Research, Society and Development, v. 12, n. 3, e13012340420, 2023
(CC BY 4.0) | ISSN 2525-3409 | DOI: http://dx.doi.org/10.33448/rsd-v12i3.40420

Consciousness influences in ToM and Metacognition functioning - An artificial intelligence perspective

Influências da consciência no ToM e no funcionamento da Metacognição - Uma perspectiva da inteligência artificial

Influencias de la conciencia en el funcionamiento de ToM y Metacognición: Una perspectiva de inteligencia artificial

Received: 02/03/2023 | Revised: 02/23/2023 | Accepted: 02/24/2023 | Published: 03/01/2023

Victoria Bamicha
ORCID: https://orcid.org/0000-0003-0113-2550
Net Media Lab Mind - Brain R&D IIT - N.C.S.R. "Demokritos", Greece
E-mail: vbamicha @iit.demokritos.gr
Athanasios Drigas
ORCID: https://orcid.org/0000-0001-5637-9601
Net Media Lab Mind - Brain R&D IIT - N.C.S.R. "Demokritos", Greece
E-mail: dr@iit.demokritos.gr

Abstract
Consciousness is a cognitive function that maintains its eternal character as long as it is strengthened and enriched by the optimal functioning of the corresponding neural networks of the brain, which are stimulated during its activation. The present study explores its relationship with the cognitive functions of the Theory of Mind and Metacognition and briefly explains their approach through Artificial Intelligence. The selection of the bibliographic review contributed to the utilization of the existing scientific knowledge and research data for the most effective analysis and study of the subject. The observations made throughout the research highlight the pivotal role of consciousness in the evolution of the aforementioned cognitive processes, as it is at the core of their development. Essentially, the research seeks to emphasize the importance of consciousness in the functioning of the Theory of Mind and Metacognition, as it serves as the springboard for the perception and understanding of our existence, significantly influencing our further social and cognitive development.
Keywords: Consciousness; Theory of mind; Metacognition; Artificial intelligence.

Resumo
A consciência é uma função cognitiva que mantém seu caráter eterno enquanto for fortalecida e enriquecida pelo funcionamento ideal das redes neurais correspondentes do cérebro, que são estimuladas durante sua ativação. O presente estudo explora sua relação com as funções cognitivas da Teoria da Mente e da Metacognição e explica brevemente sua abordagem por meio da Inteligência Artificial. A seleção da revisão bibliográfica contribuiu para a utilização do conhecimento científico existente e dados de pesquisa para a análise e estudo mais eficazes do assunto. As observações feitas ao longo da pesquisa destacam o papel central da consciência na evolução dos processos cognitivos mencionados, pois está no centro de seu desenvolvimento. Essencialmente, a pesquisa busca enfatizar a importância da consciência no funcionamento da Teoria da Mente e da Metacognição, pois ela serve de trampolim para a percepção e compreensão de nossa existência, influenciando significativamente nosso posterior desenvolvimento social e cognitivo.
Palavras-chave: Consciência; Teoria da mente; Metacognição; Inteligência artificial.

Resumen
La conciencia es una función cognitiva que mantiene su carácter eterno en tanto se fortalece y enriquece con el óptimo funcionamiento de las correspondientes redes neuronales del cerebro, las cuales son estimuladas durante su activación. El presente estudio explora su relación con las funciones cognitivas de la Teoría de la Mente y la Metacognición y explica brevemente su abordaje a través de la Inteligencia Artificial. La selección de la revisión bibliográfica contribuyó a la utilización del conocimiento científico existente y datos de investigación para el análisis y estudio más eficaz del tema. Las observaciones realizadas a lo largo de la investigación destacan el papel fundamental de la conciencia en la evolución de los procesos cognitivos antes mencionados, ya que se encuentra en el centro de su desarrollo. Esencialmente, la investigación busca enfatizar la importancia de la conciencia en el funcionamiento de la Teoría de la Mente y la Metacognición, ya que sirve como trampolín para la percepción y comprensión de nuestra existencia, influyendo significativamente en nuestro posterior desarrollo social y cognitivo.
Palabras clave: Conciencia; Teoria de la mente; Metacognición; Inteligencia artificial.

1. Introduction

Consciousness as a process includes a collection of information referring to the individual's current state in his environment. It is distinguished by the capacity to access data in the parts of the brain that permit the identification of abnormalities and mistakes, decision-making, and planning of long-term objectives while applying logical thinking (Koch & Tsuchiya, 2007).

The mental mechanism of consciousness is not a simple ability but constitutes a higher term of a set of heterogeneous types of mental states, that share the content of experiences (Flanagan, 1995). It is a fundamental feature of the mind. The human brain can process the information it receives to respond effectively to any specific environmental stimulus. Consciousness is associated with the meta-representations that create in the brain, including internal representations of self and those of the external environment. In this sense, it is considered an emergent property of complex self-reference, and a natural product of the functioning nervous system (McPhaila, 2009). Its development is a vital process for the development of the child's social and emotional development, laying the basis for understanding mental states and, consequently, the formation of Theory of Mind (ToM) (Lewis, 2003).

Conscious awareness of mental states contributes to the cognitive and social-emotional well-being of the individual. Whenever this procedure requires higher-order mental processing necessitates the involvement of the executive function, which promotes the adaptation and regulation of behavior and, as a result, the adjustment of related intentions, beliefs, and desires (Rosenthal, 2008). Children's ability to understand and adopt first- and second-order mental state reasoning contributes to the correct processing of complex social messages, emotions, and situations (Miller, 2009).

One is said to be conscious when they are paying attention to both themselves and their surroundings, representing a salient mental capacity and adaptive strategy. When a child can recognize the different perspectives between himself and others, his cognitive growth is ongoing and approaches metacognition (Lewis, 2003).

Metacognition includes a set of mental processes that involve planning, monitoring, and evaluating an individual's thoughts, knowledge, and performance (Grimaldi et al., 2015). It emerges through three essential functions: observation, regulation, adaptation, or otherwise consciousness (Drigas et al., 2021; Drigas & Mitsea, 2021a,b,c). The introspection component of metacognition is a fundamental mental ability. It distinguishes us from other living things and is a prerequisite for the emergence of conscious awareness (Grimaldi et al., 2015).

Technological advancement with a priority on artificial intelligence around the middle of the 20th century allowed humans to design, organize and execute programs with prescriptive and selective reasoning (Erb, 2016). Artificial intelligence and computer systems are developed whose use benefits humans, providing the ability to solve problems and perform complex tasks. This is accomplished through modeling human behavior, combining the ability to learn, adapt, and understand the environment. Machine learning is a branch of artificial intelligence that leverages previous inputs and experiences to refine and assimilate new data (Anagnostopoulou et al., 2020).

Numerous investigations have shown that computations that presumably reflect unconscious processing in the human brain are nevertheless implemented to a significant extent by the computers working for humans. However, just as Neurobiology provided the inspiration for artificial neural networks, the improvement of artificial consciousness could be drawing on corresponding neural processes in the human brain that produce consciousness (Dehaene et al., 2021). It is noteworthy that artificial intelligence presents positive effects, especially, through machine learning, as part of the assessment of several neurodevelopmental disorders, providing the possibility of organizing, analyzing, and categorizing enormous amounts of data (Anagnostopoulou et al., 2020). In particular, benefits are identified from the involvement of Artificial Intelligence (AI) and technology in the education sector to make it accessible for students with special needs. More precisely, co-education using assistive technology is encouraged, and human efforts to provide education free from prejudice and exclusion are bolstered.

Therefore, although machines do not replace humans, they empower and facilitate their adaptation (Garg & Sharma, 2020; Sideraki & Drigas, 2021; Bakola et al., 2022).

Since the individual's social, emotional, and cognitive development is vital to their psychological and mental well-being, it is necessary to investigate factors that affect their functioning. Therefore, this paper, examining the effect of Consciousness on the cognitive mechanisms of Theory of Mind and Metacognition, seeks to provide readers with a comprehensive assessment of the parameters that weigh the relationship between them and promote social communication and cognitive progress. In addition, the involvement of Artificial Intelligence in the operation of the three mental processes highlights its significant role in strengthening and improving them.

2. Methodology

The present study is a literature review conducted in selected databases such as Google Scholar, Research Gate, and Scopus. Methodologically, it is used as it is considered beneficial for describing a topic and its underlying concepts and theories (Aromataris & Pearson, 2014). Specifically, Bamicha and Drigas used narrative review because it provides a breadth of coverage of the literature and flexible treatment of the evolving knowledge and concepts of the subject. Additionally, it contributes to understanding the growing volume of original publications (Byrne, 2016).

Initially, the sources were searched, found, and collected, according to the following keywords: consciousness, theory of mind, metacognition, and artificial intelligence defined the search. In the second stage of the research, the material of the sources was categorized according to their content, to cover the thematic sections of the article. The final phase involved writing up the research and coming to conclusions, which occurred after this. The narrative review covered a great chronological range between 1979 to 2022, while most of the literature review is chronologically related to the last two decades (2000-2020), attempting to concentrate on the period from 2013 until the present. The preference was for articles published in reputable international scientific publications, and those that did not provide a clear explanation and interpretation of the findings were disregarded.

The current research summarizes the influences of conscious processing on ToM and Metacognition functions. It attempts to connect common aspects of their functional mechanisms, as they constitute three interdependent mental processes that determine the social and cognitive development of the individual. Then follows an AI approach to the aforementioned mental functions.

3. Theoretical Approach to Concepts

3.1 Consciousness

The brain is an information-processing system. Even though there are many differences in the individual processes of consciousness, such as input selection, focused attention, working memory, and the neural information processor, they are nevertheless related to each other to make up the output of consciousness (Velmans, 2015).

The most complex mental phenomenon known as consciousness presents difficulties in understanding due to its particular character. According to Aristotle, one's ability to think implies that one has perception and consciousness, that one thinks. Freud stated that mental processes are themselves unconscious, and are perceived through consciousness, just as we perceive the external world through the senses (Rosenthal, 2005).

From antiquity to the present, the nature and genesis of the experiences that make up consciousness have remained a mystery, although they are the focus of scientific and scholarly inquiry. We briefly present the most popular theories of consciousness. One concerns the Global Neuronal Workspace (GNW) (Koch, 2018). According to GNW, consciousness emerges

when incoming sensory information, located in a small space that acts as an information repository, is transmitted to multiple cognitive systems that process this data. A conscious process is brought about by the transmission of the data to the network of neurons that seem to be active in the frontal and parietal lobes. Consequently, the individual consciously perceives the situation or event (Kanai et al., 2019; Koch, 2018).

Another theory of consciousness is that of "Higher-Order Thought" (HOT) which holds that consciousness depends on the existence of a higher thought that represents the content of the conscious state. Hence, the representations associated with consciousness have a metacognitive component (Shea & Frith, 2019; Brown et al., 2019). Essentially, the consciousness of a mental state arises when one is aware of oneself, that is, of being in that state. As a result, he knows his conscious mental state (Rosenthal, 2005). Integrated Information Theory (IIT) is a theory where consciousness, through mechanisms, integrates information in the brain effectively relating the external causal structure of the world to the internal causal structure of the system. It is accomplished by experientially combining smaller discrete pieces of information into larger unified wholes. Consequently, mental states are only conscious if they reach an appropriate level of information integration (Ludwig, 2022; Persuh et al., 2018; Koch, 2018).

Consciousness is complex, incorporating various sensory modalities related to the respective experiences. The conscious process affects other brain systems and influences the individual's behavior, providing a possibility of adaptation. From this perspective, consciousness is considered that has biological significance for humans. Several experimental indications support that non-conscious systems evolve by promoting appropriate inferences about consciousness (Earl, 2014).

Consciousness includes two fundamental states of consciousness, vigilance, and awareness (Zeman, 2006). Awareness refers to conscious perception and consists of cognition, intentions, and experiences stored in memory (from the past) and the present. In particular, self-awareness is characterized by a mental process involved in the social-cultural environment without necessarily being dependent on or influenced by external stimuli. While the awareness of the environment constitutes the conscious perception of it through the sensory pathways. The awakened state of consciousness is based on how stimuli interact with our mind and body (Cvetkovic, 2011).

Chalmers (1997) mentions three more significant psychological dimensions of consciousness: introspection, which refers to a process by which we can become aware of the content of our internal states, reportability, which refers to our ability to report the content of our mental states, self-consciousness where it is about our ability to realize, to be aware of our existence as individuals and our differentiation from others. Drigas and Mitsea (2020a) point out that individual experiences higher levels of consciousness, pushed into a state of transcendence when they have developed a sense of spirituality and meaning in life, where through sharing their wisdom and interaction with others, they contribute to their self-fulfillment.

According to neuroscience, the content and levels of awareness are two fundamental components of consciousness. Some neurological impairments associated with deficits in language development, memory, and self-awareness affect the content of consciousness. Whilst different levels of consciousness depend on the functioning of a variety of brain systems related to attention, alertness, and awareness of oneself as well as the surrounding world in general. The prefrontal cortex plays a crucial role in conscious visual perception (Fabbro et al., 2019). Remarkable is the interaction of consciousness with attention and working memory. It has been proven that when one observes something, he typically understands it, and whenever he does not notice anything, he frequently does not grasp it. However, attention and consciousness are not linked when the stimuli to be detected are weak (Graziano, 2022; Posner, 1994). The capacity to store and use information is known as WM, a system for operating and maintaining only consciously perceived information. WM is the ability to store and process information for the benefit of different cognitive and social-emotional skills, including conscious processing (Persuh et al., 2018).

The close relationship between consciousness and attention proves the biological value of the former, as its performance can affect the quality of an individual's life. Attention is the basis for human cognition, awareness, and self-awareness.

Consciousness is engaged when the individual directs their attention to an occurrence or a situation that he considers significant (Earl, 2019; Drigas & Mitsea, 2020c). In addition, the conscious function significantly promotes the regulation of the homeostasis of the organism by facilitating the use of flexibility, planning, and other cognitive and emotional procedures of the individual, especially Cognition and Metacognition, to respond appropriately to the changing conditions of each context (Damasio & Meyer, 2009).

3.2 Theory of mind

The mental ability known as "ToM" helps us explain and predict the behavior of ourselves and others as if we had read their minds. It is an aspect of social cognition that enables us to understand the body language of others. Her mental machinery depends on a representation of imaginary conditions disconnected from reality. Consequently, when we try to interpret someone's behavior, based on a belief, the belief may not correspond to reality and is based on a different perspective of the state of the world than ours (Gallagher & Frith, 2003).

Understanding how thoughts, feelings, and beliefs influence human behavior is essential for social reasoning and everyday interaction. In particular, the growth of smooth social connections and accurate social perception, which result from the evolution of ToM, boost an individual's mental health and ease their adjustment to and integration into society (Peterson & Wellman, 2019).

Mind consciousness emerges in two distinct stages of development and evolution. Initially, the ToM faculty enables understanding, perceptual access to the world, the separation of states of knowledge and ignorance, and the perception of other people's goals. Subsequently, it becomes aware of the existence of others' beliefs, which may be different or incorrect (Gakis et al., 2018).

ToM being a higher cognitive process constitutes a complex mental tool. Its effective functioning is accomplished through the cooperation and harmonious engagement of social and cognitive skills, particularly executive skills, the cultivation of which strengthens its performance at the cognitive and metacognitive levels (Bamicha & Drigas, 2022a). Once humans can reflect on their mental states, they constitute a primary paradigm of metacognition linked to their consciousness. Additionally, metacognition is the basis of human consciousness by occupying an essential role in an individual's social and cognitive development (Frith & Frith, 2012).

3.3 Metacognition

Metacognition is the awareness, conscious assessment, and control of one's thinking and understanding of how one's cognitive abilities work (Drigas et al., 2021; Flavell, 1979). Conscious deliberate thoughts that are the target of other ideas are the fundamental components of it. Moreover, it is characterized by self-esteem and self-management of knowledge, which promote efficacious self-regulation of cognitive and affective mechanisms (Papleontiou-Louca, 2003).

According to Schraw and Moshman (1995), knowledge of cognition comprises not just a person's awareness of his or her cognition but also knowledge as a whole. We distinguish three types of metacognitive awareness declarative Knowledge, procedural Knowledge, and conditional Knowledge. The first relates to the person's understanding of himself regarding the learning process and the variables influencing his performance. The second concerns knowledge about performing procedural skills and selecting appropriate strategies for problem-solving. And the latter is related to knowledge about the usefulness of cognitive processes.

Human metacognition reflects the discrimination, interpretation, and transmission of subtle cues that depend on cultural learning and involve the continuous flow of cognitive processes. In particular, it promotes effective intrapersonal decision-

making, evaluates, and ensures the smooth functioning of ongoing thought and behavior, helping to identify our errors. It also enhances the regulation and development of executive functions, as well as the detection of attention gaps (Heyes et al., 2020).

Self-observation, self-regulation, and self-knowledge are necessary and beneficial aspects of the metacognitive process that have a deep connection to the social development of the individual. Elements are essential for adapting to the social environment and engaging effectively with others (Winkielman & Schooler, 2012). In particular, metacognitive functioning is expressed by declarative expressive products of reflection and observation processes leading to selected conscious procedures of control. In other instances, it is manifested by unconscious processes of observing one's knowledge and cognitive processing. Humans use both conscious and unconscious forms of metacognition, while animals and young children display only the latter (Efklides & Misailidi, 2010).

3.4 Artificial Intelligence (AI)

Many scholars have developed numerous definitions of AI in their quest to comprehend and study it. They cited AI as an example of technology that aims to make machines intelligent so that they can understand, interpret and predict the environment. It is also said to be directly related to the cognitive branch of computing that deals with solving cognitive problems involving human learning, mimicry, memory, and pattern recognition. In addition, it encompasses the theory and development of computational systems whose operation covers tasks that mainly have human intelligence as a prerequisite like visual perception, decision-making, and translation between languages (Chassignol et al., 2018).

We distinguish three types of artificial intelligence based on their mechanism and use Artificial Narrow Intelligence (ANI), Artificial General Intelligence (AGI), and Artificial Super Intelligence (ASI). ANI (machine learning) is the simplest form of AI, with limited capabilities to address only one problem. AGI (machine Intelligence) is purely a hypothetical form of AI, combining cognitive abilities comparable to human ones, and a general function similar to human neural activity. (Bakola et al., 2022). And ASI is a science fiction area, known as future intelligence since its realization will surpass all human abilities, enriching machines with rational decision-making. Moreover, it will help robots and machines to develop emotional relationships similar, to some extent, to those created by humans (Soni, 2022; Markotic, 2021; Abdoullaev, 2022)

The development of AI influenced by neuroscience and cognitive psychology has improved the decoding properties of neural activity, promoting the understanding and prediction of the behavioral and cognitive content of the human brain. Moreover, this technological development is emerging as a powerful tool for neuroscientists and clinicians, both at diagnostic and therapeutic levels, including social and cognitive domains (Macpherson et al., 2021).

Callaway et al. (2022) report that AI substantially impacts the identification and dissemination of optimal cognitive strategies that enhance human judgment, decision-making, and behavior. As people practice relevant real-world tasks or simulations of these tasks, providing metacognitive feedback from an internet-based cognitive tutor, they discover inefficient decision-making strategies (Callaway et al., 2022).

4. Correlating Consciousness to ToM

The dominant view in neuroscience is that the brain produces consciousness, which occurs when the electrical activity in our brain neurons works in a complex way that creates consciousness (Mays & MAYS, 2011). This process of being an "active cognitive being with knowledge" requires the proper functioning of the nervous system that regulates one's viewpoint of perception as it intentionally engages with the internal and external world (Trevarthen & Delafield-Butt, 2017). Theory of Mind is a cognitive construct that holds a fundamental role in human social relations. It allows the development of the mental world via social interactions. Besides, combining the possibility of using language to exchange communicative messages and

Knowledge, enhances human consciousness (Fabbro et al., 2019). Furthermore, ToM enhances the child's awareness of the self as an active cognitive agent (Wang & Frye, 2021).

Research reports the presence of different levels of consciousness depending on the age of children. By the first year of age, they show a minimal level of consciousness, in which the child is capable of distinguishing himself from others through an implicit ability. At the age of two, children exhibit the first forms of self-consciousness. They gradually recognize themselves in the mirror, use personal pronouns, and manifest conscious emotions such as embarrassment and shame. Between the ages of 4 and 5, children display the second stage of reflective reflexive consciousness. At this age, executive skills and ToM progressively develop, contributing to the further development of reflective consciousness (Fabbro et al., 2019). They gradually develop first-order mental representations and understand the beliefs, and thoughts one has about someone else. Essentially, they begin to perceive that others have a different consciousness from their own (Duval et al., 2011).

Children gradually acquire at the ages of 3-4 a concept of knowledge, which brings out conscious awareness. That occurs when they understand the causal relationship between their ability to access information and their ability to act as they wish. They should be aware of their level of knowledge or ignorance, which means that knowledge depends on access to relevant information, in order to be able to formulate second-order thinking about something they know (first-order situation). Thus, the evolution of the representing process depends on conscious awareness as a process. (Perner & Dienes, 2003).

Mental representations are states of the human nervous system, that have biochemical characteristics, and their functions depend, among other things, on consciousness. A representation conveys information about the presence of a stimulus and is part of a person's mental life when it becomes an object of consciousness. Consequently, every mental representation requires consciousness, which can influence its causal forces, affecting the formation of the representation (Swiatczak, 2011).

People interpret behaviors according to how they encode them, which is significantly related to unconscious perceptual processes. Nevertheless, the behavior explanation process occurs consciously (Lillard & Skibbe, 2005). Additionally, developed ToM necessitates knowledge of one's innermost feelings, desires, and thoughts; in this sense, connected to the experiential component of metacognition or the ME (Efklides, 2008).

An acceptable definition of consciousness in medicine is that a person is in a state of being conscious if he is aware of internal or external stimuli. In addition, an individual's awareness of his inner thoughts, perception, and the knowledge that the self is a separate entity can be referred to as the concept of consciousness as a higher-order mental process. On this view, higher-order consciousness is associated with two interacting mental functions Self-awareness and Theory of Mind. The ability to perform mental states seems to be related to self-awareness, as understanding one's mind is a prerequisite for understanding the mind of another. Hence, the acquisition of self-awareness, the internal recognition of the self, turns the individual into a higher-order state of consciousness (Keenan et al., 2005).

According to Török and Kéri (2022); Mitsea et al. (2022a) mindfulness, derived from the Buddhist meditative tradition, involves self-observation and contributes crucially to the development of conscious internal representations that are components of developed ToM. It essentially facilitates the acceptance of experiences without bias and action, enhancing better self-awareness, self-regulation, and inhibitory capacity, effectively contributing to both the development of ToM and Metacognition. Furthermore, αll mindfulness training exercises strengthen and rebuild brain function (Hussain, 2015; Drigas & Mitsea, 2020b,c). Mindfulness practice is a state of consciousness whereby it helps the person to observe and recognize habitual, distracting thoughts and feelings without becoming attached to or responding to them (Hussain, 2015). Satlof-Bedrick and Johnson (2015); Drigas and Karyotaki (2019) mention that this procedure enables knowledge gained through introspection, characterized by attention and awareness of the present moment in experience and constitutes a higher-order conscious awareness, which is metacognitive.

Research suggests that introspection, self-reflection, and ToM are interrelated mental functions in the understanding of self and others. Consciousness, especially the reflective dimension of consciousness, activates the cognitive mechanism, executive functions, and thought control for the individual to get to know themselves better and develop successful interpersonal relationships (Tordjman et al., 2019).

Human self-consciousness, the meta-representation of one's mental states, and the ability of ToM are closely related to higher cognitive functions. Research shows an interplay of processes in the right prefrontal cortex. Self-consciousness includes self-awareness and being aware of one's mental states, such as perceptions, attitudes, opinions, emotions, and intentions to act. This process is necessary to understand others and to move to the knowledge of the subjectivity of the other, as it presupposes knowledge of oneself, for which the participation of consciousness is deemed necessary (Vogeley, 2001).

Frith and Happé (1999) indicate that restricted endoscopic awareness might result in first-order representations linked to recently processed sensory stimuli without the capacity to modify them. Consequently, a person with self-consciousness impairments would find it challenging to comprehend their acts and behavior, and discern between their own will and unintended behaviors.

Of crucial importance in the functioning of consciousness and ToM are attention and awareness, which interact with each other, as one can be considered a schematic representation of the other. The former is a natural process in the brain, while awareness represents knowledge of what the brain observes and reports. In particular, the construct of consciousness, which presupposes the involvement of attention, is used to model the attentional state not only of the individual but also of the awareness of other people. Consequently, the ability to be aware of one's mental state promotes the development of social cognition (Kelly et al., 2014). In an investigation by Aydin and Özgeldi (2019) children's training in ToM tasks may bring benefits to metacognitive processing, as through a deeper conscious understanding of the sources of knowledge, skills such as self-regulation, planning, observation, and evaluation related to metacognition boosted.

The interaction of ToM and Metacognition with the mechanisms of consciousness involves the mutual influence between cognitive capacities and conscious access to information, ensuring effective social and cognitive behavior. As a result, consciousness mechanisms, through the functions that mediate and integrate the information, encourage the development of cerebral, metacognitive, and social skills and social cognition (Gakis et al., 2018).

5. Correlating Consciousness to Metacognition

The word conscience derives from the Latin term conscĭentĭa, interpreted as knowledge shared with others, suggesting that it encompasses a form of shared, relational or social cognition. Moreover, the ability to be aware of one's own experiences, perceptions, behaviors, and mental states is also related to the notion in both colloquial language and neuroscience (Fabbro et al., 2019). Giving a metaphorical interpretation consciousness could also be referred to as "the knowledge one share with oneself" (Zeman, 2005). Conscious inner speech and mental imagery allow one to reflect, to control one's conscious and unconscious functioning. Consciousness is a "mental tool" that pushes the central nervous system to adapt to the changing circumstances that arise (Velmans, 2012). Furthermore, it is considered functionally necessary for the flexible action of a cognitive control system and the integration of cognitive information, making decision-making adaptive (Proust, 2019).

Kralik et al. (2018) claim that consciousness contributes to the formation of mental models and incorporates elements of experiences from the present, past, and future. It includes perception, thinking, and experiential process, which are related to processes involved in decision making like our perception of "self". Thus, consciousness reflects a form of metacognition.

It is established that our mental life includes many conscious states, but also many that occur without being consciously perceived. Metacognitive judgments inform us about our cognitive state and thus influence our actions, decision-making, and

hence the course of our thought processes (Rosenthal, 2000). Remarkably, metacognitive experiences, a key component of metacognition, involve conscious cognitive or affective experiences that impact the stock of metacognitive knowledge by adopting new goals or revising previous ones in cognitive processes (Papleontiou-Louca, 2003). Research points to the apparent connection between consciousness and metacognition as conscious mental access to our cognitive states is what most defines metacognition. However, our metacognitive access to information carried by unconscious states that are not conscious and require higher-order thoughts for that state may take place (Rosenthal, 2000).

Conscious and non-conscious cognitive processes occur continuously during our waking hours, although we are constantly experiencing core consciousness, including perceptions, emotions, and non-reflexive knowledge. Gradually when the individual's attention is directed to explicitly evaluating the contents of his experiences, he develops a conscious process. Therefore, meta-consciousness is the explicit representation of the content of consciousness in which the person interprets, characterizes, or recognizes the state of mind, which necessitates the use of metacognition (Schooler, 2002; Winkielman & Schooler, 2012). Identification, evaluation, and measurement of metacognitive abilities—particularly in young children—are influenced by awareness of the role of conscious and implicit processes in cognition (Whitebread et al., 2010).

All forms of consciousness are products of biological evolution, in some cases particularly enhanced by social or technological progress. Not all kinds of human consciousness are available to all people, and there are differences in the existing ones due to different sensory mechanisms, needs, and abilities. In addition, the potential appearance of several types of human consciousness is influenced by the physical, social, and cultural background, in conjunction with the person's metacognitive techniques (Sloman, 2020).

Dehaene et al., (2021) argue that consciousness combines two distinct types of information processing in the brain: the selection of information for global transmission and flexible use of the resulting inferences, and self-observation of this information, leading to a personal assessment of certainty or error. Subjective observation of knowledge, the cognitive mechanism, is one of the defining properties of consciousness. From this perspective, consciousness constitutes the link between cognition and metacognition (Koriat, 2000).

Consciousness can arise when a part of the brain, acting as a "subject" observing another part as an object, evaluates or inhibits its activity. It could also be restricted to attention and its cerebral mechanisms since we are usually conscious of what we observe (Tononi et al., 2016). Therefore, another role of consciousness is viewed as being metacognition, as a higher-level, first-order meta-representation of a sensory stimulus requires consciousness. The evaluation of metacognitive judgments is also frequently regarded as a gauge of the presence of conscious perception (Kanai, et al., 2019). According to Drigas and Pappas (2017) an individual's metacognitive development is critically dependent on the maturation of the metacognitive processes of observation, regulation, and adaptation, which together compose and are associated with the function of consciousness.

Shea et al. (2019) assert that conscious representations have elements of both global accessibility and metacognition. Besides that, they point out that the Global working space of memory continually separates representations according to a dominant metacognitive component. Hence, in a conceptual sense, all conscious copies of the mind are accompanied by a metacognitive appraisal (Lehmann et al., 2021).

Introspection has been investigated by several philosophical and scientific schools of thought and has traditionally developed as a method of studying people's inner thoughts. Asian civilizations gave great importance to introspection and self-reflection, which are significant meditative processes, with consciousness holding a privileged role in the evolution of corresponding practices and experiences. The West philosophically and historically occupies a dominant position in regard to the concept of self-examination involving introspection and self-consciousness (Gould, 2006). In particular, the Ancient Greeks, specifically Socrates, and Plato, referred to the significant ability of the individual to turn inward to achieve self-awareness and self-improvement (Drigas & Bakola, 2021; Gould, 2006).

In addition, a metacognitive process called introspection entails paying close attention and observation to what the person is experiencing and is distinguished by the occurrence of the experience (Overgaard & Sandberg, 2014). Thus, it involves investigating the mind and consciousness or specific aspects of them. Consequently, the observation of the individual's thoughts and feelings, combined with the overall introspective observation of their internal processes, make them an Observer of themselves (Gould, 2006).

As Lamotte et al. (2012) suggest that individuals may be aware of their cognitive ability in a particular domain, which directly affects the implementation of the strategies they choose and their performance. The findings of their study investigating the role of individual time awareness on participants' temporal judgments in conjunction with attention indicated that the more participants were aware of the role of attention in time perception, the lower the temporal distortions they exhibited.

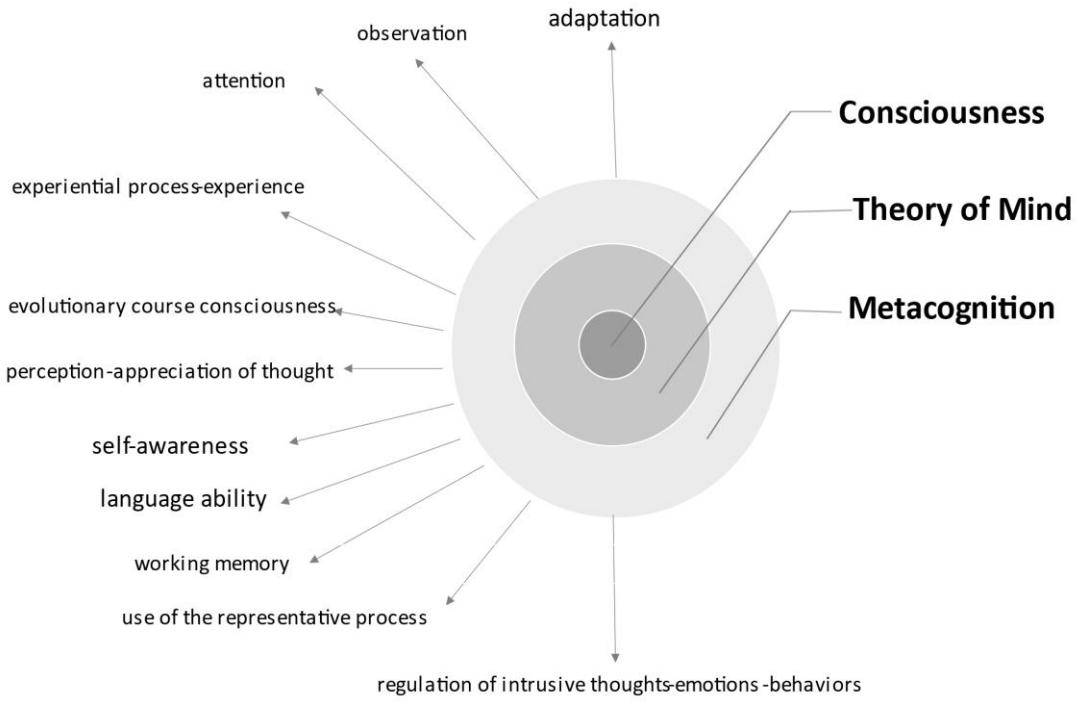
It is widely accepted that metacognition is closely related to conscious states. Metacognitive processes are a vital aspect of conscious awareness, and the cognitive functions associated with reflection and introspection are inextricably linked to consciousness. The contents of second-order metacognitive processes reflect the contents of consciousness. Essentially, metacognition is associated with higher-level knowledge, namely working memory, conscious awareness, and executive control processes. However, it sometimes appears that higher-order processes, which involve the cooperation of working memory and cognitive control, are sometimes partially separated from conscious awareness (Jachs et al., 2015).

Metacognition is also associated with mechanisms of conscious perception. While metacognitive function is not the same concept as consciousness, there is, however, a close relationship between the two processes, as processes such as alertness, arousal, self-awareness, action control, and others permeate their function. Metacognition could be seen as a specific aspect of consciousness through which one can observe, assess and introspectively control the quality of an ongoing perceptual process. In contrast, consciousness is related to the perception of the experience that an individual is experiencing (Grimaldi et al., 2015).

In a further distinction between the cognitively controlled and conscious processes of metacognition and the automatical unconscious processes, the inhibitory function of awareness is to reject unnecessary information that would dominate memory and behavior, influencing metacognitive judgment. Consequently, metacognitive observation, attention, and control are at the heart of consciousness ((Koriat, 2000).

According to Efklides (2008) nonconscious implicit observation can lead to abstract control by slowing down processing and increasing effort for the individual to respond to complex stimuli or difficult tasks. In cases where difficulties are not dealt with by implicit regulation, the outcome of the observation leads to conscious awareness in the form of metacognitive emotions that strongly stimulate our attention to the progression of metacognitive processing. Thus, explicit metacognitive awareness is associated with active information in working memory, social interaction, understanding the thoughts of others, and our need to communicate with others. Therefore, the social aspect of metacognition implies personal consciousness, which means products of implicit observation, explicit consciousness, and executive control (Efklides, 2008).

Figure 1 - The functional relationship between Consciousness, ToM, and Metacognition. Common mental processes in their mechanism.



Source: Authors.

The upper Figure 1 illustrates the relationship between Consciousness - ToM - Metacognition

Authors Bamicha and Drigas created the specific figure in the present study to capture the functional relationship between Consciousness, ToM, and Metacognition and the main common mental processes in their mechanism. More specifically, consciousness is a subjective, continuous, and dynamic process of the mind that builds, strengthens, and enriches the construct of Knowledge and Metacognition. It is at the core of the graded development of the three cognitive functions Consciousness-ToM-Metacognition, which show common mental processes (attention, observation, perception-thought evaluation, experiential process-experience, working memory, use of the representative process, regulation of intrusive thoughts-emotions -behavior, adaptation, self-awareness, language ability, evolutionary course of consciousness) upon completion of their function. The specific processes occur at different evolutionary levels in Consciousness-ToM-Metacognition, depending on the goals they perform and are called upon to fulfill. It is pointed out that the development of the three aforementioned mental mechanisms is strengthened and enriched essentially by the contribution of language development and higher mental skills, the executive ones.

6. The Role of the AI

John McCarthy (2007) referring to the term "artificial intelligence" points out it is a science that creates intelligent machines. It is associated with the utilization of computers in understanding human intelligence, but without artificial intelligence necessarily relying on biologically observable methods. In particular, based on computer mechanisms and programs that show impressive performance in several human tasks, making it easier for humans to perform them and deservedly earning the name "intelligent".

The human brain's structural and functioning qualities have served as a source of inspiration for artificial intelligence research to develop systems. It constitutes an integrated intelligence system with perception, planning, and decision-making capabilities, making it an enticing model for AI design. As a result, the research focus has shifted to developing artificial general intelligence (AGI) systems that can imitate human intellect (Macpherson et al., 2021)

The main distinctive difference between humans and machines is that humans process the information they receive from external stimuli, feeding back different attitudes and beliefs toward things based on pre-existing knowledge (Zhao et al., 2022).

Creating a flexible and efficient Theory of Mind can be a great challenge for AI. Learning rich models of others will improve decision-making in complex multi-agent tasks with beneficial applications in communication and pedagogy while enhancing human-machine interaction (Rabinowitz, et al., 2018). When humans extract correct inferences about machines' "mental states" and those can infer human intentions more accurately, then the interaction between them is effective, deriving benefits for both sides by focusing more on the human (Zaroukian, 2022).

AI acts as a lure in the development of AI, focusing on robotics. In particular, it provides intelligent robots with the possibility of social intelligence, strengthening human-robot interaction. Although a robot may act ethically without AI, the ability to predict the intentions of others will potentially enhance the scope of its ethical responses. Furthermore, it provides an opportunity to expand on the training of human social skills (Winfield, 2018; Bamicha & Drigas, 2022b). Rabinowitz et al. (2018) argue this may be accomplished by building a ToM neural network, or ToM-net, that uses meta-learning to build models of the agents it meets based on watching their behavior. As a result, human beings and the growth of technology would gain from the development of machine ToM that learns the capacities of responsible social beings and enhances human-machine interaction.

By interpreting the relationship between mental representation and awareness, we can understand that if people were not aware of the representations they present, they would not be able to associate mental copies of the mind of different kinds. Consequently, they would not be able to exhibit adaptive behavior. Several researchers in the computational theory of mind and artificial intelligence believe they can describe mental representation by ignoring consciousness. They contend that the manipulation of structured symbols may be used to explain intelligence and cognition. This approach would be valid if consciousness were not an active process but a passive observer of representations (Swiatczak, 2011).

According to one view of several researchers, consciousness emerged when organizations gradually acquired the ability to run internal simulations using internal models, developing flexible and intelligent behavior (Brown et al., 2019).

Computational ToM argues that the human mind consists of a computational machine about information processing, having software that uses representational entities. It differs from ToM nevertheless could be augmented with features of mind reading as a property resulting from lower-level processing functions of the brain (Erb, 2016).

Humans can interact with AI products in intelligent, technical environments by applying ToM skills. For example, the interaction between a human and a humanoid robot can create a sense in humans that the machines have the knowledge and situational awareness, intentions, and beliefs. Due to the anthropomorphic behavior exhibited by machines, people gradually attribute mental states to them as they somehow develop ToM. However, doubts arise about the possibility of ToM neural networks being activated in humans by interaction with advanced machines (Erb, 2016).

The condition "meta-reasoning" is a general AI term that refers to "thinking about thinking" within a computational system. More specifically, reasoning algorithms lead to decision-making, and a meta-reasoning algorithm evaluates and checks the previous one to select the most appropriate decision-making method. In essence, we would say that "meta-reasoning" involves dimensions of the human metacognitive process (Zaroukian, 2022).

According to Aleksander and Morton (2007) as mentioned in the study by Kralik et al. (2018), for a system to approach artificial consciousness, it is necessary to have a set of metacognitive "observations", such as observation of internal thoughts,

and external environment, self about the external environment and time (in the present, past, future). Notwithstanding, an AI system will need to generate and process data related to analogous processes to realize specific observation capabilities. Consciousness seems to involve metacognitive aspects that contribute to its effective functioning and lead to decision-making. Ganapini et al. (2021) emphasize AI metacognition refers to the set of processes and mechanisms that would enable a computational system to monitor and control its cognitive activities, processes, and structures. The ultimate purpose would be to improve the quality of the system's decisions. Therefore, they proposed a centralized meta-cognitive module it would combine data from both internal and external sources to address a single problem.

Jackson (2020) gives another dimension between metascience, which may be closely related to metacognition in human intelligence, and human-level artificial intelligence. By suggesting that the representation and processing that could support the metacognition of an AI system could also sustain an AI system that is reasoned about meta- scientifically for various fields of science. This view is grounded in the reasoning that scientific reasoning is a subset of cognition in general, and meta-scientific reasoning might be a subset of metacognition. Whereas meta-science considers the systematic method of knowledge acquisition for systematic methods of knowledge acquisition, meaning the science that deals with the understanding and formulation of science in all scientific fields.

The "offerings" of artificial intelligence, as impressive and valuable as they are, suggest the distinctiveness of intelligence and consciousness. Giving due value to subjective experience leads to flexible, creative, and innovative behavior effectively enriched by human presence (Cleeremans & Tallon-Baudry, 2021).

7. Discussion

After the literature review concerning the study of the correlation of consciousness with the cognitive functions ToM and Metacognition and the AI approach to them, we present the discussion about the set of findings resulting from the implementation of the procedure.

Consciousness as a higher mental process enables man to perceive oneself and understand others and the world in general. The value of experience arises as the individual interacts with others, forming meta-representations from which infer predictions about behavior and actions. In particular, dynamic interaction with others facilitates the incorporation of meta-representational images of the self, as these develop as a natural consequence of the reciprocal communicative exchanges we cultivate (Cleeremans & Tallon-Baudry, 2021). Moreover, explicit consciousness, by facilitating the mutual influence of the individual with objects, events, or people, promotes the emergence of social knowledge. Consequently, the child progressively forms knowledge of self and others as an outgrowth of communicative contact with the environment and others, with consciousness maintaining a prominent role in promoting social cognition (Lewis, 2003).

Mind and consciousness are multidimensional entities that incorporate brain communication and the social conditions that allow human adaptation to the social and cultural environment. ToM emerges as a dimension of reflexive consciousness in human experience, occupying a dominant position for developing social communication, interaction, and empathy (Sanhueza & Fossa, 2022).

The process of attributing mental states to others is a function of the mind's ability to read thoughts, intentions, and beliefs and requires phenomenal consciousness. Essentially, one must have seen and experienced comparable experiences in themselves to recognize and assign mental states to others. Consequently, phenomenal consciousness precedes ToM, specifically our ability to attribute conscious experiences (Sebastián, 2016).

From a functional perspective, one may regard metacognition as a collection of cognitive elements, the understanding of which lies in their interconnection and inter-processing (Kralik et al., 2018). As it leads to conscious knowledge of one's

cognitive states, the metacognitive process enables the person to monitor and regulate his cognitive function. Introspection is intimately tied to human consciousness and serves as a mediator in the appraisal of mental states (Hampton, 2009).

The close connection between consciousness and metacognitive mechanisms is characteristic, as higher-order conscious awareness promotes superior metacognitive performance. Moreover, consciousness informs our metacognitive confidence judgments, improving and enhancing metacognitive sensitivity. It is because conscious signals tend to be powerful while leveraging conscious perception of a stimulus as an intrinsic feature of metacognition (Morales & Lau, 2021).

Block (1995) asserts that there are two main types of consciousness that we distinguish and relate to the metacognitive process Self-consciousness and Observational Consciousness Monitoring-consciousness. The former is associated with the perception of the concept of self and the ability to use this concept in thinking about oneself. While the latter entails the individual's internal monitoring and perception of one's state or self, it is a metacognitive process of higher thought in which the individual is consciously aware of being in that state.

Artificial intelligence combines human psychological knowledge to simulate the rational thinking of the individual. It creates an emotional interaction between humans and machines, machines and machines, approximating the form of human communication. Therefore, computers can use cognitive psychology techniques to perceive and comprehend human emotions and engage in conversation with people. Thereby enhancing dimensions of empathy, ToM, and Metacognition (Zhao et al., 2022).

The complexity and flexibility of the human cognitive apparatus were the triggers for the creation of artificial intelligence. However, this project requires a deep understanding of the human mind, its processes, and the creation of appropriate conceptual models that can be used accordingly (Erb, 2016). To conclude, we highlight that the application of AI should serve society as a whole, providing opportunities for improvement in various areas (Bakola et al., 2022).

Moreover, in recent decades, significant social changes have been observed, are related to the role of A.I. and technology in people's daily lives. The most important of them concern communication, diffusion, and management information and the ability to assimilate and utilize the produced new knowledge. We have to underline the role of Digital Technologies in the education domain as well as in all aspects of everyday life, which are very productive and successful, facilitate and improve assessment, intervention, decision-making, educational procedures, and all the scientific and efficient procedures via Mobile (Stathopoulou et al., 2018; 2019; 2020 Kokkalia et al., 2016; Drigas et al., 2015; Vlachou et al., 2017; Papoutsi et al., 2018; Karabatzaki et al., 2018), various ICTs applications (Drigas et al., 2004; 2005; 2006; 2009; 2013; 2014; 2015; 2016; 2017; 2019; Pappas et al., 2018; 2019; Papanastasiou et al., 2018; 2020; Alexopoulou et al., 2019; Kontostavlou et al., 2019; Charami et al., 2014; Bakola et al.,2019; Kontostavlou et al., 2019; Alexopoulou et al., 2019), via AI Robotics & STEM (Drigas et al., 2004; 2005; 2009; 2014; Vrettaros et al., 2009; Anagnostopoulou et al., 2020; Lytra et al., 2021; Pappas et al.,2016; Mitsea et al., 2020; Chaidi et al., 2021: Chaidi et al., 2021) and games (Chaidi & Drigas, 2022; Kokkalia et al., 2017; Drigas, & Mitsea, 2021a,b,c). 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), unprecedented technological capabilities of man, have a catalytic effect, create a new social reality and shape the Information Society (Pappas & Drigas, 2015; 2016; Drigas & Koukiannakis, 2004; 2006; 2009; Drigas, & Kontopoulou, 2016; Theodorou, & Drigas, 2017; Drigas, & Kostas, 2014; Bakola et al., 2019; 2022; Drigas, & Politi-Georgousi, 2019; Karyotaki et al., 2022). Moreover, games and gamification techniques, and practices within general and special education improves the educational procedures and environment, making them more friendly and enjoyable (Drigas et al., 2014; 2015; Papanastasiou et al., 2017; Kokkalia et al., 2016; 2017; Doulou et al., 2022; Chaidi 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 & Papoutsi, 2020; Drigas & Mitsea, 2020a,b,c; 2021a,b,c; 2022; Kokkalia et al., 2019; Pappas & Drigas, 2019; Papoutsi, & Drigas, 2016; Karyotaki & Drigas, 2015; 2016; Papoutsi et al., 2019; 2021; Chaidi & Drigas, 2020; Drigas, & Karyotaki, 2019; Mitsea et al., 2020; 2021; Angelopoulou & Drigas, 2021; Tourimpampa et al., 2018; Kapsi et al., 2020; Drigas et al., 2021; 2022; Galitskaya & Drigas, 2021). Finally, Driga et al., (2019); Stavridou et al., (2021), and Zavitzanou and Drigas (2021) suggest that various environmental and dietary factors can act as inhibitors or facilitators of the improvement of mental abilities and strengths.

8. Conclusions

To sum up, Consciousness is a dynamic mental process that interacts with the human mind and significantly influences the growth of ToM and Metacognition. Essentially, it contributes significantly first to our awareness of our existence and then to our cognitive and metacognitive development. It represents the core of mind reading and metacognitive evaluation of cognitive and social mechanisms. It is emphasized how crucial linguistic proficiency and executive function are to the functional development of Consciousness, ToM, and Metacognition. Furthermore, the conscious process is the foundation stone for the evolution of human personality while at the same time constituting a major imitation factor for the development of artificial intelligence. In particular, the development of technology and especially the progress of data science, with an emphasis on artificial intelligence systems, has opened up new ways of enhancing the human factor in all areas of life. In addition, it provides the opportunity to empower artificial intelligence with elements of human Consciousness, for the benefit of the undeniably stronger one, the human mind.

Future research would be advantageous and requisite to attend to investigate educational practices that promote the development of consciousness and can be applied to the educational process, focusing specifically on the preschool period. The cultivation of conscious perception and action at this age would initially bring significant benefits to the development of ToM and Metacognition, laying the foundations of their evolution and then to the stimulation and improvement of the individual at a social, cognitive, and metacognitive level.

References

Alexopoulou, A, Batsou, A, & Drigas, A. (2019). Resilience and academic underachievement in gifted students: causes, consequences and strategic methods of prevention and intervention. *International Journal of Online and Biomedical Engineering* (iJOE), 15(14):78-86. https://doi.org/10.3991/ijoe.v15i14.11251

Anagnostopoulou, P., Alexandropoulou, V., Lorenzo, G., Lykothanasi, A., Ntaountaki, P., & Drigas, A. (2020). Artificial intelligence in autism assessment. *International Journal of Emerging Technologies in Learning (iJET)*, 15(6), 95-107. https://doi.org/10.3991/ijet.v15i06.11231

Angelopoulou, E. & Drigas, A. (2021). Working Memory, Attention and their Relationship: A theoretical Overview. *Research. Society and Development*,10(5), 1-8. https://doi.org/10.33448/rsd-v10i5.15288

Aromataris E, & Pearson A. (2014). The systematic review: an overview. *The American Journal of Nursing*, 114(3):53-58. https://doi.org/10.1097/01.naj.0000444496.24228.2c PMID: 2457253

Aydin, U., & Özgeldi, M. (2019). Unpacking the Roles of Metacognition and Theory of Mind in Turkish Undergraduate Students' Academic Achievement: A Test of Two Mediation Models. *Croatian Journal of Education: Hrvatski časopis zaodgoj i obrazovanje,* 21(4), 1333-1365. https://doi.org/10.15516/cje.v21i4.3303

Bakola, L. N., Rizos, N. D. & Drigas, A. S. (2019). ICTs for Emotional and Social Skills Development for Children with ADHD and ASD Co-existence. *International Journal of Emerging Technologies in Learning*, 14 (5), 122-131. https://doi.org/10.3991/ijet.v14i05.9430

Bakola, L. N., Drigas, A., & Skianis, C. (2022). Emotional Intelligence vs. Artificial Intelligence: The interaction of human intelligence in evolutionary robotics. *Research, Society and Development*, 11(16). http://dx.doi.org/10.33448/rsd-v11i16.38057

Bamicha, V., & Drigas, A. (2022a). The Evolutionary Course of Theory of Mind-Factors That Facilitate or Inhibit Its Operation & the Role of ICTs. *Technium Soc. Sci. J.*, 30, 138-158. https://doi.org/10.47577/tssj.v30i1.6220

Bamicha, V., & Drigas, A. (2022b). ToM & ASD: The interconnection of Theory of Mind with the social-emotional, cognitive development of children with Autism Spectrum Disorder. The use of ICTs as an alternative form of intervention in ASD. *Technium Social Sciences Journal*, 33, 42-72. https://orcid.org/0000-0001-5637-9601

Block, N. (1995). On a confusion about a function of consciousness. *Behavioral and brain sciences*, 18(2), 227-247. https://psycnet.apa.org/doi/10.1017/S0140525X00038188

Brown, R., Lau, H., & LeDoux, J. E. (2019). Understanding the higher-order approach to consciousness. *Trends in cognitive sciences*, 23(9), 754-768. https://doi.org/10.1016/j.tics.2019.06.009

Byrne, J. A. (2016). Improving the peer review of narrative literature reviews. Research integrity and peer review, 1, 1-4. DOI 10.1186/s41073-016-0019-2

Callaway, F., Jain, Y. R., van Opheusden, B., Das, P., Iwama, G., Gul, S., ... & Lieder, F. (2022). Leveraging artificial intelligence to improve people's planning strategies. *Proceedings of the National Academy of Sciences of the United States of America*, 119(12). https://doi.org/10.1073%2Fpnas.2117432119

Chaidi, I., & Drigas, A. (2020). Parents' Involvement in the Education of their Children with Autism: Related Research and its Results. *International Journal Of Emerging Technologies In Learning (Ijet)*, 15(14), 194-203. https://doi.org/10.3991/ijet.v15i14.12509

Chaidi, E., Kefalis, C., Papagerasimou, Y., & Drigas, A. (2021). Educational robotics in Primary Education. A case in Greece. *Research, Society and Development*, 10(9), e17110916371-e17110916371. https://orcid.org/0000-0001-8798-3182

Chaidi, I., Drigas, A., & Karagiannidis, C. (2021). ICT in special education. *Technium Soc. Sci. J*., 23, 187. https://dx.doi.org/10.47577/tssj.v23i1.4277

Chaidi I, Drigas, A., (2022). Digital games & special education. *Technium Social Sciences Journal* 34, 214-236. https://orcid.org/0000-0001-5637-9601

Chalmers, D. J. (1997). *The conscious mind: In search of a fundamental theory*. Oxford Paperbacks. https://psycnet.apa.org/record/1996-97863-000

Charami, F., & Drigas, A. (2014). ICTs in English Learning and Teaching. *International Journal of Engineering and Science.* 2(4):4-10. DOI: 10.3991/iJES. v2i4.4016

Chassignol, M., Khoroshavin, A., Klimova, A., & Bilyatdinova, A. (2018). Artificial Intelligence trends in education: a narrative overview. *Procedia Computer Science*, 136, 16-24. https://doi.org/10.1016/j.procs.2018.08.233

Cleeremans, A., & Tallon-Baudry, C. (2021). The function of consciousness is to generate experience. https://doi.org/10.31234/osf.io/jfpw2

Cvetkovic, D. (2011). *Introduction to States of Consciousness.* In: Cvetkovic, D., Cosic, I. (eds) States of Consciousness. The Frontiers Collection. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-18047-7

Damasio, A., & Meyer, K. (2009). Consciousness: an overview of the phenomenon and of its possible neural basis.[W:] Steven Laureys & Giulio Tononi (eds.), *The neurology of consciousness: cognitive neuroscience and neuropathology*. 3-14.

Dehaene, S., Lau, H., & Kouider, S. (2021). What Is Consciousness, and Could Machines Have It? *In Robotics, AI, and Humanity* 43-56. *Springer, Cham*. https://doi.org/10.1126/science.aan8871

Doulou, A., & Drigas, A. (2022). Electronic, VR & Augmented Reality Games for Intervention in ADHD. *Technium Soc. Sci. J.*, 28, 159. https://doi.org/10.47577/tssj.v28i1.5728

Drigas, A. S., Vrettaros, J., Stavrou, L., & Kouremenos, D. (2004). E-learning Environment for Deaf People in the E-commerce and New Technologies Sector. *WSEAS Transactions on Information Science and Applications*, *1*(5), 1189-1196.

Drigas, A. S., Stavridis, G., & Koukianakis, L. (2004). A Modular Environment for E-learning and E-psychology Applications. *WSEAS Transactions on Computers*, *3*(6), 2062-2067.

Drigas A.S., Kouremenos, D., Kouremenos. D., & Vrettaros, J. (2005). "An e-learning system for the deaf people," 2005 6th International Conference on Information Technology Based Higher Education and Training, Santo Domingo, Dominican Republic, 2005, 2(1), 20–24. https://doi.org/10.1109/ITHET.2005.1560236

Drigas, A. S., Vrettaros, J. & Kouremenos, D. (2005). "An e-learning management system for the deaf people," AIKED '05: Proceedings of the Fourth WSEAS International Conference on Artificial Intelligence, Knowledge Engineering Data Bases, article number 28

Drigas, A. S., Koukianakis, L. G., & Papagerasimou, Y. V. (2005). A system for e-inclusion for individuals with sight disabilities. *Wseas transactions on circuits and systems*, 4(11), 1776-1780.

Drigas, A., Koukianakis, L., & Papagerasimou, Y. (2006, October). An e-learning environment for nontraditional students with sight disabilities. In *Proceedings. Frontiers in Education. 36th Annual Conference* (23-27). IEEE. https://doi.org/10.1109/FIE.2006.322633

Drigas, A. S., & Koukianakis, L. G. (2006). An open distance learning e-system to support SMEs e-enterprising. WSEAS Transactions on Information Science and Applications, 3(3), 526-531.

Drigas, A., & Koukianakis, L. (2009, September). Government online: an e-government platform to improve public administration operations and services delivery to the citizen. In World Summit on Knowledge Society (pp. 523-532*). Springer, Berlin, Heidelberg.*

Drigas, A., Vrettaros, J., Tagoulis, A., & Kouremenos, D. (2010). Teaching a foreign language to deaf people via vodcasting & Web 2.0 tools. In *Organizational, Business, and Technological Aspects of the Knowledge Society: Third World Summit on the Knowledge Society, WSKS 2010, Corfu, Greece, September 22-24, 2010. Proceedings, Part II 3* (pp. 514-521). Springer Berlin Heidelberg.

Drigas, A., & Dourou, A. (2013). A Review on ICTs, E-Learning and Artificial Intelligence for Dyslexicâ? s *Assistance. International Journal of Emerging Technologies in Learning (iJET)*, 8(4), 63-67. http://dx.doi.org/xxx

Drigas, A., Leliopoulos, P. (2013). Business to consumer (B2C) e-commerce decade evolution. *Int. J. Know. Soc. Res. (IJKSR)* 4(4), 1–10.

Drigas, A., & Papanastasiou, G. (2014). Interactive White Boards in Preschool and Primary Education. *International Journal of Online and Biomedical Engineering (iJOE)*, 10(4), 46–51. https://doi.org/10.3991/ijoe.v10i4.3754

Drigas, A., & Kostas, I. (2014). On Line and other ICTs Applications for teaching math in Special Education. *International Journal of Recent Contributions from Engineering, Science & IT (iJES)*, 2(4), pp-46. http://dx.doi.org/10.3991/ijes.v2i4.4204

Drigas, A., Kokkalia, G. & Lytras, M. D. (2015). Mobile and Multimedia Learning in Preschool Education. *J. Mobile Multimedia*, 11(1/2), 119–133.

Drigas, A., Pappas, M., & Lytras, M. (2016). Emerging technologies for ict based education for dyscalculia: Implications for computer engineering education. *International journal of engineering education*, *32*(4), 1604-1610.

Drigas, A., & Vlachou, J. A. (2016). Information and communication technologies (ICTs) and autistic spectrum disorders (ASD). *International Journal of Recent Contributions from Engineering, Science & IT (iJES)*, 4(1), 4-10. http://dx.doi.org/10.3991/ijes.v4i1.5352

Drigas, A., & Kontopoulou, M. T. L. (2016). ICTs based Physics Learning. *International Journal of Engineering Pedagogy (iJEP)*, 6(3), 53-59. https://doi.org/10.3991/ijep.v6i3. 5899

Drigas, A., Kokkalia, G. & Lytras, M. D. (2015). Mobile and Multimedia Learning in Preschool Education. *J. Mobile Multimedia*, 11(1/2), 119–133.

Drigas, A. & Kokkalia, G. (2017). ICTs and Special Education in Kindergarten. *International Journal of Emerging Technologies in Learning* 9 (4), 35–42. http://dx.doi.org/10.3991/ijet.v9i4.3662

Drigas, A. S. & Papas, M. A. (2017). The Consciousness-Intelligence-Knowledge Pyramid: An 8x8 Layer Model. International Journal of Recent Contributions from Engineering Science & IT, 5(3), 14-25.

Drigas, A. S., & Pappas, M. A. (2017). The consciousness-intelligence-knowledge pyramid: an 8x8 layer model. *International Journal of Recent Contributions from Engineering, Science & IT* (iJES), 5(3), 14-25. https://doi.org/10.3991/ijes.v5i3.7680

Drigas, A. S., & Karyotaki, M. (2019). "A Layered Model of Human Consciousness." International Journal of Recent Contributions from Engineering, Science & IT (IJES), 7(3), 41. https://doi.org/10.3991/ijes.v7i3.11117

Drigas, A. S. and Politi-Georgousi, S. (2019). Icts as a distinct detection approach for dyslexia screening: A contemporary view. *International Journal of Online and Biomedical Engineering (iJOE)*, 15(13):46–60. https://doi.org/10.3991/ijoe.v15i13.11011

Drigas, A. & Mitsea, E. (2020a). The Triangle of Spiritual Intelligence, Metacognition and Consciousness. *International Journal of Recent Contributions from Engineering Science & IT*, 8(1), 4-23. https://doi.org/10.3991/ijes.v8i1.12503

Drigas, A. & Mitsea, E. (2020b). A Metacognition Based 8 Pillars Mindfulness Model and Training Strategies. I*nternational Journal of Recent Contributions from Engineering Science & IT*, 8(4), 4-17. https://doi.org/10.3991/ijes.v8i4.17419

Drigas, A. & Mitsea, E. (2020c). The 8 Pillars of Metacognition. *International Journal of Recent Contributions from Engineering Science & IT*, 15(21), 162-178. https://doi.org/10.3991/ijet.v15i21.14907

Drigas A., & Papoutsi C. (2020). The Need for Emotional Intelligence Training Education in Critical and Stressful Situations: The Case of COVID-19. *Int. J. Recent Contrib. Eng. Sci. IT* 8 (3), 20–35. 10.3991/ijes. v8i3.1723 https://doi.org/10.3991/ijes.v8i3.172355

Drigas, A., Kokkalia, G. & Economou, A. (2021). An 8-Layer Model for Metacognitive Skills in Kindergarten. *NEUROLOGY AND NEUROBIOLOGY*, 4(1), 2-10. http://dx.doi.org/10.31487/j.NNB.2021.01.01

Drigas, A., & Bakola, L. N. (2021). The 8x8 Layer Model Consciousness-Intelligence-Knowledge Pyramid, and the Platonic Perspectives. Int. J. Recent Contributions Eng. Sci. IT, 9(2), 57-72. https://doi.org/10.3991/ijes.v9i2.22497

Drigas, A., & Mitsea, E. (2021a). Metacognition, stress-relaxation balance & related hormones. *International Journal of Recent Contributions from Engineering, Science & IT* (iJES), 9(1), 4–16. https://doi.org/10.3991/ijes.v9i1.19623

Drigas, A., & Mitsea, E. (2021b). 8 Pillars X 8 Layers Model of Metacognition: Educational Strategies, Exercises &Trainings. *International Journal of Online & Biomedical Engineering*, 17(8). https://doi.org/10.3991/ijoe.v17i08.23563

Drigas, A., & Mitsea, E. (2021c). Neuro-Linguistic Programming & VR via the 8 Pillars of Metacognition X 8 Layers of Consciousness X 8 Intelligences. *Technium Soc. Sci. J.*, 26, 159.

Drigas, A., Mitsea, E., & Skianis, C. (2021). The Role of Clinical Hypnosis and VR in Special Education. *International Journal of Recent Contributions from Engineering Science & IT (iJES)*, 9(4), 4-17. https://doi.org/10.3991/ijes.v9i4.26147

Drigas, A., & Mitsea, E. (2022). Breathing: a Powerfull Tool for Physical & Neuropsychological Regulation. The role of Mobile Apps. *Technium Soc. Sci. J.*, 28, 135. https://orcid.org/0000-0001-5637-9601

Drigas, A., Mitsea, E., & Skianis, C. (2022). Clinical Hypnosis & VR, Subconscious Restructuring-Brain Rewiring & the Entanglement with the 8 Pillars of Metacognition X 8 Layers of Consciousness X 8 Intelligences. *International Journal of Online & Biomedical Engineering*, 18(1). https://doi.org/10.3991/ijoe.v18i01.26859

Duval, C., Piolino, P., Beaming, A., Eustache, F. & Desgranges, B. (2011). Age effects on different components of theory of mind. *Consciousness and Cognition*, 20(3), 627-642. https://doi.org/10.1016/j.concog.2010.10.025

Earl, B. (2014). The biological function of consciousness. *Frontiers in psychology*, 5, 697. https://doi.org/10.3389/fpsyg.2014.00697

Earl, B. (2019). The structure of mind and the role of consciousness. *Journal of Psychology*, 7(2), 84-101. https://doi.org/10.15640/jpbs.v7n2a9

Efklides, A. (2008). Metacognition: Defining its facets and levels of functioning in relation to self-regulation and co-regulation. *European Psychologist*, 13(4), 277. https://psycnet.apa.org/doi/10.1027/1016-9040.13.4.277

Efklides, A., & Misailidi, P. (2010). Introduction: The present and the future in metacognition. *In Trends and prospects in metacognition research* (pp. 1-18). Springer, Boston, MA. https://psycnet.apa.org/doi/10.1007/978-1-4419-6546-2_1

Erb, B. (2016). Artificial Intelligence & Theory of Mind. Ulm University (2016), 1-11. http://dx.doi.org/10.13140/RG.2.2.27105.71526

Fabbro, F., Cantone, D., Feruglio, S., & Crescentini, C. (2019). Origin and evolution of human consciousness. *Progress in Brain Research*, 250, 317-343. https://doi.org/10.1016/bs.pbr.2019.03.031

Flanagan, O. (1995). Consciousness and the natural method. *Neuropsychologia*, 33(9), 1103-1115. https://doi.org/10.1016/0028-3932(95)00051-4

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive–developmental inquiry. *American psychologist*, 34(10), 906. https://psycnet.apa.org/doi/10.1037/0003-066X.34.10.906

Frith, U. & Happé, F.G.E (1999). Theory of Mind and Self-Consciousness: What Is It Like to Be Autistic? *Mind & Language*, 14 (1), 1–22. https://doi.org/10.1111/1468-0017.00100

Frith, C. D., & Frith, U. (2012). Mechanisms of social cognition. *Annual review of psychology*, 63(1), 287-313. https://doi.org/10.1146/annurev-psych-120710-100449

Gakis, M., Cichoń, E., Cyrkot, T., & Szczepanowski, R. (2018). Consciousness and Social Cognition from an Interactionist Perspective: A New Approach on Understanding Normal and Abnormal Relations between Metacognition and Mindreading. *In Prefrontal Cortex. IntechOpen*. http://dx.doi.org/10.5772/intechopen.79584

Gallagher, H. L. & Frith, C. D. (2003). Functional imaging of 'theory of mind'. *TRENDS in Cognitive Sciences*, 7 (2), 77-83. https://doi.org/10.1016/S1364-6613(02)00025-6

Galitskaya, V., & Drigas, A. (2021). The importance of working memory in children with Dyscalculia and Ageometria. *Scientific Electronic Archives*, 14(10). http://dx.doi.org/10.36560/141020211449

Ganapini, M. B., Campbell, M., Fabiano, F., Horesh, L., Lenchner, J., Loreggia, A., ... & Venable, K. B. (2021). Thinking Fast and Slow in AI: the Role of Metacognition. arXiv preprint arXiv:2110.01834. https://doi.org/10.48550/arXiv.2110.01834

Garg, S., & Sharma, S. (2020). Impact of artificial intelligence in special need education to promote inclusive pedagogy. *International Journal of Information and Education Technology*, 10(7), 523-527. doi: 10.18178/ijiet.2020.10.7.1418

Gould, S. J. (2006). Unpacking the many faces of introspective consciousness: A metacognitive-poststructuralist exercise. *Handbook of qualitative research methods in marketing*, 186-197.

Graziano, M. S. (2022). A conceptual framework for consciousness. *Proceedings of the National Academy of Sciences*, 119(18), e2116933119. https://doi.org/10.1073/pnas.2116933119

Grimaldi, P., Lau, H., & Basso, M. A. (2015). There are things that we know that we know, and there are things that we do not know we do not know: Confidence in decision-making. *Neuroscience & Biobehavioral Reviews*, 55, 88-97.

Hampton, R. R. (2009). Multiple demonstrations of metacognition in nonhumans: Converging evidence or multiple mechanisms? *Comparative cognition & behavior reviews*, 4, 17. https://doi.org/10.3819%2Fccbr.2009.40002

Heyes, C., Bang, D., Shea, N., Frith, C. D., & Fleming, S. M. (2020). Knowing ourselves together: The cultural origins of metacognition. *Trends in Cognitive Sciences*, 24(5), 349-362. https://doi.org/10.1016/j.tics.2020.02.007

Hussain, D. (2015). Meta-cognition in mindfulness: A conceptual analysis. In Psychological Thought. *PsychOpen GOLD.* 8 (2) 132–141. https://doi.org/10.23668/psycharchives.1972

Jachs, B., Blanco, M. J., Grantham-Hill, S., & Soto, D. (2015). On the independence of visual awareness and metacognition: a signal detection theoretic analysis. *Journal of experimental psychology: human perception and performance*, 41(2), 269. http://dx.doi.org/10.1037/xhp0000026

Jackson, P. (2020). Toward metascience via human-level AI with metacognition. *Procedia Computer Science*, 169, 527-534. https://doi.org/10.1016/j.procs.2020.02.214

Kapsi, S., Katsantoni, S., & Drigas, A. (2020). The Role of Sleep and Impact on Brain and Learning. *Int. J. Recent Contributions Eng. Sci. IT*, 8(3), 59-68. https://doi.org/10.3991/ijes.v8i3.17099

Karabatzaki, Z., Stathopoulou, A., Kokkalia, G., Dimitriou, E., Loukeri, P. I., Economou, A., & Drigas, A. (2018). Mobile Application Tools for Students in Secondary Education. An Evaluation Study. *International Journal of Interactive Mobile Technologies*, 12(2). https://doi.org/10.3991/ijim.v12i2.8158

Karyotaki, M., & Drigas, A. (2015). Online and other ICT Applications for Cognitive Training and Assessment. *International Journal of Online and Biomedical Engineering.* 11(2), 36-42. http://dx.doi.org/10.3991/ijoe.v11i2.4360

Karyotaki, M., & Drigas, A. (2016). Latest trends in problem solving assessment. *International Journal of Recent contributions from Engineering, Science & IT (iJES)*, 4(2), 4-10. http://dx.doi.org/10.3991/ijes.v4i2.5800

Karyotaki, M., Bakola, L., Drigas, A., & Skianis, C. (2022). Women's Leadership via Digital Technology and Entrepreneurship in business and society. *Technium Soc. Sci. J*., 28, 246. https://orcid.org/0000-0003-3764-8268

Koriat, A. (2000). The feeling of knowing: Some metatheoretical implications for consciousness and control. *Consciousness and cognition*, 9(2), 149-171. https://doi.org/10.1006/ccog.2000.0433

Kanai, R., Chang, A., Yu, Y., Magrans de Abril, I., Biehl, M., & Guttenberg, N. (2019). Information generation as a functional basis of consciousness. *Neuroscience of consciousness*, 2019(1), niz016. https://doi.org/10.1093/nc/niz016

Keenan, J. P., Rubio, J., Racioppi, C., Johnson, A., & Barnacz, A. (2005). The right hemisphere and the dark side of consciousness. *Cortex*, 41(5), 695-704. https://doi.org/10.1016/S0010-9452(08)70286-7

Kelly, Y. T., Webb, T. W., Meier, J. D., Arcaro, M. J., & Graziano, M. S. (2014). Attributing awareness to oneself and to others. *Proceedings of the National Academy of Sciences*, 111(13), 5012-5017. https://doi.org/10.1073/pnas.1401201111

Koch, C., & Tsuchiya, N. (2007). Attention and consciousness: two distinct brain processes. *Trends in cognitive sciences*, 11(1), 16-22. https://doi.org/10.1016/j.tics.2006.10.012

Koch, C. (2018). What Is Consciousness? *Scientific American*, 318(6), 60-64.

Kokkalia G, Drigas A, Economou A (2016). Mobile learning for preschool education. *International Journal of Interactive Mobile Technologies*10(4). https://doi.org/10.3991/ijim.v10i4.6021

Kokkalia, G., Drigas, A., Economou, A., Roussos, P., & Choli, S. (2017). The use of serious games in preschool education. *International Journal of Emerging Technologies in Learning*, 12(11), 15-27. https://doi.org/10.3991/ijet.v12i11.6991

Kokkalia, G., Drigas, A. S., Economou, A., & Roussos, P. (2019). School readiness from kindergarten to primary school. *International Journal of Emerging Technologies in Learning (Online)*, 14(11), 4.

Kontostavlou, E.Z., & Drigas, A.S. (2019). The Use of Information and Communications Technology (ICT) in Gifted Students. *International Journal of Recent Contributions from Engineering, Science and IT*, 7(2), 60-67. https://doi.org/10.3991/ijes.v7i2.10815

Kralik, J. D., Lee, J. H., Rosenbloom, P. S., Jackson Jr, P. C., Epstein, S. L., Romero, O. J., ... & McGreggor, K. (2018). Metacognition for a common model of cognition. *Procedia computer science*, 145, 730-739. https://doi.org/10.1016/j.procs.2018.11.046

Lamotte, M., Izaute, M., & Droit-Volet, S. (2012). Awareness of time distortions and its relation with time judgment: A metacognitive approach. *Consciousness and cognition*, 21(2), 835-842. https://doi.org/10.1016/j.concog.2012.02.012

Lehmann, M., Neumann, C., Wasserthal, S., Schultz, J., Delis, A., Trautner, P., ... & Ettinger, U. (2021). Effects of ketamine on brain function during metacognition of episodic memory. *Neuroscience of consciousness*, 2021(1), niaa028. https://doi.org/10.1093/nc/niaa028

Lewis, M. (2003). The emergence of consciousness and its role in human development. *Annals of the New York Academy of Sciences*, 1001(1), 104-133. https://doi.org/10.1196/annals.1279.007

Lillard, A., & Skibbe, L. (2005). Theory of mind: Conscious attribution and spontaneous trait inferences. *The new unconscious*, 277-305.

Ludwig, D. (2022). The functional contributions of consciousness. *Consciousness and Cognition*, 104, 103383. https://doi.org/10.1016/j.concog.2022.103383

Lytra, N., & Drigas, A. (2021). STEAM education-metacognition–Specific Learning Disabilities. *Scientific Electronic Archives*, 14(10). http://dx.doi.org/10.36560/141020211442

Macpherson, T., Churchland, A., Sejnowski, T., DiCarlo, J., Kamitani, Y., Takahashi, H., & Hikida, T. (2021). Natural and Artificial Intelligence: A brief introduction to the interplay between AI and neuroscience research. *Neural Networks*, 144, 603-613. https://doi.org/10.1016/j.neunet.2021.09.018

Mays, R. G., & MAYS, S. B. (2011). A theory of mind and brain that solves the 'hard problem'of consciousness. *In annual conference of the International Association for Near-Death Studies (IANDS), Durham, NC. Retrieved from http://selfconsciousmind. com/papers. html# theory-article.*

McCarthy, J. (2007). What is artificial intelligence? http://www-formal.stanford.edu/jmc/

McPhaila, A. V. (2009). From a classical neuroscience towards a quantum theory of mind and consciousness. *Natural Philosophy*: 003

Mitsea, E., Lytra, N., Akrivopoulou, A., & Drigas, A. (2020). Metacognition, Mindfulness and Robots for Autism Inclusion. *Int. J. Recent Contributions Eng. Sci. IT*, 8(2), 4-20. https://doi.org/10.3991/ijes.v8i2.14213

Mitsea, E., Drigas, A. & Mantas, P. (2021). Soft Skills & Metacognition as Inclusion Amplifiers in the 21st Century. *International Journal of Online & Biomedical Engineering*, 17 (4), 121-132. https://doi.org/10.3991/ijoe.v17i04.20567

Mitsea, E., Drigas, A., & Skianis, C. (2022). Mindfulness Strategies for Metacognitive Skills Training in Special Education: The Role of Virtual Reality. *Technium Soc. Sci. J.*, 35, 232. https://doi.org/10.47577/tssj.v35i1.7275

Morales, J., & Lau, H. (2021). Confidence tracks consciousness. *Qualitative consciousness: themes from the philosophy of David Rosenthal*, 1-21.

Overgaard, M., & Sandberg, K. (2014). Kinds of access: Different methods for report reveal different kinds of metacognitive access. Frith (Eds.), *The cognitive neuroscience of metacognition* (pp. 67–85). Springer-Verlag Publishing. https://doi.org/10.1007/978-3-642-45190-4_4

Papanastasiou, G. P., Drigas, A. S., & Skianis, C. (2017). Serious games in preschool and primary education: Benefits and impacts on curriculum course syllabus. *International Journal of Emerging Technologies in Learning,* 12(1), 44–56. https://doi.org/10.3991/ijet.v12i01.6065

Papanastasiou, G., Drigas, A., Skianis, C., Lytras, M., & Papanastasiou, E. (2018). Patient-centric ICTs based healthcare for students with learning, physical and/or sensory disabilities. *Telematics and Informatics*, 35(4), 654-664. https://doi.org/10.1016/j.tele.2017.09.002

Papanastasiou, G., Drigas, A., Skianis, C., & Lytras, M. (2020). Brain computer interface-based applications for training and rehabilitation of students with neurodevelopmental disorders. A literature review. *Heliyon,* 6(9), e04250

Papleontiou-Louca, E. (2003). The concept and instruction of metacognition. *Teacher development*, 7(1), 9-30. https://doi.org/10.1080/13664530300200184

Papoutsi, C. & Drigas, A. (2016). Games for Empathy for Social Impact. International *Journal of Engineering Pedagogy* 6(4), 36-40. https://doi.org/10.3991/ijep.v6i4.6064

Papoutsi, C., Drigas, A., & Skianis, C. (2018). Mobile Applications to Improve Emotional Intelligence in Autism-A Review. *International Journal of Interactive Mobile Technologies*, 12(6). https://doi.org/10.3991/ijim.v12i6.9073

Papoutsi, C., Drigas, A., & Skianis, C. (2019). Emotional intelligence as an important asset for HR in organizations: Attitudes and working variables. *International Journal of Advanced Corporate Learning,* 12(2), 21–35. https://doi.org/10.3991/ijac.v12i2.9620

Papoutsi, C., Drigas, A., & Skianis, C. (2021). Virtual and augmented reality for developing emotional intelligence skills. *Int. J. Recent Contrib. Eng. Sci. IT (IJES)*, 9(3), 35-53. https://doi.org/10.3991/ijes.v9i3.23939

Pappas, M.A., & Drigas, A.S. (2015). ICT based screening tools and etiology of dyscalculia. *International Journal of Engineering Pedagogy*, 3, 61-66. http://dx.doi.org/10.3991/ijep.v5i3.4735

Pappas, M., & Drigas, A. (2016). Incorporation of artificial intelligence tutoring techniques in mathematics. *International Journal of Engineering Pedagogy*, 6(4), 12–16. https://doi.org/10.3991/ijep.v6i4.6063

Pappas, M. A., Drigas, A. S., Papagerasimou, Y., Dimitriou, H., Katsanou, N., Papakonstantinou, S., & Karabatzaki, Z. (2018). Female entrepreneurship and employability in the digital era: The case of Greece. *Journal of Open Innovation: Technology, Market, and Complexity*, 4(2), 15.

Pappas, M. A., & Drigas, A. S. (2019). Computerized Training for Neuroplasticity and Cognitive Improvement. *Int. J. Eng. Pedagog*., 9(4), 50-62.

Proust, J. (2019). From comparative studies to interdisciplinary research on metacognition. *Animal Behavior and Cognition*, 6(4), 309-328. https://doi.org/10.26451/abc.06.04.10.2019

Perner, J., & Dienes, Z. (2003). Developmental aspects of consciousness: How much theory of mind do you need to be consciously aware? *Consciousness and cognition*, 12(1), 63-82. https://doi.org/10.1016/S1053-8100(02)00010-7

Persuh, M., LaRock, E., & Berger, J. (2018). Working memory and consciousness: The current state of play. *Frontiers in human neuroscience*, 12, 78. https://doi.org/10.3389/fnhum.2018.00078

Posner, M. I. (1994). Attention: the mechanisms of consciousness. *Proceedings of the National Academy of Sciences*, 91(16), 7398-7403. https://doi.org/10.1073/pnas.91.16.7398

Rabinowitz, N., Perbet, F., Song, F., Zhang, C., Eslami, S. A., & Botvinick, M (2018, July). Machine theory of mind. *In International conference on machine learning* (pp. 4218-4227). PMLR. https://doi.org/10.48550/arXiv.1802.07740

Rosenthal, D. M. (2000). Consciousness, content, and metacognitive judgments. *Consciousness and cognition*, 9(2), 203-214. https://doi.org/10.1006/ccog.2000.0437

Rosenthal, D. (2005). *Consciousness and mind*. Clarendon Press, 227-251.

Rosenthal, D. M. (2008). Consciousness and its function. *Neuropsychologia*, 46(3), 829-840. https://doi.org/10.1016/j.neuropsychologia.2007.11.012

Sanhueza, M. I., & Fossa, P. (2022). Why Theory of Mind Is Not Enough to Understand Others. *Behavioral Sciences*, 13(1), 12. https://doi.org/10.3390/bs13010012

Satlof-Bedrick, E., & Johnson, C. N. (2015). Children's metacognition and mindful awareness of breathing and thinking. *Cognitive Development*, 36, 83-92. https://doi.org/10.1016/j.cogdev.2015.09.011

Schooler, J. W. (2002). Re-representing consciousness: Dissociations between experience and meta-consciousness. *Trends in cognitive sciences*, 6(8), 339-344.

Schraw, G., & Moshman, D. (1995). Metacognitive theories. *Educational psychology review*, 7(4), 351-371. http://www.springerlink.com/content/1040-726X

Sebastián, M. Á. (2016). Consciousness and theory of mind: a common theory? THEORIA. Revista de Teoría, Historia y Fundamentos de la Ciencia, 31(1), 73-89.

Shea, N., & Frith, C. D. (2019). The global workspace needs metacognition. *Trends in cognitive sciences*, 23(7), 560-571. https://doi.org/10.1016/j.tics.2019.04.007

Sideraki, A., & Drigas, A. (2021). Artificial Intelligence (AI) in Autism. *Technium Soc. Sci. J.*, 26, 262. http://dx.doi.org/10.33448/rsd-v11i16.38057

Sloman, A. (2020). Varieties of evolved forms of consciousness, including mathematical consciousness. *Entropy*, 22(6), 615. https://doi.org/10.3390/e22060615

Stathopoulou, A., Karabatzaki, Z., Kokkalia, G., Dimitriou, E., Loukeri, P. I., Economou, A., & Drigas, A. (2018). Mobile Assessment Procedures for Mental Health and Literacy Skills in Education. *International Journal of Interactive Mobile Technologies, 12*(3):21-37. https://doi.org/10.3991/ijim.v12i3.8038

Stathopoulou, A., Karabatzaki, Z., Tsiros, D., Katsantoni, S., & Drigas, A. (2019). Mobile Apps the Educational Solution for Autistic Students in Secondary Education. *International Journal of Interactive Mobile Technologies*, *13*(2), 89-101. https://www.learntechlib.org/p/207548

Stathopoulou A., Loukeris D., Karabatzaki Z., Politi E., Salapata Y., and Drigas, A. S., (2020) "Evaluation of Mobile Apps Effectiveness in Children with Autism Social Training via Digital Social Stories," Int. J. Interact. Mob. Technol. (iJIM); 14 (03). https://doi.org/10.3991/ijim.v14i03.10281

Stavridou Th., Driga, A.M., Drigas, A.S., (2021). Blood Markers in Detection of Autism. *International Journal of Recent Contributions from Engineering Science & IT (iJES)* 9(2):79-86. https://doi.org/10.3991/ijes.v9i2.21283

Swiatczak, B. (2011). Conscious representations: An intractable problem for the computational theory of mind. *Minds and Machines*, 21(1), 19-32. http://dx.doi.org/10.1007%2Fs11023-010-9214-y

Theodorou, P., & Drigas, A. S. (2017). ICTs and Music in Generic Learning Disabilities. *International Journal of Emerging Technologies in Learning*, 12(4). https://doi.org/10.3991/ijet.v12i04.6588

Tononi, G., Boly, M., Gosseries, O., & Laureys, S. (2016). The neurology of consciousness: an overview. *The Neurology of Consciousness*, 407-461. https://doi.org/10.1016/B978-0-12-800948-2.00025-X

Tordjman, S., Celume, M. P., Denis, L., Motillon, T., & Keromnes, G. (2019). Reframing schizophrenia and autism as bodily self-consciousness disorders leading to a deficit of theory of mind and empathy with social communication impairments. *Neuroscience & Biobehavioral Reviews*, 103, 401-413. https://doi.org/10.1016/j.neubiorev.2019.04.007

Török, E., & Kéri, S. (2022). The Relationship Among Mentalization, Mindfulness, Working Memory, and Schizotypal Personality Traits in the General Population. *Frontiers in Psychology*, 2272. https://doi.org/10.3389/fpsyg.2022.682889

Tourimpampa, A., Drigas, A., Economou, A., & Roussos, P. (2018). Perception and Text Comprehension. It'sa Matter of Perception!. *International Journal of Emerging Technologies in Learning (Online)*, *13*(7), 228. https://doi.org/10.3991/ijet.v13i07.7909

Trevarthen, C., & Delafield-Butt, J. (2017). Development of consciousness. *In Cambridge Encyclopedia of Child Development* (pp. 821-835). Cambridge University Press.

Zaroukian, E. (2022). Theory of Mind and Metareasoning for Artificial Intelligence: A Review. DEVCOM Army Research Laboratory, 1-15. https://apps.dtic.mil/sti/pdfs/AD1175466.pdf

Zavitsanou, A., & Drigas, A. (2021). Nutrition in mental and physical health. *Technium Soc. Sci. J.*, 23, 67. https://doi.org/10.47577/tssj.v23i1.4126

Zeman, A. (2005). What in the world is consciousness*? Progress in Brain Research*, 150, 1-10. https://doi.org/10.1016/S0079-6123(05)50001-3

Zeman, A. (2006). What do we mean by "conscious" and "aware"? *Neuropsychological rehabilitation*, 16(4), 356-376. https://doi.org/10.1080/09602010500484581

Zhao, J., Wu, M., Zhou, L., Wang, X., & Jia, J. (2022). Cognitive psychology-based artificial intelligence review. *Frontiers in Neuroscience*, 16. https://doi.org/10.3389/fnins.2022.1024316

Velmans, M. (2012). The evolution of consciousness. *Contemporary Social Science*, 7(2), 117–138. http://dx.doi.org/10.1080/21582041.2012.692099

Velmans, M. (2015). The evolution of consciousness. *In Biologising the Social Sciences* (pp. 37-58). Routledge.

Vlachou, J. A., & Drigas, A. S. (2017). Mobile Technology for Students & Adults with Autistic Spectrum Disorders (ASD). *International Journal of Interactive Mobile Technologies*, 11(1), 4-17. https://doi.org/10.3991/ijim.v11i1.5922

Vogeley, K., Bussfeld, P., Newen, A., Herrmann, S., Happé, F., Falkai, P., ... & Zilles, K. (2001). Mind Reading: Neural Mechanisms of Theory of Mind and Self-Perspective. *NeuroImage,* 14, 170-181. https://doi.org/10.1006/nimg.2001.0789

Vrettaros, J., Tagoulis, A., Giannopoulou, N., & Drigas, A. (2009). An empirical study on the use of Web 2.0 by Greek adult instructors in educational procedures. *World Summit on Knowledge System (WSKS)*, 49, 164-170. http://dx.doi.org/10.1007/978-3-642-04757-2_18

Whitebread, D., Almeqdad, Q., Bryce, D., Demetriou, D., Grau, V., & Sangster, C. (2010). Metacognition in young children: Current methodological and theoretical developments. *Trends and prospects in metacognition research*, 233-258.

Winfield, A. F. (2018). Experiments in artificial theory of mind: From safety to story-telling. *Frontiers in Robotics and AI*, 5, 75. https://doi.org/10.3389/frobt.2018.00075

Winkielman, P., & Schooler, J. W. (2012). Consciousness, metacognition, and the unconscious. *The Sage handbook of social cognition*, 54-74.