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TITLE

Protocol to assess dyslexia in six-year-old children

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KEYWORDS

Dyslexia, assessment, diagnostic criteria, treatment response, structured interviews, standardised test.

SUMMARY

This research sets out a proposed protocol for the identification of dyslexia. The protocol is based on diagnostic and response to intervention models. The proposal involves using structured interviews and standardised tests for the assessment of reading and writing performance and determinant factors.

ABSTRACT

In recent years, there has been an increase in the prevalence of dyslexia at early ages in different countries and regions. This increase has serious consequences within school and family settings, due to the poor academic performance that characterises people with dyslexia and the socio-emotional problems they sometimes display. One of the most frequent problems in the identification of the dyslexia is the lack of a common diagnostic protocol that encompasses specific criteria for the assessment of any child. The Learning Disabilities and Development Disorders research group at the University of Malaga has developed a protocol for the early detection of dyslexia. The protocol is based on the diagnostic and response to intervention models. Consequently, it takes into account diagnostic criteria agreed upon by some associations and committees of experts, as well as certain specific cognitive and language determinants that characterise people who present with dyslexia following adequate instruction, according to recent research. The action protocol is developed over several stages, and we propose the use of structured interviews with parents and teachers alongside standardised tests for the evaluation of intelligence, reading and writing, as well as the risk factors that determine the appearance of the problem. This action protocol provides a model for the detection of dyslexia, which seeks to distinguish it from other comorbid

problems and identify its characteristics and determinants, in order to offer effective intervention and/or prevention from an early age.

INTRODUCTION

The DSM-5 establishes specific learning difficulties as a diagnostic category within neuro-developmental disorders. Dyslexia has been considered one of the most common specific learning difficulties. It is characterised by difficulties with accurate and fluent word recognition, along with spelling and orthographical accuracy. It also entails difficulties in reading comprehension[1]. These manifestations appear after the start of compulsory schooling, from the age of six onwards.

In recent years, there has been an increase in the prevalence of dyslexia at early ages. Some authors state that between 5% and 17.5% of school age children are affected by dyslexia[2,3]. These percentages indicate the importance of considering early detection, since it has serious consequences within school and family settings, due to the poor academic performance that characterises people with dyslexia and the socio-emotional problems they sometimes display.

In spite of this, there is often a lack of consensus about how to identify dyslexia. This is due to the on-going debate about the adequacy of identification criteria offered by the different explanatory models, derived from ambiguity in the definitions given in dyslexia. On the one hand, the traditional perspective advocates a model of diagnosis for the identification of these problems. More recently, however, the response to intervention model has emerged as an alternative for such purposes.

The diagnostic model considers several criteria when identifying dyslexia: the discrepancy criterion, the exclusion criterion and the specificity criterion (Figure 1).

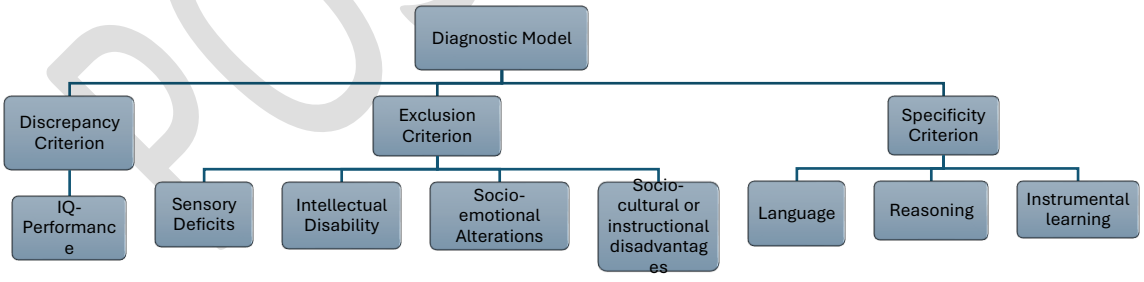


Figure 1. Criteria considered by the diagnostic model

The discrepancy criterion is based on the fact that people with dyslexia present a discrepancy between their intellectual potential and their performance. This criterion is not accepted by some authors who do not find it necessary to use IQ to determine the appearance of dyslexia[4,5]. In contrast, other authors find that

divergent children are more resistant to interventions than non-divergent children or that there are differences between them[6,7]. Although the discrepancy criterion has been widely criticised, there does not appear to be consensus about its use. In our opinion, it is somewhat premature to dispense with IQ when it comes to identifying dyslexia. Discarding the use of IQ might make it hard to distinguish this problem from others such as intellectual disability. In this regard, discrepancy should be the first step in identifying dyslexia[8].

The exclusion criterion refers to the difference between dyslexia and other specific disorders with which it occurs concomitantly. These disorders are usually sensory deficits, mental disability, emotional disturbances and socio-cultural or educational disadvantages[1,9]. There is some controversy about the overlap between some of these disorders and dyslexia. Hence, for example, socio-emotional alterations and low social competence are sometimes included as characteristics of people with dyslexia, when it would actually appear that these difficulties are being generated by dyslexia[10]. Advocates for the use of the exclusion criterion argue that there is a risk that dyslexia will fall into a catchall category that encompasses other comorbid pathologies[11] if they are not considered for its diagnosis.

The specificity criterion implies certain restrictions with regard to the domains that are affected in dyslexia, such as language, reasoning and instrumental learning problems[1,9]. Some authors argue that language problems should be included within the category of dyslexia[12,13]. However, others believe that they should be differentiated and categorised as comorbid conditions, because language is acquired without formal education whereas other domains do require such instruction[10]. In this regard, dyslexia is characterised by problems with reading and writing, justified by difficulties in phonological processing [14,15] or a general sensory deficit [16,17]. Those who argue that dyslexia is a deficit in phonological processing indicate that dyslexics present difficulties in tasks involving the effective use of the phonological code, presenting a deficit in the creation of phonological representations of words. As a result, they present difficulties acquiring the alphabetical principle and remembering grapheme-phoneme correspondences[10]. Proponents of dyslexia as a general sensory deficit argue that people with dyslexia present difficulties in tasks that require the processing of auditory stimuli presented quickly, displaying difficulties of auditory perception, owing to a deficit in their rapid temporal processing[10]. These basic difficulties give rise to phonological problems, which explain the difficulties they face recognising words.

The response to intervention model (RTI) integrates evaluation and intervention within the school system by means of a multi-level prevention system that maximises the performance of students and reduces behavioural problems[18]. This model can be used to identify pupils who are at risk of manifesting reading and writing difficulties, monitoring their progress and offering interventions based on the pupil's response. This model identifies people with dyslexia as subjects who do not respond to the intervention received by all students in the classroom and assume that it may be due to a cognitive or educational deficit [19]. The identification of dyslexia is a decision-making process, in which assessment will be interspersed

with instruction. In each assessment stage, the progress made by students after each instruction stage is considered. So, if the performance assessment of the class as a whole is found to be adequate, the possible inadequacy of the instruction delivered is ruled out. Once it has been confirmed that instruction is adequate, the second stage involves identifying, by means of curricular measures, any students whose performance and progress is below that of their classmates, considering them to be students at risk of having dyslexia. In the third stage, individual curricular adaptations will be applied for these children. If these curricular adaptations are not sufficient, because the child is still not progressing, specialised educational measures are required, and the child is considered to be dyslexic[19-21] (Figure 2).

This model focuses on academic performance, eliminates the IQ-performance discrepancy and assessments of intelligence, and reduces the number of false positives[8]. However, there are few criteria to determine whether a child does or does not respond well to intervention over time. In addition, these problems coexist with other issues, and non-response to intervention could be due to the existence of comorbidity between them[10,22,23]. These studies are sceptical about the use of the RTI model as a diagnostic instrument.

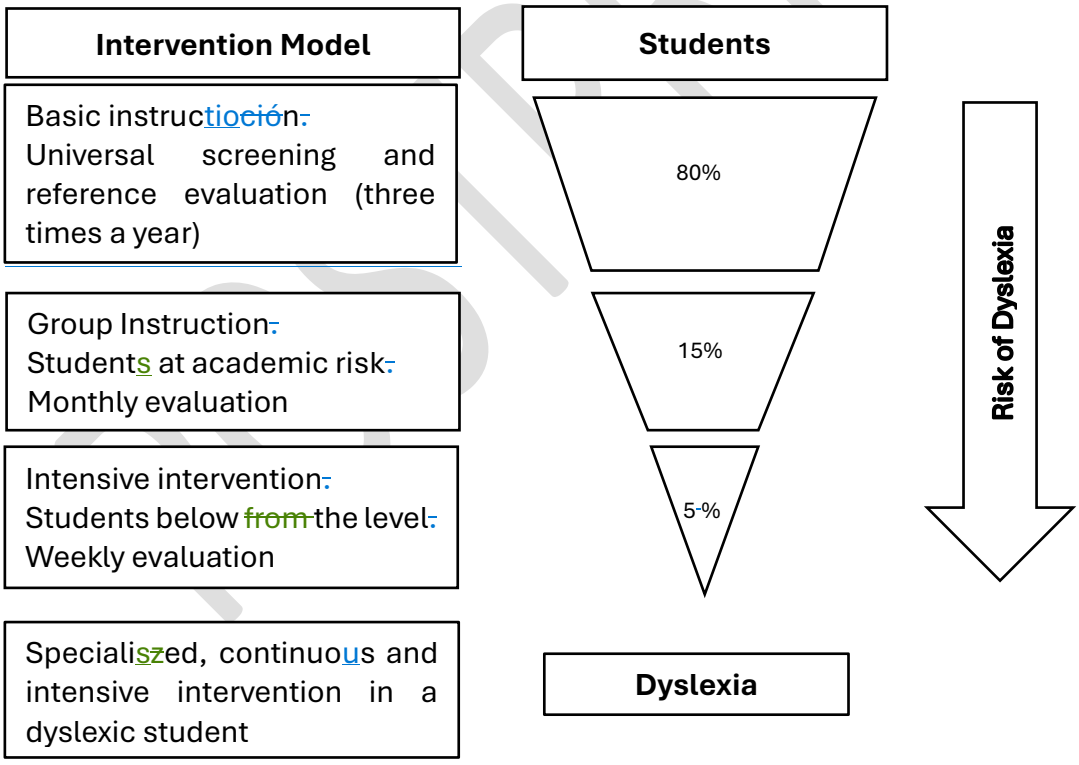


Figure 2. Multilevel system of the Rtl model

Therefore, there does not appear to be any consensus regarding the criteria that should be used to identify specific learning disabilities, and, in particular, dyslexia. Whereas diagnostic models use discrepancy, exclusion and specificity criteria, the response to intervention model considers poor performance in basic instrumental tasks following adequate instruction as a criterion. Both models have been criticised and present certain weaknesses. For this reason, the Learning Disabilities and Development Disorders research group at the University of Malaga has developed a protocol for the early detection of dyslexia, which considers the strengths of the diagnostic model and the response to intervention model.

In short, the aim of this paper is to present a proposed protocol to detect dyslexia at an early age. It sets out to provide an objective diagnostic procedure for the assessment of this neurodevelopmental disorder, in order to differentiate it from other comorbid disorders, from an early age. For the diagnosis of this specific learning disability, the protocol takes into account the evaluation of certain specific cognitive and linguistic determinants after adequate instruction in reading and writing (response to intervention model), as well as the discrepancy, exclusion and specificity criteria (diagnosis model). The action protocol is developed over several stages, following different types of instruction, and we propose the use of structured interviews with parents and teachers alongside standardised tests for the evaluation of intelligence, reading and writing, as well as the risk factors that determine the appearance of the problem. This action protocol provides a dynamic model for the detection of dyslexia, which seeks to distinguish it from other comorbid problems and identify its characteristics and determinants, in order to offer effective prevention at an early age.

PROTOCOL

This present study has been developed in accordance with the Helsinki Declaration, which establishes ethical principles for the development of research with humans. In addition, it follows the guidelines and was approved by the University of Malaga's Experimentation Ethics Committee (CEUMA).

The protocol presented below should be carried out by psychologists within the school setting, beginning in the first year of Primary Education (6 years of age), and with the collaboration of teachers **(Figure 3).**

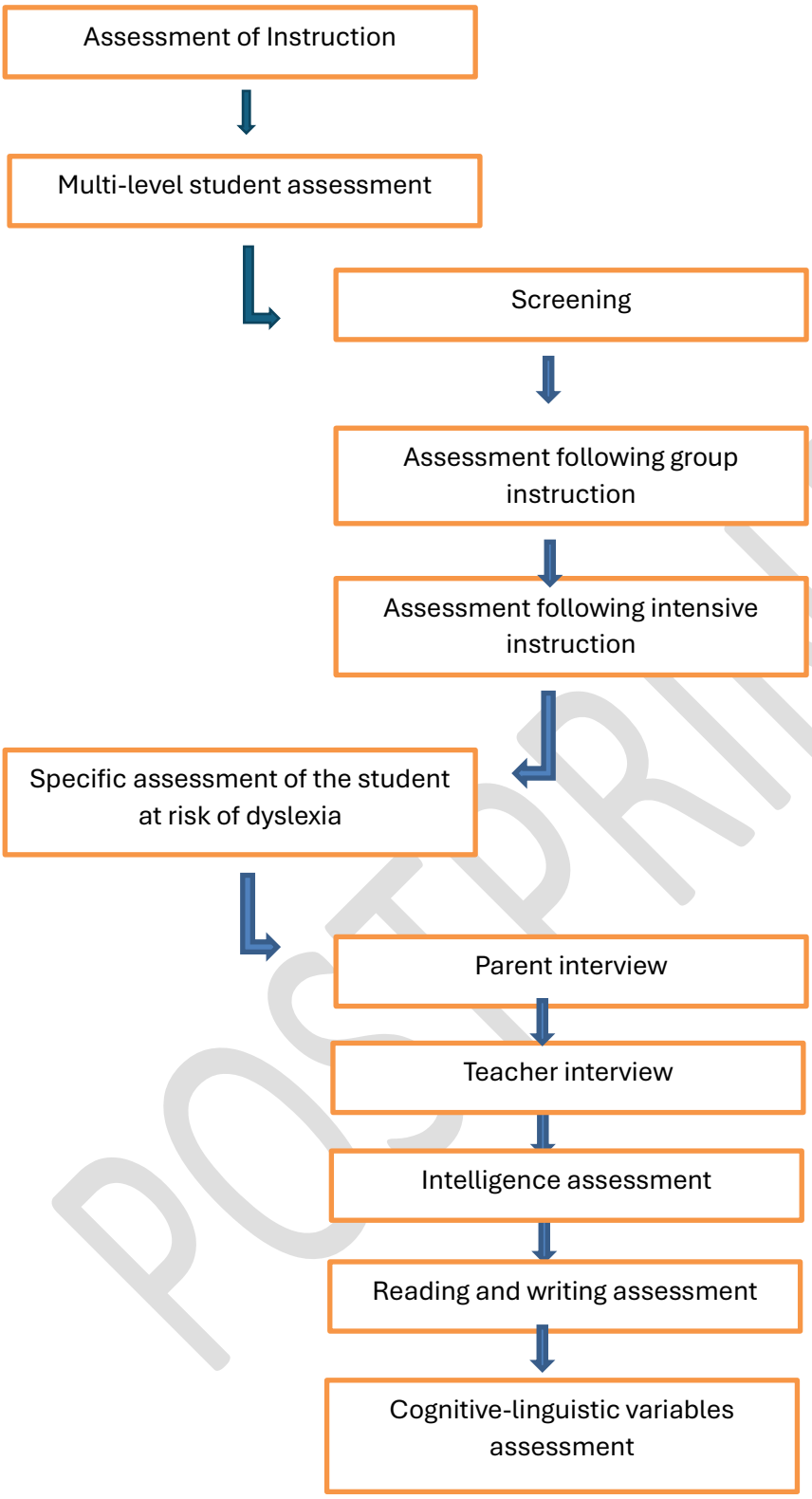


Figure 3. Graphic representation of the action protocol

1. **Stage 1. Assessment of Instruction**

    1. Inform parents that their children will be assessed, in order to analyse whether they are at risk of having dyslexia.
    2. Obtain informed consent from parents so that students can be assessed periodically.
    3. Assess the reading and writing performance, based on the curriculum (CBM), of all the students in class, following adequate reading and writing instruction in in their regular classroom[20], for two hours every day over the course of approximately six months. For the assessment of reading and writing performance based on the curriculum, use the indicators recommended by the National Reading Panel (NRP): phonological awareness, knowledge of the alphabet, vocabulary, reading fluency and comprehension[24].

        4.1. For the evaluation of these indicators, administer the test to detect dyslexia[25,26] either collectively or individually, informing participants of the instructions for performing each test.
    4. Analyse the scores obtained. If the majority of the students have achieved similar appropriate scores in the assessment, rule out the possibility of inadequate teaching.

2. **Stage 2. Multilevel assessment of student performance**

    1. **Screening. Level 1**

        1.1. After analysing the scores obtained in stage 1, identify students who are at risk of dyslexia, according to the standards established for the tests administered.

        1.2. Include students identified as being at risk in the next level.

    2. **Assessment following group instruction. Level 2**

        2.1. After any students identified as being at risk have received frequent reading and writing instruction in small groups, (30 minutes, three to five times a week, for approximately 10 sessions), evaluate their response to that instruction, either collectively or individually[24]. To perform this assessment, administer screening tests for dyslexia[25,26], which take the aforementioned indicators into account, informing the participants of the instructions to perform each test (Figure 4).

        2.2. Identify students who present a risk of dyslexia determined on the basis of low test scores, following the instruction received.

        2.3. Include the selected students in the next level.

Figure 4. Assessment of the responses of students, who have been identified as being at risk, to frequent reading and writing instruction in small groups.

3. Assessment following intensive instruction. Level 3

3.1. After students identified as being at risk have received even more frequent reading and writing instruction in smaller groups, evaluate their response to that instruction[24].

3.1.1. To perform this assessment, administer screening tests for dyslexia, collectively or individually[25,26], which take the aforementioned indicators into account, informing the participants of the instructions to perform each test (Figure 5).

3.2. Identify students who present a risk of dyslexia determined on the basis of low test scores, following the instruction received.

3.3. Include the students selected in the next level.

Figure 5. Assessment of the responses of students, who have been identified as being at risk, to more frequent reading and writing instruction in even smaller groups.

3. Stage 3. Specific student assessment

To corroborate the diagnosis of dyslexia among students identified as being at risk, carry out the following assessment protocol for each student.
NOTE: Students who do not present any intellectual disabilities or sensory-motor handicaps, but who do perform poorly in reading comprehension and fluency and written accuracy, and present problems in most of the cognitive-linguistic variables evaluated, as well as possible socio-emotional, family and/or school repercussions, shall be classed as having dyslexia.

1. Interview with parents

1.1. To begin the specific student assessment protocol, inform parents that their child needs to be evaluated extensively because they have suspected dyslexia.
1.2. Obtain informed consent from parents so that students can be assessed specifically.
1.3. Conduct a structured interview with the student's parents, in order to gather information about their child in terms of their personal development (biological, motor, sensory, social, communicative-linguistic) and the family setting (family history, family organisation, expectations about their child's difficulties, family impact of the child's difficulties).
1.3.1. In this section, the psychologist will ask the parents about their child's development, the existence of family history and

the family setting.

2. Interview with the teacher

2.1. Conduct a structured interview with the teacher, in order to find out their opinion about the problem their student might present, their personal development (motor, sensory, social, communicative-linguistic, style of learning and motivation), the classroom environment (class organisation, position of the student within the classroom, materials used by the student, the student's integration in the classroom) and their school record (schools attended, academic performance, diversity management measures received and approach to schooling).

2.1.1. In this section, the psychologist will give the teacher the following instructions: "In order to obtain information and your opinion about the student, complete this structured interview referring to the student's possible problem, their personal development, learning and motivation, their academic record and environment in the classroom".

3. Measure of Intelligence

3.1. Administer a cognitive scale[27] to assess intelligence in children, in accordance with the instructions set out in the test handbook, in order to rule out possible intellectual limitations.

3.2. Analyse the student profile obtained, in order to ascertain information about the cognitive and linguistic aspects (fluent reasoning, visual-spatial, working memory, processing speed and verbal comprehension) required to make the diagnosis and to establish the affected and unaffected cognitive-linguistic areas that would justify dyslexia and rule out other problems.

4. Measure of Reading and Writing

4.1. To measure reading fluency and comprehension, individually carry out a reading assessment[25] for children aged six.

4.1.1. In the reading fluency test, instruct the student to read a list of words and another list of pseudowords as fast as they can.

4.1.1.1. Record the number they got right and the time they took to complete each test.

4.1.1.2. Correct the answers in accordance with the correction criteria indicated in the test handbook.

4.1.2. For the reading comprehension test, instruct the student to read a text in silence and then answer questions about what they have read.

4.1.2.1. Record the answers given by the student and

correct them in accordance with the correction criteria indicated in the test handbook.

4.1.3. Analyse the student's reading profile in terms of accuracy, speed and comprehension, in accordance with the test instructions.

4.2. To assess written accuracy, carry out the copying and dictation test with the student[26], in accordance with the instructions indicated in the test handbook.

4.2.1. To carry out the copying test, instruct the student to copy out several texts by hand in a maximum of one minute.

4.2.1.1. Correct the student's answers in accordance with the correction criteria indicated in the test handbook.

4.2.2. To carry out the dictation test, instruct the student to write down by hand the words they will hear in a maximum of two minutes.

4.2.2.1. Correct the student's answers in accordance with the correction criteria indicated in the test handbook.

4.2.3. Analyse the numbers of right and wrong answers from both tests, in accordance with the correction criteria indicated in the handbook.

5. Cognitive-linguistic measures

5.1. After assessing reading and writing performance, evaluate the cognitive-linguistic variables that might explain the appearance of dyslexia[24,28-31]: phonological awareness, knowledge of the alphabet, naming speed, short-term memory, vocabulary, and phonological and semantic fluency.

5.2. To assess phonological awareness, use a phonemic segmentation test[26].

5.2.1. In this test, instruct the student to repeat words after removing a certain syllable or phoneme.

5.2.2. Write down the answers given by the student and correct them in accordance with the correction criteria indicated in the test handbook.

5.3. To assess knowledge of the alphabet, use a letter reading test [25].

5.3.1. In this test, instruct the student to say the names of the letters shown to them on printed cards.

5.3.2. Record the answers given by the student and correct them in accordance with the correction criteria indicated in the test handbook.

5.4. To assess naming speed, use a test for the student to name pictures[26].

5.4.1. In this test, instruct the student to say the name of the pictures shown on cards as quickly as possible.

5.4.2. Make a note of any errors and the time they take. Correct the test in accordance with the correction criteria indicated in the test handbook.

5.5. To assess short-term memory, use an inverse digit test[26].

5.5.1. In this test, instruct the student to repeat in reverse order the sequence of digits they will hear.

5.5.2. Write down the answers given by the student and correct them in accordance with the criteria established in the test handbook.

5.6. To assess vocabulary, carry out a vocabulary test[26]

5.6.1. Instruct the student to simply mark the drawing that represents the word given by the examiner.

5.6.2. Correct the student's answers in accordance with the criteria established in the test handbook.

5.7. To assess phonological fluency, use a verbal fluency test[26].

5.7.1. In this test, instruct the student to say in one minute all the words that begin with the sound /p/.

5.7.2. Write down the answers given by the student and correct them in accordance with the criteria established in the test handbook.

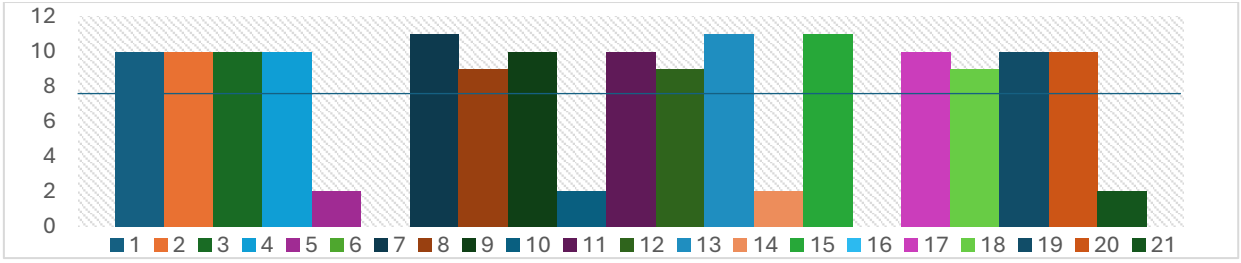
5.8. To assess semantic fluency, carry out a semantic fluency test[26] and instruct the student to say in one minute all the animal names they know.

5.8.1. Write down the answers given by the student and correct them in accordance with the criteria established in the test handbook.

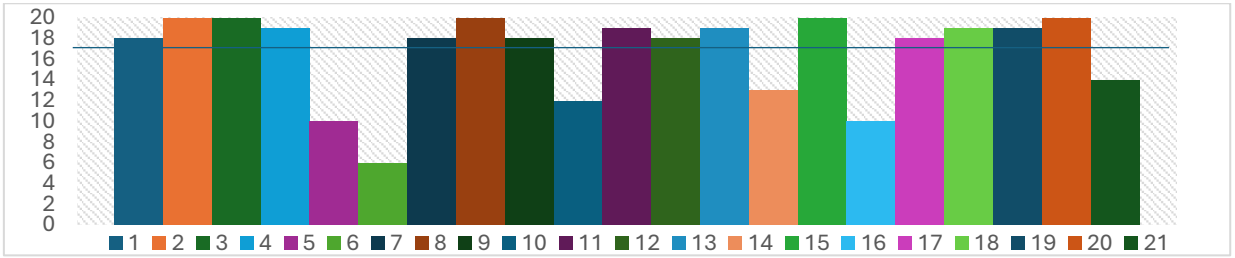
REPRESENTATIVE RESULTS

This next section sets out a series of representative results obtained by one student diagnosed with dyslexia, following the proposed action protocol.

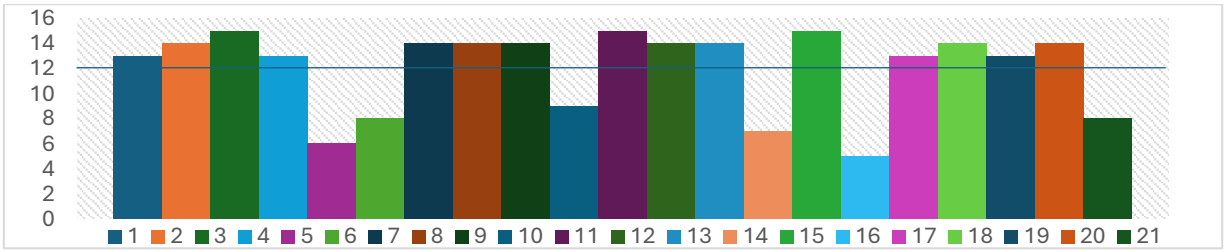
Table 1 shows the scores obtained by Year 1 Primary students in phonological awareness, knowledge of the alphabet, vocabulary, and reading fluency and comprehension, after ordinary reading and writing instruction. The results indicate that most of the students achieve similar direct scores in the assessment, close to the average achieved by the group (Figure 6). This confirms that the instruction they received is adequate. However, we also see that some students present lower scores in most of the measures (subjects 5, 6, 10, 14, 16 and 21). These students are considered to be at risk of dyslexia and receive group instruction.



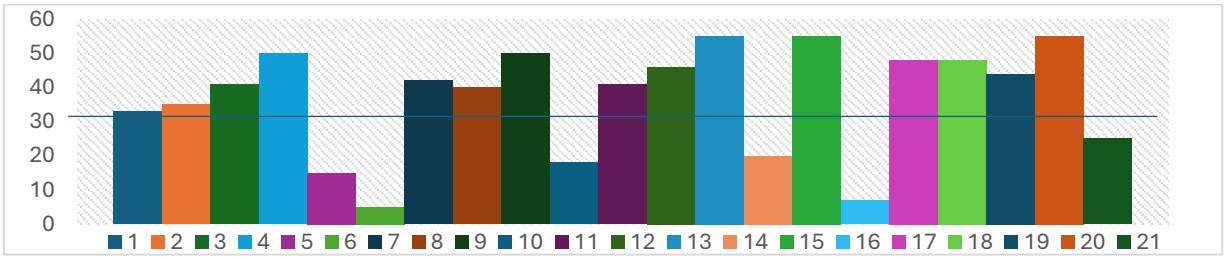
A. Phonological Awareness



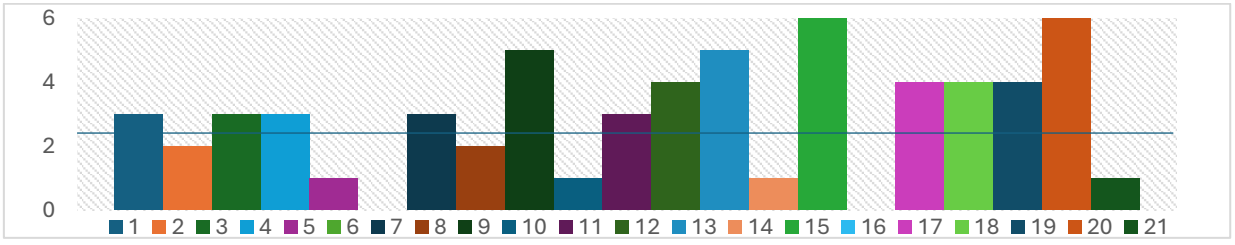
B. Knowledge of the Alphabet



C. Vocabulary



D. Reading Fluency



E. Reading Comprehension

Figure 6. Direct scores obtained by students in a classroom setting for the indicators considered, with an indication of the group average, following group intervention.

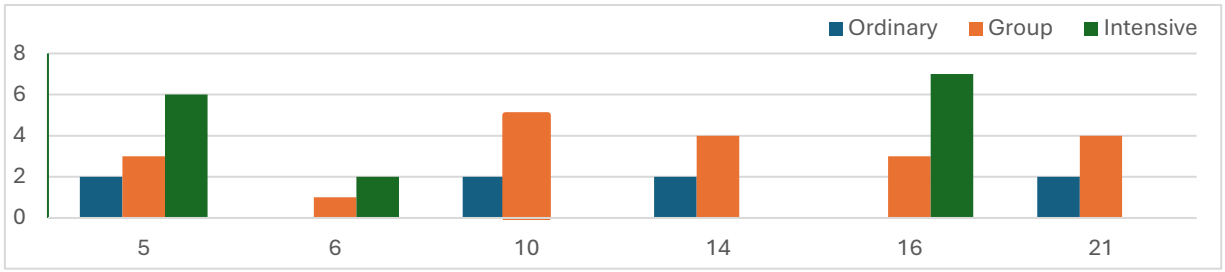
Table 1. Direct scores obtained by students in a classroom setting for the indicators considered

Subject	Pa	Ka	Vo	Rf	Rc
1	10	18	13	33	3
2	10	20	14	35	2
3	10	20	15	41	3
4	10	19	13	50	3
5	2	10	6	10	0
6	0	6	8	5	0
7	11	18	14	42	3
8	9	20	14	40	2
9	10	18	14	50	5
10	2	12	9	15	1
11	10	19	15	41	3
12	9	18	14	46	4
13	11	19	14	55	5
14	2	13	7	14	1
15	11	20	15	55	6
16	0	10	5	7	0
17	10	18	13	48	4
18	9	19	14	48	4
19	10	19	13	44	4
20	10	20	14	55	6
21	2	14	8	16	1

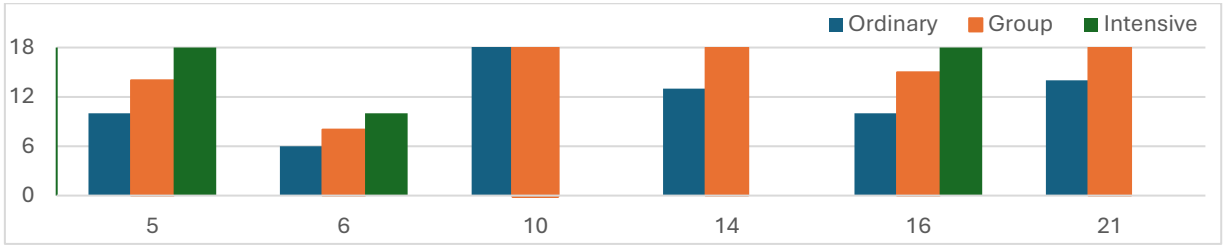
Note: PA= Phonological awareness (P_{max} =12); KA = knowledge of the alphabet (P_{max} = 20); Vo = Vocabulary (P_{max} = 16); RF = Reading Fluency (P_{max} = 88); RC = reading comprehension (P_{max} = 16)

Table 2 shows that, after these students have received frequent adequate reading and writing instruction in small groups (intervention group), some of the students continue to obtain low scores in most of the variables evaluated (phonological awareness, knowledge of the alphabet, vocabulary, and reading fluency and comprehension) (Students 5, 6 and 16) whereas others have improved on their previous scores (students 10, 14 and 21) (Figure 7). These students are not considered to be at risk of having dyslexia and go back to receiving regular instruction only, whereas the others are considered to be at risk and will receive intensive instruction (students 5, 6 and 16). The table also shows that, after more frequent instruction in smaller groups (intensive intervention), one of the students selected above still achieves low scores (student 6), whereas the others improve their scores (students 5 and 16). The student who continues to achieve low scores is considered to be at risk of having dyslexia, whereas the ones who have improved their scores are not.

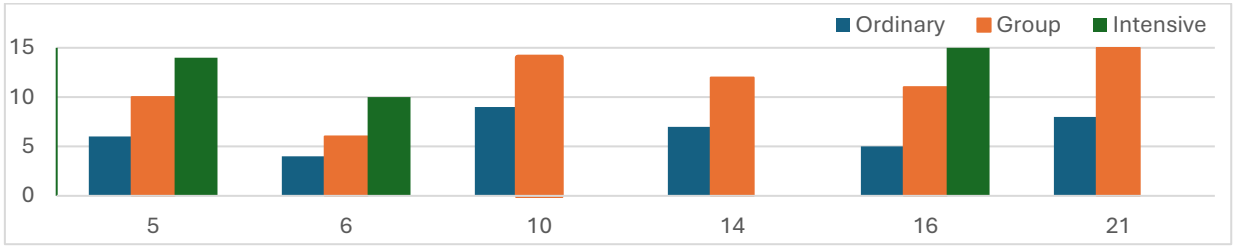
These data confirm that the Response to Intervention model facilitates the detection of dyslexia in children.



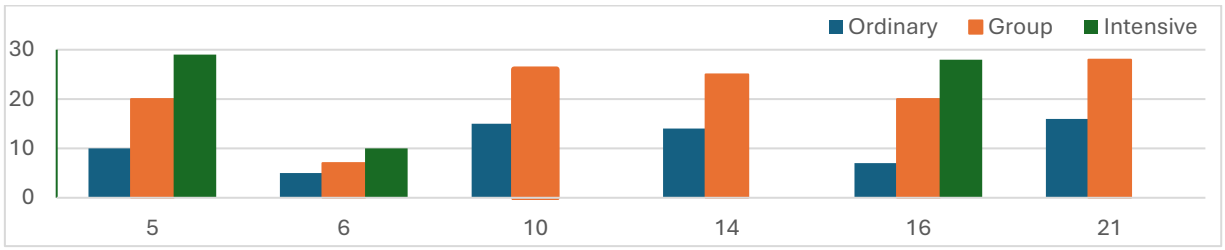
A. Phonological Awareness



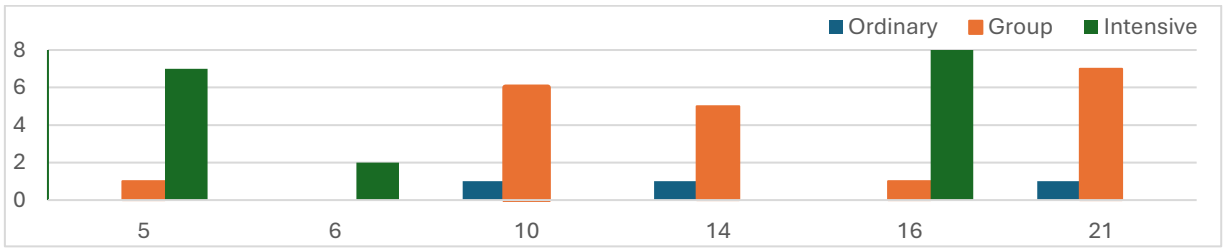
B. Knowledge of the Alphabet



C. Vocabulary



D. Reading Fluency



E. Reading Comprehension

Figure 7. Direct scores gained by subjects at risk of dyslexia in the selected indicators, following different types of instruction.

Table 2. Direct scores obtained for the indicators considered by the selected students who are at risk of dyslexia, following different types of instruction.

Subject	Ordinary Instruction					Group Instruction					Intensive Instruction				
	Pa	Ka	Vo	RF	RC	Pa	Ka	Vo	Rf	Rc	Pa	Ka	Vo	Rf	Rc
5	2	10	6	10	0	3	14	10	20	1	6	18	14	29	7
6	0	6	4	5	0	1	8	6	7	0	2	10	10	10	2
10	2	12	9	15	1	5	17	14	26	6					
14	2	13	7	14	1	4	18	12	25	5					
16	0	10	5	7	0	3	15	11	20	1	7	19	15	28	8
21	2	14	8	16	1	4	18	15	28	7					

Note: PA= Phonological awareness (P_{max} =12); KA = knowledge of the alphabet (P_{max} = 20); Vo = Vocabulary (P_{max} = 16); RF = Reading Fluency (P_{max} = 88); RC = reading comprehension (P_{max} = 16)

Below are the results of the specific assessment of student 6, selected as being at risk of dyslexia following the different types of intervention received, in order to corroborate the diagnosis of dyslexia.

After the parents signed the informed consent, they reported that their daughter did not present any physical, sensory or motor problems. They stated that she had a lingual frenectomy and received speech therapy, due to her difficulties with language and speech. There is no similar family history. The family acknowledged their daughter's situation and was collaborative and interested. These data indicate that the student might present a problem of dyslexia, ruling out other problems, in accordance with the criteria of specificity and exclusion.

Following the interview with the teacher, it was clear that she recognises the student's problems with oral and written language, that the student respects school rules and norms, that she recognises her limitations, that she feels comfortable in class, that she needs constant reinforcement, that she works slowly if not stimulated, that she needs some of the materials to be adapted, that she feels close to the teacher, and that she previously attended another school, where she received speech therapy sessions. These data indicate that the student might present a problem of dyslexia, and other problems can be ruled out, in accordance with the criteria of specificity and exclusion.

After assessing her level of intelligence using a cognitive scale[27], we found that the student did not present any intellectual disabilities, with a GAI score of 103. In the scales measuring Verbal comprehension, Perceptual reasoning, Working memory and Processing speed, the score achieved was above 85, which confirms that her intellectual capacity is adequate, thus confirming that she might have dyslexia.

The results obtained in the assessment of reading processes[25] indicate that the student presents difficulties in reading fluency. This is shown by the scores obtained in Accuracy and Speed of reading words and pseudowords (PC=5, respectively), which is below the normal range, in accordance with the correction instructions in the handbook. This student also presented a low score in the Text

comprehension test (PC=5). Furthermore, the results of the Copying and Dictation evaluation in the test to detect dyslexia[26] indicate that the student presents difficulties in writing (PC=10 and 5, respectively), in accordance with the test criteria. These results show that the girl has dyslexia, since she does not present any intellectual disabilities, but does have difficulties with reading and writing performance (discrepancy and specificity criteria), scoring below the 50th percentile in the reading and writing tests.

With regard to the possible factors that could explain her dyslexia, the results indicate that the student presents difficulties in the Knowledge of Letters test[25] (PC=3), in accordance with the scoring criteria set out in the handbook. In addition, according to the dyslexia detection test used[26], the student presents low scores for Phonological awareness (PC=5), Naming speed (PC=2), Short-term memory and Phonological fluency (PC=1 and PC=2, respectively). She also presents difficulties in Semantic Fluency and Vocabulary (PC=2 and PC=4, respectively). These results confirm the existence of a diagnosis of dyslexia, due to the difficulties she presents in phonological processing, and as a result of reading comprehension problems, since she scores below the 50th percentile in the evaluation of the factors considered.

In conclusion, following adequate instruction in reading and writing in the regular classroom setting, group settings and intensively, we found that one of the students presented low scores in reading and writing, thus displaying a risk of dyslexia. According to data compiled from parents and her teacher, the student might present dyslexia, since possible sensory, intellectual and/or socio-emotional problems that could justify her reading and writing problems have been ruled out, and she displays problems in terms of her oral language and a need for education support. This information is verified after the specific evaluation conducted, wherein no intellectual difficulties were observed, but difficulties in reading and writing were detected, associated with phonological processing (knowledge of the alphabet, phonological knowledge, naming speed, short-term memory, phonological fluency), which leads to reading comprehension problems (semantic fluency, vocabulary). These results would confirm a diagnosis of dyslexia, based on the response to intervention model and the diagnostic model.

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DISCLOSURES

The authors have nothing to disclose

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