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Research Article

PSYCHOMOTOR DEVELOPMENT DISORDERS IN THE EARLY DIAGNOSIS AND INTERVENTION IN SPECIFIC LEARNING DISORDER. A CASE STUDY

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ABSTRACT

The present study focuses on psychomotor development disorders of a 5.9-year-old child early diagnosed with Specific Learning Disorder. Data analysis indicated the occurrence of psychomotor disorders in coexistence with other cognitive and language difficulties of case A. Regarding the psychomotor development, main difficulties were recorded in the fields of body shape, spatiotemporal orientation, left-right discrimination, and visual-motor coordination. The ABA single-subject research design was applied. In the baseline phase (A), difficulties were revealed in specific psychomotor skills (dependent variable), which were treated assigned to a well-adjusted 4-month

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intervention program (phase B), and successfully decreased. This variation led to the withdrawal of the intervention's implementation (phase A), while in the final assessment after 4 months, the case recorded high performance, indicating steadily minimized difficulties, and thus emphasizing the effect of the psychomotor skills. A thorough interpretation of the results sheds light on the significant role of psychomotor development both in the early occurrence and in the intervention of SLD. Overall, our findings suggest that further and more targeted research is needed to investigate the complex and strong interactions that arise early between the components of SLD structure, such as neurobiological, cognitive, linguistic, and psychomotor.

KEYWORDS

Specific Learning Disorder; multifactor approach; early diagnosis; early intervention; psychomotor disorders; single-subject research design.

INTRODUCTION

The term 'Specific Developmental Learning Difficulties' describes a wide range of weaknesses in the procedure of learning, composing the clinical profile of Specific Learning Disorder (SLD) (APA, 2013). They vary among individuals and may affect different skills, such as reading, writing, and/or math.

Early diagnosis and intervention in SLD are considered essential and crucial (Pennington & Lefty, 2001). It is pointed out that if SLD children attend appropriate retraining programs since kindergarten or 1st grade, they manifest better progress as intervention lasts less time.

At the preschool age, SLD is characterized (Carroll et al., 2016) by dysfunctions or slow rate or difficulties in obtaining one or more of the aspects of development, such as: language, cognitive, psychomotor, and social development, as well as phonological awareness.

Regarding the psychomotor system (laterality, fine and gross motor skills, spatiotemporal orientation), several studies (Teixeira et al., 2015) agree about its effectiveness on the development of writing and reading skills. Such aspects totally strengthen those research findings (Denisa et al., 2021; Zakopoulou et al., 2021) that not only consider the psychomotor development as a key and effective mental component during preschool but mostly, indicate strong interactions between impairments in psychomotor skills and the difficulties in learning, which could potentially predict the early occurrence of SLD.

Specifically, researches described difficulties focusing on the construction of body shape and dominant laterality (Helland & Asbjørnsen, 2001), the discrimination and perception of right-left terms, the acquisition of fine motor skills (specialized movements of hand and fingers via drawing- sketching, pencil manipulation, usage of tools as scissors) bilateral coordination, the acquisition of spatial-temporal orientation and visual-motor coordination, the acquisition of graphomotor behavior, underlying difficulties on motor coordination and balance (Marr & Cermak, 2003). The child commonly copes with difficulties regarding discrimination terms (concept) 'up - down', 'in front of - behind'. Equivalent difficulties are displayed at the mathematic sequence of numbers and identification of their symbols and 'random' sequences such as days of the week, months, alphabet,

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multiplication tables (timetables) (Desoete, & Baten, 2017).

Moreover, a great part of research (Łockiewicz & Matuszkiewicz, 2016; Mati-Zissi et al., 1998) focuses on the value of drawing (sketching) and cognitive strategies used by SLD children while drawing. The final drawing depends on structural difficulties that the child faces, such as visuospatial perception problems regarding coding and decoding of information, organization, planning and sequence of drawing (sketching) (Zakopoulou et al., 2011).

In the present study all skills, such as body shape, graphomotor ability, laterality, spatio-temporal orientation, and prewriting skills are treated as core components of psychomotor development. In essence, they reflect the cognitive process of their interaction with the human mind and body, which combine for the acquisition of gross and fine motor skills, and with visual-motor coordination to contribute to the acquisition of the visuospatial perception, which is considered a core function of obtaining reading and writing skills (Carroll et al., 2016).

Based on the above theoretical aspects, the aim of the present study is to investigate the role of psychomotor development difficulties in the early diagnosis and intervention of SLD via a preschooler's case study. It should be mentioned that in the current study we paid attention only to the diagnosis and intervention on the case's psychomotor development disorders.

METHODOLOGY

Case A. Study

Given the approval of his parents, case A. volunteered to participate in the implementation of the research entitled "Formulating profiles of children with early signs of specific learning difficulties to develop early types of appropriately adjusted intervention", which was conducted by the Laboratory of New Approaches in Communication Disorders of the Department of Speech Therapy, University of Ioannina, in collaboration with the Medical-Pedagogical Centre of the Child Psychiatric Clinic of the University Hospital of Ioannina. The whole survey was carried out during the period 10/05/2016 to 10/06/2017 in accordance with ethics, as adopted by the General Assembly of the World Medical Association (2013), while the protocol was approved by the Scientific Committee of the University Hospital of Ioannina (code id: 1-15/4/2016).

In this context, a baseline evaluation was carried out showing difficulties in perceiving, coding, and processing the features of linguistic information and sequential symbols (visual and auditory), as well as difficulties in psychomotor development, such as: difficulties in spatio-temporal perception, graphomotor skills and graphomotor performance. This poor performance was indicative of a pattern of slowed acquisition in the areas of psychomotor, cognitive and language development of the child, crucial for the later acquisition of the mechanisms of reading and writing. Therefore, it was deemed necessary to involve this case in an appropriately tailored individualized intervention program aimed at strengthening these domains.

Four months from the onset of the implemented intervention program an inter evaluation was carried out, followed by a final evaluation 4 months after the completion of the intervention.

MATERIALS

To investigate possible early signs of specific learning difficulties, a battery of assessments was carried out at the baseline research phase.

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Specifically, the case A. parents were asked to complete: (a) a parent's developmental and family history and (b) the following questionnaires: (i) the Symptom Checklist-90-R (SCL-90-R) scale for the investigation of psychological, behavioral and physical symptoms of parents (Donias et al., 1991), (ii) the Parental Stress Index-Short Form (PSI-SF) for the assessment of possible parental distress, difficult behaviors of the child and possible dysfunctional interaction with the child (Haskett et al., 2006), and (iii) the Child Behavior Checklist (CBCL), assessing six areas related to: anxiety/depression, social withdrawal, sleep disorders, physical problems, aggressive behavior and destructive behavior (Achenbach & Ruffle, 2000).

Moreover, three cognitive diagnostic tools were administered to the child:

(a) Early Dyslexia Identification Test (EDIT), (Zakopoulou, 2003): a 20-minute individually administered screening tool (mean degree of reliability 0.98) of the early identification of signs of developmental dyslexia in kindergartners (5.4 to 6 years old). Targeted to identify the early developmental dyslexia's profile, three sectors were examined through the following 7 tasks, as follows: (a) Visual-spatial Abilities (Sketching, Copying Shapes, Visual Discrimination, Laterality/Left-right discrimination), (b) Grapho-phonological Awareness (Phonemes Discrimination; Name Writing), and (c) Working Memory (Phonemes Discrimination, Name Writing, Copying shapes, Visual-verbal correspondence).

(b) ATHINA Test (Paraskevopoulos et al., 1999): a well-standardized in Greek test of learning disorders (mean degree of reliability 0.85). Targeted to detect difficulties in cognitive, perceptual, psycholinguistic, and motor processes, four sectors were examined through the following 14 tasks: (a) Verbal Intelligence (Verbal Correspondence, Vocabulary, Copying Shapes), (b) Short-term Sequence Memory (Numbers Memory, Pictures Memory, Shapes Memory), (c) Integration of Incomplete Performances (Sentences completion, Words completion), (d) Grapho-phonological Awareness (Phonemes Discrimination, Phonemes Composition, Grapheme Discrimination), and (e) Neuro-psychological Maturity (Laterality, Left-right Discrimination, Visual-motor Coordination).

(c) The Greek edition of the Wechsler Preschool and Primary Scale of Intelligence (WPPSI-IIIGR) (Sideridis & Antoniou, 2015), (only the core subtests for children ages 4.0-7.3 years were examined). Four scales through 8 subtests were tested, representing the Verbal IQ (VIQ) (Information, Vocabulary, and Word Reasoning), the Performance IQ (PIQ) (Block Design, Matrix Reasoning, and Picture Concepts), the Processing Speed Quotient (PSQ) (Coding), and the Full-Scale IQ (FSIQ) (Information, Vocabulary, Word Reasoning, Block Design, Matrix Reasoning, Picture Concepts, and Coding).

(d) The Greek version of the Child Behavior Checklist forms for ages 1½ to 5 (CBCL 1½–5) included in the Achenbach System of Empirically Based Assessment (ASEBA) (Roussou, 2009). ASEBA is a multi-level system assessing behavioral and/or emotional problems, as well as competencies. The CBCL (1½–5) form provides scores creating profiles classified in normal, borderline, and clinical ranges for Total Problems, Internalizing, Externalizing, and 7 syndromes: Emotionally

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Reactive, Anxious, Depressed, Aggressive Behavior, Attention Problems, Somatic Complaints, and Withdrawn.

(e) ProAnaGraPho (Zakopoulou & Tsarouha, 2009): a method targeted to support children between 5-7 years old with early occurrence of neurodevelopmental disorders, such as SLD. It includes 79 exercises assessing the acquisition of three main sectors through the following 11 sub-sectors, such as: (A) Visuospatial Abilities (A1. Body Shape, A2. Spatial Orientation, A3. Temporal Sequences, A4. Right-left Discrimination, A5. Ordering, and A6. Visual-motor coordination); (B) Working Memory (B1. Visual Working Memory, B2. Audio Working Memory, and B3. Sequence Working Memory); (C) Grapho-phonological Awareness (C1. Phonological Awareness and C2. Phoneme-grapheme Correspondence).

It should be mentioned that, to assess possible disorders related to the psychomotor development of the case, we considered only the recordings in five tasks of the EDIT test (Sketching, Copying Shapes, Visual Discrimination, Left-right discrimination, Name Writing) and in three tasks of the ATHINA test (Copying Shapes, Left-right Discrimination, Visual-motor Coordination).

Based on the difficulties revealed in the domain of the psychomotor development, a well-adjusted intervention program was designed, while appropriate stuff (set of suitable implemented tasks) of the ProAnaGraPho intervention method was selected, respectively (Fig. 1).

Tasks of psychomotor assessment of the EDIT & ATHINA tests	**Respective intervention exercises of ProAnaGraPho method**
Psychomotor Development Sectors	**Exercises**
A1: Construction of Body Shape S = Sketching	1. Knowing my body 2. Guiding the wand to find his way 3. My body left & right 4. Where is everything? 5. Playing & learning my body in the space 6. Completing the face (a) & the body (b) 7. Joining the parts 8. Finding the right place
A2: Spatio-temporal Orientation CSh= Copying Shapes GD= Grapheme D= Discrimination NW= Name Writing	1. The body silhouette 2. Where am I every time? 3. Around the well… but more specifically? 4. The geometric shapes 5. Playing with colors 6. Where is the little mouse?

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	7. Reading the pictures
A3: Temporal Sequences	1. Describing my day 2. Putting the pictures in the right order: morning, noon, afternoon, or evening 3. The seasons 4. Learning the days of the week and the seasons 5. Reading the days of the week and the seasons 6. Listening and understanding a story 7. The calendar with days and months
A4: Left/Right Discrimination	1. Playing with multicolor jewelry 2. Left or right positions? 3. Painting partial elements in each side 4. Which is on the right and which on the left? 5. Do I go right or left from the smallest to the biggest? 6. The boat and the arrow: where is each one looking at'? 7. What do I do right and what do I do left?
A5: Sorting Visual-motor coordination: Copying Shapes; Grapheme Discrimination; Name Writing; visual-verbal correspondence	1. Sorting the shapes from the big to the small 2. Making a story from the beginning 3. Putting the pictures in order 4. Following the order to draw the circles 5. Joining the birds with the right number and color 6. Completing the boxes 7. Filling in the numbers in the windows
A6: Visual-motor Coordination	1. Complementing the brooms 2. Leading the mouse to his food 3. I lost someone on the road 4. I change my hand as soon as I see a tree 5. Finding the exit 6. Strange routes

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Fig. 1. Assessment tasks and intervention exercises in the field of psychomotor development.

The whole psychomotor intervention program was totally implemented in 43 sessions, which took place over a 4-month period on a weekly basis (3 sessions per week), each session lasting 45 minutes (Fig. 2).

Sectors	A1	A2	A3	A4	A5	A6	Total
N of sessions	8	7	7	8	7	6	43

Fig. 2. Number of Sessions (S) per sector of the ProAnaGraPho method.

STATISTICAL ANALYSIS

Aiming to investigate the effects of the intervention program on the case's psychomotor difficulties, we used the ABA single-subject research design (Scruggs & Mastropieri, 2001).

During the Baseline phase (A) the case was evaluated in specific psychomotor tasks, which indicated the level of his psychomotor difficulties (the dependent variable). Following the baseline phase, a well-adjusted 4-month intervention program was assigned to the case (phase B), during which his difficulties were seen to decrease. This variation led to the withdrawal of the intervention's implementation (phase A). During this period the case's difficulties were steadily minimized, while he recorded higher performance in the final evaluation, thus indicating the effect of the psychomotor difficulties in the early onset of SLD.

RESULTS

In the Baseline phase (A), the following results were obtained regarding the overall profile of case A.:

1. According to the Developmental and Family history, typical motor and language development with signs of emotional immaturity were recorded.
2. According to the Achenbach Questionnaire for Parents, the child's behavior was classified within the standard range with no records of syndromes or internalizing/externalizing problems.
3. According to the PSI and SCL-90 Scales increased rates (high levels) of stress control were recorded by the mother.
4. According to the results of the WPPSI-III TEST, normal intelligence emerged.
5. According to the EDIT results, a particularly low and insufficient performance was recorded on the tasks of Sketching, Copying Shapes, Visual Discrimination, Left-right Discrimination, Phonemes Discrimination, and Name Writing, indicating early signs of SLD.
6. According to the ATHINA results, insufficient performance was recorded on the areas of copying, composition, and memory of shapes (visual), and discrimination of graphemes, sounds and vocabulary, reinforcing the early profile of SLD.

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In detail, the results per measurement were the following (Fig. 3):

Developmental and family history Crawled: 7 months Walked: 11 months Babbling: 3 months Word production: 10 months Enuresis when tired or stressed Caesarean section due to placental abruption Divorced parents Domestic violent incidents Nervousness – Possessiveness – Jealousy	Achenbach CBCL Normal Range
Test EDIT (Psychomotor development tasks): B2. Sketching: Particularly low performance B6. Name Writing: Particularly low performance B3. Copying Shapes: Particularly low performance B4. Visual Recognition: Unsuccessful performance B5. Left/Right discrimination: Unsuccessful performance B8. Visual-verbal Correspondence: Unsuccessful performance	Test ATHINA: Copying Shapes: Insufficient performance Grapheme Discrimination: Insufficient performance Phonemes Discrimination: Insufficient performance Visual-motor Coordination: Incomplete Laterality: right-hand side Foot / eye / ear – left-hand side *Remarks:* Visual type problems and semantic coding problems in tasks
Test WPPSI-III: VIQ: 80 PIQ: 91 PSQ: 74 FSIQ: 87 *Remarks:* Normal IQ without significant deviation of verbal and Performance IQ	

Fig. 3. Baseline evaluation results per measurement.

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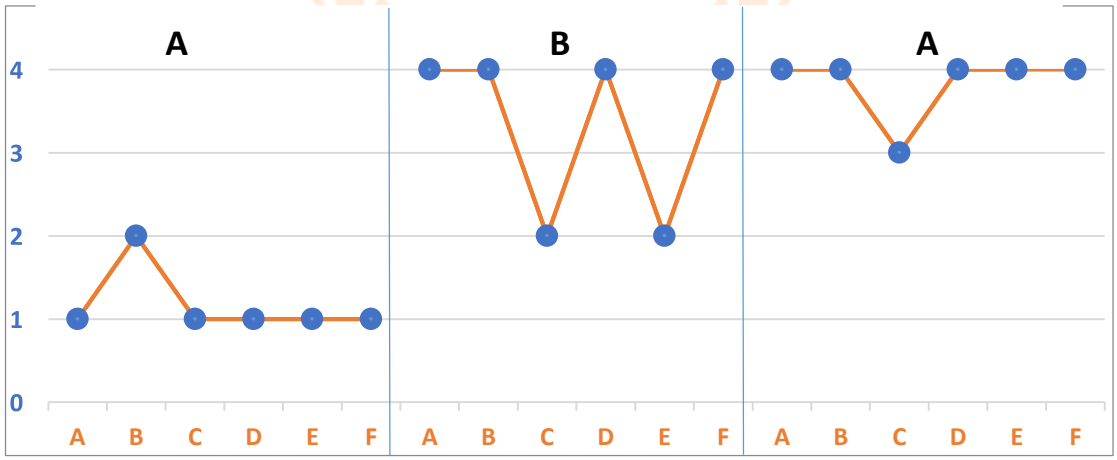
Regarding the domain of the psychomotor development, the recordings on the tasks in the Baseline phase, were as follows:

(a) Body Shape: Sketching= particularly low performance
(b) Spatio-temporal Orientation: Copying Shapes = particularly low performance; Grapheme Discrimination = unsuccessful performance; Name Writing = particularly low performance
(c) Left/Right Discrimination: unsuccessful performance
(d) Visual-motor Coordination: Copying Shapes = particularly low (EDIT) & insufficient performance (ATHINA); Grapheme Discrimination = unsuccessful performance; Name Writing = particularly low performance; Visual-verbal Correspondence = unsuccessful performance

Interestingly, 4 months upon the completion of the intervention, the case's performance improved in the inter-evaluation phase (B), as follows:

(a) Body Shape: Sketching = successful performance
(b) Spatio-temporal Orientation: Copying Shapes = successful performance; Grapheme Discrimination = successful performance; Name Writing = unsuccessful performance
(c) Left/Right Discrimination: unsuccessful performance
(d) Visual-motor Coordination: Copying Shapes = successful performance; Grapheme Discrimination = successful performance; Name Writing = unsuccessful performance; Visual-verbal Correspondence = successful performance.

Moreover, in the final evaluation four months after the inter-evaluation phase, the case recorded successful performance in four out of five tasks and marginally successful in only one task. Thus, it became obvious that the dependent variables reached a successfully steady state (Fig. 4).



DISCUSSION

Although it is commonly accepted that motor difficulties often coexist with dyslexia (Scarborough, 1990), more research is needed to investigate the possible connections between delayed achievement of psychomotor development and later reading and writing skills in children at risk of SLD. In an attempt to add to this research perspective, in the present study we examined whether possible difficulties in the field

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of psychomotor development in addition to the difficulties in cognitive and language skills could be considered as a core component of an SLD profile.

Interestingly, the results of the current case indicated both the occurrence of psychomotor disorders as well as their coexistence with other cognitive and language difficulties of the case A.

Specifically, the data analysis led to the following findings:

I. Main difficulties were recorded regarding the fields of body shape, spatiotemporal orientation, left/right discrimination, and visual-motor coordination that well indicate the child's delay to the acquisition of psychomotor and graphomotor development, which, in turn, are considered crucial for the acquisition of the writing mechanism. In particular, the emerged difficulties describe the difficulties of the case in acquiring the skills of writing, copying shapes, spatial processing and drawing skills, indicating the presence of difficulties in graphomotor skills (graphomotoricity). It is important to note that assessing a limited range of functional skills is likely to underestimate the extent of a child's problems. For this reason, the significance of the difficulties in this area have been considered as a whole, thus clearly indicating that difficulties in the field of psychomotor development can be detected and faced at an early developmental stage, before entering school.

II. Overall, the case presented difficulties in moving, symmetry and maintaining the spatial boundaries, as well as additions and replacements while writing his name. According to Davis & Broitman (2011), similar difficulties are attributed to difficulties in understanding spatial concepts and correlations. In addition, low performances in drawing, name writing, and sound discrimination are related to the presence of symptoms of SLD (Zakopoulou, 2003). Considering the difficulties in graphomotor behavior associated with the difficulties in grapho-phonologic awareness (ATHINA Test), vocabulary, information (WPPSI-III) and coding (WPPSI-III), it could be supported that the presence of similar difficulties in preschool age seem to be considerable for predicting impairments in acquiring reading and writing skills at the school age.

III. In detail, our findings underline the significance of specific sectors of the psychomotor development as early key components of the SLD structure, as follows:

(i) Body shape construction: Psychomotor therapists working with individuals with neurodevelopmental disorders, usually evaluate and treat psychomotor developmental disorders, and report that body shape is considered as one of the basic elements for constructing individual's personality as he moves in a three-dimensional environment with his body being the focus of reference, having already acquired the sense of his body (Nikiforou-Tsitsika, 2005). They base their intervention on movement, action, verbal and non-verbal communication, emotions, and images, including body experience, space, and time.

(ii) Space Orientation: The development of the concept of space orientation requires body's position awareness, that is, the position and orientation in relation to persons and things, the awareness of the position of things

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between them, and the ability of the individual to set himself in the world around, to organize things together, to place them and make them move. The perception of the concept of space significantly contributes to the writing and reading processes, as he will understand the direction of the letters (up-down, left-right) and will avoid the inversion of letters or words. Children who have difficulty perceiving and organizing space often make letter inversions.

(iii) Time Orientation: According to De Meur & Staes (1990) the concept of time is closely related to the concept of space. These two concepts are interrelated as they are simultaneously acquired. Time sequence occurs when different events occur at close moments. The child discovers the above concepts, by learning to classify and memorize his movements and events according to their chronological order. Time orientation facilitates the learning of reading, the sequence of letters and words. The child with special learning difficulties finds it difficult to retain the order and sequence of events, does not perceive and distinguish the time intervals and cannot organize his time.

(iv) Visual-motor coordination: This ability is a complex developmental function that requires typical sensory, motor, and cognitive mechanisms as well as accurate coordination, in order to design and execute a planned movement properly (Smits-Engelsman et al., 2001). The writing acquisition and, in particular, the graphomotor ability, depends directly on the development of visual-motor skills (Germano et al., 2013). According to research findings (Vasileva, 2015) fine motor activities help children to be able to use their hands with the greatest dexterity, achieving visual-motor perception and fine motor skills coordination, thus resulting in correct writing and reading.

(v) Left/Right discrimination: The ability to discriminate left-right is based on a complicated neurophysiological process and is related to age and intelligence. The child's awareness of the left-right should be consistently obtained around the age of 5-6 years, whereas the child's ability to recognize the right or left hand of the opposite person (reversibility), is acquired at the age of 6.5 years (Feder & Majnemer, 2007). According to researchers (Weintrau & Graham, 2000), there is a relationship between hand preference, specific learning disability and other forms of language disorders. A child who has not mastered the left-right discrimination will face problems with orientation and positioning in space and with the placement and orientation of objects within it, resulting in an inability to recognize the difference between them, thus, negatively affecting the reading and writing skills' acquisition.

IV. As regards the intervention program, the observed results seem particularly promising. Considering the measurements of the diagnostic tools as well as the direct observations during their administration to the case, we registered the difficulties of obtaining sectors, which were addressed within a well-designed individualized intervention program. As evidenced by the data, even from the intermediate evaluation phase, a progressive significant improvement and successful achievement of all intervention objectives was recorded, while four months after the completion of the program implementation, a steady degree of readiness of the case to master the mechanisms of reading and writing,

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has been signalized. These findings are considered to add to research data that support the larger effect sizes of interventions applied with kindergarten (Vasileva, 2019), indicate the importance of executive skills in predicting the children's low readiness for learning to read (Thompson et al., 2015), and argue that when the children 'at risk' for SLD improve their psychomotor skills early, they become progressively familiar with writing (Toffalini et al., 2017).

However, it should be noted that the current findings cannot support per se that the successful achievement of psychomotor skills could be indicative of a comprehensive intervention of early signs of SLD. Instead, they strongly emphasize the appropriate implementation of individualized, well-adjusted to the child's strengths and weaknesses, multi-tiered and multisensory interventions.

CONCLUSION

Overall, our findings suggest that further and more targeted research is needed regarding complex and strong interactions early occurred between the components of the SLD, such as neurobiological, cognitive, language, and psychomotor. Due to this multidimensional nature of SLD, a holistic framework of multifactorial assessments and interventions should be implemented to address these difficulties, which allow not only to identify early signs of SLD, but rather to successfully treat them during the preschool years, before children fail to learn to read and write.

In general, the contribution of successful interventions to enhance the development of social and emotional skills at an early stage, positively affect children's social interaction, and improve their cognitive and behavioral skills as well as their academic achievements should be acknowledged.

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