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The Predictive role of Cognitive Factors and Academic Self-efficacy on Academic Functioning of Children at Risk for Specific Learning Disabilities

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Abstract: The goals of the study were to examine the predictive power of general cognitive ability, working memory, and self-efficacy in first grade for academic functioning of children at risk for learning disabilities in second grade. The study involved 82 children (age 6-7 years) from five local public elementary schools in middle-class neighborhoods in Jerusalem, including 41 children at risk for specific learning disabilities and 41 typically developing peers. In the first stage of the study, (performed at the end of first grade), general cognitive ability and working memory were assessed using subtests from the Wechsler Intelligence Scale for Children (the subtests consisted of: Vocabulary and Block Design for general cognitive ability; Arithmetic and Digit Span for working memory). Academic self-efficacy was rated using a structural interview. At follow-up, academic functioning was assessed at the end of second grade. A serial-multiple mediation analysis revealed significant mediating roles for levels of performance in the Arithmetic subtest and for academic self-efficacy in predicting the academic functioning in second grade. The significance of the Arithmetic subtest, based on contemporary research on the structure of the intelligence was proposed. Educational implications call for sensitizing teachers to the unique role of academic self-efficacy in shaping trajectories of academic functioning development among children with RLD and in using effective strategies of promoting self-efficacy.

Keywords: *Academic self-efficacy, children at risk for Specific learning disabilities, cognitive predictors, academic functioning.*

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Introduction

Studies indicate that early school experiences have a long-term effect on children's functioning and adjustment (Fabian & Danlop, 2002). This period is especially difficult for children at risk for developing learning disabilities (RLD). At this age, the diagnosis of children with specific learning disabilities raises many professional concerns, due to the difficulty of reaching a valid diagnosis in the early stages of formal academic learning, and the wish to avoid the effects of labeling (Fletcher, Lyon, Fuchs & Barnes, 2018). Thus, the Israeli Educational Policy prefers to delay formal diagnosis, and to treat children who reveal early learning and reading difficulties as students at risk for developing specific learning disabilities, in line with the Reaction to Intervention (RTI) approach (Catts, Nielsen, Bridges, Liu & Bontempo, 2015).

Nevertheless, early interventions were found effective for various fields of child functioning, including learning (Anderson et al. 2003; Guralnick, 1997,). A meta-analysis by Wanzek and Vaughn (2007) emphasizes the importance of timing in early intervention programs: those conducted with kindergarteners and first-graders were found to be more effective than programs with children in the second and third grades (Wanzek &Vaughn, 2007).

In this regard, early identification of academic challenges may help teachers in planning effective intervention programs for at-risk students, and may support the achievement of long-term goals in the academic and socio-emotional realms (Jenkins & O'Connor, 2002).

Consequently, early psychological assessments take on particular importance. The Wechsler Intelligence Scale for Children (WISC) is widely used in the diagnosis of children at risk for specific learning disabilities (SLD). Without

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ignoring the ongoing debates about the usefulness of WISC for LD diagnosis and the prognosis of academic achievements of children with LD, it has been widely used in Israel as in many countries (Margalit, 2018).

The current study examines the role of general cognitive ability and working memory in the academic functioning of children at risk for learning disabilities, and compared it to their typically developing peers. The study also assesses the role of self-efficacy in the functioning of children with RLD.

General cognitive ability and working memory abilities as predictors of academic challenges and learning disabilities

Many studies (Deary, Strand, Smith & Fernandes, 2007; Elliot, 1990) have examined the relations between cognitive abilities and academic outcomes. The first intelligence test (Stanford-Binet) was created as a child assessment tool for the identification of children with learning difficulties and their placement in special education programs (Binet & Simon, 1916). A large body of research indicates a high correlation between level of intelligence and level of academic achievement (Deary et al., 2007; Kaufman et al., 2012). The level of intelligence predicts academic outcomes in different age groups (Laidra et al., 2007; Kaufman, Reynolds, Liu, Kaufman & McGrew, 2012; Kuncel et al., 2004). Research proposed that IQ can be considered a good predictor of academic achievement in elementary school (Mayes, Calhoun, Bixler & Zimmerman, 2009), and students with higher verbal IQ in preschool tend to achieve higher academic grades at school (Gutman, Sameroff & Cole, 2003).

General intelligence predicts success in most subjects of learning, but varies among different subjects. Thus, a large longitudinal study of English children revealed that intelligence accounts for 58.6% of variance in mathematics, 48% of variance in English, and 18.1% of variance in art (Deary et al., 2007). Studies indicate that the predictive value of intelligence for academic outcomes increases with age (Kaufman et al., 2012). Thus, the role of the cognitive abilities in predicting academic achievements for students with Specific learning disabilities (SLD) requests a special attention.

SLD are neurodevelopmental disorders with a biological origin that lead to persistent difficulties in the acquisition of specific basic academic skills. The assessment of intelligence has been considered an important part in the diagnostic process of children with SLD, intended to identify the gap between competence and achievements. Although Siegel (1989) has demonstrated that the patterns of performance on intelligence tests are not a reliable assessment for the diagnosis of LD (D'Angiulli & Siegel, 2003; Siegel, 1989), many studies have focused attention on the differences in intelligence profiles between children with SLD and their typically-developing peers (Giofre & Cornoldi, 2015). According to this approach, SLD can be identified via a specific pattern of strengths and weaknesses in intelligence assessment tests. The identification of a particular pattern of Strengths and Weaknesses (PSW) within an individual's cognitive functioning is thought to provide important information for the diagnosis of SLD (Flanagan, Ortiz, & Alfonso, 2007).

Working memory is commonly considered a predictor of academic achievement. Students with special education needs are approximately six times more likely to demonstrate impaired working memory ability than their typical peers (Gathercole, Alloway, Willis & Adams, 2006; Pickering & Gathercole, 2004; Sabol & Pianta, 2012). The role of working memory for academic achievements is critical especially in the early grades of primary school (Allow, 2009; Duncan et al., 2007; Stipek & Valentino, 2015; Lu, Weber, Spinath & Shi, 2011). A strong correlation was found between level of working memory and math achievements (Flanagan, Ortiz, Alfonso & Mascolo, 2006; Kytala & Lehto, 2008; Swanson, Jerman, & Zheng, 2008). In addition, a poor working memory predicts difficulties in several academic subjects (Gathercole, Pickering, Knight & Stegmann, 2004; Swanson, & Jerman, 2007).

Alongside cognitive factors, emotional factors have an important role in shaping children's academic functioning in the early grades. Academic self-efficacy plays a major role among the emotional factors that influence academic functioning.

Academic self-efficacy

Self–efficacy has been defined as a belief in one's ability to organize and perform courses of action (Bandura 1997, 2015), while academic self-efficacy has been defined as a student's belief in his or her ability to successfully attain educational goals (Elias & MacDonald, 2007). According to social learning theory (Bandura, 2018), academic self-efficacy determines whether coping behavior will be initiated in the face of obstacles, as well as the level of effort applied by individuals to overcome their difficulties.

Research has demonstrated that this construct plays an essential role in shaping learning motivation, persistence, and academic achievement (Ben-Naim, Laslo-Roth, Einav, Biran & Margalit, 2017; Zimmerman, 2000; Cassidy, 2015). It is as yet unclear at what age self-efficacy is sufficiently developed to impact school outcomes. The results of several studies confirm that in the early developmental stages, children tend to show positive self-efficacy that often does not correlate with actual achievements. Preschoolers and first-grade children tend to overestimate their abilities, and their self-beliefs are characterized by globalism and a lack of differentiation (Harter, 2012; Tirosh, Tsamir, Tabach, Levenson & Barka, 2013; Trzesniewski & Donnellan, 2010). Perhaps at this age stage they are not able to adequately compare their achievements to those of their peers. The sense of mastery, considered to be the main source of self-efficacy, has lower influence on self-efficacy at early ages. At this stage, the self-efficacy is influenced by the home environment with activities that offer challenges for children's curiosity, including explorative activities (Schunk & Pajares, 2002). The internalization of parents' and teachers' expectations and the process of interpersonal comparison require a higher level

of development of cognitive functions (Harter, 2012). Self-efficacy declines during the school years and becomes more calibrated with external evaluations (Klassen, 2002; Schunck & Pajares, 2002). This process may be attributed to greater competition with peers, more norm-oriented grading, and less support provided by the teacher to individual children (Pintrich & Schunk, 1996). However, some research has demonstrated that self-efficacy may be predictive of the level of academic outcomes even for children in the first to third grades (Lee, & Jonson-Reid, 2015; Liew, McTigue, Barrois & Hughes, 2008; Wilson & Trainin, 2007).

Children with SLD often report lower levels of academic self-efficacy than their non-LD peers (Ben-Naim et al., 2017; Tabassam & Grainger, 2002). Self-efficacy predicts success in various domains of academic achievement among children (Pajares 1996; Phan & Ngu, 2014; Steinmayr & Spinath, 2009; Zimmerman, 2000). Significant correlation between academic self-efficacy and level of academic achievement has also been found among students with SLD (Klassen, 2007). However, few studies have examined the role of academic self-efficacy in the academic achievements of young children (Lee & Jonson-Reid, 2015).

The purpose of the study

The purpose of the current study was to examine the predictive power of general cognitive ability, working memory, and academic self-efficacy for the academic functioning of children at risk for learning disabilities. We hypothesized that general cognitive ability, working memory, and academic self-efficacy mediate trajectories of academic development from first to second grade for children at risk for learning disabilities. In addition we hypothesized that already in first grade, when the child's academic difficulties are not yet clearly established and before formal diagnosis has been performed, differences in academic self-efficacy can already be identified.

Method

Participants

The sample consisted of 82 children (aged 6-7 years) from 14 first-grade classes at five local public elementary schools in middle-class neighborhoods in Jerusalem, including 41 children at risk for specific learning disabilities (19 boys and 22 girls) and 41 typically-developing peers (12 boys and 29 girls). At follow-up, academic functioning was measured at the end of second grade using the Student's detailed Functioning Profile (equivalent to performance grades), filled in by the teachers.

No information about parents' age and education was available. The group of children at risk for specific learning disabilities (RLD) was formed on the basis of comprehensive interviews of the children's teachers by the school's educational counselors. The goal of the interview was to identify children who require supplementary learning assistance (in line with RTI policy). The interviews took place in March of the first-grade year and included questions relating to the strengths and weaknesses of the child and his or her level of mastering basic learning skills – reading, writing, and math. However, no formal psychological assessment for SLD was performed, and no children with identified and/or diagnosed disabilities were included in the study. Comparisons of gender proportions or ages among the two groups of children did not yield significant differences. The children from the typical-development (TD) group were randomly selected from the same classes.

Measures

General cognitive ability

We used the two subtests from the Wechsler Intelligence Scale for Children (WISC-R95) to measure global cognitive abilities – the Vocabulary subtest and the Block Design subtest. We implemented the WISC-R95 according to the instructions of the Israeli Ministry of Education, since this battery has Israeli norms. The Vocabulary subtest is considered a measure of expressive vocabulary and verbal knowledge; it is considered a relatively good estimate of general intelligence (Parkin & Beaujean, 2012). The Block Design subtest shows the highest correlation with general cognitive ability among the subtests, related to visual processing (Parkin & Beaujean, 2012). Both subtests are part of the WASI (Wechsler Abbreviated Scale of Intelligence), used as a reliable brief measure of intelligence (Kamphaus, 2005). The Vocabulary/Block Design (VBD) combination has been shown to be correlated with the full-scale IQ test and has been used in various studies for the brief estimate of intellectual functioning (Davalos, Kisley, Polk & Ross, 2003).

Working memory

Two subtests from the WISC-R95 were used to measure working memory – Arithmetic and Digit Span. According to the WISC-IV model, these subtests are considered a good estimate of working memory (Wechsler, 2003). The association between the Digit Span subtest and the working memory factor has been demonstrated in numerous studies (Chen et al., 2009; Keith, Fine, Taub, Reynolds & Kranzle, 2006; Phelps, Mcgrew, Knopik & Ford, 2005). In line with early research on the factor analysis of WISC-R, the Arithmetic subtest assesses the freedom from distractibility factor (Kaufman, 1975). A number of studies reported that the Arithmetic subtest may be considered a measure of working memory (Chen et al, 2009; Kamphaus, 2001), fluid reasoning (Keith et al., 2006), quantitative knowledge (Phelps et al., 2005), and crystal

intelligence (Chen, Keith, Chen & Chang, 2009). An exploration of the structure of the intellect in an Israeli sample reveals the Arithmetic subtest to be highly associated with the working memory factor (Cohen, 2009).

Academic self-efficacy

Academic self-efficacy was measured by means of a structural interview used in the study of preschoolers' self-efficacy in mathematics (Tirosh et al., 2013). The interview includes questions related to self-efficacy in academic tasks. Each child was asked to perform six academic tasks – two reading tasks (sentence reading and short text reading), two written expression tasks (two text-related questions), and two arithmetic tasks (two orally administered arithmetic questions taken from the Arithmetic subtest of the WISC-R95). Before performing each of the six tasks, the child was asked to answer the following two questions:

Question 1: "Now I will ask you to read the sentence / read the text / answer the question / solve the mathematical problem. Do you think you will be able to perform this task?"

Question 2: "Are you very sure or slightly sure?"

Taken together, the answers to the two questions created a four-point scale of children's self-efficacy. For example, if a child answered "yes" to Question 1 and "very sure" to Question 2, his self-efficacy was graded 4. If he answered "no" to Question 1 and "slightly sure" to Question 2, his self-efficacy was graded 2.

Academic outcomes in second grade

Academic functioning was measured on the basis of teachers' assessments in the Student's Functioning Profile. This assessment is used by the Israeli Ministry of Education and includes 33 items (measured on a scale ranging from 1 to 9), consisting of items related to learning and socio-emotional child functioning. 22 items measuring reading, writing, arithmetic, and language skills were selected from the Student's Functioning Profile to estimate the level of the child's academic outcomes in second grade. For each child, the average score of the results of these 22 items was calculated. The Cronbach Alpha Coefficient for the current study was $\alpha = .98$.

Procedure

Five elementary schools participated in the study, after receiving approval from the Israeli Ministry of Education. The teachers, together with the school's educational counselors, identified a group of first-grade students with RLD and TD on the basis of comprehensive interviews of the teachers by the counselors (conducted from January to February 2017). After receiving parental consent, children were assessed individually in a quiet room at their schools, in sessions held near the end of first grade (from April to June 2017). They completed four subtests from the WISC-R95 (Vocabulary, Block Design, Digit Span, and Arithmetic) and answered questions in a structural interview measuring academic self-efficacy (modeled on the study cited above). At the end of second grade (May-June 2018) the teachers filled in the Student's Functioning Profile assessing the student's academic functioning. The statistical significance of the tested model was analyzed by means of the PROCESS Macro Model 6 (Hayes 2013), using the bootstrap method.

Results

In order to compare children's ratings in the WISC-R subtests, academic self-efficacy in first grade, and academic outcomes in second grade for the two groups (students with RLD and their typically-developing peers), a MANOVA was performed with group placement (RLD/TD) and gender as the independent variables. The analysis yielded a main effect for group placement ($F(6, 73) = 10.57$, $p = .00$, partial $\eta 2 = .457$), but not for gender or interactions.

Table 1. Means, SDs and F scores of the Univariate analysis between children at risk for learning disabilities (RLD) and the comparison group (TD).

Variables	TD group (N = 41) M (SD)	RLD group (N =41) M (SD)	F (6,77)	Partial Eta²
Vocabulary	10.4 (2.6)	8.7 (2.4)	9.148**	.106
Block Design	11.5 (3.3)	9.8 (3.0)	3.437	.043
Arithmetic	10.4 (2.2)	8.9 (2.3)	6.041*	.073
Digit Span	11.0 (2.2)	10.0 (2.8)	3.851	.048
Academic Self-efficacy	3.6 (0.3)	3.2 (0.6)	13.387**	.148
Academic outcomes-second grade	7.2 (1.5)	4.8 (1.3)	53.011**	.408

*p< .05; **p< .01

Table 1 presents means, SDs, and F scores for the univariate analysis of the group placement. The results of the analysis revealed significant differences between the groups in terms of the children's ratings on the Vocabulary and Arithmetic subtests, academic self-efficacy, and academic outcomes in second grade. No significant differences were found between the RLD and TD groups in the children's ratings on the Block Design and Digit Span subtests.

Relationships between measures

In order to examine the relationships between ratings in the WISC-R subtests, academic self-efficacy in first grade, and academic outcomes in second grade, a Pearson Correlations Test was performed. As presented in Table 2, academic outcomes in second grade significantly correlated with the children's ratings in the Vocabulary, Arithmetic, and Digit Span subtests and with academic self-efficacy.

Table 2. Correlations between assessment in Wechsler subtests, academic self-efficacy and academic outcomes in second grade.

Variables	1	2	3	4	5	6
1. Vocabulary	-					
2. Block design	.20	-				
3. Arithmetic	.36**	.30**	-			
4. Digit Span	.15	.13	.23*	-	.	
5. Academic Self-efficacy	.15	-.01	.18	.16	-	
6. Academic outcomes in second grade	.32**	.20	.49**	.29**	.43**	-

*p< .05; **p< .01

Serial-multiple mediation

In order to further explore these relationships, and to identify significant mediating paths in the academic outcomes model, we used Hayes's (2013) bootstrapping approach (model 6 in the SPSS PROCESS macro) to determine the relationship between group placement (RLD and TD) in first grade and the children's academic outcomes in second grade, while considering the mediation effects of general cognitive ability and working memory, measured by WISC-R subtests and the children's academic self-efficacy. The serial mediation model is presented in Figure 1.

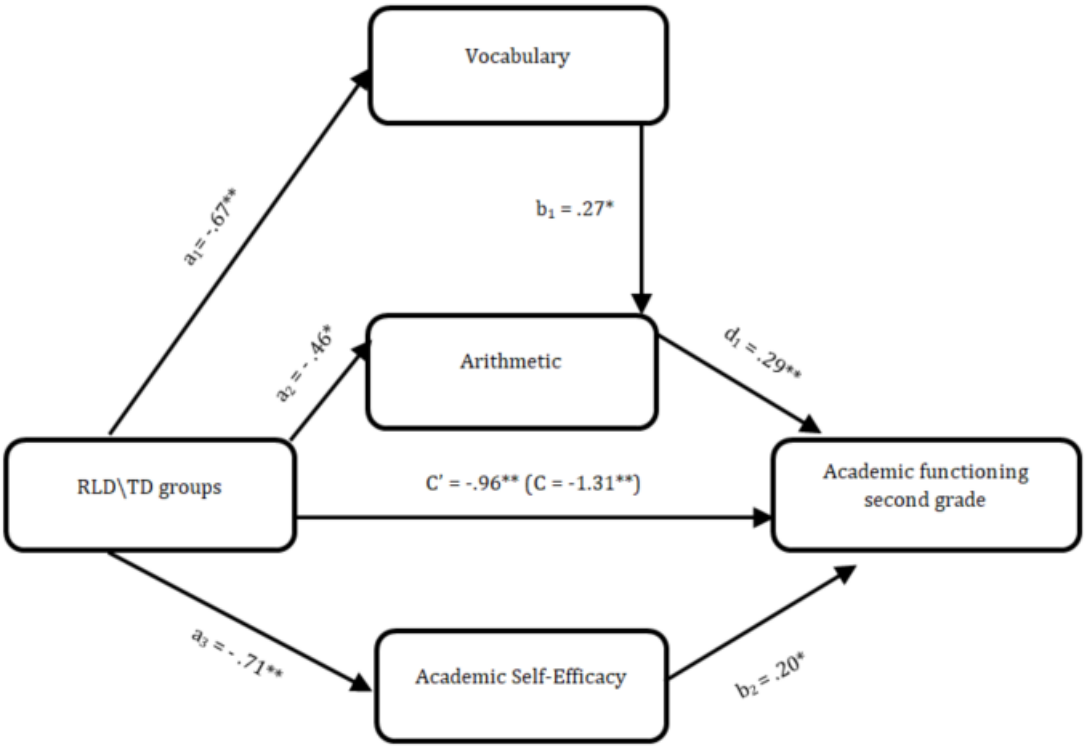

Figure 1. Children's scores in Vocabulary and Arithmetic subtests and academic self- efficacy in 1-2 grade as serial-multiple mediators between groups of children with and without RLD and their academic functioning in 2-d grade.

As presented in Figure 1, the total effect of group placement (RLD/TD) on academic outcomes in second grade was initially statistically significant (B = -1.31, SE = .17, t = -7.73, p= 0. LLCI = - 1.64, ULCI = -.97). A direct path connected group placement to the first mediator – the children's level in the Vocabulary subtest (path 1: B = –.67, SE= .21, t = −3.2, p< .01, LLCI = −1.09 – ULCI = –.25). This first mediator had a significant direct effect on the second mediator – the children's level in the Arithmetic subtest (path 2: B = .27, SE= .11, t = 2.45, p< .05, LLCI = .05 – ULCI = .49). Group placement (RLD/TD) also had a direct effect on the children's level in the Arithmetic subtest (path 3: B = -.46, SE= .22, t = -2.12, p< .05, LLCI = -.89 – ULCI = -.03). Group placement (RLD\TD) had a significant direct effect on academic self-efficacy (path 4: B = -.71, SE = .23, t = -3.08, p< .01, LLCI = -1.16 – ULCI = -.25). There was no direct path between the children's level in the WISC-R subtests and their self-efficacy. The second mediator (the children's level in the Arithmetic

subtest) had a significant direct effect on academic outcomes in second grade (Path 5: B = .29, SE= .08, t = 3.45, p<.01, LLCI =.12 – ULCI = .46). There was no direct path between the children's level in the Vocabulary subtest and their children's academic outcomes in second grade, but these relations were mediated through their level in the Arithmetic subtest, as presented in Figure 1. Additionally, academic self-efficacy had a significant direct effect on academic outcomes in second grade (Path 6: B = .20, SE= .08, t = 2.33, p<.05, LLCI =.03 – ULCI = .36).

The model overall was statistically significant. Based on this result, mediating variables were observed to mediate in part the relations between the groups identified in the first grade (RLD/TD) and the children's academic outcomes in second grade (B= -.96, SE = 0.18, t = -5.42, p = 0, LLCI = -1.32, ULCI = -.61)

Discussion

The goals of this study were to examine the impact of general cognitive ability and working memory (as measured by the WISC-R95 subtests), as well as the academic self-efficacy for predicting academic functioning among children at risk for specific learning disabilities.

Differences between two groups were found in the children's Vocabulary, Arithmetic, and Digit Span subtests. This result emphasizes the critical role of verbal processing components in school performance, and this is consistent with previous studies demonstrating that the higher verbal levels at an early age predicted higher levels of academic performance (Gutman, Sameroff & Cole, 2003).

As expected, the children identified as at risk for learning disabilities in first grade were characterized by their lower levels of academic functioning in the second grade. This corresponds with research that emphasizes the stability of students' characteristics and abilities during the school years (Alexander, Entwisle & Dauber, 1993). Children who were identified in the first grade by the pedagogical staff as at risk for developmental learning disabilities may continue to advance along the trajectory of learning difficulties. Thus, the teacher's assessment had high predictive power for the child's prospects of academic advancement. However, the serial-multiple mediation model further emphasized the importance of the cognitive strengths and of academic self-efficacy in predicting the level of academic functioning in second grade.

An attempt to understand the predictive role of Arithmetic in academic functioning in second grade brings us back to the question, what exactly the Arithmetic subtest measures. If we consider Arithmetic as a working memory task, we may ask why Digit Span – proven by numerous studies to be connected with working memory – was not found to predict academic functioning in second grade. Consideration of this subtest as a Comprehension–Knowledge task (comparable with Vocabulary) does not explain why Vocabulary was not found to be a significant predictor of academic functioning. Vocabulary was found to predict the Arithmetic subtest grade (Figure 1), but no direct effect of Vocabulary on academic functioning was found. Thus, it can be assumed that in this study, the Arithmetic subtest should be considered as a measure of fluid intelligence, but this assumption requires future studies to examine the predictive power of fluid reasoning for academic outcomes in the early grades.

Another trajectory of academic development that was demonstrated in the current study relates to the development of academic self-efficacy. The current study reveals that learning challenges were already expressed by academic self-efficacy levels already in first grade.

The academic self-efficacy of RLD children reflected the experience of failure in the acquisition of basic academic skills, social comparison, and adult's feedbacks, similarly to the results of older individuals (Ben-Naim et al., 2017). In addition, the study emphasized the importance of the academic self-efficacy and reported that it mediated the impact of the group belonging on future academic achievements. Thus, those children who were identified at risk during the first grade, yet were able to maintain a relatively positive academic self-efficacy, may reach higher academic outcomes in second grade. Future studies are needed to explore emotional factors that may empower children self-beliefs in their capabilities, regardless their academic challenges.

Educational implications

The current study has important educational implications for students at their early educational stages. In order to plan prevention of learning challenges, it is important to identify children at risk as early as possible and to provide adequate support. The results of the study emphasized the importance of the Arithmetic subtest for identifying difficulties, and demonstrating its longitudinal predictive power. These results call for future studies to further explore their implications, modes of effective intervention and also may have practical value in the early identification of children who need additional help and attention.

In addition, these results indicate the need to sensitize teachers to the possible impact of their feedback on children's academic self-efficacy, and to raise their awareness of the significant role of self-efficacy beliefs in shaping children's academic motivation, effort investment and achievements. The understanding of the role of self-efficacy in the learning process can assist teachers in using the effective strategies of self-efficacy engagement – improving the child's sense of mastery by setting realistic goals, engaging in effective modeling practices, encouraging children through positive

persuasion that is delivered honestly and contains feedback regarding children's growth and developmental abilities and achievements (Pajares, 2006).

Research limitations

The study has several limitations. The small sample, and the fact that all the participants share a similar socioeconomic level, may prevent generalization. Future studies should include larger samples with diverse groups of children in order to further examine the relationships between variables. Another limitation of this study is the fact that all the information regarding children's academic functioning relies on questionnaires. Future studies should include direct assessment of children's academic achievements. In addition, in this study, the data was obtained at two points in time – toward the end of first grade and the second grade. Future longitudinal studies may clarify the trajectories of children's academic development and the mediating role of children's cognitive and emotional peculiarities in this process at different age stages.

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