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Relations between temperament and false belief understanding in the preschool age --Manuscript Draft--

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Corresponding Author:	Giulia Pecora Universita degli Studi di Roma La Sapienza Rome, ITALY
Corresponding Author Secondary Information:	
Corresponding Author's Institution:	Universita degli Studi di Roma La Sapienza
Corresponding Author's Secondary Institution:	
First Author:	Giulia Pecora
First Author Secondary Information:	
Order of Authors:	Giulia Pecora
	Elsa Addessi
	Melania Paoletti
	Francesca Bellagamba
Order of Authors Secondary Information:	
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Abstract:	Emerging evidence suggests that Theory of Mind (ToM) is related to some aspects of children's temperament. Specifically, recent studies have shown that false belief understanding is positively related to shyness and withdrawn behavior and negatively associated with aggressive conduct. However, still little is known about which other aspects of temperament are related to children's ability to understand others' mental states. In the present study, we aimed to investigate relations between false belief understanding and temperament in preschool children. In the first phase of our research (T1), we administered a false belief task to 101 3- and 4- year-old Italian children. In the second phase (T2), 69 children belonging to the original sample were assessed again at 5 and 6 years of age, and their temperament was evaluated through parental ratings. Correlational analyses and independent-samples t-tests revealed significant positive relations of false belief understanding to inhibitory control and negative relations to motor activity/hyperactivity and anger/frustration (even though the latter was only marginal), whereas no relation was found to attention control. These results confirm and extend findings from previous studies. Unexpectedly, we did not find any significant association with shyness, despite evidence to the contrary from recent research. Overall, our findings show that false belief understanding relates differently to various dimensions of temperament in the preschool period and highlight the importance of conducting further investigations on the relations between ToM and temperament.
Response to Reviewers:	 Editor: 1. Do not number the lines of your manuscript and use 1" margins through the manuscript. Double space the manuscript. 2. Break the blinding in the manuscript. 3. Under Measures, omit the headers, Time 1, Time 2. 4. On page 7, Missing data (without this header) should be the second paragraph under Data Analyses. 5. On page 7, omit all headers and sub-headers in the Results section.

6. On page 10, combine the first two paragraphs in the Discussion.

7. The presentation of your research will be greatly enhanced if you can edit your

manuscript for grammar, clarity and accuracy of scientific expression.

Response to Editor: we have amended the manuscript in accord with the editor's requests.

Reviewer #1:

The authors have been responsive to my second set of suggestions. I believe that this version of the manuscript is almost publishable. Below, I have some remaining suggestions.

Major Suggestions

(1) I am happy to see that the authors better highlight the uniqueness of their study and also emphasize the importance of data from different cultures. The author state that studies have not investigated relations between temperament and false belief understanding in Italy so far (p. 11). A study by Longobardi, Spataro, D'Alessandro, and Cerutti (2016) was recently published and includes Roman children. Findings from that paper should be incorporated in the introduction and Discussion.

Response 1: we thank the reviewer for noticing this gap in our literature review. We have mentioned Longobardi et al.'s (2016) findings in the Introduction (p. 5) and Discussion (pp. 11 and 13).

(2) "Reliability was conducted on approximately 20% of the videotapes" (p. 6). Who conducted this reliability coding? The authors; research assistants?

Response 2: the authors of this study conducted all analyses, including the reliability coding. We have added this information to the manuscript (p. 7).

(3) The manuscript could benefit from another careful proof-reading. Many typos and grammatical errors remain. For example:

i. "Moore and et al.'s (2011)..." (p. 4). Remove "and".

ii. "...may prevent children from making fundamental experiences for the understanding of others..." (p. 5) could be reworded: "...may prevent children from engaging in fundamental experiences that contribute to the understanding of others..."

iii. "...t-test revealed no significant differences in children's performances..." (p. 6); change to "performance". This mistake is also found on p. 12.

iv. "All the three scores of ..." (p. 10). Remove "the".

Response 3: we have modified the text in accord with the reviewer's suggestions and further proof-read the whole manuscript. We hope that the new version of the manuscript will satisfy the reviewer's and editor's expectation.

(4) The first paragraph of the "Preliminary Findings" section can be removed. Those descriptive statistics are already provided in Table 1, and the authors report the related inferential statistics in the subsequent paragraphs.

Response 4: we agree with the reviewer that this paragraph is quite redundant with the data provided in Table 1. We have deleted this part and only stated that "When considering the three scores of the False Belief task, the percentages of children passing the task were slightly higher than those reported in a previous study using the same task with Italian 3- and 4-year-old children (Cavalli, 2007)" (see p. 9). (5) In the Discussion, I would briefly mention how the (marginal) relation between anger and false-belief understanding (reported on p. 9) would fit with prior findings of links between aggression and theory-of-mind (Lane et al., 2013; Song et al., 2016; Wellman et al., 2011).

Response 5: we thank the reviewer for this suggestion. We have added a part in the Discussion that integrates our findings with those reported by previous studies. In particular, we have stated that "On the basis of prior research (e.g., Lane et al., 2013; Song et al., 2016; Wellman et al., 2011), we expected false belief understanding to be significantly and negatively related to Anger/Frustration. Our predictions were verified,

even though only in part, since a marginally significant relation between the False Belief task's Global score and Anger/Frustration was found" (please, see p. 12).

(6) It is too broad and imprecise to explain prior findings (e.g., Lane et al., 2013; Wellman et al., 2011) in terms of how "internalizing" and "externalizing" behaviors relate to performance on false-belief task (p. 10). Lane et al. and Wellman et al. do not make these broad distinction in their articles.

Response 6: we agree with the reviewer and have modified the text as it follows: "Despite some evidence showing false belief understanding to be positively related to shy temperament and negatively related to aggressive conduct [...]" (p. 11).

(7) If the authors must discuss individualism and collectivism (which I don't think is needed), please discussion individualism and collectivism as occurring along dimensions/spectrums, and discuss cross-cultural differences in realtive terms rather than categorically (p. 11).

Response 7: according to the reviewer's suggestion, we have decided not to discuss the differences between cultures in terms of collectivism and individualism. Rather, we have reformulated this part by better focusing on studies involving Italian children and integrating Longobardi et al.'s (2016) study in the discussion of our findings (see pp. 13-14). We have also welcomed the reviewer's advice to discuss the cross-sectional differences in relative terms.

Minor Suggestions

(8) Throughout the manuscript, upper-case N should be used when identifying the entire sample size, and lower-case n should be used when identifying a sub-sample.

Response 8: we thank the reviewer for highlighting this oversight. We have corrected this aspect throughout the manuscript.

(9) In the section, "Relations between temperament and false belief understanding" (p.8) are the authors analyzing age as a continuous variable or as a dichotomous variable (young vs. old)? Please specify.

Response 9: we have used age as a dichotomous variable (younger vs. older children) also for the correlational analyses. We have added this information to the paragraph (p. 9).

Please, note that we have highlighted the main corrections in yellow throughout the manuscript.

Thanks to the reviewer and editor for the insightful suggestions.

RELATIONS BETWEEN TEMPERAMENT AND FALSE BELIEF UNDERSTANDING IN THE

PRESCHOOL AGE

Giulia Pecora • Elsa Addessi • Melania Paoletti • Francesca Bellagamba

Running head: Temperament and false belief understanding

G. Pecora (Corresponding author) Dipartimento di Psicologia dei Processi di Sviluppo e Socializzazione, "Sapienza" Università di Roma, Rome, Italy Via dei Marsi 78 Rome, 00185 Italy giulia.pecora@uniroma1.it

E. Addessi Istituto di Scienze e Tecnologie della Cognizione, Consiglio Nazionale delle Ricerche, Rome, Italy

M. Paoletti Dipartimento di Psicologia, "Sapienza" Università di Roma, Rome, Italy

F. Bellagamba Dipartimento di Psicologia Dinamica e Clinica, "Sapienza" Università di Roma, Rome, Italy

Introduction

A core aspect of social-cognitive development, which has been the subject of outstanding research over the last 30 years, is the ability to understand ourselves and other people as active agents having personal interpretations of the world (Astington & Gopnik, 1991; Wellman, 1990). This ability, known as Theory of Mind (ToM), is crucial for understanding the mental states (e.g., desires, intentions, emotions, beliefs) that underlie one's own and others' behavior and anticipating future actions (Premack & Woodruff, 1978). Substantial achievements in the acquisition of ToM occur during the preschool age (e.g., Wellman, Cross, & Watson, 2001, for a meta-analysis), when children start to understand that reality does not always correspond to their own view, and that other people may have different interpretations of events.

Being able to understand what other people believe about the world is crucial for the development of a ToM. Among all mental states, beliefs are particularly complex, involving the ability to mentally represent how different people would interpret external events. Importantly, this ability allows one to recognize whether individuals have false beliefs guiding their conduct and predict future behavior (Razza & Blair, 2009). False belief understanding has been extensively studied in children using location and content false belief tasks, in which they have been asked to consider what another person would know about the location of an object or about the content of a receptacle, respectively. A typical location false belief task is the Sally-Anne task (Baron-Cohen, Leslie, & Frith, 1985). Children are asked where the main character of a story, Sally, would look for her marble, after her friend Anne has taken the marble out of a basket (Place A; i.e., where Sally placed the marble initially) without Sally's knowledge and has put it into a box (Place B). In this case, in order to give the correct answer to the question: "Where will Sally look for her marble?", children need to refrain from saying what they know (i.e., the marble is in Place B) and think about what Sally actually knows about the situation (i.e., the marble is still in Place A). In other words, to succeed in this task children have to recognize that Sally has a false belief about the location of her marble. An example of a content false belief task is the Smarties task (Perner, Leekam, & Wimmer, 1987; Gopnik & Astington, 1988), in which the child is presented with a candy box containing unexpected objects (e.g., pencils) and needs to imagine what another person would think about the content of the box by only looking at the container.

Generally, typically-developing children start to explicitly reason about beliefs during the preschool period. Whereas the majority of children under 3.5 years of age tend to give answers based on reality instead of others' beliefs, thus failing in such tasks, a progressive trend has been found starting from 3.5 years of age. In

fact, children develop the ability to refer correctly to what other people believe about certain events at around 4 years of age and greatly improve during the ensuing years (e.g., Sodian, 2005; Wellman et al., 2001).

ToM is related to important developmental processes, such as social competence (e.g., Capage & Watson, 2001; Razza & Blair, 2009), language (Lohmann & Tomasello, 2003; Milligan, Astington, & Dack, 2007), and executive functions (Henning, Spinath, & Aschersleben, 2010; Marcovitch et al., 2015; Muller et al., 2012), with a particularly strong association with inhibitory control (e.g., Bellagamba et al., 2015; Carlson, Claxton, & Moses, 2015). A number of studies have shown robust correlations between ToM and inhibitory control during the preschool age (e.g., Bellagamba et al., 2015; Carlson & Moses, 2001; Chasiotis, Kiessling, Hofer, & Campos, 2006). Children who are better able to inhibit an impulsive response in order to produce a more cautious one, generally obtain higher scores in ToM tasks. However, to our knowledge only relatively little investigation has been conducted relating ToM to self-regulation using measures of temperament, and results seem to slightly differ. For example, Blair and Razza (2007) used a self-regulation composite score, by collating some subscales from the Children's Behavior Questionnaire (CBQ; Putnam & Rothbart, 2006; i.e., anger, approach, attention, and inhibitory control), and found a significant positive correlation with false belief understanding. Carlson and Moses, in a prior study (2001), also used the inhibitory control subscale from CBQ, but they found only a weak association with a ToM battery that included two false belief tasks. In another study, Carlson et al. (2004) found that CBQ's composite self-regulation score (including inhibitory control, perceptual sensitivity, attentional focusing, and impulsivity) was not significantly related to ToM. Discrepancies among these results might depend on the multiple ways in which variables were treated, using either composite or separate scores. Interestingly, even though attentional focusing (the ability to sustain attention on specific targets; Rothbart & Bates, 2006) is a component of self-regulation in Rothbart et al.'s temperament model, Wellman et al. (2011) and Lane et al. (2013) did not find any significant relation to ToM. The authors argued that the nonsignificant relation might be due to the fact that attention control reflects more general cognitive abilities and may not represent a socially relevant aspect of temperament.

Although several studies have highlighted the importance of studying the links between ToM and temperament (Lane et al., 2013; Longobardi, Spataro, D'Alessandro, & Cerutti, 2016; Mink, Henning, & Aschersleben, 2014; Moore, Bosacki, & Macgillivray, 2011; Walker, 2005; Wellman, Lane, LaBounty, & Olson, 2011), still little is known about how the ability to understand others' mental states is connected with children's individual differences in temperament. In the last decade, some studies have targeted how false belief understanding relates to shy temperament and aggressive conduct in early childhood. Wellman et al. (2011)

found that lower scores in aggressive behavior and higher scores in shyness were associated with more advanced ToM in the preschool age. The authors suggested that children described as shy generally prefer to watch other children playing instead of joining social activities, and suggested that the tendency to observe others might encourage the disposition to understand others' mental world. Similarly, in a cross-cultural study with preschool children, Lane et al. (2013) found that children who were better able to understand others' false beliefs, were described as less aggressive and more withdrawn, even though the relation to the withdrawn behavior was significant only for children with lower physiological reactivity. On the contrary, when both withdrawal and physiological reactivity were high, children showed poor false belief understanding. Interestingly, Longobardi et al. (2016) showed that inhibition to novelty in Italian 4- and 5-year-olds was associated with higher scores in an unexpected location ToM task. To our knowledge, this represents the only study so far on the relation between temperament and ToM in an Italian sample. Analogous results were found also in younger children, with temperament in infancy predicting false belief understanding in the preschool age. For example, Mink et al. (2014) found that a shy, observant temperament at 18-months of age was positively related to false belief understanding at age 3. Similarly, Brink et al. (2015) showed that infants who were more socially observant at 10- to 12-months of age demonstrated a more advanced ToM at age 4. Interesting results also emerged from Moore et al.'s (2011) study on ToM and social behavior in zero-acquaintance situations, in which a better ToM (including false belief understanding) was related to higher frequency and greater proportion of time spent by 4year-olds observing unknown peers during playful activities. These results give further support to Wellman et al.'s interpretations and extend their conclusions on the effects of observant behavior to both ToM and social interactions with unfamiliar peers. To our knowledge, only one study is in contrast with these results, revealing gender differences in this relation: in Walker's (2005) study, a higher ToM in boys was related to higher aggression and lower shyness, whereas no significant relation emerged for girls. However, contrary to the other studies reported above, the authors adopted a cross-sectional design instead of a longitudinal design, which, as such, did not allow for causal predictions between the variables. Overall, shyness and aggressive temperament seem to relate differently to ToM, suggesting that children more prone to withdrawn behavior in social situations might gain some benefit from their shy temperament, by having more opportunities to observe peers and reason about their inner states. On the contrary, more aggressive children may miss important occasions to observe and thus understand others' mental states. In fact, peer rejection and social exclusion represent two frequent consequences of aggressive misconduct that, in turn, may prevent children from engaging in fundamental experiences that contribute to the understanding of others, such as sharing emotions with peers and building

positive social relationships (e.g., Chen, Huang, Chang, Wang, & Li, 2010; Ladd, 2006; Song, Volling, Lane, & Wellman, 2016).

In our study, we aimed to investigate the association between temperament and false belief understanding during the preschool age. We collected data on false belief understanding within a broader study that we conducted in 2011 and 2013 on the association between preschool children's ToM and inhibitory control. Two years later, our interest focused on temperament and its relations to ToM. In the light of previous studies, we hypothesized that children's false belief understanding would have been negatively related to aggressive behavior and positively related to those dimensions of temperament that might be linked to a more observant aptitude towards others' mental world, such as shyness and fear. Moreover, considering findings that show positive relations between inhibitory control and advanced ToM (e.g., Blair & Razza, 2007; Carlson, Mandell, & Williams, 2004), we expected positive relations between ToM and inhibitory control and negative relations between ToM and dysregulation dimensions, including motor activity and impulsivity. Furthermore, based on findings from relevant research, we tested the relation between false belief understanding and attentional focusing, expecting nonsignificant relations between these variables (Lane et al., 2013; Wellman et al., 2011).

Method

Participants

Participants took part in a broader longitudinal study on the link between inhibitory control and false belief understanding. Some of the data obtained in this study had already been published in previous articles (Addessi et al., 2014; Bellagamba et al., 2015; Pecora et al., submitted).

The first phase of this study (Time 1) involved 101 typically-developing children, tested when they were 3 and 4 years-old (*M* age = 41.12; range = 35.07-49.00). Fifty-one three-year-olds (*M* age = 35.13 months \pm .46; 24 boys and 26 girls) and 50 four-year-olds (*M* age = 47.11 \pm .49; 27 boys and 23 girls) were included. Children were recruited from 11 preschools of the metropolitan area of Rome, coming from families of middle socioeconomic status. Two years later (Time 2), 69 children belonging to the original sample participated in the study (*M* age = 65.14; range = 58.26-83.26). Thirty-eight five-year-olds (*M* age = 60.1 months \pm .56; 16 boys and 22 girls) and 31 six-year-olds (*M* age = 72.17 months \pm 2.16; 21 boys and 10 girls) were included. This study complied with the APA Ethical Guidelines, and was approved by the Ethics Committee of the Department of Dynamic and Clinical Psychology of Sapienza University of Rome.

Procedure

At Time 1, children were administered a content False Belief task, included in a broader battery of tasks. Children were individually tested by two female experimenters in a single session, either at school or at home, depending on parents' preference. The majority of children were tested at school (n = 73), whereas a smaller number of children was tested at home (n = 28). An independent-samples *t*-test revealed no significant differences in children's performance on the False Belief task between children tested at home and children tested at school (Self-attribution: t(96) = 1.15, p = .25; Other-attribution: t(96) = .98, p = .33; Global score: t(96) = .91, p = .36). All sessions were videotaped for future coding. At Time 2, parents were contacted again and asked to complete two questionnaires, one regarding children's temperament and the other one relative to inattentive and hyperactive/impulsive behavior.

Measures

Smarties task (Perner, Leekam, & Wimmer, 1987; Gopnik & Astington, 1988). In this content False Belief task, children's ability to understand their own and others' beliefs was investigated. Ninety-eight children were presented with this task. 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-year-old). After showing the child a chocolate candy box, the experimenter asked a control question ("What does this box contain?") to verify what the child knew about the box and to determine a baseline statement. Then, the experimenter showed the child that the box actually contained some crayons and put them back again into the box and asked two experimental questions: "When you first saw this box, before we opened it, what did you think was inside?" (Self-attribution false belief), and "If your mom/friend comes over right now, what would s/he believe the box contained?" (Other-attribution false belief). Reliability was conducted by the authors on approximately 20% of the videotapes and was 1.00 (index of concordance).

Answers to the control question were not scored; they were used, however, to evaluate the answers given to the two experimental questions. We computed three scores: i) Self-attribution score, ii) Other-attribution score, and 3) Global score. We gave either 0 or 1 to responses to Self-attribution and Other-attribution scores: zero was given for the wrong answers (e.g., "crayon" to both questions) and 1 was given for the correct answers (i.e., what the child believed to be into the box before it was opened). As for the Global score, if the child answered both the experimental questions correctly, her/his final score was 1, otherwise her/his final score was 0, either s/he was wrong in one or both of the experimental questions. Two independent raters coded the task.

Children's Behavior Questionnaire – Short Form (CBQ-SF; Putnam & Rothbart, 2006; Rothbart, Ahadi, & Hershey, 1994). This parent-report questionnaire measures temperament in children aged 3 to 7. It includes three

main scales, each of them divided into a number of subscales. We administered 9 subscales, including Impulsivity ($\alpha = .63$), Activity Level ($\alpha = .74$), Shyness ($\alpha = .86$), Fear ($\alpha = .69$), Anger/Frustration ($\alpha = .72$), Attentional Focusing ($\alpha = .73$), Inhibitory Control ($\alpha = .72$), Perceptual Sensitivity ($\alpha = .52$), and the additional scale of Aggression ($\alpha = .84$). Because of a low Cronbach's alpha, Perceptual Sensitivity was excluded from the analyses. The questionnaire included 56 items, each of them referring to some aspects of children's behavior in everyday life. Parents were asked to rate to what extent those statements were suitable to describe children's behavior on a 7-point Likert scale ranging from 1 (extremely untrue) to 7 (extremely true). Obtaining higher scores on CQB's subscales means showing higher levels of those behaviors.

Scala diretta ai genitori per l'individuazione di comportamenti di disattenzione e iperattività del bambino (SDAG; Cornoldi, Gardinale, Masi, & Pettenò, 1996). This questionnaire measures inattentive and impulsive/hyperactive behavior in children from 5 years of age. Both scales include nine items, making a total of 18 items (Cronbach's alphas: Inattention $\alpha = .73$; Hyperactivity/Impulsivity $\alpha = .78$). Parents had to evaluate how often children showed some behaviors on a 4-point Likert scale ranging from 0 (never) to 3 (very often). Similar to the CBQ, higher scores on a scale meant that the child was more prone to show inattention and/or impulsivity in everyday activities. We included this questionnaire in order to compare a measure broadly used in international literature (i.e., CBQ) with a measure commonly used in Italian clinical practice and research on two aspects of self-regulation potentially relevant for ToM development.

Parents were asked to complete both questionnaires within one month before/after children's birthday. Fifty-four CBQs and SDAGs (78% of the total) were completed and returned.

Data analyses

In order to investigate age and gender differences in the study variables, analyses of variance (two-way factorial ANOVAs) were conducted. Then, zero-order correlations between temperament and false belief understanding (Self-attribution, Other-attribution, and Global score) were performed in order to examine relations among the variables and to investigate concurrent validity between two questionnaires that are usually used for different purposes. Indeed, the CBQ has been broadly employed in the international research, whereas the SDAG has been validated and used specifically in the Italian context for clinical purposes. Finally, we performed independent-samples *t*-test in order to investigate temperament differences between children who passed and did not pass the False Belief task.

Attrition between Time 1 and Time 2 was moderate, with the sample decreasing from 101 to 69 participants (31% of missing data). Therefore, we performed the Little's test (1988) for MCAR in order to exclude the

possibility that the data were not missing completely at random. The Little's test was not significant, $\chi^2(43) = 41.73$, p = .53, revealing that the missingness met the MCAR assumption. We conclude that attrition was due to the fact that some children had left the preschool they attended at Time 1 and parents did not give consent for home visits.

Results

Preliminary analyses revealed no univariate outliers. The skewness and kurtosis were judged sufficient to meet the assumptions for parametric analyses (Curran, West, & Finch, 1996). Descriptive statistics are presented in Table 1. When considering the three scores of the False Belief task, the percentages of children passing the task were slightly higher than those reported in a previous study using the same task with Italian 3- and 4-year-old children (Cavalli, 2007).

----- table 1 about here -----

A series of two-way factorial ANOVAs with age (younger, older) and gender (girls, boys) as between-subject variables and false belief understanding (Self-attribution, Other-attribution, and Global score) and temperament as dependent variables were conducted.

A significant effect of age on Self-attribution emerged, F(1,97) = 7.12, p = .009, with older children (M = .68, SD = .47) obtaining significantly higher scores than younger children (M = .68, SD = .47). The main effect of age was also significant for Other-attribution, F(1,97) = 4.53, p = .036. Specifically, older children (M = .38, SD = .49) responded better than younger children (M = .19, SD = .39) to the second experimental question. The effect of age on the Global score of the False Belief task was only marginally significant, F(1,97) = 3.52, p = .064. In particular, older children (M = .30, SD = .46) tended to perform better in the task than younger children (M = .14, SD = .36). All other main effects and interactions were non-significant, all $F \le 1.62$, $p \ge .21$.

ANOVAs on temperament revealed a marginal effect of age on Activity Level, F(1,50) = 2.94, p = .093, with older children (M = 4.90, SD = 1.25) being described as more active than younger children (M = 4.24, SD = 1.06). A marginal effect of age was also found on Shyness, F(1,50) = 3.24, p = .078. Older children were described as less shy (M = 3.01, SD = 1.18) than younger children (M = 3.77, SD = 1.43). A significant difference for gender was found in Aggression (F(1,50) = 5.18, p = .027), with boys (M = 3.62, SD = 1.06) being described as more aggressive than girls (M = 2.94, SD = .98). All other main effects and interactions for the CBQ and the SDAG were non-significant, all $F \le 2.35$, $p \ge .13$.

Zero-order correlations were also carried out among false belief understanding, temperament, and age (younger vs. older children) (see Table 2). Overall, results revealed that all three scores of the False Belief task

were positively associated with Inhibitory Control, albeit this relation was only marginal for the Otherattribution score. Furthermore, a significant and negative association was found with Hyperactivity and Activity Level, but only for the Global score. While Self-attribution was only marginally and negatively related to Activity Level, Other-attribution was not related to any of the two dysregulation dimensions. Attention was not related to any of the False Belief task's scores, except for a marginal and positive relation to Self-attribution. A marginal and negative association was found between the Global score and Anger/Frustration. Finally, age was positively related to all three scores of the False Belief task.

Correlations also showed consistency between the two questionnaires, with significant associations between CBQ's Attentional Focusing and SDAG's Inattention and between SDAG's Hyperactivity/Impulsivity and CBQ's Activity Level and Impulsivity.

----- table 2 about here -----

Independent-samples *t*-tests were performed in order to verify whether temperament differed depending on children's success or failure in the False Belief task.

As for the *t*-test on CBQ and Self-attribution, results indicated that scores in Inhibitory Control were significantly higher for children who succeeded (M = 4.93, SD = .80) than for children who failed (M = 4.18, SD= .94) in Self-attribution, t(50) = -3.08, p = .003. A marginally significant difference emerged in Activity Level between children who responded correctly (M = 4.26, SD = 1.18) and not correctly (M = 4.90, SD = 1.17) to the first experimental question, t(50) = 1.96, p = .056. Finally, a marginally significant difference emerged also in Attentional Focusing between children who succeeded (M = 5.21, SD = .82) and did not succeed (M = 4.75, SD= 1.07) in Self-attribution, t(50) = -1.75, p = .087. As for the *t*-test on CBQ and Other-attribution, results revealed that Inhibitory Control was only marginally significantly higher for children who responded correctly (M = 4.98, SD = 1.00) than for children who did not respond correctly (M = 4.46, SD = .88) to the second experimental question, t(50) = -1.81, p = .076. Finally, as for the *t*-test on CBQ and the Global score, results showed that scores in Activity Level were significantly lower for children who passed the task (M = 3.78, SD =1.02) than for children who did not pass the task (M = 4.72, SD = 1.18), t(50) = 2.31, p = .025. A significant difference was also found for Inhibitory Control, between children who passed the task (M = 5.20, SD = .75) and children who did not pass the task (M = 4.46, SD = .93), t(50) = -2.34, p = .023. Moreover, we found a marginally significant difference in Anger/Frustration between children who did succeed (M = 3.80, SD = 1.29) and did not succeed (M = 4.55, SD = 1.19) in the task, t(50) = 1.75, p = .086.

As for the *t*-test on SDAG and Self-attribution, only a marginally significant difference emerged in Inattention between children who succeeded (M = 6.29, SD = 3.25) and did not succeed (M = 7.90, SD = 3.05) in the first experimental question, t(50) = 1.84, p = .072. As for the *t*-test on SDAG and Other-attribution, a significant difference emerged in Hyperactivity, between children who succeeded (M = 5.77, SD = 4.73) and did not succeed (M = 8.55, SD = 3.68) in the second experimental question, t(50) = 2.20, p = .033. Finally, also for the Global score a significant difference in Hyperactivity was found between children who passed (M = 5.11, SD= 3.48) and did not pass (M = 8.43, SD = 4.02) the task, t(50) = 2.30, p = .026.

Overall, considering only the statistically significant results, children who succeeded in the task showed higher means in Inhibitory Control and lower means in Activity Level and Hyperactivity, compared to children who did not succeed in the task.

Discussion

In this study, we aimed to investigate the relation between temperament and false belief understanding during the preschool age, assuming that both ToM and temperament are crucial for social development by influencing how children perceive and interact with others. Despite some evidence showing false belief understanding to be positively related to shy temperament and negatively related to aggressive conduct (e.g., Lane et al., 2013; Wellman et al., 2011), our results revealed that none of the three scores of the False Belief task was significantly related to either shyness or aggression. Wellman et al. (2011) suggested that shy children might be more attentive to others during social interactions thanks to their greater aptitude for observation, which could facilitate their understanding of others' minds. Longobardi et al. (2016) supported this view by finding that false belief understanding in Italian children was related to inhibition to novelty at 4 and 5 years of age. While our results cannot support this perspective, it is worth pointing out that we tested false belief understanding and temperament at different time points than in Wellman et al.'s and Longobardi et al.'s studies. It might be the case that shyness undergoes some remarkable changes during the development, especially between early and late preschool period. We believe that there may be factors influencing the temporal stability of shyness, such as the higher likelihood of being exposed to novel interactions during the transition between preschool and primary school. In particular, emotional arousal can be less prominent across the development because children become accustomed to the interaction with unfamiliar peers and adults (Crozier, 2002). This interpretation can be partly supported by the marginal effect of age on shyness at Time 2, with older children being described by parents as less shy than younger children. A measure of shyness at Time 1 would have provided important information to disentangle this issue. Moreover, it is important to note that we used different scores from those used in Wellman et al.'s study and in other research. For example, Wellman et al. (2011) aggregated the Shyness score from the CBQ and the CBCL, whereas we extrapolated Shyness only from the CBQ. Notably, our statistical plan was also different, which could partly account for the discrepancy between our results and those of other studies.

Importantly, both correlational analyses and *t*-tests showed significant negative associations between false belief understanding and dysregulation dimensions. Overall, children who could better understand false beliefs were reported to be less likely to show motor activation and restlessness, and were less inclined to play reckless games. This result extends previous findings (LaBounty, Bosse, Savicki, King, & Eisenstat, 2016; Lane et al., 2013; Mink et al., 2014; Moore et al., 2011; Wellman et al. 2011), suggesting that children who are often on the move, less able to stay seated for a long time and willing to play games in which speed and motor activities are prevalent, are more likely to miss the chance to observe and understand others' mental world. The fact that the relation to motor activity emerged from both CBQ and SDAG further strengthens this result.

All three scores of the False Belief task were positively related to inhibitory control, suggesting that children who were reported to be more cautious and better able to inhibit impulses were also more capable to understand their own and others' false beliefs. This result is consistent with those found by Blair and Razza (2007), in which false belief understanding was positively related to self-regulation assessed with the CBQ, and with a number of studies showing that ToM relates to inhibitory control tested through behavioral tasks (e.g., Bellagamba et al., 2015; Carlson, Claxton, & Moses, 2015; Carlson & Moses, 2001; McAlister & Peterson, 2013; Razza & Blair, 2009).

The relation between attention and false belief understanding was nonsignificant (or only marginally significant for Self-attribution), which is in line with the literature (e.g., Lane et al., 2013). As previously suggested, it might be the case that the ability to willfully sustain attention on targets and the ability to understand others' beliefs do not share common processes, referring the first factor to more cognitive dispositions and the second one to more socially relevant abilities. Moreover, some recent research has shown that attention focusing may be more related to an affective ToM (which encompasses the ability to understand others' emotions), instead of a cognitive ToM (which includes false belief understanding) (e.g., LaBounty et al., 2016).

On the basis of prior research (e.g., Lane et al., 2013; Song et al., 2016; Wellman et al., 2011), we expected false belief understanding to be significantly and negatively related to Anger/Frustration. Our predictions were verified, even though only in part, since a marginally significant relation between the False Belief task's Global score and Anger/Frustration was found. This temperament dimension refers to emotional reactions that children may show when a goal is blocked or a desire is not satisfied (e.g., "Has temper tantrums when s/he doesn't get what s/he wants", "Gets quite frustrated when prevented from doing something s/he wants to do"). Thus, children with advanced ToM might be more able to understand the reasons provided by adults for unexpected denials and requests, thus contributing to limit frustration and temper tantrums.

Finally, it is important to note that the CBQ's attention and dysregulation dimensions were significantly related to the corresponding dimensions of the SDAG, thus showing that, even though grounded in two different fields (international research and the Italian clinical field, respectively), children's profile emerging from these questionnaires was consistent when put in relation to performance on the False Belief task.

Strengths, limitations and future directions

In the last decade, several authors have strongly advocated the need for increasing efforts to replicate existing research (Klein et al. 2014). In probabilistic disciplines, such as medicine, psychology, behavioral ecology, and evolutionary biology, the findings of empirical reports are often inflated by type I error (Parker and Nakagawa 2014) and attempts to replicate published results often fail (Palmer 2000; Open Science Collaboration 2015). Given that replicability is a fundamental feature of scientific research (Leek and Peng 2014), progress, especially in the behavioral sciences, requires an assessment of the extent to which findings of behavioral research can be reproduced. In the light of these considerations, we believe that our study can make a contribution in terms of replicability and generalization of results since, to our knowledge, only one study (Longobardi et al., 2016) has investigated the association between temperament and false belief understanding in Italian children so far. Although both ToM and temperament represent two core aspects of children's development and received great attention by Italian academics, research on their relation is still limited. Specifically, Longobardi et al. (2016) showed that false belief understanding was significantly related to inhibition to novelty in older children (4-5 years-old), but not in younger children (3-4 years-old). Moreover, in none of the two age groups motor activity emerged in association with the understanding of others. Discrepancies between Longobardi et al.'s (2016) findings and our results may be due to differences in the methodological and statistical approach. However, these authors also suggest that further research is needed on how the Italian culture affects the relation between ToM and temperament, since cultural differences in parenting and education have been proven to influence both of these two crucial aspects of children's development. From cross-cultural studies conducted by Hughes and colleagues (Hughes et al. 2014; Lecce & Hughes, 2010), for example, 5- and 6- year-old Italian children obtained significantly lower scores in false belief tasks than their British counterparts. The authors ascribed such difference to the fact that Italian children generally begin school one year after British children and possibly to

 the fact that, as reported in other studies, Italian mothers tend to talk to their children referring to mental states to a lesser extent than British mothers do. In Lane et al. (2013), Chinese children outperformed U.S. children in false belief tasks, even though no significant difference by location emerged for the relation between false belief understanding and temperament. At the same time, it seems that children from Eastern cultures (e.g., Korean, Chinese) tend to be more prone to express shyness and behavioral inhibition than children from Western cultures (e.g., Canadian, North-American) (Chen & French, 2008).

Overall, our study, albeit not cross-cultural, has the merit to provide data on a novel research topic in a different population. Remarkably, performance in the False Belief task of our sample is consistent with findings obtained by Longobardi et al. (2016) and by other studies that used analogous location false belief tasks with European and American children (e.g., Henning, Spinath, & Ascherleben, 2011; Thoermer, Sodian, Vuori, Perst, & Kristen, 2012).

However, despite the merit of making a contribution to an emerging branch of research and providing data from a different population, our results must be intended as only preliminary, due to the small sample size and the lack of ToM and temperament measures at both phases of research. In particular, administering a false belief understanding task at Time 2 or a temperament questionnaire at Time 1 would have helped to examine whether the relation between these variables differs depending on the time point, either concurrent or different. We believe that implementing temperament and false belief measures at both phases of research would have permitted a more thoughtful reasoning on the causal relations between the study variables and would have allowed a more direct and sensible comparison with other research (e.g., Wellman et al., 2011).

Conflict of interest and Informed consent

We disclose any actual or potential conflict of interest and declare that our work has not been published previously, that it is not under consideration for publication elsewhere, that its publication is approved by all authors and that all procedures involving human participants were in accordance with the ethical standards of the Italian Ethics Committee of the Department of Dynamic and Clinical Psychology of Sapienza, University of Rome. Informed consent was obtained from all participants included in the study.

Author contributions

GP: collaborated with the design of the study, performed the experiments, analyzed the data, and wrote the paper. EA: designed the study, assisted with the data analyses, and collaborated with the writing of the study.

FB: designed the study, assisted with the data analyses, and collaborated with the writing of the study. MP: performed the experiments and collaborated with the writing of the study.

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VariableN	Total sample			3 years				5 years			6 years				
	М	SD	п	М	SD	п	М	SD	n	М	SD	п	М	S	
Time 1															
False Belief task															
Global score	98	.22	.42	48	.15	.36	50	.30	.46	-	-	-	-	-	
Self-attribution	98	.55	.50	48	.42	.50	50	.68	.47	-	-	-	-	-	
Other-attribution	98	.29	.45	48	.19	.39	50	.38	.49	-	-	-	-	-	
Time 2															
CBQ-SF															
Impulsivity	54	4.36	1.03	-	-	-	-	-	-	29	4.14	1.11	25	4.61	3.
Activity Level	54	4.55	1.19	-	-	-	-	-	-	29	4.24	1.06	25	4.90	1.
Shyness	54	3.41	1.36	-	-	-	-	-	-	29	3.77	1.43	25	3.01	1.
Anger/Frustration	54	4.41	1.21	-	-	-	-	-	-	29	4.29	1.18	25	4.55	1.
Fear	54	4.16	1.26	-	-	-	-	-	-	29	4.05	1.19	25	4.29	1.
Attentional Focusing	54	5.01	.94	-	-	-	-	-	-	29	5.00	.98	25	5.01	.9
Inhibitory Control	54	4.60	.91	-	-	-	-	-	-	29	4.52	.78	25	4.69	1.
Aggression	54	3.31	1.07	-	-	-	-	-	-	29	3.25	1.02	25	3.37	1.
SDAG															
Inattention	54	6.96	3.29	-	-	-	-	-	-	30	7.23	3.47	24	6.61	3.
Hyperactivity	54	7.82	4.03	-	-	-	-	-	-	30	7.11	2.85	24	8.71	5.

Table 1. Descriptive statistics of the study variables at Time 1 and Time 2

SDAG = Scala diretta ai genitori per l'individuazione di comportamenti di disattenzione e iperattività del bambino.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
False belief task														
1. FB Self-attribution	-													
2. FB Other-attribution	.30**	-												
3. FB Global score	.49**	.85**	-											
CBQ-SF 4. Impulsivity	041	05	061	-										
5. Activity Level	27†	23	31*	.49**	-									
6. Shyness	12	07	16	37**	27*	-								
7. Fear	.026	.17	.19	.14	049	.080	-							
8. Anger/Frustration	22	08	24†	.22	.34*	.13	.063	-						
9. Attentional Focusing	.24†	.16	.20	19	34*	077	060	42**	-					
10. Inhibitory Control	.40**	.25†	.31*	28*	52**	.067	.15	40**	.72**	-				
11. Aggression	15	22	19	.27*	.49**	28*	063	.23†	37**	47**	-			
SDAG														
12. Inattention	25†	22	18	048	.25†	.035	.037	.38**	58**	51**	.44**	-		
13. Hyperactivity/Impulsivity	20	30*	31*	.44**	.65**	12	10	.35**	49**	60**	.45**	.53**	-	
14. Age	.27**	.21*	.19†	.23†	.28*	28*	.098	.11	.007	.096	.058	096	.20	-

Table 2. Zero-order correlations between false belief understanding, temperament, and age

Note. FB = False Belief; CBQ-SF = Children's Behavior Questionnaire – Short Form; SDAG = Scala diretta ai genitori per l'individuazione di comportamenti di disattenzione e iperattività del bambino; $**p \le .01$; $*p \le .05$; $†p \le .10$.