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Theory of Mind in relation to Metacognition and ICTs. A metacognitive approach to ToM

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Abstract. Theory of Mind constitutes a complex cognitive ability of the individual that impulses him to acquire social knowledge. While the development of Metacognition contributes to the construction of a higher mental structure, allowing the observation, control, and readjustment of the cognitive mechanism with the aim of its optimal performance. The present study investigates the existence of correlation and mutual influence between the two functions. Survey results show that Tom and Metacognition are connected and interact with each other in man's social, cognitive, and evolutionary course, forming two mental processes of outstanding importance for his well-being. Additionally, the predictive power of ToM in the development of Metacognition is highlighted.
Keywords: theory of mind, mindreading, metacognition

Introduction

Research suggests that executive functions, Theory of Mind (ToM), and Metacognition are higher cognitive processes that are closely linked and are involved in each other's functioning to complete a task. Executive functions constitute the cognitive control of behavior, the self-control of one's desires, beliefs, thoughts, and objectives. Cognitive control involves self-awareness, which is identified to some extent with the metacognitive ability and the ability to represent one's objectives and mental states, for which the correct functioning of the ToM is crucial. The metacognitive ability consciously controls and evaluates the efficient attribution of mental states to oneself and others (Sodian, & Frith, 2008).

In the first years of his life, the child gradually develops ToM. Then distinguishes that his behavior is motivated by desires and beliefs that may be different or incorrect from those of other people. He gradually becomes conscious of his knowledge or ignorance, laying the groundwork for the growth of his early metacognition (Kuhn, 2000). In particular, children at age 4-5 years acquire the concept of representation as they perform false belief tasks. They subsequently understand knowledge as part of an information processing system and appreciate the importance of accessing information so that they can understand what is essential to gain knowledge. Fundamental to the path to metacognition is the acquisition of meta-representation, children's understanding that people can represent the world in their minds (Lockl, & Schneider, 2006).

Metacognition, as a higher cognitive process, allows the individual to be aware of his cognitive functions, observe them while they are working, control them, achieving their adaptation according to the requirements of the learning process or a situation. Therefore, distinguished adaptation, or ''consciousness'', is a dynamic process that is a dominant pillar in the knowledge pyramid (Drigas & Papas, 2017; Drigas, Kokkalia, & Economou, 2021). The metacognitive process contributes to the interpretation of any action or behavior that includes a set of cognitive functions. It aims to exploit the individual's potential, at conquering his self-awareness, and by extension at realizing his existence, at improving consciousness,

through self-perception, self-experience, and self-control (Drigas & Mitsea, 2020a, 2020b, 2020c). The education of awareness through the implementation of special programs in general and special education schools provides significant benefits in stress reduction, brain neuroplasticity, hormonal homeostasis, and improving children's physical, emotional, social, and cognitive development (Drigas & Mitsea, 2020b).

Metacognition contributes to the development of a set of cognitive, social, and emotional processes. In particular, it conduces to the development of oral communication, attention, language ability, problem-solving, social knowledge, self-control, and self-regulation (Flavell, 1979).

Misailidi (2010, 2011) reports that preschool children develop metacognitive vocabulary understanding alongside ToM ability, strengthening the link between the two abilities. This is mainly because developmental changes observed in one function interact with corresponding information in the other, but it's unclear which one underlies the other. There even seems to be interaction and mutual support between the two functions.

A set of studies report the interaction of ToM and Metacognition not only in typically developing children but also in children with autism. In particular, the research of Grainger,_Williams, & Lind 2016 reports that children with ASD presented impaired metacognitive observation, which is considered crucial for the development of ToM since it provides the possibility of representing the individual's mental states and the effective control of cognitive of its processes. In addition, McMahon et al., 2016 found that metacognition is a predictive indicator of mental level, linked to both the cognitive and social performance of children with ASD. Therefore, it could have a way of intervening with their weaknesses.

It is argued that the individual's metacognitive ability is at the top of the hierarchy of control of cognitive functions, allowing flexible planning of actions in the future, thus ensuring the most effective adaptation to the changing environment (Frith, C. D. 2012).

Research reports that the functioning of ToM is particularly linked to other well-known, mainly executive processes that are also involved in the metacognitive process. Some of them are memory, observation, attention, cognitive flexibility, and inhibitory ability, since the creation and processing of complex mental and cognitive states requires the cooperation and involvement of higher energies (Boucher, 2012; Miranda, Berenguer, Roselló, Baixauli, & Colomer, 2017; Hamilton, Hoogenhout, & Malcolm-Smith, 2016).

Method

The present study constitutes a literature review and was carried out on selected databases such as Google Scholar, Research Gate, Scopus, PubMed, and ERIC. It relied methodologically on the literature review since it can be particularly effective and efficient in providing a brief review of a specific topic or research problem, aiming to advance knowledge (Snyder, 2019). It aims to search for the existence of an interaction between Theory of Mind and Metacognition and summarize the possible correlation between the two functions.

Theoretical background of the concepts

The conceptual approach of the Theory of Mind

Successful social interactions require the individual's ability to monitor the constantly changing mental states of others. It is argued that people's behavior is determined by their beliefs, even if they are false, and not by reality. This process results from ToM, which is a conscious but implicit process (Frith, & Frith, 2012).

ToM concerns the perception and understanding of the mental states of the person himself and other people. Mental states, while not visible, assume their existence and assess their content through specific behaviors, resulting in actions (Sabbagh, & Bowman, 2018). In particular, ToM consists of the individual's ability to attribute mental states to himself and others, perceiving the causal relationship that connects them, with the behavior that causes (Misailidi, 2003).

Developmental psychology mentions three main theoretical directions that approach the functioning of ToM: Theory about theory, Stimulation Theory, and Modularity Theory, whereabouts according to Flavell, 1999 its best interpretation is achieved by the combination of both three theories.

The development of ToM appears progressively in children with the understanding of intentions, and desires and then with the perception of beliefs. However, the integration of the content of mental states differs according to the individual's experiences and tendencies (Sabbagh, & Bowman, 2018).

ToM is a fundamental social-cognitive ability, the development of which affects various aspects of children's lives and develops gradually between 2 and 5 years of age. By the age of two, a basic understanding of emotion, perception, desire, and intention is observed. At the age of 4-5, false belief reasoning appears, where children test new theories through their experiences, revising existing ones (Carlson, Koenig & Harms, 2013).

A notably significant period for the development of ToM is the preschool age, as during this period developmental changes are observed in the mechanisms of ToM, setting the milestones for its further evolution (Sabbagh, & Bowman, 2018).

However, the mental process of processing behaviors and evaluating the content of beliefs gradually develops with the acquisition of language ability and executive skills (Sodian, 2011). False belief understanding is associated with some real-world behaviors in 4-year-old children, suggesting progress in their cognitive development (Astington & Jenkins, 1995).

It is noteworthy that in the preschool age individual differences in ToM arise depending on the biological maturation of executive functions, language ability, personal perception, and conceptual understanding, as well as cognitive, social, individual, and environmental differences of children. It thus influences the timing of ToM developmental stages (Hughes, & Devine, 2015; Apperly, 2012).

Research reports the existence of two ToM systems, one is implicit unconscious, appears at an early age, and is associated with monitoring mental states, and the other gradually evolves, and operates in a deliberate, controlled manner allowing explicit, conscious inferences (Schneider, & Dux, 2014). Additionally, we distinguish between cognitive ToM, where the individual is led to conclusions about the motives and beliefs of others, and emotional ToM requires empathic cooperation to understand emotional states (Kalbe et al., 2009; Sebastian et al., 2012).

The conceptual approach of Metacognition

The concept of metacognition includes complex terminology with overlapping concepts such as reflection, attribution, perspective-taking, and ToM. The terminology and conceptualization of metacognition were established by Flavell, 1979 (Moshman, 2018). Metacognition, as a higher mental process, refers to the individual's knowledge of the functioning of their cognitive skills, as well as awareness, awareness, evaluation, and regulation of their thinking (Drigas, Kokkalia, & Oikonomou, 2021; Flavell, 1979).

Three key characteristics that distinguish metacognition from cognition are intentionality, self-consciousness, and self-awareness (Worley, 2018). It is considered to be an essential ability for the creation of self-identity, in which the individual evaluates, revises, and regulates his known situations through consciousness and reflexivity. In particular, metacognition through cognitive involvement in thinking, allows the representation of the self ´´ from the inside´´ from within, promoting self-awareness (Proust, 2007).

Metacognition metaphorically can be rendered as claimed by Plato as 'the silent dialogue of thought' or, as Socrates puts it, 'the conversation that the soul has with itself about the matters it considers as it thinks, converses with itself' (Worley, 2018).

Investigating metacognition from different research fields of developmental psychology, cognitive psychology, neuropsychology, and educational psychology, it was found it cannot be considered a unitary concept. Probably due to the variety of differences in its conceptualization from the different cognitive fields, having as an essential component the awareness of mental activity (Norman et al., 2019).

Metacognition has a significant role in the development of the child's conceptual thought. Concepts are mental representations involved in a set of cognitive processes categorizing information, recalling from semantic memory, and making inferences. A metacognitive evolution creates a new phase of conceptual development, as the child's metacognitive abilities lead to the acquisition of new concepts and the readjustment of existing ones (Smortchkova, & Shea, 2020).

Metacognition as a higher brain function works severally in the prefrontal and parietal cortex of the brain and depends on their proper functioning. Deficits in the ability of cognitive functions strongly affect the person's functional capacity and quality of life, especially in neurological and psychiatric conditions, where limited development is felt (Vaccaro, & Fleming, 2018).

According to Flavell, 1979, and Papaleontiou-Louca, 2019 we distinguish four basic dimensions of metacognition.

Metacognitive knowledge concerns the knowledge and understanding of the individual's cognitive abilities and strategies, such as other people. It is enriched by the information resulting from the conscious observation of behaviors, and activated in various contexts, through the awareness of metacognitive knowledge, but also the communication and social interaction with others whose ToM is a prerequisite (Efklides, 2008).

Metacognitive strategies relate to how we intentionally engage in various activities by controlling our cognitive functioning (Norman et al., 2019.). They require the operation of metacognitive skills such as selective attention, working memory, planning, conflict resolution, inhibitory control associated with observation, control, and metacognitive regulation of knowledge (Efklides, 2008).

Metacognitive regulation concerns the regulation of the cognitive and learning function, which the student achieves by controlling his learning, but also generally those who monitor and control their cognitive mechanism through a set of skills (Papaleontiou-Louca, 2019).

Metacognitive experiences are judgments and feelings that emerge during a cognitive process reflecting aspects of it (Norman et al., 2019). It is essentially what the person knows and feels when they undertake a task and processes information. They include metacognitive feelings, judgments, appraisals, and knowledge about specific cognitive processes. Although metacognitive emotions arise from an unconscious process, when perceived by consciousness, they constitute evidence for analytical evaluations or control decisions (Euclid, 2008; Norman, 2020). The aforementioned dimensions of metacognition complement and enrich each other during the metacognitive process (Papaleontiou-Louca, 2019; Euclid, 2008; Norman et al., 2019).

Metacognitive knowledge includes Declarative knowledge, the knowledge that the individual has about his cognitive mechanism and the factors that promote or inhibit its functioning (Fagnant, & Crahay, 2011). Also, it includes

Procedural knowledge that operates automatically and involves the knowledge to perform tasks, the active control and regulation of the cognitive function adopted by the individual to achieve a goal. Finally, it includes conditional knowledge that the individual knows when and for what reason uses declarative and procedural knowledge utilizing optimal strategies satisfactorily (Fagnant, & Crahay, 2011; Papaleontiou-Louca, 2019).

Metamemory plays a particularly important role in metacognitive function, that is, knowledge of states and memory processes as defined by Flavell, 1979. Metamemory consists of declarative and procedural metamemory. The first is characterized as explicit knowledge about memory performance and strategies, while the second is the ability to observe and control memory performance (Lavis, & Mahy, 2021).

Correlation of Theory of Mind to Metacognition

The flexible adaptation of behavior to various social situations requires our ability to represent our actions, goals, intentions, and emotions. This process is achieved through social-emotional and cognitive functions since they allow the creation of representations such as metacognition and ToM. It has been observed that these two functions share a common feature of focusing on the individual's internal processes, whether related to one's mental state, cognitive processes, or related to those of others (Kanske, 2018).

The acquisition of ToM constitutes a fundamental ability for human cognition, effective social behavior in interpersonal relationships, and a milestone in the social-cognitive development of the individual (Aydin, & Özgeldi, M. 2019, Flavell, J. 2004). Used the terms

Theory of Mind, Mentalizing, and Mindreading (Frith and Frith 1999; Aydin, & Özgeldi, M. 2019). Study findings indicate that the gradual development of ToM is associated with increased knowledge of inferential and interpretive mental processes. Therefore, it is a mental cognitive tool that affects cognitive processing in various domains in memory, problem-solving, and decision-making, with consequences in the metacognitive process (Lockl, & Schneider, 2007).

Recent reports on the connection of ToM with Metacognition emphasize the correlation between two different functional mechanisms, which contribute to the formation of social knowledge. In particular, the interaction of ToM, Metacognition, and consciousness mechanisms involve the mutual influence between mental abilities and conscious access to information, ensuring effective social and cognitive behavior (Gakis, Cichoń, Cyrkot, & Szczepanowski, 2018).

However, the metacognitive function is often hindered or affected by unconscious processes that affect its smooth development, such as established learned weaknesses, prejudices, false beliefs, critical thoughts, and behaviors. The result of this is the limitation of the individual's ´´internal dialogue´´ with himself and consequently altering sound metacognitive judgment (Drigas, Mitsea, & Skianis, 2022a, 2022b; Bargh, & Morsella, 2008).

Regarding the relationship between the two complex functions ToM and Metacognition, various research has been carried out and have supported, based on the data obtained, the existence or not of the connection between them.

1. In particular, researchers report that mind reading and Metacognition are two independent abilities that involve distinct cognitive mechanisms.

2. Others argue that there is a representational mechanism in which mental states are accessed through different information channels.

3. Several researchers argue that the ToM skill precedes Metacognition, emphasizing that Metacognition is a consequence of our ability to turn the mind's reading function on itself (Carruthers, 2009a).

4. In contrast to the simulation theory of ToM, mind-reading is based on metacognition, which is strengthened as children grow. Hence, attributing mental states to others depends on accessing and understanding our mental states (Koriat, & Ackerman, 2010).

Metacognition, closely related to social cognition, suggests, in a sense, that the individual acquires metacognitive concepts by controlling, and regulating his cognitive states, as a result of social feedback. Then, when the person expresses specific Metacognitive verbalizes, he uses them as a social-cognitive tool that enhances human coordination. In addition, they make the person a significant cognitive factor by improving the ability to predict other people's behaviors, and actions (Zawidzki, 2021).

As children master the concepts of mental states and gradually realize their causal relationship with the individual's behavior, they provide opportunities for the development of metacognition. It has been observed that advanced ToM facilitates the development of metacognitive abilities such as observation of control. Therefore, in a sense, metacognition involves mastering mindreading perception (Aydin, & Özgeldi, M. 2019; Frith, & Frith, 1999; Bartsch, & Estes, 1996).

ToM develops gradually in preschool, laying the foundations for communication and social interaction. It involves the belief that people have minds and that their mental states differ both from each other and reality (Efklides, 2008). Understanding ToM is considered a context where a specific form of metacognitive knowledge can be developed, enabling children to utilize ToM as a cognitive tool that promotes the development of complex forms of knowledge of mental phenomena (Lecce, Bianco, Demicheli, & Cavallini, 2014).

Metacognition is the declarative knowledge of cognitive processes, which is not plainly articulated in children's thinking about the mental functions of observation, memory, attention, and so

on. ToM has an essential role in the development of metacognition because children, as they realize that reality differs from its representations and that these differences between people, lay the basis of epistemological thinking that has knowledge as its object and is part of metacognitive knowledge (Efklides, 2008).

ToM abilities are significantly influenced in terms of their development by the development of executive skills that are part of the metacognitive mechanism. Especially to the extent that the metacognitive process involves planning, allocation of attention, self-regulation, and working memory is directly related to executive function. Emphasizing the close relationship between inhibitory control and ToM in preschool children, it is considered that developed executive function combined with ToM ability is a prerequisite for the development of metacognition (Lai, 2011).

Metacognition and Tom in their early development involve different processes that overlap and interact during development. Studies document the relationship between Tom and Metacognition, noting that ToM is predictive and is causally responsible for the development of later explicit Metacognition. The causal interactional relationship, however, is most visible during early school age (Kim, 2020).

To perform a false belief task children are required to distinguish between belief and reality and then to represent the other person's belief, that is, to make a meta-representation, which is considered particularly important for metacognitive knowledge. Specifically, in declarative metamemory, memories are not a copy of reality but a mental representation (Lecce, Demicheli, Zocchi, & Palladino, 2015).

Metacognition focuses on processes that support intrapersonal Metacognition, and self-evaluation. However, it seems essential that the resulting metacognitive information may be shared with others, to improve collective decision-making. In particular, recent studies show that people who communicate their metacognitive representations, and their confidence in their perceptual decisions, in certain circumstances promote improved joint perceptual decision-making, problem-solving, and regulation of group behavior. Explicit Metacognition even permits the regulation of interpersonal cognitive control (Vuillaume, 2019).

Reliable metacognitive awareness is strongly related to children's ability to understand their mental states. Essentially, a person cannot control and understand his cognitive activity if he is not able to represent first-order mental states, that is, to represent perceptions, memories, and judgments in a certain way (Bernard, 2015).

Recent research in cognitive neuroscience points out that the structural substrates of high-order cognition and perceptual accuracy involve neural networks with common elements in both Metacognition and Mindreading (Valk, 2016).

A study found that different processes mediate the operation of ToM compared to metacognitive processing. However, Metacognition may inform, and enhance the performance of ToM. Specifically, the individual can derive insight and cognition monitoring of mental processes and apply it to interpret and predict the behavior of others (Koriat, & Ackerman, 2010). The study by Feurer, Sassu, Cimeli, & Roebers 2015 noted that children in kindergarten who had developed early monitoring skills later showed advanced skills in ToM.

Several studies report a strong link between ToM, metacognition, and mindfulness. Mindfulness techniques enhance executive attention is a core component of mindreading and metacognition. Characteristically, present-moment thinking experienced in mindfulness practices, particularly in the metacognitive process, supports cognitive functions that contribute to self-awareness and understanding of others (Tan, Lo, & Macrae, 2014; Dimaggio, et al., 2008; Anagnostopoulou, & Drigas, 2020).

The development of ToM and Metacognitive ability in children.

According to Flavell's research, Metacognition develops gradually when preschool children, around five years old, master ToM, as they can explicitly represent mental states. Then children in the first school term can assess what they know and express it verbally. They gradually enter the metacognitive process, reflecting on their mental process and evaluating them. It is a meta-representation of mental states, as first-order representations constitute second-order representations (Proust, 2019).

However, while preschool children are aware of their thoughts and have some knowledge of their thinking, they are not aware of the continuous flow in time of their mental activity. They perceive it only as an episodic case related to a task they perform. Furthermore, children of this age appear to be unaware of the existence of inner speech and, consequently, may not interpret it as a form of thought (Flavell, 1993, 1995; Flavell, Flavell, & Green, 2001). But young children possess metacognitive knowledge, even if they do not explicitly know it or do not verbalize it (Efklides, & Misailidi, 2010).

Understanding false beliefs contribute to the development of metacognition since it brings mental activity to children's attention. Specifically, when responding to false belief tasks, they can understand that mental representations do not necessarily correspond to the reality to be examined. Consequently, through this discovery, they are pushed to reflect on their cognitive activity, introducing the development of explicit metacognition (Lecce, Demicheli, Zocchi, & Palladino, 2015; Kuhn, 2000; Efklides, 2008). The metacognition of preschool and elementary school children appears to be significantly influenced by the

evolution of cognitive, executive, and verbal skills (Lai, 2011).

Research findings regarding the metamemory of 4-year-old children point out that children at this age realize that they can only remember or forget something for which they had previous experience, that is, they had developed a mental representation for it. Consequently, in preschool age, they begin to become aware of and associate the function of memory with the acquisition, retention, and retrieval of knowledge gradually over time (Lyon, & Flavell, 1994). Research results show that preschool children's perception of memory is unrealistic, as they believe they remember, while often overestimating their memory capabilities. Also, the relationship between memory and metamemory at this age is limited, because children do not spontaneously use memory strategies, as they are unfamiliar with memory tasks and unable to assess their mnemonic practices (Schneider, & Löffler, 2016).

Lecce, Zocchi, Pagnin, Palladino, and Taumoepeau, 2010 longitudinal study of school-aged children highlighted the significant association of early cognitive ToM with later metacognition about their reading ability. Essentially, he pointed out that ToM is a precursor to metacognition. But also, both mental state knowledge and metacognitive knowledge are prominent in children's cognitive and social development (Amran, et al., 2021).

Notable are the results of another longitudinal study by Local, & Schneider, 2006, where they demonstrate that early ToM abilities are a precursor to subsequent metamemory. It is noteworthy that the concept of representation acquired by the preschool child through ToM allows him to first reflect on his own and others' memories. In addition, this specific study found that metacognitive vocabulary and general metamemory improve significantly in kindergarten, in contrast to knowledge of mental verbs and memory strategies that show weaknesses at this age. Similar research on explicit metacognitive knowledge found that cognitive abilities between the ages of 3 and 5 predicted declarative metamemory at five years old (Paulus, Talas, Proust, & Sodian, 2014).

Another study found a link between first-order false belief understanding and metamemory in preschool children, implying that metamemory is an emerging age-specific skill (Lecce, Bianco, Demicheli, & Cavallini, 2014). Nearly equivalent conclusions were reached in Ebert's 2015 longitudinal study of 3-4-year-old children, demonstrating that children's abilities to meta-represent in combination with early language skills constitute the basis for the acquisition of metamemory knowledge.

The development of ToM in conjunction with metacognitive ability, particularly at school age, assists children in understanding the concept of learning as representational change rather than only behavioral change, as is the case in preschool age. A particularly significant advancement is elementary school children's growing understanding that learning differentiates thinking itself, such that is, they learn to understand, promoting a metacognitive understanding of learning, where learning results from knowledge change (Wang, & Frye, 2021).

Children around the age of six, on the other hand, while they can perceive their knowledge adequately, have difficulty appreciating their ignorance. It may be due to their lack of age-appropriate knowledge and their limited metacognitive insight (Kloo, Rohwer, & Perner, 2017; Rohwer, Kloo, & Perner, 2012).

According to several studies, children's metacognitive performance improves dramatically between early childhood and adolescence. During early and middle childhood, children's metacognitive judgments appear to differ more. Since there are some signs of early implicit metacognitive abilities (Paulus, Tsalas, Proust, & Sodian, 2014; Destan, Hembacher, Ghetti, & Roebers, 2014). Recent research using non-verbal tasks, focusing on the child's error observation and judgment confidence, has found that children around the age of 3-5 show rudimentary forms of metacognition. Suggesting that metacognition is not only limited to explicit manifestations, emphasizing the importance of implicit forms of self-control and regulation (Goupil, & Kouider, 2019).

However, most studies have found developmental changes in metacognitive monitoring and control during the school years. It is even mentioned that metacognitive abilities do not always require a solid view of knowledge about knowledge, but can be based on data derived from the learning process. However, metacognitive development does not stop in childhood and continues into adolescence (Paulus, Tsalas, Proust, & Sodian, 2014).

Adolescence is a critical period for the development of metacognitive skills. Brain neuroimaging findings have shown that brain regions associated with mind-reading and metacognitive functioning undergo significant development in adolescence (Paulus, Tsalas, Proust, & Sodian, 2014)

Research points to the connection of ToM and Metacognition in children on the Autism spectrum, emphasizing that the development of metacognitive skills is necessary for the development of executive functions, social competence, and Theory of Mind not only in children with typical development but also in children with ASD (Torske, Nærland, Øie, Stenberg, & Andreassen, 2018; McMahon, Henderson, Newell, Jaime, & Mundy, 2016). A recent study reports that the limited development of ToM and mindfulness of individuals with features of autism as well as schizophrenia affects their metacognitive concerns, experiences, and judgments. Because of the causal relationship that appears to exist between ToM, mindfulness, and metacognition individuals can

improve their mind-reading skills by cultivating their mindfulness (Török, & Kéri, 2022).

Also, it has been observed that people with ASD show weaknesses in self-observation, which affects the process of self-awareness at the most basic level, but still their relationship with others, thus their metacognitive ability and ToM (Zalla, Miele, Leboyer, & Metcalfe, 2015). However, the study by Wojcik, Waterman, Lestié, Moulin, & Souchay 2014 found that adolescents with high-functioning autism had a metacognitive ability to control their study time and memory performance. While a recent study of adolescents with autism found that the accuracy of explicit metacognitive judgments about a person's mental states was strongly associated with mind-reading ability. Therefore, individuals with ASD who show deficits in ToM show reduced performance in explicit metacognitive tasks, but not in implicit tasks (Nicholson, Williams, Lind, Grainger, & Carruthers, 2021).

Metacognition, as defined by Bednarz, Trapani, and Kana 2020, is the ability to self-reflect on one's thoughts and experiences about oneself. It affects the functioning of ToM, the ability to process the thoughts, beliefs, and intentions of others. Essentially, to conclude other people's beliefs, thoughts, and feelings if they are in a comparable situation, one first relies on recollection of one's thoughts and experiences. The findings of their study showed that metacognitive ability and behavioral regulation affect different aspects of the social functioning of students with autism. Specifically, it was found that self-observation, flexibility, and working memory skills can predict social awareness ability, enhancing aspects of ToM.

Following are some commonalities in the operation of ToM and Metacognition

• ToM and Metacognition appear to begin with the same objective, the investigation of children's knowledge and understanding of mental phenomena (Wojcik et al.14; Kloo et al., 2021).

• They constitute two mental processes that reflect the individual's ability to create meta-representations of self and others (Feurer et al., 2015).

• The use of an internal thought process is crucial for the function of both mechanisms (Flavell et al., 1995; Carruthers, 2009b).

• The observation process in ToM is of decisive importance, where the child at the age of 5 is able to distinguish between what he knows and what he does not know. While in metacognition it reflects the meta-representation of the current state (cognitive-emotional), which the individual monitors and evaluates in himself (Feurer et al., 2015).

• Necessary for the development of mindreading and metacognition is the engagement and development of social interaction, language ability, and executive skills (Lai, 2011; Sodian & Frith, 2008; Feurer et al., 2015).

Metacognitive approach to ToM

According to the eight-level model of metacognition by Drigas, Kokkalia, & Economou, 2021 children first observe their mental states and evolve thoughts, and feelings about them. They get information by using their senses to comprehend inputs. They then retain a portion of the information in their memory, which they will subsequently use to forecast and understand their behavior as well as that of others.

Then follows a figure and brief reference to the metacognitive approach of ToM based mainly on the original study by Drigas & Papas, 2017.

This particular shape was chosen symbolically given that the ellipse is the projection of the circle on the cone when intersected by an inclined plane, thus focusing on the fundamental common feature of the cognitive mechanism of ToM and Metacognition, the representation of the inner and outer world, the mental projection of reality.

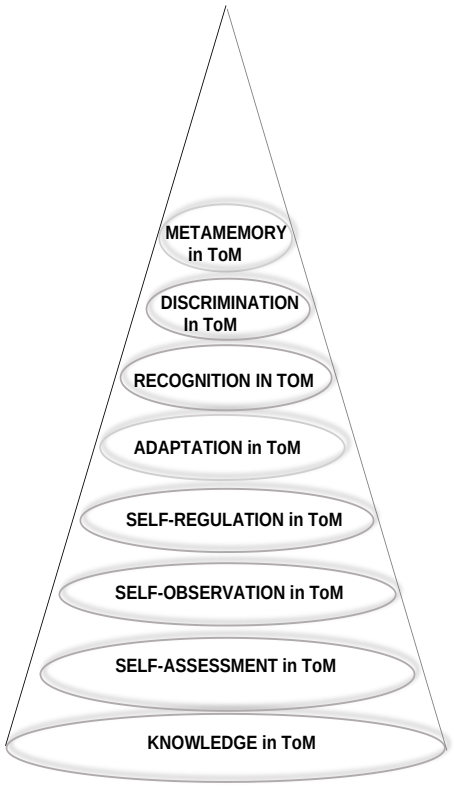

Fig. 1 The metacognitive approach of ToM according to the eight-level model of Metacognition (Drigas & Papas, 2017; Drigas & Mitsea, 2020b; Drigas, & Mitsea, 2020c; Drigas, Kokkalia, & Economou, 2021; Mitsea, Drigas, & Skianis, 2022a, b).

Metacognition allows the individual to develop meta-representations of internal mental states which he can observe, control, and regulate, after discerning, identifying, and improving

dysfunctional elements to fulfill the original goal (Mitsea, Drigas, & Skianis, 2022a, b).

KNOWLEDGE in ToM. We consider that a person has developed ToM, when he understands and is aware that both his own and other people's conduct results from the mental states, which are shaped by his experiences, without necessarily being in line with the objective reality (Zahou, Tattou, & Platsidou, 2014).

SELF-ASSESSMENT in ToM. The individual's access to the understanding of his mental states allows him to judge and evaluate them according to his actions. As a result, the individual learns behaviors that will aid him in understanding and interpreting the thoughts and feelings of others. Gradually through this process, it is introduced into the path of self-consciousness ((Frith, & Happé, 1999).

SELF-OBSERVATION in ToM. Based on self-observation, the person can observe, and understand the mental states of others and draw conclusions about them (Fitzpatrick et al., 2018).

SELF-REGULATION in ToM. The development of ToM at the level of self-regulation is of particular value for the achievement of the individual's social communication, but also the development of social skills and effective interpersonal relationships. ToM essentially aids the individual in decoding and controlling their emotions, conduct, and ability to more readily adjust to social settings (Nader-Grosbois, & Mazzone, 2014; Denham, et al., 2014).

ADAPTATION in ToM. The perception of the causal relationship between mental states and the behavior they cause is of crucial importance in ToM development. This mastery enables the individual to recognize and process these mental states, achieving control, modification, and adaptation of his and others' behavior according to the circumstances (Misailidis, 2003).

RECOGNITION in ToM. Progressively, the individual becomes aware, and recognizes his knowledge or his ignorance of various mental states, laying the foundations for the development of his early metacognitive ability (Kuhn, 2000).

DISCRIMINATION in ToM. The individual's capacity to create representations independent of objective reality falls under the heading of meta-representational thinking. This specific cognitive process allows the individual to distinguish his egocentric thinking from the other's perspective, which he adopts to understand his mental states and

interpret his behavior, promoting the development of ToM to higher levels of mental thinking. Additionally, meta-representational thought is directed not only toward others and the external world, but also toward oneself by evaluating one's representations and promoting the development of metacognition (Battistelli, & Farneti, 2015).

METAMEMORY in ToM. From preschool age, a kid gradually understands that to recall or forget something, one must have had prior exposure to it, or it must have created a mental image of it. Then he begins to realize in time the connection of the mnemonic function with the acquisition, retention, and recovery of knowledge, as well as the factors that affect it (Lyon, & Flavell, 1994).

According to the metacognitive approach of ToM that preceded it, the transition from one level to another is achieved by the cooperation of higher cognitive and metacognitive processes, which allows the individual to possess social skills and develop social knowledge. Consequently, he can recognize and understand the current emotional, social, and cognitive conditions, acting effectively and adapting his behavior according to the circumstances (Drigas, & Papoutsi, 2018; Drigas, Kokkalia, & Economou, 2021).

ToM - Metacognition, and Learning

Research findings point out that the child's transition from the family environment to kindergarten, and then to elementary school, involves increased demands and challenges for the child to adapt and cope satisfactorily with the new conditions. However, executive abilities (attention, self-regulation, working memory, and others) are considered necessary skills in the transition process, without including two significant complex mental abilities, ToM and Metacognition, obviously because they are not typical indicators of school readiness. However, both cognitive functions enable the child to construct meta-representations of self and others (Feurer, Sassu, Cimeli, & Roebers, 2015).

ToM as meta-representational thinking promotes the individual's metacognitive awareness of his ignorance or knowledge, recommending a beneficial factor for the learning process, nevertheless, more widely for his personal, social, and academic course (Baglio, & Marchetti, 2016; Battistelli, & Farneti, 2015).

Of decisive importance for the development of ToM abilities, especially in preschool age, is the social interaction that contributes to causal understanding, the predictive process of concluding, and, consequently, the development of causal reasoning (Carbonero Martín, Sáiz). Manzanares, & Román Sánchez, 2013). Additionally, according to Vygotsky's approach, social interaction contributes to the origin and development of higher mental functions such as metacognition. Cognitive acts are first experienced at a social level and then at an individual level, as the results of similar experiences are internalized and promote the individual's reflection (Papleontiou-Louca, 2003).

Metacognition contributes significantly to the course of the learning process as it helps students to perceive, understand, organize and redirect their thinking. It then allows them to develop and apply appropriate problem-solving strategies, adapting their behavior to the current cognitive challenges with the aim of self-improvement (Papleontiou-Louca, 2002.) The connection between observation and self-control that occurs throughout the metacognitive process is crucial to successful and

productive learning. Older students and adolescents can use their capacity for observation to improve their cognitive performance, as well as to implement efficient control mechanisms ((Schneider, & Löffler, 2016).

The process of metacognition plays a significant role in general and special education. It involves higher mental abilities in the awareness of the performance of cognitive skills, prompts the person to discover his weaknesses and capabilities, the limits of his knowledge, to gain self-control, know himself, and master self-awareness (Drigas, & Mitsea, 2020c).

Research findings show that metacognitive awareness is enhanced by strategies such as focusing attention, performing, evaluating a task, and using mental imagery. In addition, maps, protocols of self-questioning-thinking, collaborating with other classmates, and providing feedback to each other, as well as the guided discovery process are quite effective educational methods (Hatzipanteli, Grammatikopoulos, & Grigoriadis, 2014).

In the educational process, teachers may encourage students' metacognitive growth by offering chances for metacognitive experiences that contribute metacognitive information to metacognitive knowledge. As a result of this, children are conscious of their thoughts, mainly through the promotion of two significant metacognitive processes, consciousness and introspection (Papleontiou-Louca, 2003).

Some practices in the educational procedure that utilize ICTs tools significantly improve social, communication, and cognitive impairments, namely attention and behavior regulation, recognition and expression of emotions, and social interaction. Consequently, they first promote mindreading growth and hence, the metacognitive process (Bakola, Rizos, & Drigas, 2019; Mitsea, Drigas, & Skianis, 2022b).

In addition, the function of neurotransmitters, the proper nutrition of the body, and the limitation of the toxicity of the environment strengthen the immune system, intelligence, and cognitive abilities and significantly enrich ToM and metacognition, improving the behavior of the individual in his interpersonal relationships, but and its cognitive performance (Drigas, & Mitsea, 2020b).

Conclusions

The present study carrying out a literature review that preceded it led to a set of findings, the main conclusions of which are listed below.

It is noteworthy that both ToM and Metacognition constitute two dominant mechanisms for processing social and cognitive information and two necessary tools for interpersonal relationships (Battistelli, & Farneti, 2015). In addition, ToM is a system closely related to metacognition. In particular, developed metamemory enhances children's ability to correlate their thoughts, feelings, and behaviors (Jones, Souchay, Moulin, Reynolds, & Adlam, 2019).

Metacognition arises as a consequence of the individual's ability to read his mental states, which are accessed through interpretation and not introspection, self-observation of himself as occurs in the metacognitive process (Carruthers, 2009b). However, the acquisition of a mental dictionary combined with the cultivation of ToM helps children to observe their mental activity, promoting the growth of their introspection and, as a result, metacognition (Flavell, Green, & Flavell, 2000).

Social interaction contributes significantly to the development of ToM and Metacognitive function. Since children acquire social speech through their ability to read minds, they actuated to internalize information processing processes, improving their cognitive and metacognitive course (Lai, 2011). In addition, interpersonal relationships and social interaction are fundamental to self-concept which substantially influences one's metacognitive judgments and abilities (Jost, Kruglanski, & Nelson, 1998).

According to various research, when children respond to false-belief tasks they have grown a representational understanding of the mental world and possess a meta-representational conception of the mind as a necessary condition for acquiring knowledge for cognition (Ebert, 2015).

Children acquiring ToM have a fundamental knowledge of metamemory at an early age which fosters the development of metacognition. However, this occurs when knowledge is articulated, combined with the development of verbal and executive skills (Carruthers, Fletcher, & Ritchie, 2012). Children's understanding of their knowledge depends on the information they derive empirically is the first step for the child to begin to understand the processes and contents of memory, suggesting that ToM precedes metamemory (Lockl, & Schneider, 2006). ToM aids kids in reflecting, comprehending, and evaluating their cognitive processes, which call for metamemory and metacognitive knowledge (Kloo, Sodian, Kristen-Antonow, Kim, & Paulus, 2021). Therefore, ToM can be considered the "harbinger" of Metacognition (Bamicha, & Drigas, 2022a).

Children gradually begin to perceive, at the age of 6-7, thinking as an internal mental activity. The ability to represent one's thoughts and feelings in addition to those of others is the fertile ground for metacognition (Efklides, A., & Misailidi, P. (2019).

The dominant advantage of the individual's ability to reflect on his thinking lies in the ability to control and adapt his cognitive process (Norman et al., 2019). Metacognition develops gradually after ToM with the goal of self-monitoring and executive control of our processes. It is an inherently higher-order process that includes first-order meta-representations of the individual's cognitive processes. Each of its layered cognitive architectures features a set of automatic information retrieval and decision-making. In addition, it has a

supervisory system that intervenes and modifies the procedures performed at the first level. The supervisory processes presuppose the individual's acquisition of self-awareness and first-order metacognitive information organized into levels (Carruthers, 2009a).

Research indicates the existence of an interaction between Theory of Mind and the functioning of the individual's social, emotional, cognitive skills and metacognitive process, with ToM being developmental prior to metacognition. However, it is not entirely clear which of the two mechanisms underlies the other (Bamicha, & Drigas, 2022b; Kim, 2020? Misailidi, 2010, 2011). Metacognitive skills training is instrumental in developing and improving ToM but more generally cognitive, social-emotional skills that promote an individual's academic, personal, professional, and social well-being (Mitsea, Drigas, & Mantas, 2021; Bamicha, & Drigas, 2022a).

Beyond the above, we should emphasize the importance of digital technologies in ToM, as well as in the field of education, given that their offering is very productive and successful. In particular, ICTs enhance and improve metacognitive skills, assessment, intervention, and educational processes through various ICT applications. AI, STEM & ROBOTICS as essential supporters of ToM-based education, new performance drivers, and digital games turn metacognitive education into a friendly and enjoyable interaction, effectively enriching the learning process. In addition, enhancing and combining ICT with theories and models of metacognition, mindfulness, meditation, and emotional intelligence cultivation as well as environmental factors and nutrition, accelerate and further improves ToM and Metacognitive-based educational processes and outcomes, both in general and special education and in their practices such as assessment and intervention. More specifically, in recent decades, significant social changes have been identified, related to the role of A.I. and technology in people's daily lives. The most important of these are the improvement of communication, the dissemination and management of information, and the ability to assimilate and utilize the new knowledge generated. We must underline that the role of Digital Technologies in the field of education, furthermore, in all facets of day-to-day existence is of decisive importance. Specifically, they improve and enhance all scientific and productive procedures, including assessment, intervention, decision-making, and educational processes through mobile phones (Stathopoulou, A., et al., 2018, 2020, 2022, Kokkalia, G., 2016, Drigas, A., & Papanastasiou, G., 2014,), various digital applications (Drigas et. al., 2004, 2015, 2, 2016, Drigas, A., & Kokkalia, G., 2017, Pappas, M., et al., 2018, 2019, Drigas, A., & Leliopoulos, P., 2013, Papanassiou, G., et al., 2018, 2020, Alexopoulou, A., et al., 2019, Kontostavlou, E., & Drigas, A., 2019), AI & STEM (Vrettaros, I., et al., 2009, Anastasopoulou, P., et al., 2020, Lytra, N., & Drigas, A., 2021) and digital games (Chaidi, I., & Drigas, A., 2022, Kokkalia, G., et al., 2017, Drigas, A., & Mitsea, E., 2021). The New Technologies (NT) and more specifically Digital Technologies provide the tools for access, analysis, and transfer of information and its management and utilization of new knowledge. Information and Communication Technologies (ICT), the unprecedented technological capabilities of man, have a catalytic effect, create a new social reality and shape the Information Society (Pappas, M., et Drigas, A., 2015, 2016, Drigas, A., et Koukiannakis, L., 2004, 2006, 2009, Drigas, A., & Kontopoulou, M., 2016, Theodorou, P., & Drigas, A., 2017, Drigas, A., & Kostas, I., 2014, Bakola, L., et al., 2019, 2022, Drigas, A., & Politi-Georgousi, S., 2019, Karyotaki, M., et al., 2022).

Concluding, it's necessary to refer that the combination of ICTs with theories and models of metacognition, mindfulness, meditation, and emotional intelligence cultivation accelerates and improves more over the educational, productive, and decision-making practices and results (Drigas, A., & Papoutsi, C., 2020, Drigas, A., & Mitsea, E., 2020, 2021, 2022, Kokkalia, G., et al., 2019, Pappas, M., & Drigas, A., 2019, Papoutsi, C., & Drigas, A.,2016, Karyotaki, M., & Drigas, A., 2015, 2016, Papoutsi, C., et al., 2019, 2021, Chaidi, I, & Drigas, A., 2020, Drigas, A., & Karyotaki, M., 2019, Mitsea, E., et al., 2020, 2021, Angelopoulou, E., & Drigas, A., 2021, Tairimpampa, A., et al., 2018, Kapsi, S., et al., 2020, Drigas, A., et al., 2021, 2022, Galitskaya, G., & Drigas, A., 2021).

Finally, to summarize, ToM is an indispensable mental tool required for processing, comprehending, and interpreting the social environment, paving the way for the development of metacognition. Then, the metacognitive mechanism utilizing higher mental skills interacts with the mind-reading processes and directs the individual to an inner conscious communication with himself. The ultimate objective of this reflective process of the individual is to improve, self-regulate and adapt the dysfunctions he identifies in his cognitive and social-emotional mechanism. Therefore, the development of ToM is not only related to the emergence of effective social behavior and successful interpersonal relationships but introduces children to new ways of sophisticated forms of thinking for their mental, cognitive and metacognitive functioning, with the undivided contribution and cultivation of social interaction, language ability, executive skills but also the involvement of a flexible approach of ICTs.7

Some key differences between Theory of Mind and Metacognition are summarized in the following **Table 1.**

Table 1. Differences Between ToM and Metacognition (Schraw, & Moshman, 1995; Papaleontiou-Louca, 2019; Lecce, Bianco, Demicheli, & Cavallini, 2014; Carruthers, 2009 b; Efklides, 2008; Hussain, 2015; Török, & Kéri, 2022; Flavell, et al., 2000).

Theory of Mind	Metacognition
Theories of mind are concerned with the study of mental phenomena (beliefs, desires, emotions, personality)	Metacognitive theories focus on cognitive aspects of the mind
Knowledge of mental states	Knowledge of the functioning of the cognitive mechanism
Understanding the mental states of others.	Knowledge about the mental states of someone
Understanding the content of the mind and the nature of mental states	Knowledge of cognitive processes and their relationships with the cognitive performance of the individual ‘s performance.
Reading mental states through interpretation rather than an introspective process	Introspection, self-observation of the self to control cognitive function
Awareness of personal thoughts, desires, and feelings of the individual	Conscious observation of the person's knowledge, behavior, actions
Perception and awareness of the boundaries between external reality and the inner world	Existence of mindfulness in high levels of metacognitive process
Expression of basic knowledge of mental states	Reference to mental activities that involve strategies of control, observation, adaptation

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