WHAT DO WE KNOW ABOUT BABIES' MINDS? A LITERATURE REVIEW

Caroline Campos Rodrigues da Silva [1]; Maria Regina Maluf [1]

ABSTRACT

Theory of Mind, (ToM), designates the socio-cognitive ability that develops in human beings during the first years of life, which allows them to attribute mental states to other people through inferences regarding their beliefs, desires and intentions, and thus predict or explain the behavior of others in everyday social relations. In this sense, the objective of this research was to carry out a literature review regarding the emergence and development of ToM in babies. The search was carried out in the Science Direct, Scielo and PsycInfo databases and obtained 399 results, of which 26 articles were analyzed referring to the development of ToM before expressive language. The results suggest that babies' mental abilities are more sophisticated than previously believed. However, the reason for this success is contradictory and has been conceptualized and interpreted in different ways by researchers.

Keywords: theory of mind; babies; mental states; pre-verbal

¿Lo qué sabemos sobre la mente de los bebés? Una revisión de la literatura

RESUMEN

La Teoría de la Mente, más conocida en inglés como *Theory of Mind (ToM)*, designa la habilidad sociocognitiva que se desarrolla en los seres humanos durante los primeros años de vida, lo que les permite asignar estados mentales a las otras personas por intermedio de inferencias en lo que se refiere a sus creencias, deseos e intenciones, y así predecir o explicar el comportamiento de los otros en las relaciones sociales cotidianas. El objetivo de esta investigación fue realizar una revisión de literatura a respecto de la emergencia y del desarrollo de la ToM en bebés. Se realizó la búsqueda en las bases *Science Direct, Scielo* y *PsycInfo* y se obtuvo 399 resultados, de los cuales se analizaron 26 artículos referentes al desarrollo de la ToM antes del lenguaje expresivo. Los resultados sugieren que las habilidades mentales de los bebés son más sofisticadas de lo que se creía anteriormente. Sin embargo, la razón de ese éxito es contradictoria y sigue siendo conceptualizada e interpretada de modos distintos por los investigadores.

Palabras clave: teoría de la mente; bebés; estados mentales; preverbal

O que sabemos sobre a mente dos bebês? uma revisão da literatura

RESUMO

A Teoria da Mente, mais conhecida em inglês como *Theory of Mind (ToM)*, designa a habilidade sociocognitiva que se desenvolve nos seres humanos durante os primeiros anos de vida, que lhes permite atribuir estados mentais às outras pessoas por meio de inferências a respeito de suas crenças, desejos e intenções, e assim predizer ou explicar o comportamento dos outros nas relações sociais cotidianas. Nesse sentido, foi objetivo desta pesquisa realizar uma revisão de literatura a respeito da emergência e do desenvolvimento da ToM em bebês. A busca foi realizada nas bases *Science Direct, Scielo* e *PsycInfo* e obteve 399 resultados, dos quais foram analisados 26 artigos referentes ao desenvolvimento da ToM antes da linguagem expressiva. Os resultados sugerem que as habilidades mentais dos bebês são mais sofisticadas do que se acreditava anteriormente. Entretanto, a razão desse êxito é contraditória e vem sendo conceitualizada e interpretada de modos diferentes pelos pesquisadores.

Palavras-chave: teoria da mente; bebês; estados mentais; pré-verbal

[1] Pontifical Catholic University of São Paulo – São Paulo – SP – Brazil; caroline.campos.rodrigues@gmail.com; marmaluf@gmail.com

INTRODUCTION

Research into the cognitive, emotional and social development of babies has progressed a lot in the 21st century, helped by new brain imaging techniques. Child behavior scholars admit that children's social and emotional well-being is intrinsically connected to their cognitive development. Babies are active learners, they choose what they can expect, who to expect it from, and they engage intensely in relations with others (Wellman, 2014). When the baby demonstrates, through his eyes and gestures, his desire to obtain something and the caregiver responds to him, consistent, responsive and warm support is created, which will support his learning and cognitive development.

In the baby's world, interest in other people seems to trump all other interests. Experiments with newborns show that the human face is always preferred over other stimuli, with the eyes being the preferred object. Several studies dealing with imitation and joint attention behaviors show that babies develop social understanding earlier than traditionally thought and show signs of awareness of other people's mental states.

Recent research in neuroscience shows that the human brain is a social brain and babies are born predisposed being with other humans and maintaining close proximity to them (Dehaene, 2021). Despite its immaturity, a baby's mind already has considerable knowledge, inherited from the long evolutionary history of the species. This knowledge is often not visible in babies' first behaviors, however technological advances in research methods are opening new paths that allow us to uncover the vast repertoire of skills that babies are born with.

The increase in technological and methodological resources has made new research with very young children possible. Thus, research with very young children, even before they master expressive oral language, has demonstrated that the skills that allow us to learn about the world and ourselves have their origins in early childhood. It is now known that even newborns know a lot about people, objects and language. More than that, babies and young children have learning mechanisms that allow them to spontaneously review, reformulate and restructure their knowledge (Gopnik, Meltzoff, & Kuhl, 2001).

Some of these mechanisms that have been studied in research with babies fall within the conceptual framework of Theory of Mind (ToM). ToM studies the socio-cognitive ability that develops in human beings during the first years of life and allows them to attribute mental states to other people through inferences about their desires, intentions and beliefs. From this perspective, discussions regarding the attribution of *false beliefs* to others attract the interest of researchers and educators who seek to establish and describe the moment in development when the child is capable of understanding that other people may not perceive a fact that he, the child is noticing. Thus, it is this particular moment in development that the classic theory of mind and false belief tasks assess. Thus, the child who realizes that others may not perceive what he is perceiving (e.g. the character Maxi, from the classic false belief task, who did not see that his mother moved the chocolate and, therefore, continued to believe that the treat was in the same place he had placed it), he is already able to understand that other people may have a false belief about the object in question. Classical research on theory of mind considers this to happen around 4 years of age. This specific mental achievement is very useful for social and emotional life, as it helps to explain and predict the behavior of other people in everyday social relations.

The objective of this research was to review the knowledge available in the literature regarding the development of theory of mind and the understanding of false belief in babies. It is understood that babies are children in the first and second periods of childhood, that is, between zero and 36 months of age, who are acquiring receptive language and also beginning to use expressive language.

The choice of this age group is due to the fact that the first studies on the development of ToM, which began in the 70s, were carried out with children who had already mastered oral language and were therefore considered capable of carrying out assessment tasks, which were based on listening and answering questions about story characters, just as studies were also carried out through observations of children in playful situations that involved the interactive use of language (Domingues, 2015). The studies with babies, which will be the subject of a systematic review in this research, were only carried out at the end of the 20th century and the beginning of the 21st century, when instruments resulting from new technologies such as brain imaging (fRMI), eye movements (eye tracking) and non-traditional tasks were already available (Scott & Baillargeon, 2017), which replaced the methodological resource to verbal language.

METHOD

The searches were carried out in the Science Direct, Scielo and PsychInfo databases. The descriptors mentalization, theory of mind, infant, early childhood, predictable and *-month-olds were crossed with Boolean operators (AND and OR). 399 articles were found, of which 307 were indexed in the PsycInfo database, 78 in Science Direct and 14 in Scielo.

The inclusion criteria used were: research that dealt with subjects with typical development, pre-verbal, aged between zero and 36 months; published in Portuguese, English, French or Spanish, from 2010 to 2017. In the case of longitudinal studies, research that began in the pre-verbal period was included, using at least one

instrument that did not require a more developed level of language knowledge.

After reading the titles and abstracts of 399 articles found, the following were selected for full reading: 44 from the PsycInfo database, 24 from Science Direct and 2 from Scielo, totaling 70 studies that met the inclusion criteria. Of these, five were duplicates and two others were excluded because they were in languages that did not meet the inclusion criteria, leaving 63 articles. An initial analysis generated three major thematic and methodological categories that led to the final choice of 26 research studies, all in English: A) emergence of ToM and development systems, statistical learning and cultural evolution (n=13); B) development in babies of understanding and attribution of false belief (n=8); C) parental care at the beginning of ToM development (n=5).

RESULTS OF ANALYSIS OF RESEARCH FOUND

The full analysis of the research found allowed the integration of new knowledge regarding mental representations in babies, their systems of development and understanding of false belief and the implications of parental care.

Theoretical research about the emergence and development of ToM in babies

Theoretical studies that deal with the emergence and development of ToM have been gathered into three large groups: identification of one or more development systems, evidence in favor of statistical learning and cultural evolution.

a) Identification of one or more development systems

A theoretical issue highlighted in the literature is that which deals with the cognitive bases of ToM. In order to answer the question of possible identification in humans, two systems were used to track beliefs and belief-like mental states (Apperly & Butterfill, 2009; Butterfill & Apperly, 2013). The authors discuss the lack of theoretical consensus in this regard and make reference to studies whose results demonstrate that before the age of 3 children fail belief attribution tests; in contrast, they refer to a series of other more recent research showing that children aged 13 to 15 months are successful on false belief tasks.

Butterfill and Apperly (2013) suggest that the attribution of beliefs works in a similar way to numerical reasoning, so that the limits of a basic numerical cognitive system will only be overcome when children acquire the conventional numerical system, as numerical skills depend heavily of general cognitive resources such as language, information processing and executive functions. Therefore, it is considered the existence of two systems that combine cognitive efficiency and flexibility, which are achieved through more cognitively demanding reasoning processes. In the same direction, according

to the authors, ToM also has two distinct systems for attributing belief: one that is cognitively efficient, yet limited and inflexible, and another that is flexible, but requires the use of general cognitive resources such as language and executive control.

Butterfill and Apperly's (2013) proposal confronted theoretical questions regarding how cognitive systems treat information from the ToM domain, bringing into focus other theoretical points of view debated in the area. Thus, in reference to this Two Systems Theory (TDS), Thompson (2014) states that it is a plausible explanation for the development of ToM, but it has flaws that must be overcome. One of them is to explain the good performance of babies in non-traditional tasks, since between 18 and 72 months, none of the points seem to explain what happens in this age group. In this sense, Thompson (2014) suggests the existence of an intermediate-level system, and after the level-one system, an intermediate system would develop in humans around 18 months, while the level-two system would be present in older children and adults, so that this intermediate system would support behavioral reading and perspective taking.

In contrast, Carruthers (2015) points out that the arguments offered by Butterfill and Apperly (2013) are not convincing and that the data referred to can be explained in another way. According to him, babies have a set of primitive concepts (such as find, like, know) along with simple rules to determine the application of these concepts. From this perspective, the author maintains that a single initial system develops continuously, and throughout the process, some concepts are added and others are differentiated, gradually transforming into the system used by adults. This unique system becomes increasingly efficient over time, as well as interacting more strongly with other mental faculties.

Carruthers (2015) relates the failures of 3-year-old children in ToM tasks to executive functions and linguistic skills, so that success in traditional tasks actually depends on the interaction between executive functions, memory systems and ToM. The author also points out reasons why the analogy with the acquisition of the number system should be refuted: (a) the number system can only be acquired with effort and as a result of explicit teaching, while ToM also develops through other processes such as exposure to conversations about mental states; (b) the process of acquiring number systems does not appear to be universal, while the ability to think about explicit false belief has been shown to be universal, which suggests that numerical concepts are culturally constructed, while central ToM concepts are not.

In the same direction, Christensen and Michael (2016) propose a different architecture for the systems that support the ToM ability instead of a parallel system, as suggested by TDS (Apperly & Butterfill, 2009). They propose the existence of a cooperative multi-system, in

which the representation of beliefs is part of a set of skills involved in the representation of situations. According to the authors, babies do not represent beliefs in the same way as older children or adults, however their representations of beliefs involve a general semantic memory, which is the basis for a more sophisticated representation that emerges in older children.

Kóvacs, Fogd and Kampis (2017) accept a unitary system as a starting point to analyze the processes involved in implicit ToM, that is, one that cannot be made explicit through language. According to the authors, success in ToM tasks implies that the child is able to attribute mental states, however the error can occur for several reasons, such as not paying enough attention to the agent, not identifying the agent's focus of attention or simply not being able to connect a mental state to a behavioral consequence. Data obtained through neuroimaging shows that implicit and explicit inferences, that is, level one and level two, activate the same brain area, as well as ERP studies reveal that inferences of objectives triggered by implicit and explicit instructions happen in the same space of time. Neuroimaging also suggests that the temporoparietal junction, where the temporal lobes meet, is regularly involved in both types of tasks. Such evidence leads the authors to question the dichotomous two-system approach and, instead, suggest the possibility of thinking that ToM is the result of a process that involves not only two dichotomous aspects, but the interaction of the proposed processes.

Sodian (2011) gathered evidence regarding theory of mind in babies and considers, like Chirstensen and Michael (2016) and Thompson (2014), that the proposal of one or more systems for processing knowledge and beliefs is the best way to see the evidence gathered by him, which leads to admitting that the attribution of intention, which corresponds to the system level one, already occurs in the first year of life. Babies, around 1 year of age, already integrate a precise representation of the perception of an agent's objectives, which would be a precursor to a more refined attribution of mental states in the early childhood education period. On the other hand, unlike Butterfill and Apperly (2013), who believe that representational ToM would only be developed in older children, Sodian points to evidence that two-year-old babies already have this ability and, therefore, have a level system two.

From a systemic perspective, whether this system is single, multiple or dichotomous, the research analyzed agrees with the need for more evidence, as it is not yet known how this system(s) adapts to inputs from the environment, the effects of social experiences on the development of this(these) system(s) and whether they are in fact relevant to them.

b) Statistical learning

Regarding the emergence of ToM, Gopnik and Wellman (2012) proposed that babies and children in early childhood already construct intuitive theories, that is, theories about their own mind and the other people's minds. From this perspective, the authors suggest probabilistic models as a possible possibility for changing a theory, such as ToM, and for this Bayesian inference would be the most general and consolidated way. Broadly speaking, the Bayesian rule is a formula for finding the probability of a hypothetical structure generating the pattern of evidence.

Thus, considering that causal representations in children are like a Bayesian network, good performance in false belief tasks does not depend on an isolated hypothesis but on several concepts linked together: theory and behaviors, sources of information regarding appearance and reality and representational change to predict actions. In this sense, it is possible that children up to the age of three do not yet have all the concepts linked to perform well in this type of false belief task, but they already have individual concepts.

Like Gopnik and Wellman (2012), Banovsky (2016) points out that there are in fact similarities among theories formulated by children intuitively and scientific theories. A baby's ToM allows him to make predictions about behaviors or even situations that require false beliefs to be taken into account. The relation between an adult's ToM and a baby's ToM have different complexities, but they reach similar predictions, as they share the same structure.

Ruffman (2014) suggests three factors that contribute to the development of understanding mental states: (a) the innate capacity for statistical learning that enables the learning of behavior patterns; (b) innate or early developed propensities that include interest in eyes, face, speech and human movements; (c) caregivers' use of mental verbs to describe an agent's behavior. In this sense, the understanding of mental states is initially helped by dialogues that lead children to highlight their own desires, such as wanting, for example, and by the use of these verbs to refer to certain behaviors, such as reaching for an object and smiling. According to Ruffman (2014), babies do not have an innate understanding of mental states but rather an innate basis for learning about mental states. From this perspective, the author argues that children develop an understanding of behavior and then develop an understanding of mental states.

From a different perspective, Vierkant (2012) points out that even without fully developed expressive language, it is possible to deliberate about mental states. In this sense, children's verbal reports in false belief tasks are not the only evidence of consciousness that can be presented: intentional actions can also be indicators of consciousness.

c) The cultural evolution of ToM:

Heyes and Frith (2014) point out that gaze movement tests show that implicit ToM does not require executive

control, which suggests that the neurocognitive mechanisms of ToM can be genetically inherited and, whether general or specific, these mechanisms are different of those who control the explicit theory of mind. The authors use the acquisition of written language as an analogy for the acquisition of explicit ToM: just as in the acquisition of written language, ToM is a skill passed from one generation to the next through verbal instruction. Just like literacy, acquiring ToM also involves decoding signs: in written language, signs are letters on paper and in ToM, signs are facial expressions, body movements, and statements.

Carmiol (2012) proposes the theory of cultural learning as a possible explanation for the emergence of ToM. According to Carmiol, from 6 to 9 months, babies are able to recognize people as animated beings; subsequently, from 9 to 12 months, they begin to recognize that people are agents with specific goals and, in a third moment (12 to 14 months), they understand others as agents who think about different actions aimed at specific goals, represented internally. At around 14 months, babies are able to cognitively represent goals and action plans of others and this ability, combined with the motivation to share mental states, forms the basis of what is called *shared intention*. Around four years of age, the transition from shared intention to collective intention occurs and this allows the child to recognize and use the general and abstract system of perspectives and norms characteristic of his/her own culture.

Wang and Leslie (2016) report studies that reveal spontaneous and implicit understanding of false belief already in early childhood. On the other hand, after analyzing all the studies found, they conclude that they did not obtain enough evidence to say that these early manifestations really represent a genuine ToM.

The emergence of false belief in babies

Results obtained by Southgate and Vernetti (2014) suggest that not only do babies perceive events from the perspective of others, but also representations of these perspectives generate predictions of actions and that, like adults, babies predicted an action only when it was consistent with the representation that the agent had. Southgate and Vernetti point out that correct predictions can be made based only on the agent's perceptual experience, without the baby actually reflecting on the true or false character of the representation that this agent has.

The two experiments carried out by Luo (2011) with 24 children between 10 and 11 months old suggested that the babies recognized that the agent had a false belief and, in the second experiment, the results suggested that in the false belief task of an object the babies recognized that the agent was unaware that the two objects were present at the scene. In general terms, these results point to the possibility that 10-month-old babies consider an agent's belief, whether true or false, when predicting and interpreting actions.

Buttleman, Suhrke, and Buttleman (2014) argue that 18-month-olds' false belief understanding is as sophisticated as preschoolers'. This conclusion resulted from an unexpected-identity task, to verify whether babies use their ability to represent the false appearance and real identity of an object and at the same time attribute these representations to other agents. To test this hypothesis, 63 18-month-old children were presented with four deceptive objects: a sponge that looked like a rock, a box that looked like a book, a pencil that looked like a twig and a school that looked like a duckling. In addition, real objects were used, that is, a stone, a book, a branch and a toy duck. The expected solution would be for babies to correctly attribute a goal to the researcher, using the researcher's beliefs about that object as a basis: when he or she was only aware of the appearance of the object (false belief condition), the agent would not know that there is an incompatibility between the actual appearance and identity of the object and therefore he would choose the object for misleading reasons. The results of this research showed that 18-month-old babies are able to understand another person's false belief about another object even when it can be represented in different ways. Furthermore, infants have been found to use their understanding of the agent's belief to infer that agent's goal and help the agent in accordance with that goal.

Fizke, Butterfill, van de Loo, Reindl and Rakoczy (2017) conducted experiments with 67 31-month-old children and 137 26-month-old children and concluded that, despite the limitations of this and study, the performance presented shows limits in the ToM capabilities of babies. These limits are those predicted in the two-system theory, suggested by Apperly and Butterfill (2009), reiterating that babies are capable of solving some types of tasks, such as changing location, however they are unable to solve tasks that involve mental states, such as the aspectual ones.

From a different perspective, Yott and Poulin-Dubois (2012) carried out an experiment with 48 18-month-old babies and obtained results that do not support the hypothesis that babies' performance is due to the activation of behavioral rules. The results found by Yott and Poulin-Dubois not only differ from the behavioral perspective but also diverge from the two-system theory perspective of Apperly and Butterfill (2009), the data show that babies did not reason automatically, i.e. no cognitive demands to succeed in tasks.

Priewasser, Rafetseder, Gargitter and Perner (2017), unlike Yott and Poulind-Dubois (2012), found results in favor of the behavioral perspective. The researchers argue that babies aged 9 to 18 months are "teleologists", able to think about the actions of an agent, without actually worrying about that agent's mental states. The results obtained in non-traditional tasks showed babies'

inclinations towards teleological reasoning, which presupposes that babies know the purpose and objective of the agent's action and, to do so, it is not necessary to attribute mental states but rather an objective. According to the researchers, a teleologist child seeks, first and foremost, to help the agent achieve a goal.

Crivello and Poulin-Dubois (2018) verified the performance on false belief tasks of two groups of 18-month-old babies. The experiments were conducted with 41 babies and the results of the false belief task differed from the original study. A follow-up of the first study, with a sample of 97 babies and the results did not differ significantly from chance, not obtaining similar results to those of the original study, which showed 72% success in the task.

Longitudinal data obtained by Wiesmann, Friederici, Disla, Steinbeis and Singer (2017) through false belief tasks with anticipatory looking using a Tobii T120 monitor, which tracks the subject's gaze undergoing the task. Two experiments were conducted with children at 2, 3 and 4 years of age, and at 3 and 4 years of age, children also performed traditional explicit false belief tasks. The results showed a significant change in the false belief task with anticipatory gaze between 3 and 4 years of age and correct responses only at 4 years of age, which suggests that anticipation and false belief representation do not develop before 3 and 4 years of age.

Implications of parental care on the development of ToM

Babies, living in an essentially social world, develop expectations and knowledge from an early age regarding actions and interactions that occur in the environment in which they live. Interactions experienced in early childhood will shape a child's social cognition and behavior throughout life.

Brink, Lane and Wellman (2015) pointed out the need for more studies that present connections among the first years of life, social behavior, social cognition and early childhood education. To provide a broader theoretical framework regarding how early social cognition depends on the social context in which the child is inserted, they carried out three studies and found that the maternal tendency to engage in conversations about mental states is a facilitating element in the development of ToM.

Meins, Fernyhough, Arnott, Turner and Leekam (2013) addressed the relationship between talk about mental states and ToM based on the concept of mind-mindedness. The concept of mind-mindedness concerns the inclination of caregivers to treat infants as individuals with thoughts identical to those of the caregiver, such that the caregiver (often the mother or father) "puts words in the baby's mouth," e.g. a mother who talks to her baby about the attribution of beliefs, desires and emotions "I think I'm hungry mommy, I'm hungry mommy", as if the baby was, in fact, carrying out this speech.

Meins et al. (2013) researched how mind-mindedness achieves a facilitating effect on the development of ToM. The results of this study showed several relations between mind-mindedness and child socio-cognitive development, such that the maternal tendency to make appropriate comments in conversations with children at 8 months was directly associated with performance on ToM tasks at 4 years. Children who, at eight months, had mothers with a greater tendency to make random comments, demonstrated a smaller vocabulary related to mental states and a lower level of symbolic play at 26 months.

To verify the relation among mind-mindedness, security of attachment and aspects of ToM, Laranjo, Bernier, Meins and Calrson (2010) carried out a study in three phases, with 61 dyads of mothers and babies at 12 months, at 15 months and at 26 months. The results also showed potential relations between mind-mindedness, security of attachment and the initial articulations of ToM: when mothers used appropriate mental comments more frequently during the first year of age, there was a positive association with the understanding of the ToM aspects assessed at two years old.

Laranjo, Bernier, Meins and Carlson (2014), carried out a follow-up of the above study obtaining results that suggest that the use of appropriate mental comments by mothers during play with toys at 12 months was related to performance in false belief tasks and perspective taking at 4 years old.

FINAL CONSIDERATIONS

Throughout this review, it was possible to show the success of babies in mental state attribution tasks and, in certain types of tasks, attributions are more sophisticated than previously believed. However, the explanatory hypotheses for this success are still contradictory.

Among the divergences pointed out in the categories analyzed, the researchers' interpretations largely depended on the definition adopted regarding the theory of mind: for some, ToM is the result, that is, the skill already developed; for others, the name ToM is used to designate the initial process.

Even considering the variation in the meaning given to the ability to attribute mental states, researchers agree on its developmental character: whether through a multi-system, two systems or a single branched system. ToM develops over time and, to this end, receives contributions from social factors, executive control and language.

The research reviewed suggests a strong influence of parental care on the development of ToM and provides plenty of evidence that parents who use mental verbs appropriately support development.

The studies found showed great interest among contemporary researchers in the development of ToM and specifically in the emergence of understanding

false belief, linked to the acquisition of a mental representational domain to be investigated through cross-cultural research.

Although this research has provided an overview of the area, some questions may be raised. One of them concerns the lack of references to Brazilian research on ToM in babies. Other future reviews may be able to verify whether this absence can be attributed to methodological flaws or even to the lack of standardization of the descriptors used by researchers in the area, since the term "bebê" in Portuguese does not determine any necessarily, the age group as it occurs in English, which makes it difficult to use in research. Still, it seems relevant to us that the theme is developed at a national level, considering the guidelines of the Base Nacional Comum Curricular, which establishes parameters for the daycare period, in order to enhance child development.

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This paper was translated from Portuguese by Ana Maria Pereira Dionísio.