 2005a). With respect to years of education, we found this variable a moderator in Eyes test performance. Using a similarly recruited Spanish sample population, with a total of

358 participants from both sexes and an age range from 18 to 65, the Fernández-Abascal et al. (2013) study, conducted a test re-test reliability of the Eyes test. All participants attended tertiary education, following our criteria of a mean of 14 years of education and thus were matched on years of education (10.38 and 10.76 years respectively). Eyes test mean scores in Fernandez-Abascal (27.18, SD 3.59) differed nearly by 4 points from our healthy control group (23.77, SD 4.31). We suggest differences in education could explain differences in Eyes test scores in these two Spanish healthy sample populations. This could be consistent with our results that found education as a moderator of Eyes test performance. Such a finding, while deserving further investigation, is encouraging when considering the use of training programs to improve social cognition (Rocha and Queirós, 2013; Sacks et al., 2013). This is of particular note because it supports the notion that education could improve social cognition.

The main strengths of this study lie in its sampling and design. We used two large and homogeneous samples, representatives of FEP patients and healthy control subjects, from the same catchment area; the 3-year longitudinal design and the employment of an instrument for ToM assessment with proven good psychometric properties (see systematic review Vellante et al., 2013). However, the study has several limitations. First, a data analytic consideration was the presence of missing data. Of the 160 FEP patients and 159 healthy controls initially included, 111 in each group entered the 3-year ANCOVA model. Second, the effect of medication was not examined. Patients were taking antipsychotic medications that might have influenced performance. It should be said though that previous studies have not found evidence for a medication effect on ToM performance because deficits in emotion perception were found at illness onset and show minimal response to effective antipsychotic treatment (Herbener et al., 2005; Chen et al., 2012). Third, in accordance with Kettle et al. (2008), deficits could also reflect problems in semantic knowledge of mental state terms in the Eyes test in the FEP group. Although all participants were provided a glossary of mental state terms used in the test, our data found relationship between Eyes test performance and WAIS-III vocabulary subtest. Finally, we did not analyze the relationship between ToM and real world functioning due to it being beyond the scope of the present paper.

In sum, the findings of this study confirmed stable, thus trait ToM deficit in FEP patients. The relationship between ToM deficits and neurocognitive function, as well as the possible link with daily functioning, support the implementation of training programs for social cognitive impairments in FEP patients.

AUTHOR CONTRIBUTIONS

All the authors have participated and have made substantial contributions to this paper. RA: design, statistical analysis, interpretations of data and drafting the article. ES, MF, and MR: statistical analysis, interpretations of data and revising the article. KN and AF: interpretations of data and revising the article. SO, JR, and BC: conception, design and revising.

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