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Scoping review: Does a deficit of executive functions imply the developing of a Theory of Mind with alterations? Are learning disorders based on a deficient Theory of Mind?

Rubaltelli J.¹ , Andolfi S.² , Serafini E^{2*} , Cavallini F^{1,2} ¹ Department of Humanities, Social Sciences and Cultural Enterprises, University of Parma, Italy² Tice Live and Learn, Piacenza, Italy

ABSTRACT

This Scoping Review focuses on articles that investigate the following topics: Theory of Mind, Executive Functions and Learning Disorders. The objective was to see whether these three constructs were correlated in the literature. Two databases were used: Psycinfo and Pubmed. 7 articles met our eligibility criteria while all others were excluded, initially due to their titles, and later due to their abstracts. These studies revealed that children and teenagers with specific learning disorders might produce lower results when their executive functions are tested, such as planning, performing tasks, working memory, as well as processing speed. It was also observed that children and teenagers with specific learning disorders display difficulties related to emotion recognition. Further research may focus on the analysis of the relations between executive functions in subjects with specific learning disorders and the Theory of Mind.

Keywords: Theory of Mind, Executive Functions, Learning Disorders

* Corresponding author: Elisa Serafini, Centro Tice, Piacenza, Italy.

E-mail address: serafineli2@gmail.com

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Introduction

This study will focus on children with neurodevelopmental disorders, who – as highlighted by Hutchins et al. (2006) and Uekermann et al. (2010) – often display difficulties in their social and behavioral spheres, leading to various problems when socializing and building interpersonal relationships. Moreover, difficulties in social cognition are associated to less favorable prognoses in the presence of psychiatric disorders (Martins-Junior et al., 2011). Therefore, it seems crucial to investigate the functioning of the theory of the mind when connected to different neurodevelopmental disorders. This review will feature articles on the topic of specific learning disorder and, wherever possible, in relation to executive functions, to the Theory of Mind and to social abilities. This review focuses on school-aged children and teenagers; more specifically, the population of these studies is ranged between 6 and 18 years old.

The Theory of Mind has implications in the development of the social abilities of a child and it is for this reason that it has been studied in connection to mother-child attachment, thanks to studies by Meins (1997), Fonagy (1998) and McElwain (2019) as well as in relation to the resulting child's emotional development and the child's ability of self-regulation (Cavalli et al. 2007). The Theory of Mind is also connected to the metacognitive development of the child and is often investigated in relation to cognitive abilities during childhood (Cavalli et al. 2007). Moreover, Theory of Mind appears to be related to the development of mental state talk (Hughes and Dunn, 1998; De Rosnay and Hughes, 2006) of language (Astington et al, 1998; Miller, 2006; Jenkins e Astington, 1996) and to the development of the executive functions (Carlson et al., 2015; Carlson et al., 2004; Perner e Lang, 1999). Executive functions and language are cognitive aspects representing crucial and intercorrelated elements for the Theory of Mind. In studies by Hughes (1998), Pons et al. (2009), Withehouse e Hird (2004), high scores in false belief tests were found in the presence of a higher linguistic development. According to Tomasello (1999) and San Juan & Astington (2017), language is closely linked to Theory of Mind, where Theory of Mind is seen as a representation of false belief. As far as executive functions and their role in the development of Theory of Mind are concerned, it appears that the capability of passing the false belief tests is affected by the development of some elements of the executive functions, such as: inhibitory control, as argued by Carlson and Moses (2001), by Jaques and Zelazo (2005), as well as by Sabbagh et al. (2006); perspective taking (Bigelow & Dugas, 2008); and the cognitive flexibility to maintain a rule (Carlson & Moses, 2001; Guajardo, Parker, & Turley-Ames, 2009; Müller, Zelazo, & Imrisek, 2005).

Some studies that have analyzed the relation of Theory of Mind to autism spectrum disorder (Hutchins et al., 2016) observed the presence of deficits in the social cognitive sphere; other studies have analyzed Theory of Mind in relation to attention deficit hyperactivity disorder and noticed impairments in the social-cognitive sphere, such as in facial emotion recognition (Uekermann et al., 2010) and empathy (Demurie et al., 2011). These studies serve as a starting point for the present review, whose aim is to research the presence of articles about Theory of Mind, the development of executive functions and the development of social abilities in children or teenagers with a specific learning disorder, which seems to be a topic with few research about it.

Method

Scoping reviews map the existing literature about a specific research field with the aim of describing its nature and its width. The present review analyses the existing literature on the following topics: Theory of the Mind, executive functions, and specific learning disorders. Its aim is to observe the relation between executive functions and specific learning disorder and to find out whether the literature includes articles highlighting a connection between the Theory of Mind and specific learning disorders.

Two databases were used, namely PsychINFO and PubMed. The research was initially carried out on articles dated between 1991 and 2022, and successively narrowed down to articles dated between 2008 and 2021 for the latest and most up-to-date search. The articles that have been examined are either in English or Italian and were found using the following query: Theory of the Mind OR executive functions OR specific learning disorder. At this stage, articles found through previous searches in the given databases were also added.

To be included in this review, articles had to have a focus on the Theory of the Mind, on specific learning disorder and executive functions in a population of children and teenagers aged 6-18 years old. Studies that did not encompass these variables, or that associated these variables to other mental disorders such as bipolar disorder and schizophrenia were excluded from the review. A preliminary screening of the articles based on their titles and a second screening based on their abstracts were undertaken. We did an initial screening of the titles, discarding those that did not contain the key words of interest for this review (learning disabilities, executive functions, theory of mind).

Results

Study selection process

Figure 1 illustrates the queries used in the research and screening process conducted on the articles with the relative criteria for exclusion. Database queries registered 25,556 records after adding specific criteria for exclusion, such as: the age of the sample (6-12; 13-18) and the year of publication (between 2008 and 2022). An amount of 457 articles were found and selected for the review, and 4 articles that were identified during previous searches were then added, as well. After applying the eligibility criteria, 7 articles were selected for the scoping review.

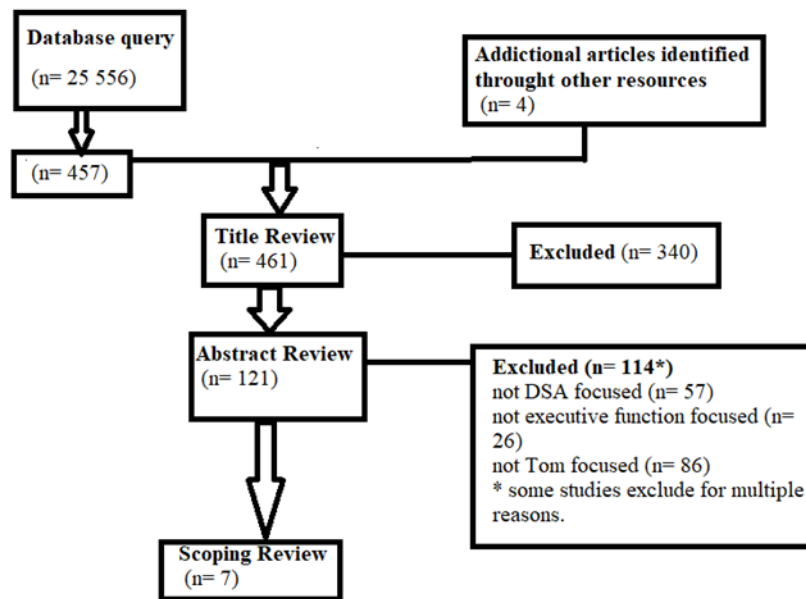


Fig.1 Flowchart illustrating the research and screening process for the selected articles.

Review of relevant articles

Table 1 illustrates the main features of the selected studies. 5 studies have been conducted in Italy, one in Turkey and one in China. Selected articles were published between 2008 and 2021. All articles feature a population of students attending their third grade of primary school or higher.

The research aims of these studies were different: for example, Schweiger (2010) wanted to measure executive functions, planning and inhibition skills, and to study how they develop in relation to the age of the child, and how a primary inhibitory control can already be present in children attending third grade, although the development of such control usually happens between grade 3 and 4 of primary school and between grade 2 and 3 of middle school. The 2010 study by Zocchi drew attention to the fact that age significantly affects variables, such as: the meta-comprehension of text materials, the development of mental state talk, the capacity to

understand others' mental states and language. Filippello et al. (2016) focuses on a population of children in grades 3 to 5 of primary school with and dysgraphia and dyslexia in comorbidity: the study highlighted how children with dysgraphia had poor performances in tests involving planning and metacognition, and in fact planning abilities seem interconnected with metacognitive ones. Through his 2020 observational cross-sectional study, Operto has found that children with specific learning disorders have obtained low scores in tests on executive functions and that they also obtained lower scores for working memory and processing speed. This article also addresses emotion recognition, for which patients with specific learning disorders have obtained scores under the norm, a data that shows an impairment in their ability of emotion recognition through facial expressions, which might be caused by the presence of a lower focused attention in these patients. A study by Conte conducted in 2020 focuses on children and teenagers with oppositional defiant disorder, specific learning disorder and attention-deficit hyperactivity disorder. The specific learning disorders experimental group showed more difficulty than other groups in tests about the understanding of rules and task implementation. In conclusion, this study highlighted the fact that specific learning disorders children have deficits in the understanding and processing of rules in memory, a problem that impinge on task executive control, and that they also have deficits in planning skills. Parents reported that these children have problems with self-regulation. Shen (2021) has conducted a study on the population of children with dyslexia compared with typically developing children, observing electroencephalograms to assess their attention. From the comparison of these two groups emerged that children with specific learning disorders had the longest response times. Children with dyslexia had to invest more cognitive resources when reading, leading to an overload of cognitive resources and a weakening of brain activation. Children with dyslexia also had lower scores in the assessment of accuracy of correct response trials. The Stroop effect on children with specific learning disorders appeared to be stronger. The study by Ayar (2021) is focused on children and teenagers with specific learning disorders and investigates family-related variables that might cause the presence of further difficulties in children suffering from specific learning disorders. For example, the variable "problems with peers" appeared to be slightly higher in children with specific learning disorders struggling at school, as well as it was found that children with dyscalculia presented higher rates of hyperactivity and attention-deficits.

One out of seven studies (Zocchi, 2010) investigates both specific learning disorder and the Theory of the Mind, by conducting an analysis on mental state talk, metacomprehension and the comprehension of emotions in children with specific learning disorder. Further studies, such as Schweiger's (2010) and Shen's (2021), assess the state of executive functions during

childhood; the former uses typically developing children as a sample, while the latter compares typically developing children with children with developmental dyslexia. Filippello (2016) compares children with dyslexia and dysgraphia with typically developing children, while the study by Conte (2020) not only compares children with specific learning disorders with typically developing children, but also compares them with children suffering from other neurodevelopmental disorders. In his study, Operto (2020) focuses on children with specific learning disorders and typically developing children to assess their executive functions, as it has been done in the two studies that were previously mentioned, but Operto also observes their facial emotion recognition abilities. The study by Ayar (2021) analyses further difficulties that might be encountered by children with specific learning disorders, considering several family-related variables.

Table 1. Eligibility criteria of the selected articles (n=7)

Year, 1st Author (Location)	Method, sample	Measurements	Results	Implications
2010, Schweiger (Milano)	125 students (from grade 3 of primary school to grade 3 of middle school) and 12 teachers. 3 tests were undertaken by children: Cattell Test, test on daily planning (TPQ Test), test for completion of sentences (CAF Test). 1 test was undertaken by teachers to assess children's performance: Questionnaire for Assessment of Executive Function (QuFE)	IQ score, executive functions, initiative, inhibition, planning skills.	Ability of task planning and organization increases as age grows, the highest increase is between grade 4 and 5 of primary school. Children in the 3 rd year of primary school already possess a primary form of inhibitory control, while a more specific impulse control connected to flexibility is to be found between grade 3 and 4 of primary school, with a following increase between grades 2 and 3 of middle school. Executive functions can be divided in three specific components: Impulse Control, Metacognitive Knowledge, and Flexibility. Structure made of 2 main indexes: Index of Metacognition, Index of Behavior Regulation.	This study pointed out the potential of new tools for assessment of executive functions during childhood. The employment of such tools would represent an opportunity both in the research and in the clinic field.

Year, 1st Author (Location)	Method, sample	Measurements	Results	Implications
Zocchi, 2010 (Pavia)	<p>42 students in grade 4 of primary school, 38 students in grade 5 of primary school. Students presented neither SLD nor other difficulties during comprehension tests. Strange Stories and tests for completion of stories are used to measure mental state talk. Children undertook a Test of Emotion Comprehension (TEC), a questionnaire for the metacomprehension of a text and the PMA test, a sub-test on vocabulary whose aim is to assess linguistic skills.</p>	<p>Mental state talks, Emotion Comprehension and Linguistic skills.</p>	<p>Age had a substantial impact on the metacomprehension of texts, the production of emotional state talk, the comprehension of mental states and on language. Results were not statistically relevant, but the scores for the comprehension of emotions were higher, the higher the age was.</p> <p>There is a statistically relevant link between language and Strange Stories, as well as between language and mental state talk. The vocabulary test is associated to the metacomprehension of texts. The questionnaire of metacomprehension of texts has a correlation to Strange Stories and to the production of mental state talks.</p>	<p>The link between ToM and Metacognition related to comprehension of cognitions is confirmed. Results do not allow us to decide upon the existence of a causal relation between them.</p>

Year, 1st Author (Location)	Method, sample	Measurements	Results	Implications
Filippello, 2016	<p>1st phase of the trial: 60 students in grade 3 of primary school, 30 children have been diagnosed with dysgraphia and dyslexia in comorbidity while 30 are typically developing children.</p> <p>Tests: WISC-III; tests for spontaneous writing drawn from a battery of assessment tools of writing and spelling skills for children in mandatory schooling: writing of narrative texts and descriptions, Tower of London exercise, assignment to assess metacognitive knowledge and planning skills over written texts.</p> <p>2nd phase of the trial: 30 children that have been diagnosed with dysorthographia before. Children have been divided in two randomized groups and have undertaken story-telling assignments. The study involved 10 afternoon meetings of 2 hours each.</p>	<p>1st phase of the trial: IQ, storytelling, description, planning skills, introduction to the various activities to carry out during the writing assignment.</p> <p>2nd phase of the trial: the story-telling assignment has been analyzed to assess the ability of generating, selecting, and organizing ideas in relation to the goal that was set, as well as translating, reviewing and editing skills.</p>	<p>1st phase of the trial: Results show that children with dysorthographia have deficient performance in planning and metacognitive tests.</p> <p>2nd phase of the trial: There is a significant difference in the performance of the group under treatment related to the number of words and sentences between the phase that preceded treatment and the one that followed, but there is no difference in the number of mistakes made. In the group that was not treated, there was no difference between the phase preceding the test and the phase that followed. In the post-treatment phase, differences emerged between the groups in terms of sentences, adjectives and subordinate phrases, but not in terms of words. This research drew attention to deficits on the planning and writing level in children with dysorthographia. Planning skills seem to be interconnected to metacognitive skills. At the end of the treatment, children were able to carry out all the steps to write a narrative text. Results differed between children who had and those who had not undergone treatment in the second phase of the research.</p>	<p>An early investigation of metacognitive strategy is crucial, as it could mitigate or solve negative effects of dysorthographia. Meta-cognitive skills and strategic skills related to learning processes seem to be able to become stable cognitive assets once learned. The small size of the sample may be a limitation to the generalizability of the research, in addition to the fact that the sample was focused on the school setting. Despite this limitation, the present study could have effects in rehabilitation setting.</p>

Year, 1st Author (Location)	Method, sample	Measurements	Results	Implications
Operto, 2020 (Salerno)	<p>Cross-sectional study. Sample: experimental group of 63 children and teenagers between 8 and 16 years old. From December 2017 to December 2019. Control group of typically developing children: 32 students. Tests: WISC-IV for IQ assessment, Nepsy- II for facial recognition, EpiTrack Junior for executive functions.</p>	<p>Facial emotion recognition, executive functions, individual intellectual functioning.</p>	<p>Children with SLD have obtained scores under the norm in the tests for executive functions, while average scores related to executive functions in the control group was within the normality range. All participants involved in the experiment had an IQ score in the norm. Sub-indexes of WISC-IV significantly differed between the two groups. Verbal Comprehension Index and Perceptual Reasoning Index were lower than those of the control group. Working Memory Index and Processing Speed Index were lower in children with SLD. In the sub-test NEPSY-II ER (Emotional Recognition), patients with SLD obtained an overall score under the norm. Through an analysis of the mistakes made when asked to recognize individual emotions, the SLD group was significantly less capable than the control group to identify happiness, sadness, anger, fear, disgust and other neutral expressions.</p>	<p>The ability to recognize emotions through facial expressions appears to be compromised in children and teenagers with SLD when compared to typically developing children. Only a limited number of studies has been conducted on pediatric population affected by SLD. Executive functions are compromised in children and teenagers with SLD, and working memory indexes and speed processing indexes were low. There might be a correlation between executive functions and facial emotion recognition, and the reason behind it might be an impairment of executive functions, which could lead to a lower focused attention. A hypothesis about SLD patients is that they might have a mechanism that affects the development of different neural circuits, which are essential for both executive functions and for facial emotion recognition.</p>

Year, 1st Author (Location)	Method, sample	Measurements	Results	Implications
Conte, 2020 (Milano)	<p>The sample is made up of 187 children/teenagers: 10 are affected by ODD, ADHD and SLD and 77 are typically developing children.</p> <p>Age range of patients is between 8 and 13. All patients have been tested with the WISC-IV sub-test related to Vocabulary and Matrix Reasoning. The sample of children with ADHD and ODD was selected by means of a questionnaire about strengths and weaknesses (SDQ); the sample of children with SLD was selected through tests drawn from 'MT-3 clinica' test collection and through tests number 2 and 3 of the battery DDE-2 for assessment of dyslexia and developmental dysorthographia. The Questionnaire for Assessment of Executive Function (QUFE) for teachers and parents was used to assess executive functions.</p> <p>BRUPAGE neuropsychological tests for children and teenagers, PTQ test of daily planning, Gambling Task and the test of the red caterpillar.</p>	<p>Some variables of executive functions were assessed, such as understanding of tasks and rules, task implementation, coherence between planning and implementation, memory of the quality of performance, memory, planning; reading and writing skills were also assessed.</p>	<p>Children with SLD have poorer performances than the control group in tests about daily planning, especially in relation to learning and temporal evaluation. Thanks to BRUPAGE test, it was observed that ADHD affects planning, while SLD affects learning and ODD affects storytelling and memory. It was observed that there is an interaction of ADHD + SLD on memory and these subjects had better performances in comorbidity compared with children with a single diagnosis. As far as PTQ test is concerned, it was observed that the SLD has a main effect on the variables of errands and traveling.</p> <p>From the questionnaire for teachers and parents (QUFE), it emerged that children belonging to a specific clinic group had significant performances in all the variables of the test, except for flexibility.</p> <p>In the parents' version of the test, it is possible to observe a main effect of ADHD subjects on the scales of Self-Regulation and Initiate, as well as SLD subjects had a main effect on the scales of Self-Regulation and Initiate, while ODD subject had a main effect on the scale of Self-Control. An interaction effect related to the variable Self-Regulation in children with ADHD + SLD in comorbidity has an intermediate score compared with those with a one diagnosis, while for the variable Organization of Materials, subjects with a single diagnosis have better performances. In the version made for teachers, the main effect of SLD and interactions were not relevant.</p>	<p>The SLD experimental group showed more difficulty than other groups in tests about understanding of the rules and task implementation. Children with SLD obtained higher scores when asked to illustrate the steps they had carried out compared with group with other diagnosis. In tests related to Planning, they obtained lower scores compared with groups with other diagnosis. Results show that children with SLD have deficits in learning and processing of rules in memory that impinge on task executive control. They also show deficits in their planning abilities. Children with SLD are not able to manipulate information they have in memory, leading to mistakes in the implementation of the task. Moreover, parents have reported that children with SLD have bigger difficulties in self-regulation and a lack of initiative. Limitation: setting of the experiment, big sample size.</p>

Year, 1st Author (Location)	Method, sample	Measurements	Results	Implications
Shen, 2021 (China)	<p>34 participants attending from grade 3 to 5 in primary school: 17 children with developing dyslexia (DD) and 17 typically developing children.</p> <p>Double-blind controlled trial. All the children completed the Raven's Standard Progressive Matrices Test and the e Stroop color-word test for central executive function, especially for inhibition. Electroencephalograms were used for recording.</p>	<p>Measurements: reaction time, accuracy, latency, and amplitude.</p>	<p>Significant effects: longer reaction times for the DD group were found, as well as longer reaction times for the incongruent trials compared with the congruent trials for both groups.</p> <p>The control group was found to be more accurate than the DD group. The results of event-related potentials (ERP) turned out to be an interesting data, as there are differences between the DD and the non-dyslexic group as far as the amplitude of ERP of the congruent and incongruent trials. In the control group, the amplitude was larger for incongruent trials than for congruent trials. In the DD group, the amplitude was larger for congruent trials than for incongruent trials. The brain activation of non-dyslexic children was larger than DD children. DD children need to invest more cognitive resources in reading, so these resources may be overloaded resulting in a weakened brain activation. The component of task-related target discrimination (selective attention) in the DD group was larger for congruent and incongruent trials, while it was larger in the control group both for congruent and incongruent trials. This indicates differences in the allocation of attentional resources between the two groups. Children with dyslexia may be distracted by other stimuli while reading, while non-dyslexic children do not need to invest too many cognitive resources while reading. The accuracy of the responses of the DD group was lower than the non-dyslexic group.</p> <p>Stroop interference occurs not only in the selection response stage, but also in the stimulus-encoding stage. The Stroop effect of DD children appears to be stronger.</p>	<p>Limitations: sample size, the inhibitory ability of DD children was not investigated in a longitudinal way, Stroop test should be combined with other tests for further examination.</p>

Year, 1st Author (Location)	Method, sample	Measurements	Results	Implications
<p>Ayar, 2021 (Turkey)</p>	<p>Sample: 278 children with SLD with age 7 to 15. Those under formal education at least for 1.5 years, and those who were previously diagnosed with SLD based on DSM-5 criteria. These factors were taken into consideration: perinatal, natal, and postnatal situation, sociodemographic information. Parent’s age at the birth of the child, number of children in the family, presence of another child with developmental problems. Patients with IQ scores of 70 or less on the WISC-R were excluded from the study. SDQ: questionnaire including 25 questions.</p>	<p>Conduct Problems, Emotional Symptoms Hyperactivity and Inattention, Peer Problems, and Prosocial Behaviors. The sum of 2 of these indexes describes the internalizing problems (Conduct Problems and Emotional Symptoms), and the sum of the other 2 describes the externalizing problems (Hyperactivity and Inattention).</p>	<p>When siblings were examined, 56 families had another child with developmental problems, and there is one child diagnosed with attention deficit hyperactivity disorder (ADHD) in five families.</p> <p>The WISC-R scores determined a total IQ of 82. Dyslexia was observed in 69.1%, dysgraphia in 75.9%, and dyscalculia in 91.4% of the patients. When SDQ scores are compared according to family characteristics: family with lower income had higher scores for Conduct Problems and Emotional Symptoms.</p> <p>Children diagnosed under the age of 8 years had higher percentage for Hyperactivity and Inattention, while children delivered by cesarean section had higher percentages for all the scales. Children with SLD and an history of hospitalization had higher scores in Hyperactivity and Inattention and externalizing problems. Peer Problems seem to have slightly increased in children with SLD with no school success. Children with dyscalculia had higher rates of Hyperactivity and Inattention and externalizing problems than their counterparts. Children with SLD with poor family income and those with antenatal smoking exposure had higher scores for Conduct Problems. Higher scores for Hyperactivity and Inattention were detected in children: with antenatal smoking exposure, with a younger age of diagnosis for SLD, with dyscalculia, and hospitalization history.</p>	<p>This study was compared to a study conducted in Thailand with 463 typically developing preschool children aged 4–6 years. The SDQ scores that were calculated were higher in children with SLD compared to typically developing children. Limitations of the study: it is based on a questionnaire and depends on the answers provided by the mothers. In fact, the psychological profile of the mothers may affect their children’s answers. Another limitation is the exclusion of immigrant families from the study because of the language barrier. Moreover, SDQ scores were not evaluated according to the severity of the SLD, which is a limitation.</p>

Discussion

The aim of this scoping review was to collect all literature related to Theory of the Mind associated with executive functions in children and teenagers with Specific Learning Disorder. This Scoping Review included 7 studies, which have been conducted between 2010 and 2021, 5 of which are Italian, one is Turkish, and one is Chinese. One of them investigates exclusively executive functions in typically developing children, another one assesses the metacomprehension of texts associated with the Theory of the Mind in typically developing patients during childhood, 4 of them assess executive functions in children with specific learning disorders compared to a group of typically developing children and 1 of them assesses executive functions in an specific learning disorders group compared to children with oppositional defiant disorder and attention-deficit/hyperactivity disorder. Lastly, there is a study that focuses solely on children and teenagers with specific learning disorders and on further problems that can arise related to their family background and characteristics. Reviews, systematic reviews and meta-analysis were excluded for the scope of this review since they did not comply with the research aims. We included clinical trials and randomized clinical trials in the review. Although the literature does not highlight a causal relationship between these two concepts, we detected relevant effects on the different variables. More specifically, one study (Zocchi, 2010) confirmed the connection between Theory of Mind and metacognition related to the comprehension of cognitions. Another study (Schweiger, 2010) observed that inhibitory control can already be present in children attending third grade, while a more specific development of inhibitory control, more specifically connected to flexibility, is to be found in children attending grade 3 to 4 of primary school while a second phase of such development is to be found between grade 2 and 3 of middle school. As far as children and teenagers with specific learning disorders are concerned, four articles (Filippello, 2016; Operto, 2020; Conte, 2020; Shen, 2021) found that their results in tests for executive functions, such as planning, compositional skills, the understanding of the rules and the ability to implement a task, working memory and processing speed, were lower than those of the control group. In one of the studies (Ayar, 2021), the focus was to investigate which family characteristics could cause further problems for children and teenagers with specific learning disorders. Shen's study (2021) has assessed attention by means of the Stroop test and the results show that children with dyslexia may be distracted by other stimuli while reading, while non-dyslexic children do not need to invest too many cognitive resources while reading. The study by Operto (2020) has not only assessed executive functions in children and teenagers with specific learning disorder but has also observed facial emotion recognition by means of Nepsy- II test. The specific learning

disorders group have obtained scores under the norm for the number of mistakes made in tasks for facial emotion recognition. The group had difficulty to identify happiness, sadness, anger, fear, disgust and other neutral expressions. Facial emotion recognition and executive functions may be intercorrelated, and the hypothesis made in this study is that impairments of executive functions may cause a lower focused attention and that patients with specific learning disorders seem to have a mechanism which affects the development of different neural circuits that are essential for both executive functions and for facial emotion recognition.

From a clinical practice point of view, the results of this review can be seen as a starting point for the design and implementation of interventions to enhance executive functions and theory of mind in children with specific learning disabilities or neurodevelopmental disorders in general.

Conclusions

This Scoping Review has brought to light the gaps in the literature that was analyzed, as it was not possible to find articles investigating the relationship between all the three concepts under research: Theory of the Mind, executive functions and specific learning disorder. The studies that were analyzed differed significantly both in terms of their research aims and in terms of methodology. Only 4 studies among the selected ones have analyzed executive functions in specific learning disorders and one of them has also taken in consideration the relationship between executive functions and emotion recognition. Further research may focus on the analysis of the relations between executive functions in subjects with specific learning disorders and the Theory of Mind.

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