

## **Self-projection in early childhood: a study on the congruence between Episodic memory, Episodic future thinking, Theory of mind and Visual perspective taking**

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Children's understanding of mental states and their temporal and spatial perspective-taking abilities change substantially during early childhood. It has been proposed that these abilities converge on common mechanisms based on self-projection. Also, remembering and prospection are thought to jointly support human capacity for mental time travel. This study explores the behavioral congruence of perspective-taking abilities by assessing episodic memory, episodic future thinking, theory of mind, and visual perspective-taking in 85 children aged four to six in Uruguay. We found no overall associations, except for theory of mind (false beliefs) and episodic future thinking. Results are discussed in the light of conceptual implications of the tasks, while we argue that enhancing equivalence in task design is essential for advancing future research.

**Keywords:** episodic memory, episodic future thinking, theory of mind, visual perspective, self-projection

### **Auto-proyección en la niñez temprana: un estudio sobre la congruencia entre la Memoria Episódica, el Pensamiento Futuro Episódico, la Teoría de la mente y la toma de perspectiva visual**

Durante la primera infancia la capacidad entender los estados mentales de otros y de adoptar perspectivas alternativas a nivel temporal y espacial cambia sustancialmente. Se ha propuesto que a estas capacidades subyace un conjunto común de mecanismos basados en la *autoproyección* desde el contexto inmediato a perspectivas alternativas. Además, se ha planteado que los procesos de recuerdo y prospección están estrechamente relacionados y sustentan la capacidad humana de *viaje mental en el tiempo*. Este estudio explora la congruencia comportamental entre tareas de toma de perspectiva, examinando memoria episódica, pensamiento futuro episódico, teoría de la mente y toma de perspectiva visual en una muestra de 85 niños en edad preescolar (44 niñas) de cuatro, cinco y seis años que asistían a cinco centros educativos públicos de Uruguay. No se encontraron asociaciones que involucraran a las cuatro habilidades y que sugirieran una base en común, excepto para la teoría de la mente y el pensamiento futuro episódico específicamente. Estos resultados se discuten a la luz de las implicaciones metodológicas de las tareas.

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*Palabras clave:* memoria episódica, pensamiento episódico futuro, toma de perspectiva visual, autoproyección.

**Autoprojeção na primeira infância: um estudo sobre a congruência entre memória episódica, pensamento futuro episódico, teoria da mente e tomada de perspectiva visual**

Durante a primeira infância, a capacidade de compreender os estados mentais dos outros e de adotar perspectivas temporais e espaciais alternativas muda substancialmente. Foi proposto que subjacente a estas capacidades está um conjunto comum de mecanismos baseados na auto-projeção do contexto imediato para perspectivas alternativas. Além disso, foi proposto que os processos de recordação e prospeção estão intimamente relacionados, dando origem à capacidade humana de viajar mentalmente no tempo. Este estudo explora a congruência comportamental entre as tarefas de tomada de perspectiva, examinando a memória episódica, o pensamento futuro episódico, a teoria da mente e a tomada de perspectiva visual numa amostra de 85 crianças em idade pré-escolar (44 raparigas) com quatro, cinco e seis anos de idade que frequentam cinco escolas públicas no Uruguai. Não foram encontradas associações envolvendo as quatro habilidades e sugerindo um mecanismo comum subjacente a todas elas, exceto para a teoria da mente e o pensamento futuro episódico especificamente. Estes resultados são discutidos tendo em conta as implicações metodológicas das tarefas.

*Palavras-chave:* memória episódica, pensamento futuro episódico, teoria da mente, perspectiva visual, autoprojeção.

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Along the preschool years, children progress in their ability to mentally project into the past and future, infer others' mental states, and adopt alternative visual perspectives. The ability to establish temporal, spatial or psychological distance between the self and object has been addressed from classical perspectives (Piaget, 1987; Vygotsky, 2003), distancing model (Sigel, 2002), and more recent cognitive psychology perspectives (Atance & O'Neill, 2005; Suddendorf & Busby, 2005; Suddendorf & Corballis, 1997, 2007; Tulving, 2005). These capacities serve adaptive purposes and have implications in different life domains (i.e., interpersonal skills, visualization of personal future, adherence to preventive health behaviors, among others; Bateman, 2015; Joireman et al., 2006; Pepper & Nettle, 2017). At least four psychological constructs have been associated with the development of perspective-taking skills: episodic memory (EM), episodic future thinking (EFT), theory of mind (ToM) and some forms of navigation. How these abilities relate and whether there is a common underlying process that occurs when projecting the self temporally and adopting alternative spatial and mental perspectives is still open to questions.

### **Constructs involved in perspective-taking**

As humans, we develop the capacity to mentally project ourselves to the past and future time. EM is the process in which we bring to consciousness a mental state that is immediately recognized as a previous personal experience. EM implies mentally re-experiencing an original experience in the form of *mental time travel*, and differs from factual knowledge about the past, which is semantic in nature (Perner et al., 2007; Tulving, 1985; Wheeler et al., 1997). Relatedly, EFT (Atance & O'Neill, 2001) is the ability to mentally construct future event representations by projecting the *self* sensorially, emotionally and cognitively. It is characterized by the anticipation of future desires, needs,

or expectations that can be located at an approximate future time and place, and are detached from the person's current motivational state.

As humans, we also develop the ability to adopt another persons' viewpoint. ToM implies the ability to infer, predict and understand another agent's mental states (e.g., knowledge, beliefs), intentions and behavior (Baron-Cohen et al., 1985; Wimmer & Perner, 1983), and developmental progressions addressing different aspects of theory of mind have been proposed (Wellman et al., 2011; Wellman, & Liu, 2004). *Level 2 Visual perspective-taking* is the ability to identify that an object viewed simultaneously by a first observer (self) and another agent positioned in a different physical location will look different for each of them, depending on their viewing conditions (Flavell et al., 1981). It therefore involves the use of spatial information, including the current position of the observer, the second observer, and the object, and social information in that it requires the simultaneous representation of two different points of view (Hutchins et al., 2014; Pearson et al., 2013). It has been stated that such spatial perspective-taking tasks may inform the development of spatial navigation (Newcombe, 2019), since they involve navigational neural substrates and correlate with navigation tasks that demand the integration of separately learned routes (Nazareth et al., 2018).

How these skills relate to each other is still an open question, and at least two explanatory models have been proposed: the *Self-projection model* (Buckner & Carroll, 2007) and the *Episodic cognition model -mental time travel-* (Suddendorf & Corballis, 1997).

## Self-projection

The *Self-projection model* refers to the ability to orient the self in time and space, based on access to autobiographical information and imagination processes (Buckner & Carroll, 2007; Jarvis & Miller, 2017). Thus, self-projection implicitly involves the ability to change perspective in a temporal, spatial, or interpersonal way, and is anchored in internal processes of mental simulation -the mental construction

of an imagined alternative perspective- (Buckner & Carroll, 2007; Shanton & Goldman, 2010). Buckner & Carroll (2007) proposed prospective functions are a prototypical case of self-projection, providing a basic foundation for decision-making, navigation and social cognition processes. Specifically, the authors proposed that prospection, EM, ToM and some forms of navigation function as a unified *self-projection* network. Arguments are twofold: evidence of common biological substrates and behavioural evidence based on similar developmental patterns. Regarding the first, some anatomical-functional evidence based on neuroimaging suggests overlap in the selective activation of frontal lobe and medial parietal-temporal lobe regions (Addis et al., 2007; Buckner & Carroll, 2007; Saxe & Kanwisher, 2003; Vincent et al., 2006). Regarding the second, some reports of behavioral coherence between these abilities include the development of future-oriented skills between ages 4-6 (Atance & Meltzoff, 2005; Bélanger et al., 2014; Redshaw & Suddendorf, 2013; Russell et al., 2010; Suddendorf & Busby, 2005); EM and ToM (Perner et al., 2007; 2010); delay of gratification, temporal organization of conflicting desires and anticipation of future needs (Bischof-Kohler & Bischof, 2007); visual perspective taking and ToM (Bigelow & Dugas, 2008; Kessler & Thomson, 2010; Tian et al., 2021), and ToM and EFT (Adornetti et al., 2021). Likewise, the self-projection model has been studied in late developmental stages, finding a consistent pattern of impairment in EM, prospection and ToM in older adults (Jarvis & Miller, 2017).

### **Mental time travel**

Another account suggests a particular grouping of temporal orientation skills, based on *mental time travel*: the combination and recombination of episodic information that serves adaptive purposes for the species in response to changing environments (Tulving, 2005; Suddendorf & Busby, 2005; Suddendorf & Corballis, 2007; Suddendorf & Moore, 2011). Suddendorf and Corballis (1997) conceptualized *mental time travel* based on the idea that procedural,

semantic, and EM systems would have direct prospective counterparts (Dudai & Carruthers, 2005; Schacter et al., 2007; Schacter & Addis, 2007; Suddendorf & Busby, 2005; Suddendorf & Corballis, 1997; 2007; Tulving, 2005). Classical studies on brain lesions indicate that patients with impaired EM have compromised prospective abilities, i.e. patient K.C. (Tulving, 1985) and M.L. (Levine et al., 1998), yet retain preserved ToM ability (Rosenbaum et al., 2007). However, contrasting evidence between memory and prospective processes includes phenomenological discrepancy (e.g., emotional valence), inconsistency in imaging activation, and differential impairment in particular types of brain lesions (Perrin & Michaelian, 2017).

Several studies targeting the early childhood stage have reported developmental interrelations between EM and EFT (Atance et al., 2015; Atance & Sommerville, 2014; Busby & Suddendorf, 2005; Prabhakar & Hudson, 2019; Quon & Atance, 2010). During the preschool stage, children are progressively more able to extract content from episodic memory to anticipate the future (Atance & Sommerville, 2014; Hudson et al., 1995; Lagattuta, 2007), verbally report past and future events (Busby & Suddendorf, 2005), anticipate future needs (Atance & Meltzoff, 2005), and project to the adult self, overall suggesting these capacities are supported by the development of a notion of *self* extended in time (Bélanger et al., 2014). Still, some studies have found correlations between future-oriented processes become non-significant when controlling for age and intelligence (Atance & Jackson, 2009).

Worth noticing, the assessment of these processes at early life stages also faces task design challenges. Factors such as agent (self, other), temporal content and extension (e.g., general or event-specific, future-self, adult-self), type of answer (e.g. item choice, verbal) might lead to different underlying demands across tasks (Hudson et al., 2011; Suddendorf & Corballis, 2007) and therefore should be taken into account when discussing performance.

## **Self-projection account during childhood: need for evidence**

Perspective-taking skills are fundamental for the development of adaptive behaviors in complex social settings. Despite general interest in the developmental patterns of these skills, studies jointly examining EM, EFT, ToM and navigation in general and specifically during early childhood are scarce. Lind et al. (2014) examined school-aged children with a diagnosis of high-functioning ASD and found impairments in navigation, EM, EFT and measures of central coherence, but not in ToM and relational memory. Despite the emergence and consolidation of these processes during the preschool years, to the best of our knowledge, only one study has jointly examined these abilities from a behavioural perspective in preschoolers. Immel et al. (2022) tested 144 4-year-old children using a 12-task battery (3 tasks per ability), and could not find evidence supporting a model with EM, EFT, ToM and navigation as first-order latent factors and self-projection as a second-order factor, nor a model testing a common latent self-projection factor. Research is still advancing in understanding these constructs' structure and mechanisms, while accounting for task design implications. Advancing these efforts in typically developing children is relevant for informing developmentally appropriate interventions, while it may provide a foundation for studying atypical development as well.

### **This study**

This study aims to explore the associations between EM, EFT, ToM and visual perspective-taking in preschool children, based on self-projection and mental time travel accounts that suggest these processes share functional similarities and common underlying mechanisms. Due to scarce previous studies jointly examining these four skills during childhood (Immel et al., 2022 for preschool age; Lind et al., 2014 for school age), we expect low to moderate significant associations between EM and EFT (mental time travel; Suddendorf & Corballis, 1997), but broader associations between the four abilities are to be explored.

## **Method**

### ***Participants***

Eligible participants were typically developing children enrolled in Preschool or Kindergarten class within the Uruguayan educational system. Children with diagnosed or suspected neurodevelopmental disorders were not assessed. This information was obtained through caregiver reports collected after obtaining informed consent. Eighty-five children ( $M = 62.72$ ,  $SD = 6.83$ , range = 51 - 75 months; 44 girls) aged 4 ( $n = 30$ ), 5 ( $n = 45$ ) and 6 participated in this study. The sample was collected concurrently in five public schools in Montevideo, Uruguay, when 43 children attended Preschool and 42 Kinder. Two schools were in quintile three and three in quintile five following the National Administration of Public Education sociodemographic categorization. The mother tongue of the sample subjects was Spanish. 73 participants had had at least one year of schooling before entering Preschool.

### ***Procedure***

This study was conducted in the context of a broader research project approved by the National Administration of Public Education of Uruguay and the University of the Republic School of Psychology Ethics Committee. Informed consent was obtained from the children's families for their participation. Children were tested individually at school in a quiet room by experimenters who received prior training for task administration. Assessment sessions lasted approximately 40 minutes, and tasks were administered in a fixed order for all subjects. The teachers provided children's sociodemographic data through an ad-hoc questionnaire.

### ***Measures***

#### ***Episodic Memory***

*Episodic Memory task*, adapted from Perner et al. (2007): administration procedures are detailed in Table 1. Target and distractor sets

were counterbalanced, ensuring that the same set was target in some cases and distractor in others. Following the authors, *recall rate* was calculated as the number of items from the target set that were recalled minus the number of false alarms (distractor set items mentioned and intrusions).

### *Episodic future thinking*

*Picture book task*, adapted from Atance & Meltzoff (2005): administration procedures are detailed in Table 1. This task explored children's anticipation of future scenarios of physiological need (e.g., physical protection from weather conditions, potential risk of physical harm, etc.). Responses were coded as 1 for each future-oriented item choice and 1 for each future-oriented verbal response. Following Ródenas et al. (1991) such responses evidenced implication of the *self* through the use of pronouns and conjugations in the first person -singular or plural- of the Spanish language, the inclusion of possible future states of the *self* that could be satisfied with the selected item and contained temporal reference to the future. A global measure (range: 0-4) was computed by summing the item choices score (2 points) and verbal justification score (2 points).

*Future preferences task*, adapted from Bélanger et al. (2014): administration procedures are detailed in Table 1. This task explores children's understanding that their adult preferences may be different from their present ones. To verify that the objects were distinguishable as adult-preferred and child-preferred objects in the cultural context of the study, a baseline study was conducted without temporal projection demands. A subsample ( $n = 21$ ) was presented with item 1 and asked to choose the object that she/he liked the most at that moment, and the object that a "grown-up person" would like the most at that moment (displaying the picture of an adult of the same sex as the child). This procedure was repeated for items 2 and 3. For item 1, all participants correctly identified the child objects, and 18 participants correctly identified the adult-preferred objects. For item 2, 18 participants correctly identified the child objects and 16 correctly identified the adult

objects. For item 3, 19 participants identified the child objects, 20 the adult objects, and 1 participant did not provide a response. Overall, the objects were considered distinguishable as of child or adult preference. For each item, score 1 was assigned when the child object was chosen in the self-now condition and the adult object was chosen in the self-future condition. Remaining combinations were coded with 0 (3 items, range: 0-3).

*EFT composite.* A composite measure of EFT was computed by summing the score of the picture book task and the future preferences task (range 0-7).

### *Theory of Mind*

*False belief Sally task,* adapted from Wimmer and Perner (1983): administration procedures are detailed in Table 1. This task evaluates the ability to anticipate the location where a character will look for an object based on the agent's false belief. One point was awarded only when ToM and control questions were answered correctly (range: 0-1).

*Unexpected content task,* adapted from Gopnik and Astington (1988): administration procedures are detailed in Table 1. The first part of the task explores representational change: children initially represent an object in one way (the toothpaste box as containing toothpaste) and then represent it in a different way after being shown it contains crayons. Last, showing the deceptive form of the object, children are asked about their past representation. The second part of the task evaluates false belief understanding regarding content. One point was assigned for each ToM question, provided control questions were correct (range 0-2).

*Composite measure of ToM.* A composite measure of ToM was obtained by summing the score of the Sally false belief task and the unexpected content task (range 0-3).

*Theory of mind task battery (TOMTB),* adapted from Hutchins et al. (2014): administration procedures are detailed in Table 1. We computed all tasks in the battery, except for visual perspective which

was computed separately. One point was assigned for each ToM question, provided control questions were correct (range 0-13).

*Visual perspective taking*

*Level 2 Visual perspective task*, adapted from the *Theory of Mind Task Battery* (Hutchins et al., 2014): administration procedures are detailed in Table 1. This task explores the ability to alternate one’s own visual perspective with that of another observer who is looking at the same object from a different location. Each correct answer received 1 point (range: 0-2).

**Table 1**

*Episodic memory, Episodic future thinking, Theory of mind and Visual perspective taking task description*

| Task                                              | Description of procedures                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|---------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Episodic Memory task<br>Perner et al. task (2007) | <p>Twenty-four images were presented alternating between a target set and a distractor set (12 images each). Each stimulus showed a single item of easy recognition for the child (toy, food, animal, etc.).</p> <p>Control: “I am going to show you some pictures, can you tell me what they are?” (Experimenter provided the vocabulary if necessary. Participants were excluded from the task if they could not name the content afterwards).</p> <p>Target set images were shown one by one for 2 seconds.</p> <p>“Now you are going to look at each picture one by one, and I will tell you if you have to put it in the bag (only target set pictures were to be placed in the bag). You must pay attention and try to remember them because later I am going to ask you which pictures you put in the bag”.</p> <p>Once the other tests were completed, the experimenter asked: “Earlier we looked at several pictures, do you remember which pictures you put in the bag?”</p> <p>Response format: free recall.</p> |

|                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|---------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Picture book task<br>Atance &<br>Meltzoff (2005)        | <p>A photograph of a landscape was presented (e.g. Training scenario: beach). "Let's imagine that you and your family are going on a trip to this place. What place is this?", "Ok, you have to help your family prepare your backpack to go to (place)". For each scenario three pictures (items) were displayed.</p> <p>Scenario 1: Rainy street. Correct item: jacket. Distractor items: gift and bucket.</p> <p>Scenario 2: Rocky hill. Correct item: Band-aid. Distractor items: book and stones:</p> <p>"Which of these three things would you carry in your backpack to go to (place)? The child was required to choose one of the items and provide verbal justification for their choice.</p> <p>Response format: forced choice based on item pictures (part 1) and verbal justification (part 2).</p> <p>Example of future-oriented justification: "Jacket, because I will be cold"</p> <p>Example of justification with no future orientation: "Jacket, because I like jackets"</p>                                                                                                                                                                 |
| Future Preferences<br>task<br>Bélanger et al.<br>(2014) | <p>First a self-now condition and then a self-future condition were administered, both presenting the same three items.</p> <p>Item 1: children's stories vs. newspapers; Item 2: plasticine vs. crossword puzzles; Item 3: children's television cartoons vs. television news.</p> <p>For the self-now condition: "Now you are a child of 4/5/6 years. Which of these items do you like the most?"</p> <p>For the self-future condition: "Look what I am going to show you... a mirror. Who is here? It is you. Now you are a child of 4/5/6 years, but one day you are going to be a grown-up man/girl like him/her. He/she is as old as (adult referent, e.g. your mum/dad/other adult caregiver)". A picture of an adult of the same sex as the child, not known to the child, was shown.</p> <p>"Which of these items will you like the most when you grow up?", displaying the four options corresponding to the item.</p> <p>The administration of items 1, 2 and 3 was counterbalanced within each block, as was the arrangement of the response options (objects) within each item.</p> <p>Response format: forced choice based on item pictures.</p> |

|                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|----------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| False beliefs Sally task<br>Wimmer & Perner (1983)             | <p>The following was depicted using puppets: “Here are (B) and (T). (T) has this little box, and (B) has this little bag. (B) and (T) like to play ball a lot and because they play for a long time, they get tired. (T) puts the ball in his little box and goes away” (the doll was taken out of the child’s sight). “In the meantime, (B) takes the ball out of the box and puts it in his bag. Later, (T) comes back because he wants to play with his ball”. Where does (T) go to look for his ball?” (false belief question). Where was the ball at the beginning of the story?” 3. “Where is it now?” (control questions).</p> <p>Response format: verbal.</p>         |
| Unexpected content task<br>Gopnik & Astington (1988)           | <p>A toothpaste box was presented to the child. “What do you think is inside the box? The box was then opened to reveal what it actually contained (crayons) and closed again. 1. “What did you think was inside the box before I opened it?” (representational change question). 2. “If the teacher came into this room right now, what would she/he think is inside the box?” (false belief question). 3. “What is really inside the box?” (control question). Score 1 was assigned for correct answer to questions 1 and 2 (toothpaste, toothbrush or similar), provided the control question was also answered correctly (range 0-2).</p> <p>Response format: verbal.</p> |
| Theory of mind task battery (TOMTB),<br>Hutchins et al. (2014) | <p>The battery is presented orally following short vignettes in a storybook format with illustrations. A series ToM of tasks are sequenced in increasing difficulty (i.e., emotion recognition, desired-based emotion, seeing leads to knowing, perception-based action, false belief, second order emotion and false belief, etc.). The child answers ToM and control questions by pointing at one of four response options shown as pictures.</p> <p>Response format: forced choice based on item pictures.</p>                                                                                                                                                             |
| Visual perspective-taking<br>Hutchins et al. (2014)            | <p>The experimenter presents an image showing a statue (frontal view) and two children located at each side of the statue, whose perspectives correspond to the right and left side of the statue. 1. “When Jasmine looks at the statue, what does she see?” 2. “When Anthony looks at the statue, what does he see?” Images of four possible visual perspectives of the statue (front, right side, left side and back) are presented simultaneously. The child selects one image to answer each question.</p> <p>Response format: forced choice based on item pictures.</p>                                                                                                  |

These tasks were adapted from English to Spanish as follows. First, the first author translated the original English version into Spanish. Next, an independent native Spanish speaker conducted the back-translation process into English. Finally, the authors compared the original and back-translated English versions to ensure conceptual equivalence. Some objects were substituted for cultural adequacy (*e.g.*, smarties box for toothpaste box).

### *Intelligence*

The following three measures were extracted from the *Kaufman Brief Intelligence Test - K-BIT* - (Kaufman & Kaufman, 1994), in its Spanish adaptation (Cordero & Calogne, 2009).

**K-BIT-Matrices.** It assesses non-verbal skills, as a measure of fluid intelligence. It requires the subject to point to the graphic option that best completes the series or relationships presented in the visual stimulus. As a measure of performance, the direct score obtained by the subject was divided by the total number of items that made up that sub-area, obtaining a coefficient of range 0-1.

**K-BIT-Vocabulary.** It assesses the level of productive language, as a measure of crystallized intelligence. It required the subject to name items shown in pictures. The score was obtained following the same procedure as in KBIT-Matrices.

**General intelligence.** As a measure of general intelligence, the coefficients resulting from the subscales described above were summed (range: 0-2).

### *Caregiver educational level*

Caregiver education level was operationalized as the highest level of education attained by the main caregiver (range 0 - 9, 0 = incomplete elementary school, 9 = postgraduate degree).

### ***Analytic strategy***

Data were analyzed in Jamovi v. 2.2.5.0 and R Studio was used for data visualization. Outlier analysis ( $Z > 3$ ) determined the suppression of EM results for one case. According to Shapiro-Wilk test, all measures except intelligence variables showed non-parametric behavior. Associations were calculated through Spearman's rank correlation coefficient.

### **Results**

Descriptive statistics are provided in Table 2 and correlational analysis in Table 3. Figure 1 presents the distribution of responses for each variable, along with bivariate distribution visualization. ToM -unexpected content and composite- and EFT correlated significantly with age ( $r_s$  range = .26 - .43,  $p < .05$ ). General intelligence correlated significantly with EM, ToM -unexpected content and composite- and EFT tasks ( $r_s$  range = .35 - .58,  $p < .01$ ). Caregiver education was significantly associated with EFT -picture book task and composite- ( $r_s = .30$ ,  $p < .05$ ). The visual perspective task did not significantly correlate with intelligence, age or caregiver education.

Regarding the relationship between perspective-taking measures, significant associations were observed between ToM -false belief Sally task and composite- and EFT -picture book and composite- ( $r_s = .36$  - .48,  $p < .05$ ). Notably, EM and visual perspective tasks showed no significant correlations with any of the perspective-taking skills. Controlling for age and general intelligence, correlations between ToM Sally false beliefs task and EFT -picture book and composite- remained significant ( $r_s = .49$ ,  $p < .01$ , and  $r_s = .37$ ,  $p < .05$ , respectively). Partial correlations between ToM composite and EFT measures were nonsignificant. Figure 2 details the distribution of participants' future thinking answers across ToM performance, distinguishing between tasks.

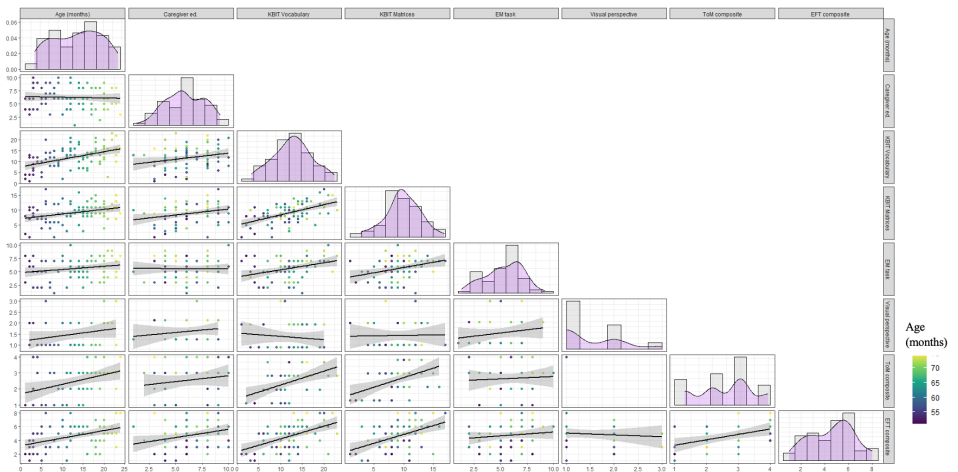
**Table 2**

*Descriptive statistics*

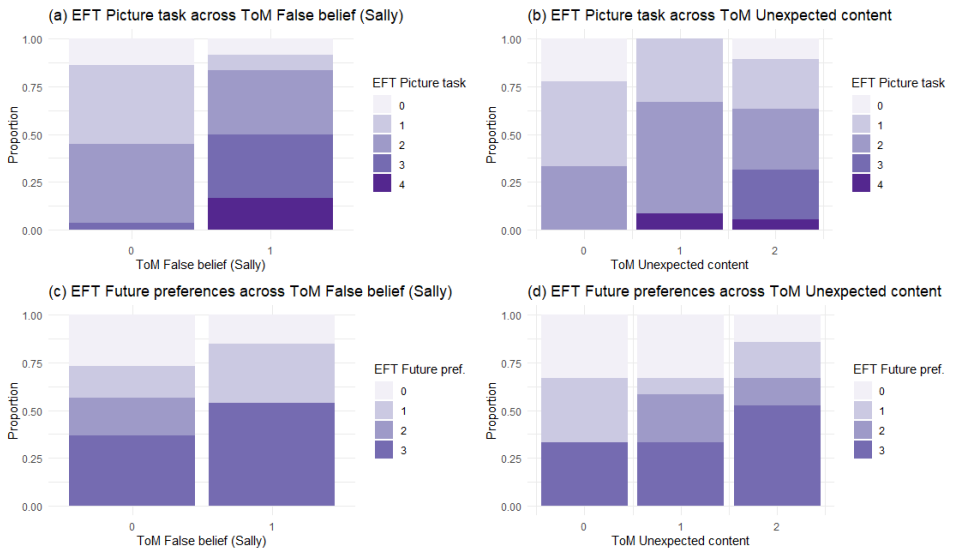
|                          | N  | M     | SD   | Min   | Max   | W    | p     | 25th  | 50th  | 75th  |
|--------------------------|----|-------|------|-------|-------|------|-------|-------|-------|-------|
| Age (months)             | 85 | 62.72 | 6.83 | 51.00 | 75.00 | 0.96 | .007  | 57.00 | 63.00 | 68.00 |
| Caregiver education      | 78 | 5.21  | 2.08 | 0.00  | 9.00  | 0.96 | .010  | 4.00  | 5.00  | 7.00  |
| Intelligence             |    |       |      |       |       |      |       |       |       |       |
| KBIT Vocabulary          | 83 | 0.49  | 0.12 | 0.18  | 0.78  | 0.99 | .855  | 0.41  | 0.49  | 0.56  |
| KBIT Matrices            | 83 | 0.31  | 0.07 | 0.15  | 0.54  | 0.98 | .220  | 0.27  | 0.31  | 0.35  |
| General intelligence     | 83 | 0.80  | 0.17 | 0.32  | 1.21  | 0.99 | .842  | 0.69  | 0.80  | 0.90  |
| Episodic Memory          |    |       |      |       |       |      |       |       |       |       |
| EM task                  | 77 | 1.58  | 2.03 | -4.00 | 6.00  | 0.95 | .007  | 0.00  | 2.00  | 3.00  |
| Theory of Mind           |    |       |      |       |       |      |       |       |       |       |
| ToM False belief Sally   | 45 | 0.29  | 0.46 | 0.00  | 1.00  | 0.57 | <.001 | 0.00  | 0.00  | 1.00  |
| ToM Unexpected content   | 44 | 1.23  | 0.83 | 0.00  | 2.00  | 0.76 | <.001 | 0.75  | 1.00  | 2.00  |
| ToM composite            | 44 | 1.50  | 1.00 | 0.00  | 3.00  | 0.87 | <.001 | 1.00  | 2.00  | 2.00  |
| ToM Battery (TMTB)       | 36 | 7.81  | 1.85 | 5.00  | 12.00 | 0.91 | .007  | 6.75  | 7.00  | 9.00  |
| Visual perspective       |    |       |      |       |       |      |       |       |       |       |
| Visual perspective       | 36 | 0.47  | 0.65 | 0.00  | 2.00  | 0.70 | <.001 | 0.00  | 0.00  | 1.00  |
| Episodic future thinking |    |       |      |       |       |      |       |       |       |       |
| EFT Picture book         | 77 | 1.66  | 1.11 | 0.00  | 4.00  | 0.91 | <.001 | 1.00  | 2.00  | 2.00  |
| EFT Future preferences   | 83 | 1.95  | 1.19 | 0.00  | 3.00  | 0.77 | <.001 | 1.00  | 2.00  | 3.00  |
| EFT composite            | 76 | 3.61  | 1.86 | 0.00  | 7.00  | 0.94 | .002  | 2.00  | 4.00  | 5.00  |

*Note.* KBIT= Kaufman Intelligence Test. EM= Episodic Memory. ToM= Theory of Mind. TMTB= Theory of Mind Task Battery. EFT= Episodic future thinking.





**Figure 1.** Variable distribution and bivariate distribution visualization



**Figure 2.** Distribution of EFT answers across ToM answers

## Discussion

This study aimed to explore the behavioral congruence between EM, EFT, ToM and visual perspective taking in a sample of children aged 4 to 6, based on previous evidence suggesting functional similarities between these abilities. We did not find associations underlying all four cognitive abilities. Instead, we specifically found significant associations between EFT and false belief ToM. Results are discussed below in the light of self-projection (Buckner & Carroll, 2007) and metal time travel conceptualizations (Suddendorf & Corballis, 1997), taking into account the methodological characteristics of tasks.

### ***EFT and ToM, but no overall associations between perspective-taking measures***

Except for EFT and ToM, the absence of correlations between the four cognitive skills in our study are in line with the still scant previous evidence exploring behavioural congruence based on self-projection in childhood (Immel et al., 2022; Lind et al., 2014). To our knowledge, Immel et al. (2022) conducted the only study jointly analyzing these four cognitive abilities in preschool population and found no evidence for an underlying self-projection latent factor. Our results are also congruent with Lind et al. (2014), who did not find a pattern of relationship for these variables in a school-aged typical development sample, nor in an ASD sample. In our study, zero-order correlations revealed an association pattern for ToM and EFT variables. To further explore behavioural coherence between these skills, we tested to what extent the observed associations could be a product of underlying general cognitive skills. After controlling for age and general intelligence, a moderate and significant correlation was still observed between ToM false beliefs Sally task and EFT picture book task, and ToM false beliefs Sally task and EFT composite. Some arguments regarding these specific associations are offered below.

Of notice, in our sample EFT association with ToM was specific to the false belief ToM component. Tracking an agent's belief involves different component processes: identifying agents as mental state holders, tracking their experience (including their visual perspective) and beliefs, and predicting their behavior based on those belief (Kampis et al., 2017; Tomasello, 2018). It is within this third process that false belief understanding and future thinking skills appear to be more closely interconnected. Conceptually, the EFT picture book task requires internally representing the future self and associated physiological states of need, such as cold or pain, conflicting with the current physiological state (Atance & Meltzoff, 2005). The false belief task requires internally representing another agent's mental state (in this case his/her false beliefs, conflicting with one's own), and predicting his/her behavior accordingly. Additionally, certain equivalences in task design should be considered, such as the explicitly presented scenarios and the use of narrative structures as input.

Implications of ToM for EFT have been addressed in previous research (Adornetti et al., 2021; Atance, 2015; Atance & Meltzoff, 2005; Bélanger et al., 2014; Hanson et al., 2014). Among the previous studies that have also reported ToM and EFT associations, Adornetti et al. (2021) found emotional facial expression recognition (affective ToM) correlated with and predicted EFT non-verbal performance in the picture book task in a middle childhood sample. Other future-oriented skills such as prosocial future-oriented behavior -sharing-, have been associated with understanding others' beliefs and desires (Moore et al., 1998). Also, preschoolers' false belief understanding has been linked to prospective memory, a future-oriented ability that demands EFT (Ford et al., 2012). However, other previous studies have not been able to confirm this association in preschool children once language was controlled (Hanson et al., 2014; Vásquez, 2015), nor in school-aged children based on zero-order correlations (Lind et al., 2014). Since both ToM and EFT are ample construct, it is still to be clarified whether associations are broad or more specific to certain components.

Visual perspective taking skills are believed to have a relevant role for tracking another agents' experience and infer their mental states (Kampis et al., 2017; Tomasello, 2018). In our study, the Level 2 visual perspective task did not correlate with ToM measures, nor any of the other perspective taking tasks. Level 2 visual perspective taking implies representing the exact way in which a different observer sees the object. This capacity is first evident at ages 4-5, with performance improving up to age 8 -decreasing egocentric responses- (Frick et al., 2014). In our sample, 61 % (n = 22) of the children failed this task, 31 % solved one item, and only 8 % solved both items, suggesting the task was in general difficult. In previous work, Tian et al. (2021) found significant correlations between Wellman & Liu's (2004) ToM task battery and Hamilton et al.'s (2009) visual perspective task but using a real model and receiving practice trials on the four views of the stimuli. Bigelow & Dugas (2008) also reported correlation between preschoolers' level 2 perspective taking and false belief location and content tasks. Specially at early stages, performance may be affected by methodological variations in the tasks (e.g., spatial complexity; Moll & Meltzoff, 2011). Thus, the lack of association observed in our sample may be genuine (due to distinct developmental paths) or a consequence of using a demanding version of the task in an early stage of this skills' development. We will return to this point in limitations and future research section.

### ***Absence of association between EM and EFT***

Contrary to expectations, no relationship was observed between the EM and EFT variables. Based on task design considerations (Hudson et al., 2011), one possibility is that the tasks shared temporal self-projection requirements but differed in temporal extension and scenario. Concerning temporal extension, the EM task proposes to re-experience an episode that occurred minutes ago (storing cards in a bag), while EFT future preferences task requires a temporal shift to the adult self. This is not a minor aspect since it has been proposed that ages 4-5 constitute a transition period in the ability to differentiate

and temporally locate recent and remote episodes (Busby & Suddendorf, 2009). Also, for the EM task the physical setting is fixed -the cards had been stored in that same room minutes before with the interviewer- whereas the EFT picture book task involves envisioning a physically different location (conflicting with the present physical setting). For the EFT future preferences task the setting is less specified, possibly adding demand to the task. These differential scene construction demands could have implications for performance: some accounts argue that the ability to generate, maintain and visualize a coherent mental scenario is a determinant processual component of memory and prospection processes (Hassabis & Maguire, 2007), and explains the observed common brain activation patterns. EM and EFT lack of correlation could also be explained based on the different response paradigms of the tasks: the former involved *free recall* (Perner et al., 2007), whereas the EFT tasks were referenced by item selection.

Still, misalignment between EM and EFT tasks may be developmental. In line with our results, a longitudinal study that analyzed EM and EFT following the *When, What, Where* paradigm found no association for these ages, even when task demands were paired in terms of format (Cuevas et al., 2015). Regarding verbal analysis, in the comparison of the production of sentences referring to the past and the future with the same temporal extension (3 months), children between 3 and 5 years old produced more episodic details linked to the past than the future (Richmond & Pan, 2013). Differences between EFT and EM have been attributed to more sophisticated requirements for future-oriented competencies (e.g., imagination, executive processing, etc.), driven by the need for flexible recombination of past episodic information (Atance & Sommerville, 2014; Cuevas et al., 2015). However, the evidence at this developmental stage seems to be still mixed, as other studies based specifically on verbal reports, including the *Yesterday-Tomorrow* paradigm, have found associations between EM and EFT measures in children (Busby & Suddendorf, 2005; Hayne et al., 2011; Quon & Atance, 2010).

### ***Limitations and future studies***

This study's limitations include sample considerations and task format implications. Regarding the former, especially for ToM and visual perspective tasks, the absence of significant correlations could be due to lower sample size, compared to the other variables. Also, for the whole study, a larger sample size would allow us to further explore underlying associations indicative of a common self-projection network through other analytic solutions, such as factor analysis.

Regarding the second, it is possible that the input presented in the EFT task had a stronger emotional valence than the input in the EM task, which could be considered more neutral (the child stores and then tries to recall the items without a specific goal beyond responding to an evaluator's demand). New studies with similar objectives could be favored by including EM tasks that address autobiographical aspects associated with the child's life experience and of more explicit emotional valence. Likewise, to achieve greater EM-EFT comparability, the analysis of episodic recall could include an explanatory phase with linguistic content analysis, as was done here in the EFT task.

A low proportion of children succeeded in the Level 2 Perspective taking task we proposed. Future studies should consider broadening the task scale range as well as including more salient physical qualities of the target object to adjust the perspective shifting demand. It should also be noticed that we selected a visual perspective task arguing it complies with the alternative location and first/third person viewpoint that characterizes navigation as a form of self-projection -as depicted in Buckner and Carroll's (2007) model-, and because such tasks have been considered to provide information on the development of navigation at early stages (Newcombe, 2019). Lastly, further research could explore other models not addressed here, such as the Mental Scene Construction model (Hassabis & Maguire, 2007), which considers the role of visuospatial processing of details and components for the construction of coherent larger units, in the context of mental scene construction. In such a case, it could be useful to include a Central coherence measure, as in Lind et al. (2014).

## Conclusions

After analyzing the behavioural congruence among four constructs traditionally linked to self-projection (EM, ToM, EFT and level 2 visual perspective-taking) we found no overall association pattern. These results do not align with the hypothesis of a common underlying mechanism, as proposed by the self-projection account. Together with previous studies, our study invites to further explore associations between specific aspects of these constructs. Our results add to previous literature suggesting ToM and EFT -particularly the ability to predict behavior based on false beliefs and to anticipate future needs-, might share common demands. These include being aware of variations of mental states as a function of experience, and projecting to alternative (including future) scenarios.

Additionally, we argue that enhancing structural equivalence across perspective-taking tasks—by aligning factors such as valence, temporal extension, scene construction demands, and response format—is essential for advancing future research in this area. Apart from theoretical and task design implications, the characterization of shared mechanisms among these skills has practical significance since it can inform more effective and timely social cognition interventions in typical and atypical development situations.

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